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Flavor Added: The Sciences Of Flavor And The Industrialization Of Taste In America

Nadia Berenstein

University of Pennsylvania, nadia.aymone@gmail.com

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Flavor Added: The Sciences Of Flavor And The Industrialization Of Taste In America

Abstract

In the mid-nineteenth century, flavor additives - volatile organic chemicals with desirable aromatic qualities - began to be used to flavor sugary confections, carbonated beverages, and other mass-marketed delights. By the mid-twentieth century, added flavors had become ubiquitous in processed, packaged foods; a sophisticated, technoscientific, and globe-spanning industry had emerged that specialized in their production. Drawing on history of science and technology, business history, and cultural history, "Flavor Added" investigates the history of synthetic flavor additives, the systems of scientific and technical knowledge that emerged to create these substances, and their social and cultural consequences. Focusing primarily on the United States, "Flavor Added" traces the origins and development of both flavor chemistry and sensory science, illuminating their entangled roots in private industry, regulatory laboratories, USDA research experiment stations, the US military, and academic institutions. Several chapters take on the technologies and tools of flavor creation, including the taste panel, the flavor profile, and the combined gas chromatograph-mass spectrometer. This dissertation also documents the professional history of flavorists, the highly specialized scientific craft-workers who develop and design flavor additives.

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FLAVOR ADDED: THE SCIENCES OF FLAVOR AND THE INDUSTRIALIZATION OF TASTE IN
AMERICA

Nadia Berenstein

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Supervisor of Dissertation

John Tresch

Associate Professor, History and Sociology of Science, University of Pennsylvania

Graduate Group Chairperson

Beth Linker

Associate Professor, History and Sociology of Science, University of Pennsylvania

Dissertation Committee

John Tresch, Associate Professor, History and Sociology of Science, University of Pennsylvania

Adelheid Voskuhl, Associate Professor, History and Sociology of Science, University of
Pennsylvania

Steven Shapin, Franklin L. Ford Research Professor in the History of Science, Harvard University

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NADIA BERENSTEIN

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ACKNOWLEDGMENTS

While I was in the thick of writing this thing, I'll admit I was pretty miserable. How does anyone do this? I was desperate for clues. I developed the habit of closely reading the acknowledgements sections of other dissertations, hoping that somehow in the gratitude-chains and the naming-names, the alchemical formula, the one weird trick for a done dissertation, would rise shimmering and present itself to me.

So my first acknowledgment here is to you, reader, and to those among you who approach the thankless task of reading a turgid, tumultuous dissertation through the rockiest of roads, the acknowledgements section, and especially to graduate students or other thinkers, writers, artists who are puzzling over not only a particular set of questions relating to flavor and its role in our sensual lives, but also, perhaps, struggling with how to write about this, or anything, at all.

Ultimately, I don't really know how it happened, getting to the end. The whole thing was a mess, a disaster, pages and pages of unmoored maunderings. "There's no train of thought here," I kept saying to myself, scrolling through the damage on Microsoft Word. I had worked so long, done so much research, so many people had trusted me with their stories, I cared so much about "my" subject — but all you could see was the sweat-stains and the tear-stains and the ugly residues of exertion, none of the love. It was a wreck, and so was I. It was August, or maybe it was December, or maybe it was March. What did seasons matter? Each day was indistinguishable from the one previous or the one succeeding, a dismal blur of pixels; nothing felt like progress.

The secret to writing is not writing. Or maybe the secret to writing is writing every day. Or maybe the secret to writing is... there's no secret. The only thing is to follow what interests you. One day, after many many many revisions, the stories started to come together, slough off their excesses and excrescences, and began to explain themselves to me.

All genuine scholarship is fundamentally, irreducibly collaborative, a dialogue with historical sources, with other scholars (whether credentialed or not), with colleagues, with friends. But this kind of production also arises from contingent conditions, life circumstances — don't forget, ignore, or evade yourself when writing. Idea-seeds cultivated in this dissertation were sown in casual conversations with strangers in the supermarket; during random TV-watching binges during anxiety meltdowns (food advertising is wonderfully suggestive); walking around with a tiny dog at the end of a leash; asleep at night, in bed. Life spat, sputtered, spattered, *always bursting with flavor*, and I was there to be splashed in its spray. It took me a while to realize that this was also what I should be registering, recording, and responding to. The conditions of writing are usually strenuously isolating, and systems of academic reputation-making generally reward the “individual talent,” the fantasy of the dissertation-producing brain in the vat. But don't forget this, readers/toilers in need of uplift, comfort, consolation! Move away from the laptop, open the window, talk to other people, talk to me, let yourself wander. I don't know whether this will seem obvious to almost everyone, but it was something that I kept forgetting.

This project began with curiosity and coincidence. In my second year of graduate school, I was in Ruth Schwartz Cowan’s history of technology seminar, and I had to come up with an idea for a paper. I lit upon a phenomenon I had recently observed. Why do concord grapes, the deep purply grapes you can find more easily at east coast farmer’s markets than at grocery stores, taste so much like grape jolly ranchers, fake grape? If one considered grape flavor as a technology, a technology that emerged at a specific historical moment and under particular material and social conditions, could it perhaps illuminate this apparent slippage between the uber-fake and the ultra-authentic?

I wondered if I could find an answer to that question at Monell Chemical Senses Center, a low-slung brick building on Market Street, fronted by an extremely compelling work of public art — “Face Fragment,” a 1975 sculpture by Arlene Love that featured giant gilded lips and a giant gilded schnoz. Every day on my way to campus, I would walk right past this gleaming mouth and nose, and mull over that unfamiliar, alluring, term: “chemical senses.”

It turned out that Monell — an active research institution — housed, within its warren of laboratories, the library of the Society of Flavor Chemists, a collection of such strangeness, richness, and untapped splendor that it inspired this whole crazy journey. Dani Reed, at Monell, was instrumental in making this resource available to me, and encouraging me to drink deeply. This project also would never have been completed without the generous, gracious support and encouragement of Alfred Goossens, of the Society of Flavor Chemists. Many of the readers of this dissertation will not know Alfred, so allow me to sketch a portrait for you. He is unfailingly elegant or even courtly – he

always wears the most gorgeous suits — and speaks English with a soft Dutch accent. A retired flavor chemist with a long and distinguished career at Naardens, Alfred was unstintingly generous with his knowledge, his expertise, his time. He was always ready to answer my questions, or introduce me to fascinating people in the flavor world. I owe him so much.

This work was supported by Chemical Heritage Foundation, where I spent a marvelous and productive year as a Beckman Fellow. My fellow dissertation fellows, Tim Johnson, Edward Driggers, Britt Dahlberg, and Dan Liu, were incredible colleagues and friends. Dan, in particular, deserves credit for helping me uncrumple some of my much-crumpled ideas, detangle the skeins of thought, and also for sharing the bounty of his incredible culinary skills. The staff of scholars, archivists, and librarians at CHF are nonpareil, and I'd like to thank in particular: Andy Mangavite, Carin Berkowitz, and Ronald Brashear. I also am incredibly grateful to the archival staff at the Hagley Museum and Library (a great source for all kinds of food technology and food additive-related treasures, and much more); the Smithsonian's invaluable trade literature collection, at the National Museum of American History; the somewhat surly but extremely knowledgeable librarians at the National Archives in College Park, keepers of the bureaucratic detritus of governance that holds so many of our nation's stories; the fabulous librarians at UC Davis's special collections library, who helped me grind through the unique and irreplaceable material in the A.W. Noling Beverage Literature Collection, during one intense summer week of research; and the staff at the MIT

Institute Special Collections, who guided me through the Arthur D. Little files, and pointed me to the Emily Wick papers.

I had the good fortune to fall in with a congenial multidisciplinary bunch of “early career” scholars, who were, like me, investigating questions about the technosciences of the senses, sensory knowledge, and pleasure — the things that sometimes get bundled together under the term “sciences of subjectivity.” Jake Lahne, who combines an actual food science background with philosophical aplomb; he and his partner Kieran Hutchinson are also marvelous people to enjoy food, spirits, and board games with. Ella Butler, canny anthropological observer. Sarah Tracy, blazingly brilliant. Ana Ulloa, whose fearlessness I hope to emulate. Christy Spackman, whose provocative questions often led me to realize the parts of my work that had grown stale. I also want to thank Ai Hisano, whose work on synthetic color in foods parallels my own story, and whose inspired insights into the ambivalent appeal of the synthetically enhanced influenced my own.

Sometimes during this, I would think, in despair. “The life of the mind! The life of the mind is no life at all!” My advisor John Tresch, with his patience, enthusiasm, and ecumenical intellect, reminded me — through his example and through his sage advice — that thinking, writing, doing, can be lively and electric and rigorous, at once. My other committee members, Heidi Voskuhl and Stephen Shapin, also provided intellectual and scholarly support and nurturance for this project.

I'm indebted to many other scholars, who shaped this work by offering productive critiques, encouragement, or other forms of intellectual nourishment: Ruth Schwartz Cowan, Lissa Roberts, Dan Raff, Roger Horowitz. Robbie Aronowitz, Regina Blaszczyk, Rachel Laudan, and Harold McGee.

Finishing (or even conceiving of) this dissertation would not have happened without my fellow grad students at Penn. My cohort, Eram Alam and Rosanna Dent, possibly the two kindest people I've ever met. Their compassion illuminates their fiercely brilliant and important scholarship. (And Jen Goldsack, who left our cohort after year two to accomplish exciting things in real life.) L. Ruth Rand, sassy empath, aviatrix, brilliant human. Deanna Day, with her intellectual courage, scrupulous honesty, and sparkling wit. Peter Collopy, whose sense of justice was a guiding light for me. Samantha Muka, who somehow combines no nonsense with maximum fun. Marissa Mika, thoughtful and generous. Elaine LaFay, a good spirit. Mary X. Mitchell, I learned so much from her boldness. Whitney Laemmler, tough as nails. Kate Dorscht, always asking amazing questions.

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I can write. Nicky Twilley, a brilliant writer, whose enthusiasm for food and flavor helped me reignite some of the embers here. Bojack Horseman also really came through for me during a tough time.

Bela Shayevich. Bela deserves her own paragraph just for the sheer quantity of my bellyaching that she had to sit through. Bela is a freethinker, an artist, and I have learned so much from her, including the virtue (necessity?) of feeling what you are writing.

Joanna Radin, my north star and kindred spirit. Joanna was on her way out of Penn as I was shimmying in, and I consider it one of the luckiest breaks in my life for our paths to have crossed.

My partner in life, for better and for worse, Robbie Lee. Robbie never stopped believing in me, even when I out ringed cowbells, gathering rosebuds, and calling it quits. Thank you, Robbie, for being a friend.

And my family, the rooms of the heart where I was first fed. My tia Mabel. My grandmother, Haydee DeJean Garcia. And of course, my mom and my dad, Elsa and Carlos Berenstein, without whom none of this would have been possible.

ABSTRACT

FLAVOR ADDED: THE SCIENCES OF FLAVOR AND THE INDUSTRIALIZATION OF TASTE IN

AMERICA

NADIA BERENSTEIN

JOHN TRESCH

In the mid-nineteenth century, flavor additives — volatile organic chemicals with desirable aromatic qualities — began to be used to flavor sugary confections, carbonated beverages, and other mass-marketed delights. By the mid-twentieth century, added flavors had become ubiquitous in processed, packaged foods; a sophisticated, technoscientific, and globe-spanning industry had emerged that specialized in their production. Drawing on history of science and technology, business history, and cultural history, “Flavor Added” investigates the history of synthetic flavor additives, the systems of scientific and technical knowledge that emerged to create these substances, and their social and cultural consequences. Focusing primarily on the United States, “Flavor Added” traces the origins and development of both flavor chemistry and sensory science, illuminating their entangled roots in private industry, regulatory laboratories, USDA research experiment stations, the US military, and academic institutions. Several chapters take on the technologies and tools of flavor creation, including the taste panel, the flavor profile, and the combined gas chromatograph-mass spectrometer. This dissertation also documents the professional history of flavorists, the highly specialized scientific craft-workers who develop and design flavor additives.

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INTRODUCTION:

WELCOME TO A NEW WORLD OF FLAVOR

“There are still luxury foods, like caviar and guinea hen,” remarks a food manufacturer in Lucy Kavalier’s 1963 book, *The Artificial World Around Us*, “but there are no longer any luxury flavors.”¹

Kavalier’s book, a work of popular science written for young adults, describes the contours of a postwar world remade by synthetic chemistry. “We are living in an age of chemicals,” she announces in the first chapter (“What Men Are Doing to Things”), an age of both better things and better living, where the necessities of daily life, as well as its pleasures and comforts, are made possible by the chemical laboratory.

Kavalier’s unnamed food manufacturer celebrates one of these signal achievements: the synthetic production of the complex chemical mixtures that replicated flavor — the essential experience of a food — and made that experience, and its associated pleasures, widely available. Although his proclamation was a bit of an overstatement — plenty of flavors cannot be effectively duplicated — the kernel of his meaning remains. Even if some products remained the rarefied tidbits of the elite, the essential experiences of sensory pleasure were available, and at a price that anyone could afford. The unnamed food manufacturer paints a picture of a postwar abundance in which

¹ Lucy Kavalier, *The Artificial World Around Us*, (New York: John Day Company, 1963): 61.

class divisions persist, although drawn along different lines. When everyone (allegedly) has enough, the distinction between haves and the have-nots transforms into a division between those who can feast on the real and those who must satisfy themselves with the synthetic.

Why is the history of synthetic flavors worth telling? Understanding the advent of synthetic flavors, the workers who devise them, and the technosocial networks in which they were produced, used, valued, and consumed not only enhances our understanding of the history of industrial food and the chemical industry in the United States, but also elucidates the role of the senses and of sensory knowledge in technical and chemical practice and in consumer culture. Further, flavor additives have shaped cultural, social, and legal notions about what is natural and what is not, and playing a leading role in debates about the perils or promises of science and technology in modernity.

Flavor, as those who sought to study it scientifically inevitably discovered, was a scientific object whose contours and modes of research were underdetermined and changing. Flavor research occurs in two distinct but inextricably intertwined fields — chemistry and sensory science—a mixed discipline that draws on physiology, psychology, among other fields. The subject has implications for our understanding of the relationship between the human sciences and "hard" sciences, as well as the position of the senses in scientific knowledge more generally.

The individuals who designed and developed flavor additives at flavor companies— flavorists and their occupational forebears—are not the only people who

worked with flavors who appear in this history. A constellation of chemists, food scientists, home economists, psychologists, sensory scientists, and engineers make up the professional network of flavor science. Flavor science takes place not only in corporate laboratories and industrial factories, but also in USDA regional research centers, regulatory testing laboratories, military research installations, and academic labs. The multidisciplinary nature of this network can be attributed to the complexity of flavor itself. Integral to, and woven within, these narratives about professionals and scientific experts are the sensate bodies of consumers, whose experiences, behaviors, and appetites were studied, measured, and refashioned, in a world of consumer goods whose sensory qualities were increasingly designed in accordance with the technoscientific practices described here.

I take synthetic flavors on their own terms as new things that also had to make a case for themselves by demonstrating their utility and value. Synthetic flavorings were not “invented” to satisfy some pre-existing need, nor can they be explained simply as substitutes or imitations of other, scarcer or more expensive, things.² Flavor additives emerged from a world whose material, economic, social, and cultural substrate was rapidly being reorganized by science, technology, and global market forces, and they found a place in a mass consumer economy whose contours, dynamics, technics, and meanings were in the process of formation.

This work can be considered historical ontology of added flavor, surveying the attempts of a heterogeneous group of scientific and technical workers to define its

² An apposite comparison could be drawn with the early history of plastics.

material and phenomenological boundaries, to develop a standard set of terms, tools, and methods to investigate its constituents, causes, and effects, and to apply technoscientific knowledge toward the production, reproduction, and control of flavor.

But what should be included in a study science of flavor, and what should be excluded? How should the lines be drawn? What, exactly, are flavors?

FLAVORS ARE CHEMICALS

Many substances used throughout history, and around the world, can be described as ‘flavor additives’: spices and essential oils, sugar, salt. These materials were considered to have medicinal as well as gustatory virtues, and could serve other functions, such as food preservation.³ The preparation of, and trade in, flavoring substances (and related perfumery materials) required special technologies, skills, and expertise, and involved practices which could be considered alchemical or proto-chemical: distillation, fermentation, extraction, as well as sensory and chemical methods to determine purity or detect adulteration.⁴ Indeed, corporate histories of companies in the flavor and fragrance industry frequently begin with a nod toward the spice trade, gilding their ultra-modern chemical business with the radiance of more heroic ages.

³ Paul Freedman, *Out of the East: Spices and the Medieval Imagination*, (New Haven: Yale UP, 2008); Wolfgang Schivelbusch, *Tastes of Paradise: A Social History of Spices, Stimulants, and Intoxicants*, trans. David Jacobson, (New York: Vintage, 1993).

⁴ The alchemical heritage is more extensively plumbed in the history of perfumes and perfumery than in spices and seasonings. See, for instance, Mandy Aftel, *Essence and Alchemy: A History of Perfume*, (New York: North Point Press, 2001). For commentary regarding why the modern perfume industry chooses to invoke a pre-Enlightenment heritage, see Maksym Klymentiev, “Creating Spices for the Mind: The Origins of Modern Western Perfumery,” *Senses & Society* 9.2 (2014): 212-31.

Throughout this work, I use the term “synthetic flavor” rather than the more familiar (to us) “artificial flavor.” “Artificial flavor” is, in ordinary speech, largely construed in contradistinction with “natural flavor.” Both of these terms have specific—though largely mysterious to everyday consumers—regulatory definitions in the U.S. Federal Code that determine whether and how they are listed on food labels. But both so-called natural and artificial flavors are artefactual — deliberately designed, produced, and added, for specific purposes, to manufactured foods.

My use of the term “synthetic flavor” also deliberately signals a historiographical rupture from stories that run smoothly from the antique spice trade to the modern manufacture of exquisitely engineered flavoring compounds. Specifically, I situate the roots of my narrative within a particular context in the history of chemistry — the emergence of organic chemistry and the development of a chemical industry based on chemical synthesis in the mid-nineteenth century. These associated events are both bound up with industrialization, which provided the carboniferous raw material for synthetic chemical processes, the commercial rationale for increasing technical and scientific control over those processes, and the social, technological, and economic bonds connecting the chemical laboratory to the factory and the consumer economy.⁵

⁵ The history of modern chemistry wrestles with two narrative arcs: chemists' quest for a distinctive chemical theory, and the continuing importance of artisanal and empirical processes of investigation in chemical research. The role of sensory knowledge in this drama is an unresolved question in the history of chemistry. See for instance, Catherine M. Jackson, “Synthetical Experiments and Alkaloid Analogues: Liebig, Hoffman, and the Origins of Organic Synthesis,” *Historical Studies of the Natural Sciences* 44.4 (2014): 319-63; Mary Jo Nye, *From Chemical Philosophy to Theoretical Chemistry: Dynamics of Matter and Dynamics of Disciplines, 1800-1950*, (Berkeley: University of California

As the material world came to be regarded as a thing whose basic composition, contours, and qualities could be manipulated by chemical processes and techniques, flavor was only one part of the world that began to be considered in chemical terms.⁶ Yet flavor presented unique challenges to those who wished to understand it, analytically, as a chemical phenomenon. The chemical constituents of flavor in foods are scarce, fleeting, labile, and promiscuous — present in minute quantities, highly volatile, generally unstable, and tending to intermingle and react with other compounds in food or packaging. For much of the period covered by this dissertation, analytic knowledge of the chemical constituents of flavors in foods was hard-won and uncertain. But the path from chemical to flavor did not exclusively (or even primarily) run through chemical analysis.

Press, 1993); Bernadette Bensaude-Vincent and Isabelle Stengers, *A History of Chemistry*, trans. Deborah van Dam, (Cambridge: Harvard UP, 1996); and especially Lissa Roberts, "Death of the Sensuous Chemist: The 'New' Chemistry and the Transformation of Sensuous Technology," *Studies in the History and Philosophy of Science* 26, no 4 (1995): 503-529. The disciplinary process of subordinating the discerning body to the quantifying procedures of experimental machines that Roberts finds to be characteristic of chemistry after Lavoisier may be complicated by modes of organic chemistry, including flavor chemistry, which uses the senses to constitute its subject.

⁶ Historians and sociologists of science have explored the emergence of chemical synthesis in the nineteenth century, uncovering the contested circumstances under which atoms and molecules, once theoretical objects, gained material reality, and documenting how this new disciplinary paradigm was brought into alignment with the systems and processes of industrial production. In particular, scholars have described the ways in which ideas, ideologies, and social relations are embedded in the material cultures and experimental practices of chemistry. See Christoph Meinel, "Molecules and Croquet Balls," in Soraya de Chadarevian and Nick Hopwood, eds, *Models: The Third Dimension of Science*, (Stanford: Stanford UP, 2004): 242-275; Ursula Klein, "Technoscience Avant la Lettre," *Perspectives on Science* 13.2 (2005): 226-66; Klein, *Experiments, Models, Paper Tools: Cultures of Organic Chemistry in the Nineteenth Century*, (Chicago: UChicago, 2003); Alan J. Rocke, *Image and Reality: Kekule, Kopp, and the Scientific Imagination*, (Chicago: UChicago, 2010); and David M. Knight and Helge Kragh, eds. *The Making of the Chemist: A Social History of Chemistry in Europe, 1789-1914*, (Cambridge: Cambridge UP, 1998.)

A chemical could also become a “flavor chemical” as a result of its sensory qualities, independent of any experimental confirmation of its presence in foods.

Recognizing the extreme technical difficulty of producing chemical knowledge about the molecular constituents of flavor, and of applying physicochemical methods to the task of controlling, stabilizing, and standardizing the flavor of foods, is necessary context for understanding the development of flavor chemistry as a commercial enterprise and a scientific field. Chemical knowledge about flavor and flavor additives themselves are both laboriously manufactured. In this way, this project draws deeply from a venerable and vital spring in history of science and technology that has shown scientific knowledge, including the standard objects of chemistry, to be the outcome of coordinated social and technological processes, rather than prior natural givens.⁷

Flavor is not just an object of chemical inquiry, but also a product of chemical industry.⁸ Classic studies of the chemical industry have focused on large, vertically

⁷ In particular, David Singerman’s work on how sugar became sucrose. David Roth Singerman, “Inventing Purity in the Atlantic Sugar World, 1860-1930,”(PhD diss, Massachusetts Institute of Technology, 2014).

⁸ To my knowledge, there have been no extended scholarly studies on the history of the flavor manufacturing, and, as a result, the industry retains a reputation for extreme “secrecy” that it has (deliberately) not done much to dispel. Much of the published secondary literature on the subject is internalist, produced by workers in the industry or published under the banner of corporate histories or trade organizations (which is not to impugn its validity or reliability, as some of these studies have proven to be extremely valuable resources, but simply to note the implied absence of a critical distance toward their subject, and their often limited scope), or journalism, which has, generally, investigated and “exposed” the ways of the flavor industry in the context of broader critiques of industrial foods. Among internalist histories: Wayne E. Dorland and James A. Rogers, Jr. monograph remains a useful source for company histories, historical production processes and equipment, glossaries of materials, and related organizations. See: Dorland and Rogers, *The Fragrance and Flavor Industry*, (Mendham, NJ: Wayne E.

integrated corporations, such as DuPont in the United States.⁹ Historians and sociologists of science have examined the organization and administration of research and development programs in large companies, the paths by which scientific discoveries were translated into commercial products, as well as the linkages between industry, academy, and state.¹⁰ Following Alfred Chandler's framework, which linked the establishment of industrial research and development to structures of managerial capitalism, business scholars have scrutinized the means by which the chemical industry achieved scale and scope in its operations.¹¹

Dorland Co., 1977). The centennial volume published by the Flavor and Extract Manufacturer's Association (FEMA) is fantastically illustrated with photographs and documents and stuffed with historical anecdotes about the political, economic, and technological incidents that shaped the industry (I remain hopeful that I will one day be permitted to view their archival records): Flavor and Extract Manufacturers Association, *FEMA 100: A Century of Great Taste*, (Washington, D.C.: FEMA, 2009). Useful historical studies can be found in trade journals relevant to the flavor and fragrance industries. See, for instance: "50 Years of Service by Van Dyk & Co.," *American Perfumer and Essential Oil Review* 63 (June 1954): 453-5; Paul Z. Bedoukian, "The Perfumery Aromatics Industry in the United States, Parts I-III" *American Perfumer and Aromatics* (November 1957): 33-6, (December 1957): 31-5, (January 1958): 43-50; Gabriel Sink, "A Tribute to the Oldest American Flavor and Fragrance House," *Perfumer and Flavorist* 17 (January/February 1992): 37-9. For journalistic accounts: Raffi Khatchadourian, "The Taste Makers," *The New Yorker* (November 23, 2009): 129-35; Eric Schlosser, *Fast Food Nation: The Dark Side of the All-American Meal*, (New York: Perennial, 2002); and Michael Moss, *Salt, Sugar, Fat: How the Food Giants Hooked Us*, (New York: Random House, 2013).

⁹ David A. Hounshell and John Kenly Smith, *Science and Corporate Strategy: DuPont R&D, 1902-1980*, (Cambridge: Cambridge UP, 1988).

¹⁰ The scholarship on the emergence, evolution, and structure of industrial R&D is vast. Notable titles include: Pap Ndiaye, *Nylon and Bombs: DuPont and the March of Modern America*, trans. Elborg Forster, (Baltimore: JHU Press, 2007); David A. Hounshell, "The Evolution of Industrial research in the United States," In R. Rosenbloom and W. Spencer (Eds.), *Engines of innovation: U.S. industrial research at the end of an era*, (Boston: Harvard Business School Press, 1996).

¹¹ Alfred D. Chandler, *Scale and Scope: The Dynamics of Industrial Capitalism*, (Cambridge: Belknap, 1990) and *Shaping the Industrial Century: The Remarkable Story*

This work focuses instead on the small-scale manufacture of chemical specialties designed to preserve and achieve desired sensory qualities at mass-scale, with significant impact on the much larger industries that relied on its products—food and beverages, as well as pharmaceuticals, tobacco products, and animal feeds.¹² While most scholars have focused on the growth of the American chemical industry after the First World War, this study begins in the nineteenth century, tracing the roots of the highly specialized American flavor and fragrance industry to a heterogeneous network of chemical producers and brokers: pharmacists, distillers, confectioners, essential oil importers, and other “practical chemists” who made or sold these goods as part of more diversified businesses.¹³ Further, while much secondary literature on the flavor industry fails to

of the Evolution of the Modern Chemical and Pharmaceutical Industries, (Cambridge: Harvard UP, 2005).

¹² On this point, this project owes a debt to Philip Scranton’s meticulous, substantial, and lucid work on American methods of custom- and batch-production in the late nineteenth and early twentieth centuries, and the role of these manufacturing strategies in producing a variegated world of goods for mass consumer markets. Philip Scranton, *Endless Novelty: Specialty Production and American Industrialization, 1865-1925*, (Princeton: Princeton UP: 1997).

¹³ Aside from histories of pharmacy and monographs about large chemical companies, scholarship about small- and mid-scale is almost all antique; this field cries out for renewed scholarly inquiry. The classic account of the American chemical industry is William Haynes’ six-volume history, published between the late 1940s and 1950s — a massive undertaking sustained by funding from the Chemical Foundation, Dow, and Monsanto. For a sense, see, in particular: William Haynes, *American Chemical Industry: A History, Volume I: Background and Beginnings* (Toronto, NY, London: D. Van Nostrand, 1954). For a useful overview of the history of pharmacy, see Gregory Higby and Elaine C. Stroud, eds, *American Pharmacy (1852-2002): A Collection of Historical Essays*, (Madison: American Institute of the History of Pharmacy, 2005). John Kenly Smith proposes several historiographical frameworks for studies of chemical modes of production (rather than histories of particular products or particular firms) in “The Evolution of the Chemical Industry: A Technological Perspective,” in Seymour Mauskopf, ed., *Chemical Sciences in the Modern World* (Philadelphia: University of Pennsylvania Press, 1993). A recent, solid monograph that considers the role played by the First World War in reorganizing the political and economic conditions of the

recognize its scope or significance before the Second World War, “Flavor Added” documents the diversity of chemical methods of production outside of well-organized, vertically integrated industries, while also documenting the perseverance of craft methods within the chemical industry.¹⁴ The peculiar chemical, social, and regulatory requirements of flavor additives make the flavor industry a prime candidate to enhance our understanding of how chemical knowledge translates into manufacturing processes and consumer products.

FLAVORS ARE MULTISENSORY PERCEPTUAL PHENOMENA

In his story “Tlön, Uqbar, Orbis Tertius,” Jorge Luis Borges describes the syntax of the languages spoken in Tlön, an imaginary planet whose customs, history, and geography are elaborated in a series of obscure and pirated encyclopedias. In the Northern hemisphere of the planet, nouns do not exist in their own right, but are instead devised by “an accumulation of adjectives.” He explains:

There are objects composed of two terms, one of visual and another of auditory character: the color of the rising sun and the faraway cry of a bird. There are objects of many terms: the sun and water on a swimmer's

American chemical industry is: Kathryn Steen, *The American Synthetic Chemicals Industry: War and Politics, 1910-1930*, (Chapel Hill, UNC Press: 2014).

¹⁴ For instance, Constance Classen, David Howes, and Anthony Synnott have written: “Artificial flavours were invented in the late nineteenth century, but didn’t become prevalent until the 1960s.” At the very least, I hope this dissertation puts that misconception to rest. Classen, Howes, and Synnott, “Artificial Flavors,” in *The Taste Culture Reader: Experiencing Food and Drink*, ed. Carolyn Korsmeyer, (Oxford and New York: Berg, 2005 [2007]): 337.

chest, the vague tremulous rose color we see with our eyes closed, the sensation of being carried along by a river and also by sleep.¹⁵

Clusters of sensations, bodily states, affective feelings, and other mental phenomena — the very stuff of subjectivity — are, in *Tlön*, materialized as nouns, the denotative objects of language. “There are famous poems,” Borges writes, “made up of one enormous word.”

This study concerns a series of attempts by scientific and technical workers to describe, determine, and comprehend flavor, an object of many terms, in the absence of a grammar that could cast it as one comprehensive, enormous, denotative word. During the hundred years, give or take, covered by this dissertation, flavor came to be associated with specific molecules and chemical processes, but also simultaneously understood as an experiential response — an embodied reaction which could only partially or imperfectly be described in terms of the chemical presences that were the apparent occasion for sensations. By the 1930s, the researchers, regulators, and flavor makers who were concerned with the determination, measurement, control, and production of flavor recognized it as a multisensory phenomenon — involving not only the chemical senses (smell and taste, broadly constituted), but also somatosensations within the oral cavity (such as mouthfeel), visual factors, and auditory components. These researchers were also increasingly aware of the influence of the personal and physiological circumstances

¹⁵ Jorge Luis Borges, “*Tlön, Uqbar, Orbis Tertius*,” trans. James E. Irby, in Donald A. Yates and Irby, eds. *Labyrinths: Selected Stories and Other Writings*, (New York: New Directions, 1964): 9.

of the eater. The state of the body, the atmospheric and environmental conditions of the room, social influences, prior experiences, all seemed to affect not just stated preferences, but the perceptual experience of flavor itself.

Historians of scientific objectivity, most prominently Lorraine Daston and Peter Galison, have described the epistemic virtue of objectivity not as a quality achieved by certain forms of knowledge, but as a set of practices, or perhaps as a style, assumed by the investigator.¹⁶ In taking as its subject scientific atlases — visual representations of natural specimens and other external, more or less observable phenomena — Daston and Galison's *Objectivity*, which has gained landmark status, may misrepresent this specific scenario as prototypical of the production of objectivity in scientific knowledge-making more generally. In parallel to the scientific atlas-makers, a group of scientific workers known as experimental psychologists and psychophysicists labored to measure, represent, and determine psychological phenomena, subjective states of mind, and the structures of consciousness.¹⁷ Notable recent works of scholarship have examined how scientists, technicians, engineers, and designers grapple with the practical and epistemological questions raised by sensory objects, and the concurrent formation of "sciences of subjectivity" to organize the study of these phenomena.¹⁸ Rather than the exception to the

¹⁶ Lorraine Daston and Peter Galison, *Objectivity*, (Cambridge: Zone Books, 2007).

¹⁷ See, for instance, Christopher Green's critique of *Objectivity* along these lines in: Christopher D. Green, "Scientific Objectivity and E.B. Titchener's Experimental Psychology," *Isis* 101 (2010): 697-721.

¹⁸ See in particular, Steven Shapin, "Sciences of Subjectivity," *Social Studies of Science* 42, no 2. (2012): 170-184. Also: Bruno Latour, "How to Talk About the Body? The Normative Dimension of Science Studies," *Body & Society* 10, no. 2-3 (2004): 205-229; Rebecca Lemov, *Database of Dreams: The Lost Quest to Catalog Humanity*, (New Haven: Yale UP, 2015); Sophia Roosth, "Screaming Yeast: Sonocytology, Cytoplasmic

rule, these “world-making” disciplines, to use Steven Shapin’s phrase, should be considered equally central to the project of understanding the peculiar technoscientific constitution of modernity.

My project contributes to this literature by documenting the practices, values, and experiences of the technicians and scientists who worked to create a science of flavor.¹⁹

In particular, I examine the technologies and instruments that these workers used to produce scientific and standard knowledge about flavor from the data of human

Milieus, and Cellular Subjectivities," *Critical Inquiry* 35, no. 4 (2009): 332-350; Jonathan Sterne, *The Audible Past: Cultural Origins of Sound Reproduction*, (Durham: Duke University Press, 2003); Emily Thompson, *The Soundscape of Modernity: Architectural Acoustics and the Culture of Listening in America*, (Cambridge: MIT Press, 2004).

¹⁹ Alternately, anthropologists have explored flavor and the production and constitution of sensing bodies and subjective knowledge in the contexts of Western industrial food systems. See, for instance, Ana Ulloa’s ethnographic studies of flavor research laboratories, flavor industry laboratories, and “molecular gastronomy” kitchens, which scrutinizes the modes of practice and ways of knowing particular to flavor-work; Ella Butler’s ongoing anthropological studies of sensory science and sensory evaluation; Jake Lahne’s anthropologically informed inquiries into the methods of sensory evaluation and the construction of sensory knowledge; David Howes’ ethnographic investigations into the development of sensory techniques; and Amy Trubek’s study of the social, cultural, and political production of the set of sensible qualities known as terroir. Ana Maria Ulloa, Josep Roca, and Heloise Vilaseca, “From Sensory Capacities to Sensible Skills: Experimenting with El Cellar de Can Roca,” *Gastronomica: The Journal of Critical Food Studies* 17.2 (2017): 26-38 and forthcoming PhD dissertation; Ella Butler, forthcoming PhD dissertation; Jake Lahne, “Sensory Science, the Food Industry, and the Objectification of Taste,” *Anthropology of Food* 2016, and “Tasting in Context: Consumer Sensory Perception of Vermont Artisan Cheese,” (PhD dissertation, University of Vermont, 2014); David Howes, “The Science of Sensory Evaluation: An Ethnographic Critique,” in *The Social Life of Materials: Studies in Materials and Society*, ed. Adam Drazin and Susanne Küchler, (London: Bloomsbury, 2015): 81-97; and Amy Trubek, *The Taste of Place: A Cultural Journey into Terroir*, (Oakland: University of California Press, 2008). See also the work of Annemarie Mol on sensual forms of knowledge production, especially: "Tasting Food: Tasting Between the Laboratory and the Clinic," in *A Companion to the Anthropology of the Body and Embodiment*, ed. Frances E. Mascia-Lees, (Wiley-Blackwell, 2011): 467-80, "I Eat an Apple. On Theorizing Subjectivities," *Subjectivity* 1 (2008): 28-37, and "Good Taste: The embodied normativity of the consumer-citizen," *Journal of Cultural Economy* 2, no 3 (November 2009): 269-284.

experiential responses and the chemical components of foods. If any general statement can be made about them, it is this: these technologies can never be disaggregated from human bodies, and always require human substrate, whether they are the technologies of laboratory taste panels or the physicochemical machines introduced into the flavor laboratory during the "instrumental revolution" in chemistry.²⁰

"Flavor Added" draws from the history of the senses, especially work that attends to the material, cultural, and social dimensions of sensory experience.²¹ Scholars such as Melanie Kiechle, Mark Jenner, Mark Smith, David Howes, Carolyn Korsmeyer, and Alain Corbin have shown that our sensory worlds are not only personal, but are

²⁰ Christy Spackman's ongoing work on the use of analytic and other technologies in the production of scientific knowledge about sensation demonstrates the potentials of this field of inquiry for STS scholars. Christy Spackman, "Transforming Taste: The Twentieth-Century Aesthetic Remaking of Water," (PhD diss., New York University, 2015). Ingemar Pettersson's dissertation work at the University of Uppsala is another recent project to examine the science of sensory analysis. For work on the "instrumental revolution," more generally, see Peter J.T. Morris, ed. *From Classical to Modern Chemistry: The Instrumental Revolution*, (Cambridge: Royal Society of Chemistry, 2000); Frederick Holmes and T.H. Levere, eds., *Instruments and Experimentation in the History of Chemistry*, (Cambridge: MIT Press, 2000); Carsten Reinhardt, *Shifting and Rearranging: Physical Methods and the Transformation of Modern Chemistry*, (Sagamore Beach, Mass.: Science History Publications/USA, 2006).

²¹ The history of the senses is doggedly interdisciplinary, combining methodologies from history, anthropology, philosophy, and the social sciences. See, for instance, Melanie Kiechle, "'The Air We Breathe': Nineteenth-Century Americans and the Search for Fresh Air," (PhD diss., Rutgers, 2012); Peter Charles Hoffer, *Sensory Worlds in Early America*, (Baltimore: JHU Press, 2003); David Howes, *Sensual Relations: Engaging the Senses in Culture and Social Theory*, (Ann Arbor: University of Michigan Press, 2003); Carolyn Korsmeyer, *Making Sense of Taste: Food and Philosophy*, (Ithaca: Cornell UP, 2002); Alain Corbin, *The Foul and the Fragrant: Odor and the French Social Imagination*, trans. Miriam L. Kochan, Roy Porter, and Christopher Prendergast, (Cambridge: Harvard UP, 1986); Adam Mack, "'Speaking of Tomatoes': Supermarkets, the Senses, and Sexual Fantasy in Modern America," *Journal of Social History* 43 (Summer 2010): 815- 842; and Mark Smith, *How Race is Made: Slavery, Segregation, and the Senses* (Chapel Hill: UNC Press, 2006).

fundamentally historical. The sensible things we attend to, and the meanings we make of them, are shaped by social, cultural, economic forces. The “authoritative” and apparently incontrovertibly personal knowledge of our senses, in other words, is always already informed by authorities and forms of knowledge other than our own experience.

Following the example of historians of the senses, I have tried to be careful not to lapse into the assumption that there is anything prior or “natural” about the flavor of things, or anything trans-historical about how flavor is perceived and understood. Although the label of “imitation” haunted (and still haunts) many foods and beverages containing “artificial flavors,” to reflexively assume that there was an “original” to which the imitation aspired mistakes both the dynamic historical circumstances in which synthetic flavorings emerged, as well as the consequences of their availability for the development of food, drinks, and other sensible goods. Thus, in pursuing this research, I have tried to avoid questions such as, “What is the flavor of an apple?” and, “Did this flavoring successfully replicate it?”

Considering flavor as a historical construct means asking, instead, questions such as: What were the forms and conditions in which apple flavor was available to eaters (including, but not limited to, apples themselves)? What were the material, social, cultural, and scientific contexts within which apple flavor was consumed, considered, discussed, and valued? How have sensory expectations around apples changed, and what forces may have contributed to these changes? In other words, there is no pre-existing, immutable, or trans-historical “apple flavor.” the phenomenon of apple flavor comes into being, in all its specificity, only upon the meeting of a certain historical body and a

certain comestible, under social circumstances where the sensation produced is, both intimately and intersubjectively, recognized as “apple.” Likewise, in linking particular chemicals with recognizable, named sensory effects, I have tried to avoid foreclosing the recognition of other possible sensory experiences resultant from exposure to these compounds, and have also tried to avoid the presumption that a certain chemical found in a food represented or produced a definite, universally agreed-upon sensation.

FLAVORS ARE FOOD TECHNOLOGIES

Gaston Bachelard, ruminating on the conditions of scientific knowledge, observed “there are no simple phenomena; every phenomenon is a fabric of relations,” produced by and embedded within practices, machines, ideologies. While proper scientific objects must be wrest from the context of ordinary sensual life and reconstituted by laboratory labor, their return to the world lays bare the special conditions of the scientific mode of knowing. “Application is complication.”²²

This history of flavor science is fundamentally about applied knowledge. It thus intersects with, and illuminates, the development of an American system of food production that resulted in an abundance of cheap calories.²³ The sciences of flavor were

²² Gaston Bachelard, *The New Scientific Spirit*, [1934], 147-8.

²³ Some of the most compelling work in this area has come from historians of technology and of business, who situate consumers, producers, and resources in dynamic technosocial systems of food production and distribution. For studies that consider the design of sensory qualities of food in industrial food systems, see, especially, Gabriella M. Petrick, “The Arbiters of Taste: Producers, Consumers, and the Industrialization of Taste in America, 1900-1960,” (PhD diss., University of Delaware, 2006); and Ai Hisano, “Eye Appeal is Buy Appeal: Business Creates the Color of Foods, 1870-1970,” (PhD. Diss, University of Delaware, 2016). Shane Hamilton, Suzanne Friedberg, Anna Zeide, Anne Vileisis, Paul Josephson, and Amy Bentley, among others, take as case

ultimately applied sciences, intended to produce not abstract knowledge, but actual things — commercial products — that yielded intended (perceptual) effects. As such, workers in this field often found themselves grappling with the complications of application. The scenarios in which they cultivated the sciences of flavor — industry, progressive government agencies, military research — framed problems of flavor in the same way as other problems of production: as technoscientific problems, with technoscientific solutions. In these contexts, certain types of solutions were pursued in preference to others. For instance, although some agricultural research was devoted to developing “better tasting” varieties of fruits, vegetables, and meats, most agricultural science was

studies specific technologies of production (refrigeration, freezing, canning) or food products (the tomato, the fish stick, baby food), illuminating the web of technosocial relations that shape systems, goods, and consumers in twentieth century economies. See: Shane Hamilton, “Cold Capitalism: The Political Ecology of Frozen Concentrated Orange Juice,” *Agricultural History* 77, no. 4 (Autumn 2003): 557–581 and “The Economies and Conveniences of Modern-Day Living: Frozen Foods and Mass Marketing, 1945-1965,” *The Business History Review* 77, no. 1 (Spring 2003): 33–60; Susanne Freidberg, *Fresh: A Perishable History*, (Cambridge: Harvard UP, 2009); Anna Zeide, “In Cans We Trust: Food, Consumers, and Expertise in Twentieth-Century America,” (PhD Diss., University of Wisconsin-Madison, 2014); Ann Vileisis, “Are Tomatoes Natural?” in Martin Reuss, Stephen H. Cutcliffe, eds., *The Illusory Boundary: Environment and Technology in History*, UVA Press, 2010; Paul Josephson, “The Ocean's Hot Dog: The Development of the Fish Stick,” *Technology and Culture* 49.1 (January 2008): 41-61; and Amy Bentley, *Inventing Baby Food: Taste, Health, and the Industrialization of the American Diet*, (Oakland: University of California Press, 2014). For more general accounts of the food system and food production informed by history of technology, see: Rachel Laudan, *Cuisine and Empire: Cooking in World History*, (Oakland: University of California Press, 2013); Warren Belasco and Roger Horowitz, eds. *Food Chains: From Farmyard to Shopping Cart*, (Philadelphia: UPenn Press, 2009); Nancy F. Koehn, “Henry Heinz and Brand Creation in the Late Nineteenth Century: Making Markets for Processed Food,” *The Business History Review* 73, no. 3 (Autumn 1999): 349-393; and Warren Belasco and Philip Scranton, eds. *Food Nations: Selling Taste in Consumer Societies*, (New York: Routledge, 2002).

oriented toward increasing yields and efficiency.²⁴ Solutions to the flavor deficiencies of industrial food were generally sought at the level of manufacturing and distribution: in the development and deployment of new chemical additives, or improvements to processing, packaging, quality control, and transportation technologies.

Many historians and other commentators have correctly drawn attention to the negative consequences of this abundance: the inequitable distribution of its rewards, its sham choices and false promises, its detrimental effects on the health and well-being of certain populations, its effects on environments, economies, and traditional ways of life.²⁵ These narratives are elaborations upon what Harvey Levenstein has called “the paradox of plenty”: the political, social, and cultural anxieties about food consumption that accompanied the proliferation of food calories.²⁶ The argument made in many of these accounts is that the industrial food system achieves its apparent cheapness and abundance at great cost, to human health and lives, as well as planetary well-being.

²⁴ See, for instance: William Boyd, "Making Meat: Science, Technology, and American Poultry Production," *Technology and Culture* 42. 4 (October 2001): 631-664; Deborah Fitzgerald, "Deskilling Farmers: Hybrid Corn and Farmers' Work," *Technology and Culture* 34.2 (April 1993): 324-43.

²⁵ For a recent bibliography of food history that emphasizes social and cultural history, see Marion Nestle and W. Alex McIntosh, "Writing the Food Studies Movement," *Food, Culture and Society: An International Journal of Multidisciplinary Research* 13, no. 2 (2010): 159–179. A comparable resource for works on the anthropology of food can be found at Sidney W. Mintz and Christine M. Du Bois, "The Anthropology of Food and Eating," *Annual Review of Anthropology* 31 (2002): 99–119; Warren J. Belasco and Philip Scranton, eds., *Food Nations: Selling Taste in Consumer Societies*, Hagley Perspectives on Business and Culture (New York: Routledge, 2002), provides a solid, international set of examples about how cultural and social food habits are susceptible and resistant to change.

²⁶ Harvey Levenstein, *Paradox of Plenty: A Social History of Eating in Modern America*, (New York: Oxford UP, 1993).

Food studies scholars and critics, documenting the industrialization of the food system, have often ignored or dismissed the sensual aspects of these changing technologies of food production. Many commentators have taken the position that flavor did not matter to manufacturers, nor to the scientific workers (such as nutritionists and food technologists) who, with their expert labor, supported the industrialization of the food system; or, alternately, that flavor played second fiddle to other concerns, such as nutrition, safety, and profit.²⁷ In response to these claims, I argue the following. The evidence that flavor was a primary concern of food manufacturers and the industrializing food system is plentiful. So why has its role been overlooked? Discussions and technological interventions aimed at shaping, controlling, and improving the sensory qualities of food in the food industry and its technosciences often do not coincide with lay notions of how flavor ought to be talked about. Although its outcomes may not be congruent with prevailing ideas about “good flavor,” when one looks for the evidence of how flavor mattered to the food manufacturers and the industrializing food system, one finds it plentifully in evidence.

In this dissertation, I consider flavor additives as technologies — as deliberately designed artifacts that operate within the context of a broader food system. This system

²⁷ For some commentators, this has resulted in an extreme skepticism that approaches a disavowal of food science and food technology as such. Take for instance, this statement from Michael Pollan in a recent interview with *Lucky Peach*'s Rachel Khong: “I sometimes find myself wondering whether we can post or imagine a food science that is actually improving food in the way that cooking for most of its history succeeded in doing. . . . We’ve had food science and food technology now for a hundred and fifty years, and so far, not so good. So far we haven’t done anything useful. But we understand a lot more, and we should be able to improve on things, not just make money and entertain people.” Rachel Khong Interviews Michael Pollan, “The End of the World as We Know it,” *Lucky Peach*, (September 10, 2014).

includes, most immediately, the other ingredients that constitute the food, wrapping and packaging materials, the machines and methods that produce the food and make it available to consumers for a fixed price, and, more distantly, the cultural, social, and environmental context within which the food is consumed. The precise form that flavor additives took, as well as the purposes that they were expected to serve, vary over the course of the century or so discussed in this dissertation, reflecting changes to the methods, institutional arrangements, and technosocial networks of flavor science, as well as changes to the market for food and other consumer goods. At different points in this dissertation, flavor additives are technologies that can efficiently convert commodities into consumer products, confer uniqueness or distinction to branded goods, enforce standard uniformity on items made from variable raw materials, minimize unpleasant or unpalatable sensations, enhance and extend pleasurable and desirable sensations, and deliver precisely calibrated sensory experiences.²⁸

Crucially, flavor is a technology that becomes effective only by acting directly on the body and mind of the consumer. But precisely how the body is believed to be susceptible to flavor, the terms under which flavor's effect on the body is theorized and

²⁸ A relevant body of literature here is the history of advertising and consumer culture, particularly accounts that investigate the social and psychological sciences that inform advertising, marketing, merchandising, and other consumer-oriented business practices. See, for instance: Lawrence R. Samuel, *Freud on Madison Avenue: Motivational Research and Subliminal Advertising in America*, (Philadelphia: University of Pennsylvania Press, 2011); William Leach, *Land of Desire: Merchants, Power, and the Rise of a New American Culture*, (New York: Pantheon, 1993); Roland Marchand, *Advertising the American Dream: Making Way for Modernity, 1920-1940*, (Berkeley: University of California Press, 1985); Susan Strasser, *Satisfaction Guaranteed: The Making of the American Mass Market*, (New York: Pantheon, 1989); Pamela Walker Laird, *Advertising Progress: American Business and the Rise of Consumer Marketing* (Baltimore: JHU press, 1998).

measured, varies over the course of this history, as does the imagined relationship between flavor sensations and resultant psychic and physiological phenomena, such as perception, appetite, affect, and behavior.²⁹ Of course, these changing understandings of the sensible body — its appetites, responses, and needs — reflect changing concerns, ideologies, and interests that deeply inform the designs and purposes of flavor technologies.³⁰

Novel preservation technologies, such as flash freezing; new materials, such as polyethylene plastics, which lined bags and containers; improvements to the cold chain that kept foods chilled from factory to supermarket — in addition to performing other functions in the food system, these should also be considered technologies of flavor.

Their consequences for the sensory qualities of food shaped the ultimate forms that these

²⁹ Sarah Tracy's ongoing research into MSG and the taste modality known as umami has been an intellectual inspiration to this scholar ever since I heard one of her papers, about umami and the democratization of deliciousness, at a Hagley Library conference on the history of the senses all the way back in 2013. Her exemplary work draws on scholarship in science and technology studies to draw connections between the intimate self and social phenomena, sensual possibilities and biopolitical contexts. Sarah E. Tracy, "Delicious: A History of Monosodium Glutamate and Umami, the Fifth Taste Sensation," (PhD diss., University of Toronto, 2016). See also: Joel Dickau, "Inventing Texture: Edible Science and the Management of Familiarity, 1963-1975," *Global Food History* 3 (2017): 1-23.

³⁰ Recent scholarship has used the history of diet and dietetics as a means to sound the resonating strings that connect histories of the body, histories of medicine and science, and political and social history. See for instance: E. Melanie DuPuis, *Dangerous Digestion: The Politics of American Dietary Advice*, (Oakland: University of California Press, 2015); Helen Zoe Veit, *Modern Food, Moral Food: Self-Control, Science, and the Rise of Modern American Eating in the Early Twentieth Century*, (Chapel Hill: UNC Press, 2013); Jessica Mudry, "The Mindful Measurement of Food: Quantification, the Food Pyramid and Discourses of Taste," *Material Culture Review* 70 (Fall 2009), 12-22; David Schleifer, "The Perfect Solution: How Trans Fats Became the Health Replacement for Saturated Fats," *Technology and Culture* 53, no 1 (January 2012): 94-119; and Chin Jou, *Controlling Consumption: The Origins of Modern American Ideas about Food, Eating, and Fat, 1886-1930*, PhD Dissertation, Princeton, 2009.

technologies took in the world. Taking the long view, one can discern a distinct tendency in the development of food technologies over the course of the twentieth century: towards production, packaging, and distribution methods that preserve foods not only from spoilage, but also from any chemical changes that could alter the sensory qualities of food. In other words, the users of these technologies aspired toward maximizing their control over the sensible matter of food, between the site of manufacture and the ready mouth of the consumer.

Although this dissertation is primarily concerned with added flavors, the changing material and technological conditions of food production and distribution provide necessary context for understanding the role that flavor additives played in this system. The contemporary flavorists' work differs from that of her or his predecessor of fifty years ago, not only because of the expanded palette of flavoring materials and the growing share of knowledge about the chemistry of flavor, but also because different production methods and packaging materials require different performances and properties from flavoring, while also affording distinct sensory possibilities.³¹

As is the case with other technologies, the uses and meanings of technologies of flavor were never exclusively determined by their creators. I follow the model of social historians of technology, who have emphasized the manifold ways in which artifacts are

³¹ Gary Cross and Robert Proctor's study of packaging, which persuasively connects the changing forms and functionalities of containers to an intensifying attention on the sensual possibilities for the thing contained, is particularly recommended to readers interested in the largely overlooked (but crucial) history of packages and containers. Gary S. Cross and Robert N. Proctor, *Packaged Pleasures: How Technology and Marketing Revolutionized Desire*, (Chicago: UChicago Press, 2014).

shaped by the technosocial worlds in which they circulate, and the users who determine their meaning and value, and, in this case, incorporate them into their bodies, habits, and social lives.³²

FLAVORS ARE DELIBERATELY DESIGNED ARTIFACTS

If there are any protagonists in this dissertation, they are the skilled workers who, in the late 1940s, begin to call themselves “flavorists.”

When this story begins in the last half of the nineteenth century, these workers may have been called ‘practical chemists’ or ‘manufacturing chemists.’ They may have been trained in a pharmacy, or worked in one of several new branches of food manufacturing: producing flavoring syrups for bottled carbonated beverages or soda fountains; flavor extracts for candies, confectionery, or other sweet things; essences for liquors and spirits; or household extracts for home kitchens. They may have been employed in the essential oil trade, in spice milling, or in the nascent synthetic perfume industry. For much of the period covered by this dissertation, they lacked a single job title or occupational identity. The professional titles most commonly used by those who make flavors today — ‘flavorist’ and ‘flavor chemist’ — only entered the vernacular after the Second World War.

³² For instance, Donald MacKenzie and Judy Wajcman, eds., *The Social Shaping of Technology: How the Refrigerator Got its Hum*, (Philadelphia: Open U Press, 1985); Wiebe E. Bijker, Thomas Parke Hughes, and Trevor Pinch, *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*, (Cambridge: MIT Press, 1987); Jeffrey Meikle, *American Plastic: A Cultural History*, (New Brunswick: Rutgers University Press, 1995); and Regina Lee Blaszczyk, *The Color Revolution*, (Cambridge: MIT Press, 2012).

Historians of science and technology have produced numerous important studies of the work-lives of professionals in technical and scientific industries.³³ The story I tell here of the professionalization of flavorists takes two bodies of scholarship — by historians of chemistry, and by business historians on the origins and organization of the chemical industry — as a foundation and backdrop. Rather than the academic chemist negotiating the disciplinary boundary with physics while investigating the structure of matter, or the industrial chemist tasked with generating new basic knowledge in the

³³ Landmark studies of technicians and the application of technical knowledge in diverse contexts include: Blaszczyk 2012; Nathan Ensmenger, *The Computer Boys Take Over: Computers, Programmers, and the Politics of Technical Expertise*, (Cambridge: MIT Press, 2010); Deborah Fitzgerald, *Every Farm a Factory: The Industrial Ideal in American Agriculture*, (New Haven: Yale UP, 2003); Margarete Sandelowski, *Devices and Desires: Gender, Technology, and American Nursing*, (Chapel Hill: University of North Carolina Press, 2000); Steven Shapin, *The Scientific Life: A Moral History of a Late Modern Vocation*, (Chicago: University of Chicago Press, 2010); and Walter Vincenti, *What Engineers Know and How They Know It: Analytical Studies From Aeronautical History*, (Baltimore: Johns Hopkins University Press, 1990). Natasha Dow Schüll provides an anthropological investigation of the design process of gambling machines, revealing the expert forms of knowledge, interventions, and adjustments in the dyadic relation of susceptible bodies and machine affordances, necessary to produce subjective states of deep play: Natasha Dow Schüll, *Addiction by Design: Machine Gambling in Las Vegas*, (Princeton and Oxford: Princeton UP, 2012). My analysis is also indebted to the sociology of technical work, in particular that of Stephen Barley and Julian Orr: Stephen R. Barley, "Technicians in the Workplace: Ethnographic Evidence for Bringing Work Into Organizational Studies," *Administrative Science Quarterly* 41, no. 3 (1996); Julian E. Orr, *Talking About Machines: An Ethnography of a Modern Job*, (Ithaca, NY: ILR Press, 1996); Stephen R. Barley and Julian E. Orr, eds. *Between Craft and Science: Technical Work in U.S. Settings*, (Ithaca: IRL Press, 1997). See also: Steven Shapin, "The Invisible Technician," *American Scientist* 77, no. 6 (1989): 554-563; Adele Clarke and Joan Fujimura, eds., *The Right Tools for the Job: At Work in Twentieth-Century Life Sciences*, (Princeton: Princeton UP, 1992); Pamela H. Smith *The Body of the Artisan: Art and Experience in the Scientific Revolution*, (Chicago: University of Chicago Press, 2004); Lissa Roberts, Simon Schaffer, and Peter Dear, eds. *The Mindful Hand: Inquiry and Invention from the Late Renaissance to Early Industrialization*, (Chicago: University of Chicago Press, 2008).

corporate research and development laboratory, I offer a different kind of narrative about chemical work and careers in chemistry. The skilled workers who made chemicals into flavors often did not have extensive academic training in chemistry, but they gained deep practical experience with chemicosensory aspects of phenomena. They gained expertise through direct experience with sensible materials in the laboratory, but their success also depended on a thorough knowledge of contexts and applications outside of the laboratory — how these substances were liable to change, react, and perform under varied conditions of industrial production and consumption.

In other words, this is a story of chemistry as scientific craftwork, sensual practice, embodied skill, and constant improvisation.

FLAVORS ARE VECTORS OF CULTURAL AND SOCIAL MEANING

Over the years I've spent researching and writing this dissertation, I've encountered one question more than any other when I mention the subject of my work, especially to people outside the academic bubble. It often goes something like this: "I bet you eat a lot less processed food, since you began working on this?" It's often not really a question, actually, but more like a kind of assertion — or a request for confirmation, like sticking out your arm and waiting for a handshake.

In order to get at what I think this frequent question means, both for the subject of my work and for me personally as the author of it, allow me to tell you a little bit about myself, the conditions of my life as an eater, my particular relationship to foods and their flavors. I was — luckily, I think — raised in a household that took the pleasure of food

very seriously. My mother will gladly recount, in fine detail, a meal that she ate in the 1970s at L'Auberge D'Ill, in the Alsatian town of Illhaeusern, or expound upon the virtues of tramezzini, vitello tonatto, or the Argentine tart known as pastafrola. My father was more ecumenical in his tastes, but no less intense in his enthusiasms. He could not restrain his glee at encountering a good Reuben sandwich, a plate of alfajores, a crispy apple. He liked to tell us that when he was a child, his grandmother would make two platters of latkes on the holidays: one for the rest of the family, and one for him.

My mother is an accomplished cook, but she is also a research scientist who toiled long hours in the laboratories of the National Institutes of Health. My father, like many men of his generation, was rather helpless in the kitchen. The person who most often prepared meals at home during my childhood was my grandmother, Haydee Garcia; I called her nona. She passed away well over a decade ago, but is still intensely missed. I feel confident in saying that no one who had ever tasted the silken flan that she produced in a bundt cake pan, and sluiced with translucent caramel, will ever forget it. Friends of the family, when traveling through Spain, knew to bring back for her tiny glass vials containing a half-dozen or so scarlet saffron pistils, which she would accept with delight, and incorporate one at a time into pilafs of fulvous rice studded with tiny green peas. She boiled cans of Borden's sweetened condensed milk, for hours, in a big pot on the stove. When cooled, the cans yielded dulce de leche. I often ate this caramelized goo, spread on saltines, for breakfast.

As an allegedly adult person, living between Brooklyn and Philadelphia, I've spent many hours at farmer's markets, weensy gourmandish stores, ethnic groceries, and

mega-supermarkets, looking, trying, talking, buying; in the kitchen, my own or that of friends, knife or wooden spoon in one hand, a glass of wine in the other, flames in the background; at the counter, table, or to-go window of hubs of sophisticated noshing “at all price points,” to use the parlance of our times. I’m a snob, but like all proper snobs, my list of favorites is always in flux. I like to think I’m open to anything. But yet I find it really, really difficult—impossible, actually—to eat from a bag of Doritos, to drink a Coca-Cola, to take my dinner from the freezer and heat it in the microwave. I could not tell you the exact location of any McDonald’s in New York City. Just the other day, around the corner from the rented apartment I’ve lived in for nearly a year, on a block I walk down nearly every day on my way to the park with my dog, I noticed, for the first time, a Domino’s Pizza, its tenancy in this neighborhood far longer than my own.

In his disquisition on the cultural economies of taste, the uber-French sociologist Pierre Bourdieu explains that the social logics and practices by which the foods that people choose to eat, the things that they relish and enjoy, are both constitutive of their identities and also reflective of their social positions.³⁴ “Tell me what you eat, and I’ll tell you who you are,” hummed Brillat-Savarin.

The question of how this project has affected my eating habits carries with it two presumptions: first, that synthetic flavors — and the science and technology of food and flavor, more generally — only affect “industrial” and processed foods, and that there are other, “better,” foods out there that are innocent of these interventions. Second, that the

³⁴ Pierre Bourdieu, *Distinction: A Social Critique of the Judgment of Taste*, trans. Richard Nice, (Cambridge: Harvard UP, 1984).

more information one possesses about the chemicals that are put into our foods, the more repulsed and disgusted one is certain to be. Both of these assumptions carve the world into two distinct parts: the realm of good food with real flavors, and the realm of bad food, made of chemicals.

As a historian of technology, I'm obligated to point out that all food production involves technology. Assuming a pre-existing distinction between "real food" and everything else — a distinction which, today, generally pits the produce aisle ("natural," "authentic") against packaged and processed foods ("artificial," "fake") — erases the manifold ways in which all food is "artificial," mixed up as it is with human knowledge and labor. When we grow plants for food, we transform them and we transform the environment they grow in. We also don't just grow food: We cook it, preserve it, ferment it, subject it to processes that also transform it chemically and nutritionally, that change its flavor and aroma, endow it with durability, social purpose, and cultural meaning. At what point do things stop being "real food"? When they are harvested by machines? When we alter their genomes using biotechnology rather than selective breeding? When somebody else makes them? When they are made in a factory? Food isn't just edible stuff out there in the world. It is, and has always been, embedded in human cultures; it constitutes culture.

As noted earlier, many recent accounts of industrial food have focused on loss, specifically on the loss of flavor in "real" food—or, in parallel, on the proliferation of "bad" industrial flavor. This flavor story has a clear moral dimension, distinguishing the good and the real from the bad and the fake. Currently, it has achieved the status of

conventional wisdom — that we chose—or had thrust upon us—beautiful, insipid apples over gnarled and speckled fruits of depth and complexity.

There is something inevitably wistful and elegiac about these arguments—a lament that the rich sensory world, in all its fetid pungency, has been replaced by scentless, climate-controlled spaces filled with piped-in music; smooth, bland armpits; Kraft singles sheathed in cellophane; vanilla ice cream containing neither vanilla, nor cream. This is, I think, a form of declensionist narrative—that standard plot that has been so potently critiqued by environmental historians. It represents the present world in terms of its losses, tatters, and absences, rather than its fluxes, flows, and dynamic relations, emergent forms, new potentials.

These narratives make the serious mistake of taking our current, exceptionally high valuation of and appetite for intense, distinctive flavor as trans-historical, and even as biologically natural to human bodies (and to “real” foods). Even as the cultural relativism of tastes are acknowledged by food scholars in all disciplines, the flavor of food is almost always regarded as a quality of paramount importance. Was there a time when flavor, the sensory qualities of food, was not comprehended as part of the phenomenological world of food and drink? Perhaps not — but what, precisely, flavor was, ontologically speaking, what its relation was to the substance, material, and value of foods, the effects it had upon bodies — all these things have changed tremendously, even in the cultural West, even in the relatively short span of what we call modernity.³⁵ Just as

³⁵ For a comparative overview surveying the changing relation of the flavor of foods to the bodies of eaters, see: Steven Shapin, “Changing Tastes: How Things Tasted in the

the meaning, power, and ontology of flavor has changed historically, so have the cultural calculations of its value, as well as the instruments and other means by which the value of food is calculated.³⁶ I might even venture to argue that the current high-foodie-culture valuation of flavor, the valor assigned to unique, distinct, or intense flavors, and the expectation that “heirloom” varieties of produce also deliver on promises of intensive flavors, is a result of the flavor-culture produced by industrial food, rather than a rejection of it.

Another version of this story, the one told most vividly, perhaps, by journalist Michael Moss in his recent book, *Salt, Sugar, Fat*, describes flavor technologies that have been refined to a degree of effectiveness such that we are more or less biologically unable to resist them. This familiar narrative is one where scientific knowledge has been leveraged to steamroller the authentic desires and needs of consumers, turning the body against its own best interests in service of the interests of powerful, multinational corporations. These narratives are, in essence, a species of technological determinism, but they are not inventions out of whole cloth. Certainly, the technologies and sciences of

Early Modern Period and How They Taste Now,” Hans Rausing Lecture 2011, Uppsala University. For an illuminating case study that examines how the relation between the qualities of food, chemical compounds, scientific knowledge, body, and state was constituted in Revolutionary France, see E.C. Spary, *Feeding France: New Sciences of Food, 1760-1815*, (Cambridge: Cambridge UP, 2014). An informative discussion of the heated debates over the virtues of culinary “refinement” can be found in Rebecca L. Spang, *The Invention of the Restaurant: Paris and Modern Gastronomic Culture*, (Cambridge: Harvard UP, 2000).

³⁶ For instance, historian Andrew Haley has argued that American diners in the late nineteenth and early twentieth centuries paid little attention to how food tasted, evaluating its appeal instead in terms of social contexts, class cues, and gendered practices of eating, as well as prevailing physiological concerns about ‘digestibility.’ See: Andrew P. Haley, “The Nation Before Taste: The Challenges of American Culinary History,” *The Public Historian* 34, no 2 (Spring 2012): 53-78.

flavor discussed in this account derive their meaning, motive, and value from a particular social, cultural, and economic context: consumer capitalism. As readers of this dissertation shall see, flavor additives—and the sciences that construed them—were explicitly designed to influence consumer behaviors. But to give these technologies ultimate power not only misrepresents the complexity of social relations around food for the purpose of designating villains; it also undermines an examination of the other substantial, structural realities that constrain our choices and limit our possibilities.

In many of these accounts, information is the answer; the individual citizen must arm herself with knowledge, which will guide her to the foods that will recognize her goodness (and reward her good choices) by endowing her with historically appropriate virtues.³⁷ Slimness underscored by strength; a clarity of thought and action reflected in unblemished, glowing skin; unanxious, energetic vigor; “wellness.” In order to achieve this, the knowledge of good and evil flavor must be accompanied by an individual retraining of the will. We must learn to correct our desires, to build an appetite for only the virtuous things, to be disgusted by the false enticements of industrial foods. Is it a coincidence that these virtuous foods (constantly changing) are often also the chosen tidbits of economic elites?

This is not the place to launch into a full-scale critique of these declensionist, determinist, elitist narratives, nor is this dissertation meant as a defense of the flavor

³⁷ Xaq Frohlich offers a sustained and fascinating critique of what he calls the “informational turn” in food labeling in his recent work. Xaq Frohlich, “The Informational Turn in Food Politics: The US FDA’s Nutrition Label as Information Infrastructure,” *Social Studies of Science* 2016: 1-27.

industry, or of the industrialized food system as it is currently constituted. But what I will say here is this: It seems to me that the interest in a system that provides greater food equity, that takes less of a toll on the planet, and that does a better job of sustaining bodies, lives, and communities, is poorly served by critiques that draw hard and fast distinctions between the virtuous (“local,” authentic, healthy) “real” and the wicked (industrial, chemical, unhealthy) “fake.”

If we accept that increasing the availability of food that sustains us *and* provides pleasure is a desirable social goal and a common good, then achieving this goal will demand not only changes in individual behavior, but also social investments, economic and agricultural policies, and educational programs. It perhaps demands even more profound social and cultural reorganizations and redistributions. It will mean addressing questions of labor, including uncompensated domestic labor—after all, one of the implications of "eat less processed food" is "do more of your own food processing." It will mean drawing on food science and food technologies.

Of course, this doesn't mean a blind acceptance of every "innovation." An historical orientation means being well aware that nothing comes from nowhere. We must follow the multiple, variable, and heterogeneous routes by which things came to be, delineating the networks of dependencies that shape materials, human bodies and bodies of knowledge, and life chances. It means trying very, very hard to acknowledge social and individual costs and consequences, including those that may be less visible, discounted, or submerged. It also means recognizing that nothing is inevitable, and that no system is immutable.

CHAPTER SUMMARY AND OVERVIEW

The seven chapters of this dissertation are grouped into three sections, each of which has a distinct chronological and historiographic orientation. The first section considers the social, political, and commercial conditions that shaped the market for, and meanings of, synthetic flavors in the U.S. before the Second World War. Much of the published secondary literature about the flavor industry begins its story in the postwar period. By tracing the roots of flavor additives, and the companies and individuals who manufactured them, to the late nineteenth century, I shed light on how these molecules became so ubiquitous within the food system and how they contributed to the shape of industrial systems of food production.

The opening chapter tracks the growth of synthetic flavor manufacturing in the U.S. from the mid-nineteenth century through the end of the 1930s. By attending to the contexts in which synthetic flavors were made and used, as well as the networks within which knowledge about flavoring materials circulated, this chapter traces the increasing specialization of flavor companies and of the workers they employed.

The second chapter introduces one of the recurring themes of this project: the contested and evolving meaning of “natural.” I take as my central example the case of NuGrape soda, whose “genuine” grape flavoring made by a Brooklyn flavor company was alleged to be “imitation” by regulators. Assessing the conflicting positions of food officials, flavor manufacturers, and consumers, I untangle the multiple, competing definitions of “natural” that prevailed in the period between the passage of the 1906 Pure Food & Drug Act and its 1938 revision and expansion.

Part Two of “Flavor Added” concerns a crucial era for the history of synthetic flavors: the Second World War and the 1950s, a period marked by the accelerating industrialization of the food system and the growing centrality of processed food in the American diet. The three chapters in this section consider flavor additives as deliberately designed technological artifacts, whose inclusion in systems of industrial food production was mediated by emergent, increasingly professionalized technoscientific practices of flavor research.

The industrial food system required more than just cheap flavorings. It required a science of flavor, one that could credibly investigate questions related to the sensory qualities of food, and develop and implement technical programs for controlling, standardizing, and improving flavor in manufactured foods. This required not only identifying the chemical components of foods, but also measuring experiential effects on sensible bodies. This measurement of sensation is the subject of the third chapter, which locates the origins of sensory science in attempts to objectively determine flavor qualities by using panels of human tasters, efforts which began in the 1930s but crystalized during the Second World War at the U.S. Army Quartermaster Food Acceptance Laboratory.

The expanding variety of packaged “convenience foods” in postwar America provides the context for the fourth chapter, which examines the relationship between flavor companies and food manufacturers in the research, development, and production of new types of food products. I detail the formation of advanced research and development operations within the flavor industry, and show how new flavor technologies created by postwar flavor companies was an essential part of their business

strategy. The fifth chapter takes a close look at the ideologies, values, and concerns that informed processes of flavor design by investigating the history of one of the most widely used tools of flavor evaluation: the flavor profile, a method developed by chemists at a Cambridge contract research and consulting company. I argue that the flavor profile was not a neutral technique, and that it profoundly shaped the sensory qualities of postwar foods in ways that reflected the needs of large food companies producing highly processed comestibles.

The final section of “Flavor Added” shifts focus to the practices, work-lives, and epistemic virtues shared by the newly professionalized experts who worked with flavor in postwar America, during a period when chemistry was transformed by what scholars have called the “instrumental revolution.” The introduction of powerful analytic technologies such as gas chromatography and mass spectrometry reshaped the chemical laboratory, refashioned the identities of analytic chemists, and redefined industries including petrochemicals, pharmaceuticals, and polymers. This section interrogates the consequences of instrumental research for flavor science.

In chapter six, I trace the gradual development of the instrumental assemblage of basic flavor research in the USDA and the academy, beginning with the first gas chromatography units in the early 1950s and ending in the early 1970s when conjoined capillary column gas chromatography-mass spectrometry had become standard in the field. I attend to the specific techniques, technical modifications, and embodied practices that distinguish flavor researchers from other users of these machines, and consider the

special problems of correlating “objective” information about chemical identity with “subjective” information about its perceptual meaning.

My final chapter considers how the expanding body of basic research about flavor was applied to the design and development of synthetic flavors at flavor companies. A rising cohort of creative flavorists, most of them hired after the war, redefined social, material, and professional norms in their field, and managed an increasingly complex set of knowledge practices related to chemicals, regulations, and commercial conditions. I track these changes by following the training regimes, professional virtues, and career ideals of members of the Society of Flavor Chemists during its first twenty years, between 1954 and 1974.

Chapter 1

Flavor by Formula: Making, Using, and Consuming Synthetic Flavors Before the Second World War

August Hofmann sucked on a pear drop, and wondered. Hofmann, director of the Royal College of Chemistry, was a member of the jury for the Great Exhibition of the Works of Industry of All Nations, the sprawling Victorian fair that, in 1851, assembled the world's accumulated technological marvels, priceless gems, mass-manufactured novelties, and assorted bric-a-brac within a dazzling glass and iron enclosure upon a hill in Hyde Park, London.³⁸

Among the ferrovitreous arcades of the 1851 Exhibition, the pear drop was, in its way, as much a marvel as any of the other industrial products on display at the Crystal Palace. The barley-sugar lozenge had the fruity aroma of a Jargonelle pear, a variety well-known in England, Hofmann's adopted homeland. But its resemblance to the pear was arrived at not by way of the ripened fruit, but from a chemical compound, synthesized from one of the byproducts of industrial alcohol distillation. As Hofmann wrote to Justus Liebig, his erstwhile professor, "pear oil," the substance used to flavor the candies, was nothing more than amyl acetate, a compound whose odor they both knew well, diluted in several volumes of neutral alcohol.³⁹ And this was only one of the many

³⁸ Jeffrey Auerbach, *The Great Exhibition of 1851: A Nation on Display*, (New Haven: Yale UP, 1999); Peter Sloterdijk, "The Crystal Palace," *Public* 37 (2008): 11-16.

³⁹ August Hofmann, "Chemistry Applied to Arts and Manufactures: Application of Organic Chemistry to Perfumery, from a Letter written by Dr. Hofmann to Prof. Liebig,"

“artificial essences” showcased at the exhibition. Perfumers, druggists, and makers of fine chemicals from Britain, France, and Germany displayed fragrant vials of substances that evoked the odors of apple, pineapple, and other fruits, as well as “artificial” oil of bitter almond and of wintergreen. All of these things captivated the scientific interest and fancy of many observers, who may well have already consumed these synthetic compounds in candies, liquors, and other beverages.

Hofmann was not able to identify the chemical compounds that comprised all the artificial fruit essences he sampled. However, he recognized that most of them were members of a group of organic chemicals then called “compound ethers.”⁴⁰ As he wrote to Liebig: “The remarkable fruity odor of many of these ethers had not been overlooked by chemists.” Indeed, what chemist had not noticed the “insupportable odor of rotten apples” that “filled the laboratory” when preparing valerianic acid?⁴¹ Even if smell and taste had lost their primary evidentiary status in the quantitative chemistry that prevailed after Lavoisier, the balance, thermometer, and other instruments had not mitigated the stinkiness of the chemical laboratory.⁴²

The Chemical Gazette 10 (March 1, 1852): 98-99. Originally appeared in the *Ann. der Chem. und Pharm.* vol 71.

⁴⁰ “Compound ethers” belong to the class of chemicals that are now referred to as esters: organic compounds comprising an oxygen atom bonded to an alcohol radical and an acid radical. Compound esters with a fatty acid radical are generally described as having a fruity smell.

⁴¹ Hoffmann 1852: 98.

⁴² Lissa Roberts, “Death of the Sensuous Chemist: The ‘New’ Chemistry and the Transformation of Chemical Technology,” *Studies in the History and Philosophy of Science* 26.4 (1995): 503-29.

Nonetheless, it would not be the academic chemists, insisted Hofmann, who would turn their sensory observations about chemical compounds into commercial products, in order to peddle a dilute solution of amyl valerianate as “apple oil” to confectioners, or suggest ethyl butyrate as a way of adding a redeeming pineapple flavor to “bad rum,” or amyl acetate to give a sugar-drop a kiss of pear. “It was reserved to practical men to make the selection and ascertain the proportions in which certain of these compounds resembled in so great a degree the aroma of particular fruits that we almost feel ourselves led to the idea, that these very compounds are the cause of the odor of the fruits in question.”⁴³ Hofmann went on to speculate that chemical analysis of fruits may one day prove this to be the case, and that these synthetic compounds might indeed be identical to those that gave ripe fruits their distinct flavors.

Like the elm trees enclosed within the Crystal Palace pavilion’s glazed interior, or like the structural architecture of the building itself—designed by gardener Joseph Paxton after the branching venation along the underleaf of the *Victoria regia*, the colossal Amazonian waterlily—the lozenges’ chemical evocation of Jargonelle pear wrenched nature into novel material contexts and juxtapositions, recalling familiar experiences but offering entirely new sensations.

How did chemicals become flavors, and how did flavor become a chemical phenomenon?

⁴³ Hofmann 1852: 99.

The answer to these questions lies with the “practical men,” who had recognized and seized upon the commercial potential of these newly available materials. Before researchers began analyzing fruits and flowers to determine the chemical causes of their flavors and aromas, a diverse group of skilled workers, trained in chemical methods if not schooled in chemical theory, were capitalizing upon these similarities, refining the sensible qualities of chemically produced flavorings, and building a market for their production and use. Within a year of Hofmann’s visit to the Crystal Palace, synthetic fruit ethers were commercially available in the United States, generally imported from England, France, or Germany. Soon after, these chemicals began to be produced domestically in the United States, and found increasingly widespread applications in manufactured sweets, beverages, liquors, and household extracts. By the end of the First World War, synthetic flavorings were commonplace. They made the child’s red candy ‘cherry’ or ‘strawberry;’ added the savors of ‘peach’ and ‘vanilla’ to the lady’s afternoon dish of ice-cream; put the ‘bourbon’ in the laborer’s nightly draught.

When this chapter opens, in the second half of the nineteenth century, synthetic flavor additives are generally one product among many manufactured by pharmacists and others with skill as “practical chemists” who make a range of chemical goods. When this chapter ends, after the First World War, flavor additives have become specialty products made by workers with unique training and skills, including specialized knowledge in the manipulation of the sensory qualities of chemical materials. This chapter traces the emergence and growth of a specialized industry producing synthetic flavors in the United States, and the concurrent appearance of individuals who fashioned themselves as experts

in the creation of flavorings, by examining three dimensions of this transformation: to materials, methods, and manufacturers.

This chapter unfolds in three parts. I begin by considering the materiality of synthetic flavors — the chemical compounds that constituted flavorings, their origins, and the material contexts in which they circulated and mingled. Two substances in particular are crucial to understanding the expanding market for synthetic flavors in the nineteenth century: sugar and alcohol. Synthetic flavorings were intimately bound up with the same industrial processes that made these substances into standardized commodities, and played an instrumental role in their conversion back into desirable, sensually attractive consumer goods.

Next, I examine the limited number of chemical compounds used in flavorings, and consider how they were made to reproduce a cornucopia of fruit flavors. What types of knowledge and what kinds of skills were required to make synthetic flavors out of chemicals, and how did this knowledge circulate, accumulate, and change? The formula is the central figure in this part of the story. On the one hand, if flavors are chemicals, then anyone with access to those chemicals and some basic chemical training should be able to make them by following rote formulas. But if the chemical aspect of flavor is perceived not as a grounds for replication and imitation, but as an opportunity for innovation, distinction, and discovery — a field for the rapid production of novelty, bringing food and flavor under the cultural logic of fashion — then an expert with a different set of skills and resources is needed. The flavor formula — whether public or

proprietary, whether conclusive or a starting point — is bound up with the identity and professional prestige of the individuals who made synthetic flavors.

From here, I turn to the relation between these makers and the companies they worked for and transacted business with. The earliest makers and users of synthetic flavorings included pharmacists, distillers, perfumers and essential oil dealers, and manufacturers of confectionery and syrups, as well as makers of household extracts for domestic consumers. The groups involved in the production of synthetic flavorings often had special access to raw materials, special skills in practical chemistry, or some combination of the two. The claims these early manufacturers made about the virtues of their products were most often about their chemical purity and freedom from adulteration, rather than the uniqueness of their qualities or the skill in their blending.

This started to change around the turn of the twentieth century, when specialized flavor and fragrance companies began to offer proprietary formulations, produced by skilled workers who blended different flavoring compounds into a finished product, as well as technical assistance directly to manufacturers. By the end of the First World War, a growing industry in synthetic flavorings had taken root in the United States, separate and distinct from its precursors in pharmacy and distillery. As a specialized chemical industry, the flavor business was generally oriented toward making products that served the needs of other manufacturers — namely, food and beverage producers — rather than products intended for ordinary, household consumers.

In this final section, I focus on the story of one exemplary synthetic flavor and fragrance company, Synfleur, and the career of its founder and chief chemist, Alois von Isakovics. Beginning in the 1890s as a manufacturer and mail-order dealer of proprietary medicines, perfumes, and other small retail goods, with the advent of the twentieth century, the company shifted to producing synthetic aromatic raw materials for manufacturers. Synfleur staked its place in the market by offering not only a wide variety of quality chemical compounds and specialties, but also expert advice and products customized for individual manufacturers. Meanwhile, Isakovics tirelessly educated manufacturers, students, and other segments of the chemically-interested public about the science underlying the production of the synthetic aromatic chemicals, aligning this category of products with those of other progressive industries, and articulating an argument for the superiority of synthetics over “natural” materials. Embedded in Isakovics’ chemical writings is a theory of flavor design, one which interrogates the material conditions which produce naturalistic sensory effects.

I conclude with a brief account of new chemical materials and flavor companies after the first world war, examining how these companies portrayed themselves as part of a scientific industry.

I. FROM GROSS MATERIALS TO ETHEREAL DELIGHTS

Shortly after the 1851 Exhibition, compound ethers — generally using the name “fruit essences” — began to appear in the United States, where they were imported, produced domestically, and sold by druggists, manufacturing chemists, and dealers in

essential oils and perfumery.⁴⁴ From the outset, synthetic flavorings rapidly found their way into a variety of sweet confections and refreshments, such as confectionery, jellies, sauces, pastries, syrups, carbonated beverages, and other sweet and sweetened things. While commercial food manufacturers could purchase flavorings in wholesale quantities, households could purchase one- or two-ounce retail bottles of flavoring extracts, for use in baking and cooking.⁴⁵

In addition to sugar drops, bon-bons, and soda fountain syrups, the compound ethers also flavored less innocent pleasures: liquors and spirits. The same synthetic chemicals used in sweets found a ready place in the production of alcoholic beverages, where they gave neutral spirits the semblance of rum, whiskey, cordials, brandies, or just about any other liquor imaginable, and “improved” lackluster swill by imparting the qualities of age and refinement. Amyl acetate, for instance, the substance that added pear flavor to sugar lozenges, was also recommended for use in “old rye, Bourbon, and

⁴⁴ “Compound ethers” belong to the class of chemicals that are now referred to as esters, organic compounds comprising an oxygen atom bonded to an alcohol radical and an acid radical. Compound ethers with a fatty acid radical were known to have a fruity smell.

⁴⁵ See, for instance, *Centennial Cookbook: J.W. Colton’s Choice Cooking Recipes, Preparation, and Calendar for 1876-1877*, [pamphlet], (Westfield, MA: J.W. Colton Co., 1876), courtesy Alfred Goossens. This booklet contains recipes for crullers, sponge cake, and other foods using Colton’s Select Flavors addressed to housewives, endorsements from politicians and medical professionals, and testimonials from confectioners, hotel operators, and other commercial food producers. It also contains advertisements for Colton’s patent medicine formulations, including Nervine tonic. Typical of flavoring extracts produced at the time, there is little distinction between household and commercial markets for these products, and, as goods, they are classified with proprietary medicines, soaps, and toilet articles.

Roanoke whiskey” as “its soft, mellow odor” imparted “to any kind of liquor the fine, soft mellowness of age.”⁴⁶

In the case of both sweet things and booze, the synthetically produced fruit ethers were used in conjunction with many other flavoring and coloring materials, both botanically derived and chemically created. Vanilla bean extract, for instance, became commercially available around the same time that the fruit essences began to circulate; vanilla flavorings, often produced by combining genuine beans with synthetic compounds including vanillin and coumarin, gained rapid popularity as the nineteenth century drew to a close.⁴⁷ Taken as a whole, what these new technologies of flavor made possible was the continual, efficient production of variety, allowing manufacturers large and small to offer goods that conformed to the fluctuations of consumer desires rather than simply reflecting natural cycles of availability.⁴⁸

The meaning of synthetic flavors was also entwined with their distinctly unappealing, chemical origins. “Some of the most esteemed modern scents are made by

⁴⁶ Pierre Lacour, *The Manufacture of Liquors, Wines, and Cordials without the Aid of Distillation*, (New York: Dick & Fitzgerald, 1868) [Originally published by subscription, New York: R. Craighead, 1853]: 57.

⁴⁷ Nadia Berenstein, “Making a Global Sensation: Vanilla Flavor, Synthetic Chemistry, and the Meanings of Purity,” *History of Science* 54.4 (December 2016): 399-424.

⁴⁸ This type of relationship is described in detail by Philip Scranton in his study of specialty production in American manufacturing during this period. Scranton argues that custom and batch production played an unheralded role in the expansion of mass production and the formation of a consumer economy, allowing for flexible, rapid response to fluctuating market demands. Like many of the specialty and custom manufacturers Scranton describes, flavor manufacturers clustered in particular urban regions, employed a specialized labor force, and tended toward a competitive strategy that emphasized novelty and quality over price reductions. Philip Scranton, *Endless Novelty: Specialty Production and American Industrialization, 1865-1925*, (Princeton UP: 1997).

chemical means, from materials which are generally considered anything but pleasant,” marveled one account of synthetic perfumes and flavorings displayed at the 1853 New York Exhibition, articulating a sentiment that would often be repeated in popular scientific literature.⁴⁹ Although it underscored the rude origins of synthetics, the sentiment was not entirely negative. It is as though the triumph of chemistry over nature was magnified by the reclamation of pleasurable substances from repulsive materials. As a book of practical chemical formulas published in 1860 informed readers, “The majority of the fruit extracts which are manufactured for sale are artificial.... Some of them — I will not say what ones — are made from the drippings of horse stables, and most delicious to the taste!”⁵⁰

As far as I can tell, horse excrement was not a component of any known flavorings.⁵¹ However, most of the synthetic fruit ethers were made from another noxious substance: ‘fusel oil.’ This foul-smelling, sickening liquid was a mixture of compounds, mainly amyl alcohol and other higher alcohols — ie, those with more carbons than ethyl alcohol’s two — separated from ethyl alcohol and other desirable substances through distillation. In other words, it was a waste product. “It will strike the reader as not unworthy of remark,” instructed one popular chemistry textbook published in the 1850s,

⁴⁹ Charles Rush Goodrich, ed. *Science and Mechanism: Illustrated by Examples in the New York Exhibition 1853-1854* (New York: Putnam & Company, 1854): 242.

⁵⁰ A.W. Chase, *Dr. Chase’s Recipes, or, Information for Everybody: An Invaluable Collection of About Six Hundred Practical Recipes...* 8th ed. (Ann Arbor, MI: A.W. Chase, 1860): 177.

⁵¹ I believe Chase’s reference is not to a flavoring, but to the alleged origins of the perfume (and medicine) known as “eau de millefleurs,” which was, by many accounts, made from cow urine or dung, and dates to the reign of Louis XV, if not before. The emphasis on the abject origins of these substances of pleasure was familiar rhetoric for both perfumes and flavors.

that the same substance that “because of its offensive smell and taste is carefully removed by the rectifier from the ardent spirits he distils, should, under the hands of the chemist, become possessed of the most agreeable and coveted fragrance!”⁵² (‘Pineapple essence’ — ethyl butyrate — was the exception; rather than being synthesized from fusel oil, it was “obtained by fermenting a mixture of sugar, sour milk, a little old cheese and some chalk,” according to contemporary sources.)⁵³

The process of converting fusel oil into fruit essences was a chemical procedure, requiring other harsh and unpalatable substances — such as potash and ‘oil of vitriol’ (sulfuric acid) — as well as substantial quantities of neutral spirit (ethyl alcohol). But to many contemporary commentators, the creation of these products seemed to require more than chemical skill. One British account of the operations of a London chemical manufacturer portrays Mr. Routledge, the firm’s extract maker, as a fine artist:

“With sundry bottles of ethereal compounds before him, ranged like the colours in a painter's palette, he adds ounces of one, drops of another, and mere hints of others, until he ultimately finds that he has made the essence required. We might as well ask the artist how he mixes his russets and purple grays, as ask Mr. Routledge how he makes artificial ribstone pippins and raspberry out of ethers whose origin is to be sought for in stinking cheese and the foulest fusel oil.”⁵⁴

⁵² James F.W. Johnston, *The Chemistry of Common Life*, Vol. 2, 8th ed., (New York: D. Appleton, 1856): 202.

⁵³ W. Bastick, “Artificial Essence of Pineapple,” in G.W. Septimus Piesse, *The Art of Perfumery...2nd American edition*, (Philadelphia: Lindsay & Blakiston, 1867): 384-5.

⁵⁴ “A Visit to Messrs. Davy and Macmurdo’s Chemical Works at Bermondsey and Upper Thames Street,” in Dr. G.L.M Strauss et al. *England’s Workshops*, (London: Groombridge & Sons, 1864): 158-9.

The skill required to make these flavorings was craft-based and artisanal, the same sort of tacit knowledge about materials that guided a painter's use of paint. At once "the products of the chemist's science and the manufacturer's art," gross materials were transformed into ethereal substances that could then impart the flavor of "strawberry, pineapple, apricot, quince, raspberry, green gage [plum], mulberry, black currant, &c." to "syrops, jellies, blanc mange, cordials" and other confections.⁵⁵

MAKING COMMODITIES INTO CONSUMER GOODS

Synthetic flavorings bound together two substances transformed by industrialization: sugar and alcohol. Sugar and alcohol, eminently versatile materials, have played multiple and changing roles in cultural and social life: as components of luxury goods, medicines, and preservatives, as well as agents of sweetness and intoxication. The meanings and uses of these substances, and the sensations and pleasures associated with them, shape and are shaped by historical, economic, and technological forces.⁵⁶ During the nineteenth century, both of these substances became mass-produced commodities, and were made homogenous, pure, and standard by new chemical

⁵⁵ "Art vs. Nature," *The American Journal of Pharmacy and the Sciences*, (April 1852): 184.

⁵⁶ Sidney Mintz, *Sweetness and Power: The Place of Sugar in Modern History*, (New York: Viking, 1985); Wendy Woloson, *Refined Tastes: Sugar, Confectionery, and Consumers in Nineteenth-Century America* (Baltimore: Johns Hopkins University Press, 2002); Iain Gately, *Drink: A Cultural History of Alcohol*, (New York: Gotham, 2008).

techniques and industrial technologies.⁵⁷ But these commodities were not yet consumer goods. Their standard and uniform properties — a chemical purity that could come to seem like an absence of qualities — had to become specific and ‘impure’ in order to gain maximum value in the consumer market.⁵⁸ Drinkers craved whiskey, not ethanol; bonbons were delectable, not sucrose.

Synthetic flavorings, and the sensations they produced, played a crucial role in transforming these standard commodities into desirable consumer goods, into objects of fashion, pleasure, and value. At the same time, the standard chemical composition of industrially produced alcohol and sugar made these materials the ideal media for the conveyance of deliberate, designed flavorful experiences. But, for the status and reputation of synthetic flavorings, getting mixed up with these two commodities had different outcomes. The dubious reputation of alcoholic beverages during a time of growing temperance sentiment, as well as commercial and political divisions within the spirits industry, cast suspicion on the quality, safety, and honesty of added flavorings. In this context, synthetic flavors came to be seen as inherently fraudulent. And while

⁵⁷ For an illuminating account of the scientific, social, and technological labor necessary to make sucrose the standard of sugar, see David Roth Singerman, “Inventing Purity in the Atlantic Sugar World,” (PhD diss., MIT, 2014).

⁵⁸ The meanings, and relative values, of purity and its opposite would come to be a subject of contention during the debates around the 1906 Pure Food and Drugs Act. For chemists, a pure substance is one that is chemically homogenous; outside of the laboratory, purity indicates wholesomeness and soundness, and carries with it moral, physical, and even spiritual virtues. Although regulators enforced the meaning of purity consistent with public understanding, as chemists they had to concede that for many products — such as maple sugar, and whiskey — the consumer could be said to pay a premium for the impurities. See, for instance, James H. Shepard, “Like Substances,” *Pure Products* 3.11 (November 1907): 507-13. Shepard was a chemist with the South Dakota Pure Food Commission.

synthetic flavors did carry an ambivalent reputation among manufacturers and consumers of sugary treats and refreshments, their use also facilitated the production of an expanding and dazzling array of sweet substances, and made a new kinds of consumer experiences — the experience of limitless variety, of immediate pleasure — imaginable, possible, and accessible to an emerging mass market.

‘ANY KIND OF LIQUOR THAT YOU WANT IN FIVE MINUTES’ NOTICE’ ⁵⁹

Industrial alcohol distillers and rectifiers played an early, crucial role in the emergence of a trade in synthetic flavorings. The connections between industrial distillation and flavor manufacturing are manifold, on both the supply and the demand sides. Distillers and rectifiers were users of flavoring extracts, and also supplied flavoring manufacturers with raw materials (fusel oil, esters, and purified ethanol, the universal menstruum for flavoring extracts).

Alcohol is a naturally occurring byproduct of fermentation. As yeasts and other microorganisms colonize a fruit juice or grain mash, they break its sugars down into molecules of ethanol, meanwhile perpetrating chemical transformations that yield higher alcohols as well as other compounds, both fragrant and obnoxious. Spirits such as whiskey and brandy are produced by further distillations of this initial fermentation. The key tool of distillation is the still, where the fermentation liquid is heated, and differentials in boiling point are used to separate ethanol from water and other chemical

⁵⁹ From the Testimony of James M. Veazey to the U.S. House of Representatives, Committee on the Judiciary, *Report on the Whisky Trust Investigation*, 52nd Congress, 2d. Session, (March 1, 1893): 10.

components — including toxic methanol and acetone, fusel oil, and a group of substances known as ‘congeners,’ which contributed flavor, richness, and body.⁶⁰

Until around 1830, the copper pot still was the standard technology of distillation. Producing spirits in this way was a batch process, and required skilled, attentive labor and plenty of fuel. The end result was not purified ethanol, but ethanol mixed with selectively limited quantities of fusel oil and congeners. Further steps, including aging in wood casks and a series of subsequent distillations known as rectification, were generally required to develop desirable flavors and diminish harsh and uninviting ones.⁶¹ A skilled distiller was a respected artisan who could bring out the treasured qualities of a spirit through careful management of the process of production. The quality of the spirit was often greatly influenced by the quality (and cost) of the raw material used in distillation, as well as the time spent aging, and it was difficult to maintain standard properties from batch to batch. Although the highest quality spirits continue to be produced using pot distillation, the

⁶⁰ Harold McGee, *On Food and Cooking: The Science and Lore of the Kitchen*, revised edition, (New York: Scribners, 2004): 713-8, 758-71. Congeners included compounds such as esters, terpenes, and phenolics, which added characteristic and valued flavors, richness, and body. While most spirits are largely composed of ethanol, different congeners account for the distinct taste of whiskey and bourbon, or rum and rye.

⁶¹ Aging (especially in wood) improves the flavor of whiskey in various ways. Fusel oil and congeners oxidize, developing into molecules with more prized sensory qualities. Compounds from the wood barrel itself also leach into the alcohol, reacting with chemicals in the whiskey and undergoing other desirable chemical changes. Some of the oxidative changes that occur to fusel oil during the process of aging result in the same ester compounds that chemists synthesized.

technical and material requirements of this technology limit the scale and speed of alcohol production.⁶²

Distillation can also be performed with a fractionating column, which separates substances of different boiling points at condensing plates arranged within an elongated cylinder. Several attempts to render this principle into a practicable continuous distillation device preceded the successful design patented in 1830 by Aeneas Coffey, a retired Irish exciseman. Coffey's two-column, steam-heated 'patent still' was extremely efficient, could be operated continuously, and did not require the close monitoring of an expert distiller. It reliably produced a concentrated spirit containing between 86 and 96 percent ethanol. This efficiently achieved purity meant that variations were kept to a minimum. Coffey's patent still, and similar devices that followed, made it possible to produce a spirit that approached the status of a homogenous commodity.⁶³ Once alcohol became a standard commodity, it could readily assume industrial applications and purposes. It also made the other, secondary, compounds — such as the fraction of fusel oil — available as raw materials for other chemical processes.⁶⁴

⁶² McGee 2004: 761-3; R.B. Weir, "Distilling and Alcohol, 1870-1939," *Agricultural History Review* 32.1 (1984): 50.

⁶³ Weir 1984: 50.

⁶⁴ Fusel oil had once been considered largely a waste product of distilling. One of the earliest uses for fusel oil was the production of synthetic flavorings, and the importance of the material grew as it began to be used in an increasing number of chemical processes, including the manufacture of celluloid, pyroxylin varnishes, photographic films, and alkaloids. Before the First World War, Russia was a major exporter of fusel oil to the United States. The Russian revolution and the expansion of prohibition caused industrial chemists to search for alternate raw materials to replace the tightening supply of this material. See R. Schupphaus, "On the Alcohols of Fusel Oil," *Journal of the American Chemical Society* 14.3 (1892): 45-60; Benjamin T. Brooks, Dillon F. Smith,

But even as the continuous still created new efficiencies, markets, and opportunities for alcohol distillers, commodity alcohol was of little value to consumers. Simply put, the same processes that made alcohol standard, also stripped it of the compounds that produced its flavor and other sensible qualities. In order to become a desirable beverage, to compete with products with known market value, manufacturers had to add substances that contributed color, flavor, and aroma.

In the United States, this was performed by a group of licensed professionals known as rectifiers, who blended neutral spirits with synthetic and botanical flavorings, or with “straight” (ie, distilled and aged) liquor, to produce branded products that were then sold to wholesalers.⁶⁵ These “blended” spirits also tended to be safer for consumers, as their mode of production meant they generally contained lower quantities of fusel oil.⁶⁶ Blending allowed for the large-scale, efficient production of liquors and spirits; cost savings could then be passed on to consumers. But it also divided the industry, pitting the interests of producers of “straight” goods from those who made and sold “blended” liquors. It also divided lawmakers and consumers, many of whom did not consider the rectified and flavored product to be “genuine” liquor, but imitations, of lesser quality and with diminished medicinal effectiveness.

and Harry Essex, “The Manufacture of Amyl Acetate and Similar Solvents from Petroleum Pentane,” *Journal of Industrial and Engineering Chemistry* 10.7 (July 1918): 511-15.

⁶⁵ Jack High and Clayton A. Coppin, “Wiley and the Whiskey Industry: Strategic Behavior and the Passage of the Pure Food Act,” *Business History Review* 62.2 (Summer 1988): 286-309; Werner Troesken, “Exclusive Dealing and the Whiskey Trust,” *Journal of Economic History* 58.3 (1998): 755-78.

⁶⁶ High and Coppin 1988: 291.

Because synthetic flavorings were necessary to the production of blended whiskies, in the 1890s, the products were caught right in the middle of one of the earliest scandals of monopoly capitalism, and drawn into the midst of Congressional hearings on the Whiskey Trust. The Whiskey Trust, or, as it was officially known, the Distilling and Cattle Feeding Company, was an organization of distillers who produced neutral spirits for the manufacture of rectified whiskey, not “straight whiskey.” The industrialization of alcohol manufacturing had led to overproduction and falling prices, exacerbated by rising imports of potato- and grain-based spirits from Europe.⁶⁷ The Whiskey Trust formed in the 1880s in response to these perilous economic conditions. By limiting production across their network of distillers, they kept prices from plunging below sustainable levels. By the time of the 1893 Judiciary Committee investigation, they dominated the market — producing more than 95 percent of all the spirits legally manufactured in the United States.⁶⁸ This market dominance allowed the Trust to develop a system of rebates to compel wholesalers and merchants to buy exclusively from them; the effect was to further drive competitors out of the market and exert a monopolistic control over prices.

The main question before the House Judiciary Committee was whether the Whisky Trust was engaging in anti-competitive practices.⁶⁹ Inextricable from this investigation of commercial practices was an inquiry into the substance of the product

⁶⁷ High and Coppin 1988; Troesken 1998; Williams Haynes, *American Chemical Industry: A History, Vol I: Background and Beginnings*, (Toronto: D. Van Nostrand, 1954): 320-1.

⁶⁸ Troesken 1998: 760.

⁶⁹ U.S. Congress. House. Committee on the Judiciary. *Report on the Whisky Trust Investigation*, 52nd Cong., 2nd sess., 1893, H. Rep. 2601.

they were manufacturing, whether there was something suspect or against public interest inherent in the very nature of rectified whisky. Indeed, many in Congress wondered whether it could rightfully be called whisky at all.

The Judiciary Committee hearings kicked off with a bombshell whistleblower as a witness, James Veazey. Born in 1854, in Hamilton County, Ohio, Veazey had worked as a traveling liquor salesman since 1878, peddling whiskies, brandies, gins, and other spirits for a half dozen companies in Ohio, Kentucky, and Illinois, before a health crisis precipitated his retirement from the road. This included three years working for Alexander Fries & Brothers, chemists, of Cincinnati, where, he became privy to "what is known as the 'secrets of the liquor trade.'" He assures the Judiciary Committee: "I became acquainted with its entire manipulation."⁷⁰

Over two days of testimony, Veazey let the members of the Committee in on the "secrets of the liquor trade," showing them exactly how a dealer could produce "any kind of liquor that you want" with "five minutes' notice." The transcripts record a man unspooling an easy, confiding patter:

"Say an order comes in for any class of goods, say Jamaica rum; Jamaica rum essence is put into [spirits] and it is colored with burnt sugar and the name branded upon it as the law requires it shall be stamped, and away it goes. Say another order comes in for gin, and the spirits is filled out of the same tub, flavored with gin essence, colored with sugar, sirup, or glucose,

⁷⁰ Testimony of James M. Veazey, Saturday, February 4, 1893, *Report on the Whisky Trust Investigation*: 1-16.

and away that goes. Yes, sir; anything you want, and it is generally in use, and represents to-day one-half of the liquor business of this country."⁷¹

Veazey answered the Congressmen's questions, providing documentation at times, but drawing dramatic authority as a witness by invoking his personal experience. For instance, when asked if the flavoring essences are poisonous, he replies: "I am not a chemist, but I have been warned when in the employ of these people not to take the crude material in my mouth."⁷²

On his second day of testimony, Veazey added some show to his big tell. He brought in two demijohns of spirits, as well as "a number of bottles containing essential oils, essences, etc.," and stirred up a full bar's worth of libations for the Judiciary Committee.⁷³ Beginning with neutral spirits, he added a drop of Jamaica rum essence, some coloring, some simple syrup, and passed out tumblerfuls for the members to sample. "Does it smell like rum and taste like it?" he asked. I picture the tipling congressmen nodding in affirmation, all except the most teetotal of the bunch, who perhaps deigns only to stick his long and disapproving nose into his tumbler to take a long and disapproving sniff. Veazey then demonstrated the effect of another additive ("bead oil") that altered a watered-down rum so that it ran thicker, with the viscosity of full-strength liquor. He mixed up rye whiskey, then "aged" it with other essences, prune

⁷¹ Ibid: 14.

⁷² Ibid.: 7.

⁷³ For a similar performance of the fraudulence and allure of ready-made liquors, see: Eli Johnson, *Drinks from Drugs, or the Magic Box: A Startling Exposure of the Tricks of the Liquor Traffic*, (Chicago: Revolution Temperance Publishing House, 1881).

juice, and raisin oil, to imitate successively older bottlings — three-year, five-year, and even "velvet" whisky, aged thirty years in oak casks.⁷⁴

Throughout his testimony, Veazey underscored that the ultimate dupe is the consumer. "The average man... is unable to protect himself, not understanding these imitations... at the time of purchase... falsely represented to him."⁷⁵

But what, really, makes the imitation so deplorable? Consider that the persuasiveness of Veazey's demonstration depended on the undetectability of the imitation, on the high quality of the flavoring. If whisky, rum, cognac made from alcohol and flavoring essences were bad imitations, then they would be less of a problem; frauds could be sniffed out, unscrupulous agents and manufacturers driven out of the market if substantially inferior to the real thing.

From the perspective of the chemists who manufactured flavoring essences, their products were directly related if not chemically identical to the compounds that gave "straight" liquors their flavors. Entered into the Congressional Record of this investigation is the complete text of a *Manual for Compounders*, published by Fries & Brothers — a handbook for users of their flavoring essences. "All natural old liquors (straight goods) contain certain odorous compound ethers arising from fermentative processes and slow oxidations," instructed the manual. But these sluggish processes can

⁷⁴ Testimony of James M. Veazey, Saturday, February 4, 1893, *Report on the Whisky Trust Investigation*: 14.

⁷⁵ Veazey's testimony was itself a fraudulent act, connected with a naked short selling stock scam. See: Nadia Berenstein, "Who's Afraid of the Whisky Trust," *Flavor Added Blog*, entry posted October 10, 2015, <http://nadiaberenstein.com/blog/2015/10/30/whos-afraid-of-the-whisky-trust> (accessed August 15, 2016).

be abbreviated by chemical reactions, producing ethers that are "the synthetical reproduction of those manufactured in nature's laboratory." Moreover, chemists who manufacturing flavoring essences often began with a raw material sourced from alcohol distillation — fusel oil, those higher alcohols, removed during distillation and otherwise a waste product. The question was whether the transformation of an undesirable waste material to a pleasant and valuable one would be effected by the oxidative effects of time, or the directed and deliberate efforts of the manufacturing chemist.

In other words, if the way that whisky changes as it ages in the barrel can be comprehended as a chemical process, then why not reproduce that process more efficiently, and thus more cost-effectively? Was this not one of the imperatives toward improvement that drives innovation? Yet this argument failed to be persuasive to many of the Congressional inquisitors and witnesses, who seemed to accept that there was something inherently inferior about whiskey produced this way.

The Congressional inquiry had little effect — it was unclear whether it possessed the legal authority to break up the corporation — though the Trust itself filed for bankruptcy in 1895, and subsequently reorganized in a less market-dominant form. However, the legitimacy and value of blended spirits, made with synthetic flavorings, continued to be in doubt, and would inform debates into the Pure Food and Drugs Act.⁷⁶ As Harvey Wiley, Chief Chemist of the Bureau of Chemistry and one of the law's proponents, explained in testimony, artificial flavorings were "chemically the same as those which are produced by the natural methods of aging in whiskey," but "there is

⁷⁶ High and Coppin 1998.

something lacking... While you can imitate nature, you cannot substitute the artificial for natural products without impairing the quality of the product.” This was an “almost indescribable” distinction that exceeded the powers of chemistry to define. “The stomach and the system are very expert wine tasters and whiskey experts, and they will detect the difference... which the chemical laboratory fails to distinguish.”⁷⁷

The imitation represented a diminution of quality, a difference in “effect,” that only the sensing body, not the skilled chemist, could register. There appeared to be a connection between the (allegedly) illicit profits of the Whisky Trust, and the specious flavor of ready-made whisky — both seemed unearned, dubious, untethered from solid virtues and values. This low reputation would continue to bedevil both manufacturers of synthetic flavors and the products they manufactured.

Sweetness and Variety

The industrialization of sugar production made that substance, once a refined luxury, a “prolific necessity.”⁷⁸ As domestic sugar production increased, and with sugar cane cultivation in the American territory of Hawaii, American consumption of refined sugar surged, particularly in the last quarter of the nineteenth century.⁷⁹

Much of Americans’ increased sugar consumption can be accounted for in manufactured foods, which packaged sweetness in a growing range of forms. New steam-

⁷⁷ Testimony of Harvey Wiley, February 28, 1900, Senate Committee on Manufactures, *Adulteration of Food Products*, 56th Cong., 1st sess., 1900, S. Rep. 516: 56.

⁷⁸ Woloson 2002: 3.

⁷⁹ Woloson 2002: 5-6.

powered machines made it possible to efficiently turn refined sugar into cheap candies: wafers, lozenges, cream centers, bon-bons, kisses, gum drops, and more.⁸⁰ The value of candy manufactured in the U.S. grew from \$3 million in 1850, to more than \$60 million at the century's end.⁸¹ Variety was the soul of the candy business; constant novelty was an imperative. One business expert, in 1915, estimated that the average wholesale confectioner offered between fifteen and six hundred different kinds of candy, with some listing more than a thousand.⁸²

Soda pop was another increasingly popular product that owed much of its appeal to sweetness. By the beginning of the twentieth century, parched Americans could quench their thirst at one of approximately a hundred thousand soda fountains, from ornate marble-and-mirrors fountains in ice cream parlors and upscale drugstores, department stores, ice cream parlors, to humbler fountains in train stations, five-and-ten cent stores, and sidewalk stands.⁸³

Soda fountains competed for trade through the encyclopedic range of flavors they made available, with new offerings creatively named to latch onto the latest trend. (For instance, at the height of the bicycle fad in the 1880s, fountains offered the “pedal pusher,” “sprocket foam,” and “cyclaphate.”)⁸⁴ Large soda fountains might have more

⁸⁰ Woloson 2002: 35-9; Samira Kawash, *Candy: A Century of Panic and Pleasure*, (New York: Faber and Faber, 2013): 27-43.

⁸¹ Kawash 2013: 29.

⁸² Kawash 2013: 40.

⁸³ Anne Cooper Funderberg, *Sundae Best: A History of Soda Fountains*, (Popular Press, 2002): 101.

⁸⁴ Funderberg 2002: 45.

than a hundred flavors on their menus, ready to prepare at a customer's request.⁸⁵ An article in *Scientific American*, in the summer of 1899, explained the economic role of the new and unique flavor in the soda fountain trade. A soda dispenser's "knowledge of syrups, waters, and chemicals enables him to mix different ingredients together which will produce a flavor peculiar to itself." This dreamed-up flavor, available nowhere else, "may have no other virtue. But if it is properly named and skillfully advertised, it may have a 'run' or a season that will pay big profits." The soda fountain operator did not expect to profit from this novelty forever. "He is satisfied if it will take for a few weeks or months." Of the countless new flavors introduced every year, fewer than one percent ever had any lasting success, according to the writer. But this cycle of novelty was a driver of sales as much as the reliable familiar flavors.⁸⁶

Joining the soda fountain was a business in bottled carbonated beverages, which began to expand rapidly when the price of sugar dropped after the Civil War. Bottlers' flavors became (and remain) a specialized branch of the flavoring industry, as these products have unique technical requirements dictated by their method of production and distribution. The dominant economic model for the manufacture of brand-name carbonated beverages consists of the distribution of flavorings to regional, independent bottling plants, which manufacture and bottle beverages under contract.⁸⁷ This places a high premium on batch consistency, flavor stability, and price control, properties that

⁸⁵ Funderburg 2002: 44.

⁸⁶ G.E.W., "Some Soda Water Fountain Statistics," *Scientific American* 81.7 (August 12, 1899): 99.

⁸⁷ See Bartow J. Elmore, *Citizen Coke: The Making of Coca-Cola Capitalism*, (New York: Norton, 2015) for an illuminating account of some of the business factors that produced this model.

synthetic flavorings could deliver much more readily than fruit-based syrups or botanical extracts.

Synthetic flavorings (and colors) did not simply make it possible to manufacture candy and soda pop at low cost for wide distribution. They made possible an experience of dazzling variety and choice that had been previously unimaginable, at least among less elite eaters. Synthetic flavors were not limited by seasonal and geographical patterns of cultivation that governed the fruits of the vine and the orchard; a synthetic pineapple did not have to be grown in Hawaii, a synthetic strawberry could be sampled in dead white winter. Soda fountains and confectioners did also use “true fruit” flavors, concentrated juices and syrups deriving their flavor only from fruit and sweeteners, but these “natural” flavors had liabilities. Fruit juices were difficult to concentrate and preserve from fermentation without developing an undesirable, ‘cooked’ taste.⁸⁸ Further, they tended to cloud or leave undesirable sediment in bottled beverages.⁸⁹ Synthetic flavors presented none of these challenges.

Then there is the question of intensity. “‘There is mighty little genuine fruit extract in the sirups and flavors of commerce,’” remarked the chemist of a flavor manufacturing house, quoted in a syndicated article from 1881, while “pushing aside glass jars, strainers, and retorts, so as to make a clear space for some of his books and

⁸⁸ Andrew Smith, *Drinking History: Fifteen Turning Points in the Making of American Beverages*, (New York: Columbia UP, 2013): 143. Smith observes the most common way of preserving fruit juice was by turning it into alcohol — fermenting it. He notes that the Shakers and the Oneida Community both developed techniques for concentrating and preserving unfermented fruit juice, which may be attributed to their prohibition on alcohol.

⁸⁹ Funderburg 2002: 46.

formulas. ‘Natural flavors are both weak and costly.’⁹⁰ The weakness of nature is contrasted with the power of the synthetic, its efficiency in delivering flavor sensations.

But even though synthetic flavors offered great advantages, and were widely commercially available by the 1870s, they were not universally used. The choice to use synthetic flavors appears to have depended on the reputation of the manufacturer or merchant, and the class of customer served. This is documented in an 1873 report on flavoring additives prepared by Henry K. Oliver, a medical doctor, for the Massachusetts Board of Health.⁹¹ His investigation began as an attempt to determine whether artificial essences were harmful, and in what quantities they could be safely consumed — questions to which he ultimately could not provide definite answers, although he warned against “habitual indulgence.” Oliver interviewed confectioners and makers of fruit jellies, visited druggists and apothecaries who operated soda fountains, and wrote to flavoring manufacturers and liquor dealers, inquiring into their use of these products. His report offers a picture of the market for artificial fruit essences at the time.

In order to find foods made with synthetic substances, Oliver had to do a bit of slumming. Tracking down jellies made with synthetic flavors necessitated a visit to a district of “second-class grocers,” where Oliver found deep-hued “currant” and other fruit-flavored jellies selling for 20 or 25 cents, less than half the price of the presumably

⁹⁰ “How Flavoring Extracts are Made,” *Iron County [MO] Register*, July 21, 1881. [Reprinted from New York Sun]

⁹¹ Henry K. Oliver, M.D. “Report on the Character of Substances Used for Flavoring Articles of Food and Drink,” *Annual Report of the State Board of Health of Massachusetts*, Vol. 4, (January 1873): 145-74.

genuine jellies sold by more prestigious grocers.⁹² Boston confectioners “of excellent repute” did not use artificial essences, and thus were able to offer only a limited number of flavors as a result.⁹³ Meanwhile, a manufacturer of popular candies “sold principally in the street and in places of public resort, railroad stations, etc.” used artificial flavors exclusively.⁹⁴ As for alcoholic beverages, he found that most of the spurious liquors were sold not in Boston, but by low-class dealers in small towns along the city’s margins.⁹⁵ The more elite the clientele, and the more well-heeled the district, the less likely Oliver was to encounter merchants that admitted to using artificial flavorings.

But it cannot be presumed that artificial essences were mainly consumed by the down-and-out. Oliver summarized the advantages of artificial fruit flavors for manufacturers. “The list of flavors could be greatly enlarged; perishable and rare fruits could be cheaply imitated in flavor by substances unchangeable and always at hand, and most persons would fail to detect the imposition.”⁹⁶ There were practical reasons for using synthetics. Oliver mentions “S,” a candy manufacturer of “good reputation,” who nonetheless used some artificial flavors in his products. “Desires to have a good list of flavors,” Oliver noted, “and finds it difficult to use fruit-juices in any but soft candy, on account of their watery element.” In other words, S. used artificial flavors not only to expand his range of flavors, but because they were materially more compatible with his production processes for hard candy, as they were more concentrated and in alcoholic,

⁹² Ibid: 165. Oliver testified that the cheaper jellies were mostly bland apply jelly, doctored with flavorings and colors.

⁹³ Ibid: 160.

⁹⁴ Ibid: 161.

⁹⁵ Ibid: 169.

⁹⁶ Ibid: 148.

rather than aqueous, solution.⁹⁷ The rumored “opinion” of “some chemists” that “the odor and flavors of flowers and fruits are really due to the presence of these ethers” had probably also “greatly encouraged their employment.”⁹⁸

Oliver also discovered that artificial flavorings themselves varied in quality and price, and manufacturers had options when it came to procuring or even making their own flavorings. One manufacturer of popular candies claimed to make his own essences, “from the best materials. They cost him nearly twice as much as those which he formerly bought.... Thinks the cheap essences are bad, but has a very different opinion of those made by himself.”⁹⁹ Another manufacturer of artificially flavored jellies claimed to pay “the highest price” for artificial fruit essences from a company in New York; his customers, he said, could not tell them from the real thing. Oliver himself agreed with this after sampling the currant jelly: “the taste decidedly resembled the currant flavor, so that it would generally pass for the genuine article.”¹⁰⁰ His report repeats the claim of one New York imitation fruit essence manufacturer: “when properly made,” he wrote, the artificial essences “are often preferred to pure fruit.”¹⁰¹

Nonetheless, the diminished reputation of synthetic flavors, their low-class cultural associations, the possibility of fraudulence and unwholesomeness that hovered around them, meant that even well-made synthetics bore the stigma of their chemical

⁹⁷ Ibid: 160.

⁹⁸ Ibid: 148.

⁹⁹ Ibid: 161.

¹⁰⁰ Ibid.: 165.

¹⁰¹ Ibid.: 163.

origins. Under these circumstances, it might be better not to disclose the use of synthetics, and instead, allow the flavor to speak for itself.

What did it mean for these products to be “properly made”? How did information about making flavors circulate? How did manufacturers attempt to improve the sensory qualities or use-value of their products, or distinguish themselves from competitors? The flavor formula, a chemical tool that could be published and shared or kept secret and obscure, sheds light on how synthetic flavor makers in the late nineteenth and early twentieth century made their products and built their trade.

FLAVOR BY FORMULA

*The artificial flavoring extracts are frequently known as ‘Fruit Ethers,’ and sometimes ‘Fruit Oils.’ Many of the ethereal ingredients of these extracts have received in the trade special, significant names. For example, amyl acetate is known as ‘Pear Oil,’ amyl valerianate as ‘Apple Oil,’ butyric ether as ‘Pineapple Oil’ and ‘Rum Ether,’ oenanthic ether as ‘Oil of Wine’ and ‘Grape Oil,’ and sometimes as ‘Cognac Oil,’ although various mixtures are also frequently sold under the latter designation. – A. Emil Hiss, *The Standard Manual of Soda and Other Beverages*, 1901¹⁰²*

Until the beginning of the twentieth century, the synthetic chemical compounds used in flavoring additives were more or less limited to the small set of compound ethers listed above, as well as a group of synthetic materials that claimed identity with naturally occurring chemicals: vanillin (artificial vanilla), coumarin (artificial tonka bean),

¹⁰² A. Emil Hiss, *The Standard Manual of Soda and Other Beverages: A Treatise Especially Adapted to the Requirements of Druggists and Confectioners*, 10th ed. (Chicago: G.P. Engelhardt & Co., 1901 [1897]): 36.

benzaldehyde (artificial oil of bitter almonds), and methyl salicylate (wintergreen oil).¹⁰³ Yet the variety of flavoring extracts available was diverse and dazzling. Emil Hiss, in the manual quoted above, provides more than twenty densely printed pages of extract and essence formulations, including five different formulas for banana essence, two for blackberry, two for gooseberry, four for nectarine, and five for peach.¹⁰⁴

How were a relatively small number of chemicals made to stand in for an expanding array of distinct flavorings? An examination of late-nineteenth and early-twentieth-century flavor formulas, and of the conditions and contexts of their circulation and dissemination, illuminates the changes to the practices, markets, and social networks involved in the production of synthetic flavorings.

Flavor and the Pharmaceutical Formulary

A nineteenth-century confectioner in search of one of the new synthetic flavors would most likely find them at the local druggists' establishment. An 1855 advertisement from Samuel Simes, whose retail drug store and chemical manufacturing business was housed in a large, four-story building that took up the Northwest corner lot on Chestnut

¹⁰³ In the final years of the nineteenth century, makers of flavorings also began to use some newer synthetic materials primarily used in perfumery: citral, often derived from lemongrass, which was used in orange and lemon flavorings; ionone, a violet-scented ketone synthesized from citral, sometimes used in raspberry; and linalyl formate, whose odor resembling bergamot, can be found in some formulas for peach, apricot, and other stone fruit.

¹⁰⁴ Hiss 1901: 36-59.

and Twelfth Streets in Philadelphia,¹⁰⁵ boasted that the fruit essences he manufactured “expressly for confectioners” gave candies and other sweets “the rich and luscious flavors of the different fruits more decidedly than the fruits themselves.”¹⁰⁶ He offered Pineapple, Strawberry, Raspberry, and Jargonelle Pear, as well as Vanilla, Orange, Blackberry, “and all other kinds.”

For much of the nineteenth century, druggists were the primary distributors, if not also the major manufacturers, of artificial flavoring essences, as well as other flavoring products in the United States. Botanical extracts and essential oils had long had a place in pharmacopeias, where they were included both for their purported therapeutic virtues as well as for their ability to make difficult-to-swallow medicines more palatable. Pharmacy trade journals and textbooks were early and important sources for formulas for synthetic flavorings.¹⁰⁷

Synthetic flavors fit nicely into the expanding portfolio of pharmaceutical products and practices. In the mid-nineteenth century, pharmacy was in the process of establishing itself as a modern professional discipline, one distinct from but in service to medicine, whose practitioners received scientific — and particularly chemical — education and training. Many druggists, such as Samuel Simes mentioned above, were

¹⁰⁵ "Samuel Simes, Operative & Dispensing Chemist," engraving mounted on paper, October 1856, Poulson Scrapbooks, vol. 8, Library Company of Philadelphia. [(8)2526.F.10]

¹⁰⁶ “Fruit Essences...” advertisement, *North American & US Gazette* [Philadelphia], (February 20, 1855): n.p.

¹⁰⁷ See, for instance, [M.] Fehling, “Artificial Fruit Essences,” *American Journal of Pharmacy*, March 1853): 155; Edward Parrish, *An Introduction to Practical Pharmacy*, 2nd ed. (Philadelphia: Blanchard & Lea, 1859).

not only retailers, but also manufacturers and wholesalers, who produced their own pharmaceutical preparations in a dedicated laboratory space, using chemical processes such as distillation, extraction, and so on. The “manufacturing pharmacist” generally had the chemical know-how to understand flavor formulas and processes, the specialized glassware and other tools to produce his own ‘compound ethers’ and to assess the purity and contents of commercially available essential oils and extracts, as well as the access to raw materials necessary for the production of flavorings.¹⁰⁸ As early as the 1850s, wholesale druggists’ supply houses and chemical supply catalogs began listing “compound ethers” among offerings, sometimes with a descriptive commercial term (e.g., ‘apple oil’) alongside the standard chemical name (amyl valerianate).¹⁰⁹

Druggists were also users of flavoring materials. In the battle for professional standing waged between doctors and pharmacists, the pharmacists’ ability to offer a more palatable preparation provided an advantage.¹¹⁰ The US Pharmacopeia and the National

¹⁰⁸ Gregory J. Higby, “American Pharmacy’s First Great Transformation: Practice, 1852-1902,” in Higby and Elaine C. Stroud, eds. *American Pharmacy (1852-2002): A Collection of Historical Essays*, (Madison: American Institute for the History of Pharmacy, 2005): 1-4; John Parascandola, “The Pharmaceutical Sciences in America, 1852-1902,” in *ibid.*, 19-23.

¹⁰⁹ See, for instance, “Descriptive Catalogue of Chemical Apparatus, Chemicals and Pure Reagents, Manufactured, Imported and Sold by Edward N. Kent, Practical Chemist, No. 116 John Street, Near Pearl,” (New York: Van Norden & Amerman, 1854); and “List of Chemical Preparations and Pure Reagents Imported and For Sale by JF Luhme & Co., 556 Broadway,” (New York: MW Siebert, 1856). Both catalogs list various compound ethers, under chemical names supplemented by commercial names indicating the fruit the chemical suggests or imitates.

¹¹⁰ John S. Haller, Jr., “With a Spoonful of Sugar: The Art of Prescription Writing in the Late 19th and Early 20th Century,” *Pharmacy in History* 26.4 (1984): 171-8. See also the advertisement for John Wyeth & Brother, Philadelphia Manufacturing Chemists, in the 1889 Meyer Brothers Catalog, which states that their products are regularly prescribed and preferred by a majority of doctors in the US and Great Britain, “on account of their

Formulary, the standard professional texts for drug formulation, both included formulas and instructions for preparing flavoring extracts. By the 1860s, these texts also included formulas for synthetic fruit flavors.

The professionalizing pharmacist was a follower of formulas, a producer of standard products that elicited standard effects on the human body (and sensorium). As flavor manufacturing became a specialized chemical industry, it would move to distinguish itself from this formula-bound model.

THE RISE AND FALL OF KLETZINSKY'S TABLE OF ARTIFICIAL FRUIT ESSENCES

Perhaps because of the professionalization of pharmacy, and the concomitant standardization of its practices and procedures, druggists' trade journals hosted the earliest American appearances of what would be the most influential and widely circulated set of flavor formulas: Kletzinsky's table of artificial fruit essences. Vincenz Kletzinsky (1826-1882) — sometimes spelled Kletzinski — was an Austrian chemist known for his work in 'animal chemistry.' That is, he studied the chemical reactions underlying the physiological processes of life: digestion, metabolism, health and disease, the ways that drugs worked upon the body.

superior quality, strength, elegance, and agreeable flavor.” [218] Meyer Brothers Drug Co., “Annual Catalogue and Prices Current,” St. Louis, MO, August 1889: 218. Smithsonian Libraries Trade Literature Collection.

Kletzinsky's Table of Formulas for "Artificial Fruit Essences" was first released into the world in 1865, when it appeared in his report of the latest pure and applied chemical research.¹¹¹ It began its circulation when it appeared in the pages of *Dingler's Polytechnisches Journal*, a widely-read German technical journal, the following year.¹¹² The table made its print debut in the United States in April 1867, in the *Druggists' Circular and Chemical Gazette*, and the following month, in the *American Journal of Pharmacy*.¹¹³

For at least fifty years, Kletzinsky's table and its associated formulas percolated through the written record: first in trade journals and professional reference books for pharmacists, confectioners, ice cream makers, and those in the beverage or soda fountain trade; later in miscellanies and formula books for amateurs. The formulas are included in two of the earliest American monographs on the subject of manufacturing and using flavoring extracts: Charles Herman Sulz's 1888 *Compendium of Flavorings*,¹¹⁴ and

¹¹¹ V. Kletzinsky, *Mittheilungen aus dem Gebiete der reinen und angewandten Chemie*, (Vienna: Selbstverlag des Verfassers, 1865): 45

¹¹² "Ueber die sogenannten Fruchtesenzen," *Dingler's Polytechnische Journal* 180 (1866): 77.

¹¹³ M. Kletzinski [sic], "On Fruit Essences," *Druggists' Circular and Chemical Gazette* (April 1, 1867): 82; "On Fruit Essences," *American Journal of Pharmacy* (May 1867): 238. Both of these early reprints contain an error, in that the column for "oil of persicot" (ie, essential oil of bitter almond, or benzaldehyde) is empty. These seem to be transcribing an error from the reprint of these formulas in the *London Pharmacy Journal*; as the original table in Dingler's Polytechnic contains quantities in this column.

¹¹⁴ This text was a selection and abridgment of a much larger volume published the same year, *A Treatise on Beverages, or The Complete Practical Bottler*. (Sulz described himself as a "technical and analytical chemist" with experience as a "practical bottler.") While *A Treatise on Beverages* was a comprehensive manual on nearly every aspect of producing bottled carbonated beverages, *Compendium on Flavorings* was intended to be work of broader utility, intended for all users of flavorings, with some recognition of the different needs these products had to fulfill in different contexts. For instance, Sulz drew

Fig 1. Kletzinsky's table of artificial fruit essences in one of its first appearances in the United States. M. [sic] Kletzinski, "On Fruit Essences," *American Journal of Pharmacy* (May 1867): 238.

Kletzinsky outlined a basic set of chemical materials that would be used in the production of synthetic flavors. These included a range of ethers and amyl ethers, a couple of essential oils, a pair of aldehydes (including benzaldehyde and acetyl aldehyde, which was listed as "aldehyd" after Liebig's usage), a handful of organic acids, and other constituents including chloroform, nitrous ether, glycerin, and, especially, alcohol. These compounds could readily be purchased from druggists' wholesalers and chemical supply houses, as well as from many essential oil dealers. Following the model of some earlier flavor formulas, Kletzinsky's table specified ratios rather than fixed quantities: the proportional quantities of one or two esters dissolved in 100 parts of alcohol. Expressing the formula as a ratio of chemicals rather than as measured quantities suggests that users could scale production up or down as needed.

By presenting each compound in a range of different flavor applications, the sensory meaning of each of these ethereal chemicals was ultimately not fixed to one particular fruit; it could vary depending on concentration, as well as chemical and local contexts. Consider the case of amyl acetate, the essence of Jargonelle pear, often sold as 'pear oil.' In Kletzinsky's table, it also plays a role in strawberry, raspberry, and orange flavorings. In the United States, this chemical was also frequently sold as 'banana oil,' named for its apparent evocation of the odor of that fruit, and was used as a component of varnishes in addition to its role in flavorings. (The candy-banana smell of isoamyl acetate

remains familiar to us.) Indeed, reprints of Kletzinsky's formulas in American publications often included an additional formula for banana essence (usually a combination of amyl acetate and ethyl butyrate) indicating the popularity of this flavoring.¹¹⁶

The text accompanying Kletzinsky's table was spare — one scant paragraph. It underscored the importance of using only chemically pure substances, including pure alcohol. It also explained that the glycerine was included in nearly all of the formulas because it “appears to blend the different odors, and to harmonize them.”¹¹⁷ Glycerine is a simple sugar alcohol, a viscous liquid derived from fatty substances such as palm oil, valued for its efficacy as a solvent. It had multiple applications in the nineteenth century, including in pharmacy, surgery, and the preparation of scientific specimens.¹¹⁸ (It remains important in flavor production to this day.) Kletzinsky's articulation of the idea that “blending” and “harmonization” were virtues to which artificial flavors should aspire would remain important, as we shall see. The production of synthetic flavors exhibiting “blendedness” and “harmony” — a condition in which the individual chemicals contributing distinct sensory qualities to a substance were not detectable to the senses, but were submerged into and contributing to a single, irreducible perceptual experience —

¹¹⁶ Nadia Berenstein, “The History of Banana Flavoring,” *Lucky Peach* (August 2016): <http://luckypeach.com/the-history-of-banana-flavoring/>

¹¹⁷ Kletsinki 1867. The version of the table published in *Dingler's* uses a phrase from perfumery, describing glycerine as causing the “individual flavor and odor notes” to blend into “a single sensory chord.”

¹¹⁸ Wm. Abbots Smith, *On Glycerine, and Its Uses in Medicine, Surgery, & Pharmacy. Being Principally an Abstract of M. Demarquay's Treatise, 'De La Glycerine,' &c.* (London: H.K. Lewis, 1863).

would also come to trouble efforts to create and enforce a definition of these flavors that distinguished them from the strictly “natural.”

Kletzinsky’s table is equally notable for what is left unaddressed. First, Kletzinsky makes no mention of how he compiled or created the table. Although it is likely that he collected formulas from commercial flavor manufacturers rather than developing them himself, it is unknown how generally these formulas were used among flavor manufacturers, or, alternately, how local or particular they were to one town or region.¹¹⁹ What is certain, however, is that the process of developing these formulas did not begin with an analysis of the chemical components of fruits. It started with a recognition of the sensory qualities of organic chemicals. Manufacturing chemists worked empirically with available organic chemicals, combining and diluting them, mixing and sniffing, until they obtained recognizable, and pleasurable, results.¹²⁰

Kletzinsky’s table also did not explain the process of actually making these mixtures: how to select chemicals in order to ensure that they were of proper purity or quality, what order they should be combined in, or what type of instruments should be used to do this. Nor did it explain anything about usage: what foods or beverages these could be added to, the quantity of flavoring that should be used in different products, how

¹¹⁹ There is some evidence that formulas may have varied regionally and internationally. For instance, an 1866 article in the *London Chemist and Druggist* (reprinted in the *American Druggist’s Circular and Chemical Gazette*) notes that the artificial fruit essences produced by German manufacturers in the Zollverein department “differ considerably from those met with in British commerce.” The substance of this difference is left unexplained. “The Composition of Some Artificial Fruit Essences,” *Druggist’s Circular and Chemical Gazette*, (Jan 1866).

¹²⁰ Roberts 1995.

the mixtures should be stored. All of these factors, as manufacturers and users of synthetic flavors were beginning to recognize, had an effect on a flavoring's quality and utility. Ultimately, by presenting different fruit flavors as combinations of a limited set of related chemical compounds, Kletzinsky's table had a static and closed quality. Aside from glycerine, it made no attempt to describe the role that each of the components played in the ultimate composition, and thus had limited utility on its own as a tool for creating novel flavors, altering existing ones, or incorporating new materials.

The contexts where Kletzinsky's formulas appear give some indications of how different groups of flavor-makers might have put these formulas to use. For instance, in his *Monograph on Flavoring Extracts*, Harrop replicates Kletzinsky's formulas (without attribution) but also provides variants for a few flavors: pineapple, strawberry, and raspberry. Harrop's alternative formulas are simpler versions with fewer components. For instance, Harrop's second raspberry flavor includes only three of the thirteen chemicals included in the first formula, which reproduces Kletzinsky's original.¹²¹ Harrop did not explicitly address the differences between alternative formulas for a single flavor, or the contexts for which each was best suited. However, he implicitly provides a key for the interpretation of the flavor formulas. In his explanation of his strawberry flavors, he writes that butyric and acetic ethers "form the base, although the combination may be added to almost without limit."¹²² In other words, by building on a standard chemical foundation that provides the "sensible core" of a flavor, the practical chemist can invent, improvise, add nuance, capitalizing on the multiple sensory possibilities available in each

¹²¹ Harrop 1891: 78-9. Also changes the relative proportion of these ethers to each other.

¹²² Harrop 1891: 77.

chemical to achieve desired effects and inflections, while still maintaining a resemblance. Harrop ends with the valediction, “license is given to figure for yourself, provided you are able.”¹²³

Nearly thirty years after Harrop’s monograph, Kletzinsky’s table is reproduced in the 1919 edition of the *Scientific American Cyclopaedia of Formulas*, a compendia of miscellaneous recipes for manufacturing household goods, where it is included alongside 15,000 formulas for things such as glues, embalming fluids, and varnishes, and descriptions of the symptoms of poisoning by sewer gas, among many other things. Although Kletzinsky's table remained more or less unchanged from its first appearances in chemistry and pharmacy journals, its meaning had changed; its standing in the world had dropped. By the twentieth century, its formulas were no longer cited in professional literature, except with caution or derision. Erich Walter, in his 1916 *Manual for the Essence Industry*, wrote: "In the course of time, the public has come to look with disfavor on the artificial fruit flavors formerly employed, and in the formulas which follow no attention will be paid to such imitations." (He then went on to supply his own formulas for imitation fruit flavors.) The 20th edition of the U.S. Dispensatory (1918) was the first to demur from including Kletzinsky's formulas, referring readers looking for that information to previous editions.

The persistence of Kletzinsky's table is one of the signs of the expanding commercial need for synthetic flavor additives, which could perform functions in factory-produced foods that “genuine” flavors could not. The diminishing status of Kletzinsky’s

¹²³ Harrop 1891: 85.

formulas, however, indicates something else: a widening divide between flavor amateurs, following standard formulas, and flavor professionals, the kind of workers who would “go figure for [themselves].” This marks the opening of a rupture at the beginning of the twentieth century between "practical chemists" who mix up flavors and fragrances, among many other things, and specialized chemical workers (affiliated with newly established firms specializing in flavor and fragrance materials) who claim a particular kind of expertise with aromatic materials, an expertise that is both scientific and sensory.

AGAINST FORMULAS: THE SPECIALIZATION OF FLAVOR CREATION

Flavor manufacturers were not merely supplying a market that required flavor additives, they were creating it — in part by distinguishing their synthetic specialties from the kind of products one obtained when following published formulas. Even as they used Kletzinsky’s table as a base for their synthetic formulations, flavor manufacturers and users improvised, customized, and improved upon the formulas to better adapt them to desired applications and specifications, and to produce unique and distinctive effects.

Formulas, in fact, were something that flavor manufacturers began to openly disparage, in the interests of protecting their own share of the market by discouraging the users of their products from attempting to make their own. “The preparation of a satisfactory extract is not by any means the simple matter than most soda water bottlers think it to be, and a good deal of money has been lost by people starting in to manufacture extracts on the strength of some formulas that have been purchased or given to them,” lectured the 1921 catalog from Warner-Jenkinson, a major supplier of bottlers’

extracts and other beverage-making supplies. "A formula in extract-making means nothing except trouble, unless the compounder of the extract has an intimate knowledge of the chemistry of the bodies he is handling.... Hence, a formula should only be considered by the chemist as the basis on which to build."¹²⁴ The true work of the flavor compounder was not following existing formulas, but developing new mixtures.

The increasing specialization of flavor-making after the First World War was illustrated in a pungent, purplish essay titled "The Formulist," which appeared in the February 1921 *Ungerer's Bulletin: A Symposium of Aromatics*, a bimonthly compendium of editorials, news, and gossip published by Ungerer & Co., a New York City firm dealing in synthetic perfume and flavor materials. "The Formulist" is a moral fable of the aromatic materials business, where the eponymous figure is ultimately contrasted with the "real creative perfumer or flavor maker."¹²⁵

"The Formulist," we are told, "is he who, on a day in the far dim past, has inherited, achieved, or had thrust upon him a formula. On that... eventful day our Formulist entered the valley of self-satisfied contentment and ceased forever to function as a builder and producer." The Formulist's career is subsequently spent assiduously protecting his cryptic recipe, like a mystic whom illumination has visited only once. "There is nothing more to be done," intones the narrator, "but to guard jealously the precious scrap of paper containing the clue to the sublime odor or flavor of his; to make

¹²⁴ Warner-Jenkinson Company, *Bottlers' and Ice-Cream Makers' Handy Guide*, (St. Louis, Mo.: Warner-Jenkinson, 1921): 77-8. A. W. Noling Hurty-Peck Collection of Beverage Literature, Shields Library Special Collections, University of California Davis (hereafter cited as Noling Collection, UC Davis).

¹²⁵ F.N. Langlois, "The Formulist," *Ungerer's Bulletin*, February 1921.

his sacred mixes in guarded seclusion; and to carry on pompously in his self-assigned role as creator of the magnum opus."

The author of the fable (F.N. Langlois, of the United Drug Company, Boston) identified two major faults with the ways of the Formulist. First, in taking his formula as perfect and complete, the Formulist shut out new research developments in chemistry, including new materials, that could enhance his formula's sensory qualities, decrease its production costs, or improve its utility. Second, the Formulist's hermeticism precluded a proper market orientation. As a secretive recluse, the Formulist was incapable or unwilling to work with others in the flavor and fragrance company, to admit that other realms of knowledge were involved in shaping a commercially viable product. Advertising men, salesmen, "the container and label artist" — all these professionals contributed to the success of a new flavor or fragrance product. By refusing to share the details of his formula with them, or integrate their reports about consumer needs or desires into his working process, the Formulist doomed himself to obscurity and his product to obsolescence.

In contrast: "Your real creative perfumer or flavor maker moves with the times. He rotates with his market. The development of one great success acts as an incentive to a series of accomplishments. If he cannot improve the odor or the flavor he casts about for a more agreeable color for it. He smells or tastes his formula with the nose or palate of the outsider. Approaching from that direction, he appreciates the inevitable fact that the world eventually tires of perfection itself. He borrows a leaf from the experience of

the cigar maker, who knows that there is a certain important section of his public which prefers a new good smoke to an old better one."

This is an early description of the role of the specialized flavor maker within the flavor company, negotiating between the material requirements of manufacturers, the sensory possibilities of chemicals, and the sensual desires of consumers. The implication is that a successful flavor could not merely reproduce static, timeless nature. The successful flavor also must reflect consumer tastes, expectations, and, especially, fashions. In other words, the flavor maker was in a fashion business, one that must constantly produce novel sensations, new variations for a public hungry for untasted fruits, unsampled pleasures, both low delights and high ones. The real creative flavor maker appreciated the inevitable fact that the world eventually tires of perfection itself. There is no perfect. There is only the pluripotent new, perpetually refreshed by the stream of newly discovered synthetic organic chemicals.

This is not to suggest that flavor makers worked freestyle, without formulas, only using their senses for a guide. If anything, proprietary formulas gained increasing importance among flavor manufacturers as they represented the accumulated skill of their specialized workforce, and were treated as significant company assets. For instance, a 1927 obituary for Dr. Rudolph Pabst, chemist and owner of the Reading Extract Company in Reading, Pennsylvania, notes that his formulas were willed to his son.¹²⁶ Bernard Polak, who headed Polaks Frutal Works, kept his formulas secure with a

¹²⁶ "Dr. Rudolph Pabst, Chemist," obituary, *American Perfumer and Essential Oil Review*, October 1927.

personal, hand-written ‘code book,’ which assigned alphanumeric values to different compounds.¹²⁷ At a time when flavor and fragrance companies had access to otherwise unknown materials and processes, such secrecy could protect a company’s advantage, as well as their investments in research and development. But these formulas were not seen as definitive, absolute, or sufficient for success. In the hands of creative flavor makers, they were tools, not final products — subject to adaptation, alteration, and innovation.

III. “TWENTIETH CENTURY RAW MATERIALS”: SYNFLEUR SCIENTIFIC LABORATORIES AND THE FORMATION OF A SCIENTIFIC FLAVOR AND FRAGRANCE INDUSTRY

On an April afternoon in 1908, dapper, consumptive Alois von Isakovics lectured before an audience of Columbia University students about the chemistry of synthetic perfumes and flavors. Isakovics was the founder and chief chemist of Synfleur Scientific



THE LATE ALOIS VON ISAKOVICS

DEHNARD POLAK, CODE BOOK, [1950] DEHNARD POLAK and Polak’s Frutal Works, Inc. Collection, 2008.044, Series 1, Chemical Heritage Foundation, Othmer Library Special Collections.

Laboratories, one of the first U.S. companies to specialize in the manufacture of synthetic aromatic materials. In a lecture suffused with odorous demonstrations, Isakovics outlined the distinctive chemistry of flavor and fragrance molecules, while making the

case for the synthetic production of these substances. According to Isakovics, with research and careful attention to chemical purity, it would be possible to produce synthetic versions of flavors and fragrances that not only rivaled but surpassed their natural counterparts in terms of sensory qualities, performance, and use value.

The first decades of Isakovics' company provide an exemplary story of specialization within this branch of the chemical industry. In the first years of the twentieth century, Isakovics transformed his company, Herbene Pharmacal, a small, urban firm producing a variety of retail goods, including proprietary medicines and perfume specialties, to Synfleur Scientific Laboratories, a company that produced perfume and flavoring materials for manufacturers — to whom they offered not only reliable and high-quality chemical materials, but also customized, exclusive flavors and fragrances, as well as expert advice on manufacturing processes, formula development, and business practices. Synfleur's shift to a primarily intrabusiness orientation — supplying other manufacturers with specialized components, rather than selling household extracts directly to consumers — became the model that would define the contours of the flavor and fragrance industry in the new century.¹²⁸ It also signaled a sharp turn away from the flavor industry's association with pharmacy or proprietary

¹²⁸ Regina Lee Blaszczyk has written extensively about intrabusiness relationships, especially those focused on design and development processes in the production of consumer goods. Her scholarship has highlighted the key role of these sorts of “fashion intermediaries” in the development of the modern consumer economy, and offers a way to bridge the divide between consumer-oriented and producer-oriented histories. Regina Lee Blaszczyk, *Imagining Consumers: Design and Innovation from Wedgwood to Corning*, (Baltimore: JHU Press, 2000); Blaszczyk, *The Color Revolution*, (Cambridge: MIT Press, 2012).

medicines, and a turn towards innovation and specialization driven by chemical research and scientific expertise.

FROM HERBENE PHARMACAL TO SYNFLÉUR SCIENTIFIC LABORATORIES

Alois von Isakovics was born in Prague in 1870, the son of a Judge Advocate General in the Austro-Hungarian army. Although he resisted his father's entreaties to pursue a military career, he showed an entrepreneurial bent from a young age. The stamp-collecting business he started as a boy grew large enough that he needed to employ several schoolmates to help with correspondence and filling orders. His education, in Vienna, "comprised the regular curriculum of a young man of good European family," according to one obituary written by a friend, though other accounts claim he studied chemistry at the university level.¹²⁹ In any case, his formal education seems to have ended at the age of sixteen, when he left Europe for the United States.

Two years later in New York, he met Mary Upshur, a seventeen-year-old student whose background stood in sharp contrast to those of the recent immigrant; her family

¹²⁹ William Dreyfus, "Alois von Isakovics," *Industrial and Engineering Chemistry* 9 (July 1917): 716. His obituaries in the American Pharmaceutical Association journal and in the American Perfumer and Essential Oil Review claim that he came to the U.S. after completing the course in chemistry at the University of Vienna. Image of Isakovics used here from his obituary in *Metallurgical and Chemical Engineering* (July 1917): 44.

traced its roots to seventeenth-century Virginia.¹³⁰ They were engaged within a year, in July 1889. It would be a long engagement. When they did get married in July 1895, six years later — and three years after Isakovics became a naturalized citizen — it was apparently with the blessing of her family. The Reverend Doctor Houghton, who officiated the ceremony at the Church of the Transfiguration in New York City, had also presided over her parents' nuptials.¹³¹

Synfleur advertising material and stationery boasted that the company was founded in 1889, but most company materials skim over its first decade. 1889 was the year of Alois' engagement to Mary, and perhaps this is a recognition of the crucial role she played in helping him build the business. I have found no record of Synfleur's existence or activities before the early 1890s, when, doing business as Herbene or Herbene Pharmacal, the company sold proprietary medicines, perfumes, bandages, and other druggists' sundries through the mail.¹³²

An 1892 notice placed by a Toronto drug wholesaler in the advertising pages of a Canadian humor magazine touts "golden Herbene Gems" as a "sure cure" for "nervousness, general debility, and all female complaints," but the majority of advertisements for Herbene that I have located sell not products, but opportunities.¹³³ Crammed between notices for morphine cures, weight-loss pills, and clandestine

¹³⁰ According to Nina [von Isakovics] Allen, great-great-granddaughter of Alois and Marie, she may have been a student at Parson's at the time, studying fine arts. Personal communication.

¹³¹ Dreyfus 1917.

¹³² Synfleur Scientific Laboratories stationery dating from 1905 does note that it is the successor to Herbene Scientific Laboratories.

¹³³ [Tarbox Bros.] "Golden Herbene Gems," advertisement, *Grip* 38 (January 2, 1892): 2.

abortifacients, Herbene's solicitations sought agents through two- or three-line advertisements in the back pages of small journals — including those targeting African-American and female readerships — offering to supply perfumes, household goods, and other sales items “on credit” with “expenses paid.” “150 per cent profit,” “big profits” were promised. The curious were invited to write to the “old and reliable Herbene Co” at a P.O. Box at Station L, in New York.¹³⁴

Station L was the uptown post office branch in Harlem, near the building on East 121st Street where the company's manufacturing laboratory was located. Otherwise, there is little definite information about the company's operations in the 1890s and early 1900s, although a 1904 judgment ordering Herbene to pay an outstanding debt of \$627 to Antoine Chiris Co., the American branch of a venerable Grasse essential oil and perfume company, indicates that the company was using this firm's products as components of their specialties.¹³⁵ A 1902 notice of incorporation — at least ten years after Herbene began running advertisements, and thirteen years after it was allegedly founded —

¹³⁴ I've only been able to locate a handful of these, the earliest advertisement dating from 1894, in a newsprint journal called *The Golden Rule*. Other advertisements appeared in the back pages of *Ladies' World* (1896); The [Baltimore] *Afro-American* (1896); and the [Washington, D.C.] *National Tribune* (1898). The language in all examples was similar. As examples of the kind of advertisements Herbene shared space with, the following appeared in the 1898 *National Tribune*: “LADIES When Doctors and others fail to relieve you, try S.R.&Sw. IT never fails. One full treatment free.” Other advertisements in the 1896 *Ladies' World* included: “Opium or Morphine Habit Cured at Home. Trial Free. NO Pain. Address Compound Oxygen Ass'n. Ft. Wayne Indiana.” and “Fat Folks reduced in weight — safely, surely, speedily. Trial Bottle Free. Chase Remedy Co. Chicago.”

¹³⁵ “Notices of Judgment,” *New York Tribune* 28 September 1904. [Judgment was filed 27 September, 1904]

claimed \$60,000 in capital, and named three directors: Alois, Mary, and Effingham L. Holywell, of Brooklyn.¹³⁶

Sometime around 1903, due to Alois' worsening pulmonary tuberculosis, he and Mary moved their family and the company to Monticello, a Catskills town in Sullivan County, New York, about ninety miles northwest of the city. This move also marked a change in the company's name and business model. Now dubbed Synfleur Scientific Laboratories, the company tacked away from producing low-status retail goods sold over the mail by commissioned agents. Instead, the company addressed itself directly to manufacturers of soaps, toilet goods, perfumes, confectionery, and other consumer products, offering fragrance and flavor materials of the highest quality, informed by the very latest scientific research. As a 1905 spring catalogue put it, Synfleur was in the business of providing "Twentieth Century Raw Materials for Progressive Manufacturers."¹³⁷

¹³⁶ "New Corporations," *Paint, Oil, and Chemical Review* 34.8 (August 1902): 28. I haven't been able to learn anything definite about Holywell — though he (or a son of the same name) may have been a real estate lawyer. He doesn't come up in any other reference I've found to Isakovics or Synfleur. As this is around the time that Herbene relocated upstate — and as Herbene Pharmacal continues to be listed in druggists' suppliers directories into the 1910s, he may have taken over the company from Alois and Marie. [A 1903 report from the Annual Meeting of the Manufacturing Perfumers' Association lists Holywell as Secretary and Counsel of Herbene, Marie as Treasurer, Alois as President and General Manager.] There also appears to have been a lawsuit filed by Holywell against Herbene in 1905. "The Courts," *Brooklyn Daily Eagle* (Oct. 4, 1905): 3.

¹³⁷ [Synfleur Scientific Laboratories], "Synfleur Materials Wholesale List," Spring 1905, Included as an enclosure in a letter from Alois von Isakovics to Harvey Wiley, May 3, 1905, Food Standards Committee, Correspondence and Reports, 1897-1938, Records of the Food and Drug Administration, Record Group 88, National Archives at College Park, MD.

The 1905 catalogue emphasized their commercial orientation: “we have no retail list. We sell to manufacturers only.” But Synfleur was also selling a particular kind of intrabusiness relationship, one that would give clients access to the expert knowledge of its founder. The 1905 list offered “complete research laboratories... at the service of our friends in the manufacturing industry. Expert advice on manufacturing problems, improvement of processes, and working formulas.... Our friends can freely submit their ideas or working formulas for suggestions... and we will cheerfully supply any legitimate manufacturer who is a consumer of our materials, with detailed working methods, insuring the best possible results at the lowest possible cost.”

Essentially, the company was selling not only a standard set of goods, but also expert knowledge and technical advice. Clients were promised that their inquiries would “receive the careful, personal attention of Mr. Alois von Isakovics.” Underwriting this business proposition was a wager on the central role that research and development would play in the flavor and fragrance industry. Materials and processes in the field were changing rapidly, and manufacturers needed a partner who would stay abreast of “the latest work and the highest improvements in science.” Synfleur had made an investment in specialized research facilities, and was offering to share its benefits while implying that manufacturers could not replicate these results on their own. This was important, as this new business model also required substantial trust on the part of the manufacturer, who was asked to share confidential and proprietary information about formulas and

processes with Synfleur. Synfleur's 1905 wholesale list made repeated assurances that all inquiries would be kept "strictly confidential."¹³⁸

In 1910, Synfleur's advisory and consulting operations were further formalized. Announcements and advertisements in trade journals such as *American Druggist and Pharmaceutical Record* and *American Perfumer and Essential Oil Review* trumpeted that the company had established a special department in its laboratories dubbed the "Synfleur Manufacturing Service," which would "furnish practical up-to-date suggestions for the users of Synfleur products as to the best means of perfecting their perfumes, toilet waters, sachets, flavoring essences, and toilet specialties of all kinds," by "placing at their disposal a wide experience based on careful research work by a staff of chemists who have for many years been scientifically trained in this field."¹³⁹ Synfleur would work with manufacturers to develop exclusive custom formulations, "proprietary combinations" that would "give them a proprietary odor or flavor of their own."¹⁴⁰

"Thousands of private formulas of well-known manufacturers were entrusted to his honor in the hope, seldom disappointed, that his competent staff of synthetic perfume and flavoring material experts might find a way to improve upon the established formula by giving a successful touch of Synfleur excellence to the finished product," wrote Isakovics' son-in-law and successor at Synfleur, Luis de Hoyos, in an obituary for his

¹³⁸ "Synfleur Materials Wholesale List" 1905.

¹³⁹ "Synfleur Perfume Materials," advertisement, *American Druggist and Pharmaceutical Record* (August 22, 1910): 124.

¹⁴⁰ Synfleur, advertisement, *Era Druggists Directory*, 1912.

chemist mentor and employer. “Whatever the origin of the formula was, whether of his own compiling or the private property of his client, the secrets of the perfume world were safe” with him. He went on to assure readers that these values were “so firmly impressed upon the efficient clannish Synfleur force who have together labored for many years by our beloved leader, that it grew to be an all-pervading feature of our business policies.” He vowed that no member of what he calls their “business family” would ever “prove a traitor to these most sacred principles of a very unique and singularly eccentric business.”¹⁴¹ Even though Isakovics was gone, the company would continue to honor its relationships and maintain the confidences of its clients.

SYNFLEUR AND THE FLAVOR CHEMICAL INDUSTRY

Synfleur was one of a number of U.S. companies that began to specialize in flavor and fragrance materials at the beginning of the twentieth century.¹⁴² Some, like Synfleur, had roots in pharmacy. Dodge & Olcott, one of the most important American flavor and fragrance companies during the first half of the twentieth century, began in 1798 as an

¹⁴¹ Synfleur, advertising insert, *American Perfumer and Essential Oil Review*, July 1917.

¹⁴² For profiles of the companies involved in the flavor and fragrance trade in the late nineteenth and early twentieth centuries, see Wayne E. Dorland and James A Rogers, *The Flavor and Fragrance Industry*, (Mendham, Nj: Wayne E. Dorland, 1977): 171-246. For a history of the production of aromatic chemicals in the United States around the time of the first World War, see William Haynes, *American Chemical Industry: A History*, Vol III: The World War I Period, (New York: Van Nostrand, 1945): 327-339.

apothecary shop on Pearl Street, in lower Manhattan. Until the 1880s, it was best known as an importer of pharmaceutical products, chemicals, and essential oils, as well as surgical instruments, perfumes, cosmetics, paints, and sundries.¹⁴³ It was not until the 1890s, when Francis Dodge (1868-1942) took the helm of the company, that the firm shifted its focus to manufacturing flavor and fragrance chemicals.¹⁴⁴ Like most nineteenth-century Americans who wished to pursue chemistry as a scientific vocation, Dodge had traveled to Germany to earn his doctorate, studying under Victor Meyer in Heidelberg, where he had distinguished himself by being the first chemist to obtain citronellol from rose oil. On returning to the U.S. in 1891, he joined the family business, and redirected its focus to specialty chemical manufacturing, including the production of synthetic aromatic chemicals, natural isolates, and essential oils.¹⁴⁵

Other American flavor and fragrance companies were founded as branches of European essential oil and aromatic chemical firms. For instance, Fritzsche Brothers was founded in 1871, by three German emigrants, in association with Schimmel & Company, of Leipzig, one of the major European producers of essential oils, natural isolates, and

¹⁴³ Founded by Robert Bach, the company went through several name changes in the early 19th century, and was not known as Dodge & Olcott until 1861. Around 1811, Robert Bach and his sons founded a distillery in Brooklyn, where they produced whiskey and other alcoholic products. This was separate from the drug business, but by 1848, Bach's "celebrated alcohol and pure spirits for perfumers" was listed among the merchandise. *The Story of An Unique Institution: Dodge & Olcott, Inc. 1798-1948*. (New York: Dodge & Olcott, 1948); Gabriel Sink, "A Tribute to the Oldest American Flavor and Fragrance House," *Perfumer & Flavorist* 17 (January/February 1992): 37-9. *The Story of an Unique Institution...* 1948: 12-3.

¹⁴⁴ Starting in the 1860s, Dodge & Olcott did manufacture methyl salicylate, oil of wintergreen, in a plant in Bayonne, NJ, but this was the company's only synthetic product prior to Francis Dodge's leadership. Haynes, *History of the Chemical Industry*, 331.

¹⁴⁵ Haynes, *History of the Chemical Industry*, 331.

synthetic aromatic materials.¹⁴⁶ Until the First World War, American companies were often reliant on European suppliers for chemical intermediaries, technical advice, and sometimes financial backing.¹⁴⁷

Like Synfleur, Dodge & Olcott, Fritzsche, Antoine Chiris, Van Dyk, and other pre-war flavor and fragrance companies began to build and maintain dedicated laboratories near their manufacturing plants. Although these were mainly control laboratories, they employed specialized chemists, and performed some basic research.¹⁴⁸ For instance, Dr. Clemens Kleber, who headed a laboratory in Clifton, New Jersey for Fritzsche Brothers, published what was perhaps the earliest flavor chemical analysis of a fruit, determining that amyl acetate was present in bananas.¹⁴⁹

The increasing organization and professionalization of the flavor industry is also indicated by the incorporation of the Flavor and Extract Manufacturers Association (FEMA) in 1909, an industry trade group that represented the business and political interests of flavor makers. Formed partly as a response to the 1906 Pure Food and Drug Act, which brought federal regulatory scrutiny and heightened consumer distrust of flavoring additives, FEMA's initial agenda aimed to restore public confidence in their members' products.¹⁵⁰ This involved working with regulators to show that adulteration

¹⁴⁶ Sink 1992: 38.

¹⁴⁷ Haynes 329.

¹⁴⁸ Haynes 331.

¹⁴⁹ Clemens Kleber, "The Occurrence of Amyl Acetate in Bananas," *American Perfumer and Essential Oil Review* 7.10 (December 1912): 235.

¹⁵⁰ "Flavor & Extract Manufacturers' Association: The First 75 Years," *Perfumer & Flavorist* 9.3 (June/July 1984): 57-8. For a comparable case study in the organization of the canning industry, see Anna Zeide, "in Cans We Trust: Food, Consumers, and

was rare, improving the quality of flavoring products, and actively combating media accounts that grouped their members with “Adulterators, Food Poisoners, and Drug Dopesters.”¹⁵¹ Promoting and sharing scientific research among its members — emphasizing that the industry was on a sound scientific footing — was both a strategy and a goal of the group.

By the 1920s, the synthetic flavor and fragrance industry was on firm ground, with domestic manufacturers supplying most of the synthetic organic chemicals consumed in the United States.¹⁵² The U.S. Tariff Commission noted that business was booming for manufacturers of synthetic aromatic chemicals, who supplied the raw materials for the flavor and perfume industries. “Progress has been made in overcoming the former prejudice against synthetic aromatic chemicals, and the most important factor in this result has been the successful and systematic development of quality products. American manufacturers of these products have not neglected that essential unit of their business, namely, the research laboratory, and the industry has consequently been placed upon a stable and scientific basis.”¹⁵³ In the 1920s, new raw materials, new processes, and an expanding and diversifying array of new food and beverage products on the market continued to drive the growth of specialized flavor and fragrance companies.

Scientific Expertise in Twentieth-Century America,” PhD Diss, UWisconsin-Madison, 2014: 67-82.

¹⁵¹ “Report of the Proceedings of the Fourth Annual Convention of the Flavor & Extract Manufacturers Association,” *American Perfumer & Essential Oil Review* 8.4 (June 1913): 86-93, quote at 89-90.

¹⁵² U.S. Tariff Commission, *Census of Dyes and Other Synthetic Organic Chemicals 1923*, Tariff Information Series 34, (Washington: Government Printing Office, 1924): 113.

¹⁵³ U.S. Tariff Commission 1924: 113.

FLAVOR CHEMICALS AS PROGRESSIVE, SCIENTIFIC MATERIALS

In order for manufacturers to be persuaded of the value of the services offered by Synfleur, they first had to be convinced that aromatic materials were scientific materials, which required expert knowledge and specialized skills. Starting in 1910, Synfleur was a monthly advertiser in the *American Perfumer and Essential Oil Review*, the leading trade journal for the flavor, fragrance, and cosmetics industries. Synfleur's advertisements most frequently took the form of four-page inserts, conspicuously printed on pink cardstock paper, and featured Isakovics' writings, which advanced a research-and-development focused business ideology. "Science is necessarily progressive," lectured a typical advertisement, from 1912, "and only manufacturers that apply science actively in their business, that take advantage of the latest research work, can hold their own with the competition."¹⁵⁴ Yet, as he wrote in an advertisement the following year, "so many manufacturers do not correctly understand the materials they are using. A man that is not acquainted with the nature of the products he handles every day, cannot appreciate quality, cannot take advantage of new ideas, cannot apply materials intelligently."¹⁵⁵ Isakovics reprinted his entire chapter on "Essential Oils, Synthetic Perfumes, and Flavoring Materials," from a textbook on Industrial Chemistry, as a special *sixty-seven* (!) page supplement for *American Perfumer and Essential Oil Review* readers in 1914.¹⁵⁶

¹⁵⁴ Synfleur advertisement, *Era Druggists Directory* 1912.

¹⁵⁵ Synfleur advertisement, *American Perfumer and Essential Oil Review*, 1913.

¹⁵⁶ Synfleur advertisement, *American Perfumer and Essential Oil Review*, 1914; Alois von Isakovics, "Essential Oils, Synthetic Perfumes, and Flavoring Materials," in Allen

Manufacturers had to be educated and informed about the scientific basis of the field before they could properly appreciate the quality of Synfleur materials.

Isakovics' insistence that flavor and fragrance materials were scientific and progressive — dynamic materials of the future — was essential to establishing their value and virtue in a marketplace that remained suspicious of synthetics. Accomplishing this also meant establishing “Alois von Isakovics,” himself, as an expert in the emerging and still weakly defined field of chemical research that dealt with the properties of aromatic materials.¹⁵⁷ Isakovics' professional reputation, and his company's prospects, was intimately connected with the status of the substances that he manufactured and sold.

Isakovics deliberately cultivated an image as a man of science, an authority and an expert on matters related to the chemistry of aromatic materials, even as his commercial interests called his disinterestedness into question. He labored to make both himself and synthetic chemicals respectable. He accumulated memberships in scientific societies and business trade groups, building a network of close relationships with others involved in chemical research and the chemical industry. A 1905 letter to Bureau of Chemistry chief Harvey Wiley refers to a conversation they had at a recent meeting of the American Electrochemical Society; his company letterhead lists his membership not in only that group, but also in the American Chemical Society, the Manufacturing Perfumers Association, the Society of Chemical Industry, and the Verein Deutscher

Rodgers, ed., *Industrial Chemistry: A Manual for the Student and Manufacturer*, (New York: D. Van Nostrand, 1914): 766-802.

¹⁵⁷ The absence of a stable identity for flavor and fragrance chemistry can be gleaned from the following circumlocution in one of his obituaries, which called him “a genius in the particular field of chemistry to which he devoted his talents.” Dreyfus 1917.

Chemiker, a list whose ultimate extensiveness is underscored by its terminal “etc.” At his death, he was also a fellow at the American Association for the Advancement of Science and the New York Academy of Sciences, as well as a member of the Chemists’ Club, the American Pharmaceutical Association, the Franklin Institute, and the Royal Society of Arts, London.¹⁵⁸

Isakovics also built his reputation as an expert by associating himself with academic institutions, giving lectures to university students, and publishing instructional material on the chemistry of flavors and fragrances.¹⁵⁹ That is to say, Isakovics strove to link his branch of chemistry with professional scientific training and academic research, and actively sought to encourage students to enter the field by portraying it as an advancing research frontier.

Between 1908 and 1914, Isakovics lectured several times at Columbia University to students of organic chemistry and pharmacy.¹⁶⁰ Isakovics’ presentations were apparently popular with students. “The lecture was listened to with the closest attention by the students who nearly filled the large lecture hall,” according to one contemporary account, “the subject being evidently one of more than ordinary interest for them.”¹⁶¹ A

¹⁵⁸ “Synfleur Herald,” 1915. Dreyfus, 1917.

¹⁵⁹ He was not the only flavor and fragrance chemist to take this step. Samuel Isermann, the president of the New York synthetic fragrance and flavor chemical manufacturer Van Dyk & Co. and the Chemical Company of America, contributed a chapter on Perfumes and Flavors to H.E. Howe’s textbook *Chemistry in Industry* (1924).

¹⁶⁰ The 1908 lecture is reprinted in a pamphlet published by Synfleur. Alois von Isakovics, *Synthetic Perfumes and Flavors: A Lecture Delivered at Columbia University*, (Monticello, NY: Synfleur, 1908).

¹⁶¹ “Synthetic Perfumes: Lecture by Dr. Alois von Isakovics,” *American Druggist and Pharmaceutical Record* (April 13, 1908): 176.

notice in the college newspaper promoting Isakovics' 1912 talk announced that it was open to all interested students; in any case, it seems that he spoke to an audience that grew each year. While he had previously spoken in ordinary lecture classrooms, in 1914, his talk was in the Chandler Lecture Theater, the largest room not only in Havemeyer Hall, which housed the chemistry department, but in the entire university.¹⁶² He kept his presentations interesting with chemical demonstrations that illustrated to the eye and to the nose the process of transforming one substance to another, more pleasant and valuable one — for instance, moth-ball scented naphthalene to the ethyl ether of beta-naphthol, a material used in a perfume known as Bromelia, reminiscent of orange blossoms. The Chandler Museum at the university later acknowledged several gifts that he had made of the “fine synthetic perfumes” that he used in his lecture.¹⁶³

Isakovics presented the chemistry of scented compounds in terms of key elements, functional groups, and chemical structures. He began by introducing the chemistry of synthetic perfumes and flavors as a branch organic chemistry — one that largely concerned molecules comprising carbon, hydrogen, and oxygen atoms, as well as some nitrogen-containing molecules. Sulfur also entered into the composition of many odorous substances, but never, he said, in desirable ways.¹⁶⁴ The addition of certain chemical functional groups — including aldehyde, hydroxyl, ketone, alcohol, methyl, and

¹⁶² A summary of von Isakovics' talk can be found in *American Perfumer and Essential Oil Review* 9, no 3 (May 1914): 84. For the size of Chandler Hall (and the popularity of chemistry classes and lectures, see “Alumni and University News,” [Columbia University] *School of Mines Quarterly* 24, (Nov 1902-July 1903): 103.

¹⁶³ “Department of Chemistry,” *Columbia University Quarterly* 14 (June 1912): 322.

¹⁶⁴ The importance of sulfur-containing compounds to flavor chemistry would be established in the 1950s.

ethyl radicals — sometimes, but not always, converted an odorless, flavorless molecule into one with a strong scent or flavor. This was particularly true when these functional groups were located at certain points on the molecule. For instance, ortho- and para-derivatives of benzene were often valuable, while meta- derivatives were frequently odorless.¹⁶⁵ Nonetheless, there were exceptions to all of these rules of thumb, and science was not yet at a point where the odor of a material, or its value, could be deduced by knowing its chemical composition and structure.¹⁶⁶

This was important, because it provided a prospective research program for synthetic flavor and fragrance chemistry. While accounts of synthetic flavoring materials still largely focused on describing the properties of the compound ethers, Isakovics presented the synthetic production of new scented materials as a continuation of work on organic synthesis begun by Wohler and carried forward by Berthelot, Liebig, Kolbe, Perkin, and other chemical luminaries.¹⁶⁷ The most important discoveries in the analysis and synthesis of scented compounds still lay ahead, he told the assembled students; each year brought new advances in this branch of organic chemistry, and there was plenty of room for growth. “This is a most fascinating field for the research chemist,” he assured his young listeners, offering “endless material to the investigator.”¹⁶⁸

¹⁶⁵ Ortho-, meta-, and para- refer to the position of functional groups around the six-carbon benzene ring for molecules with two side chains. In ortho- molecules, the two radicals are connected to adjacent carbons on the ring; the radicals are separated by one carbon in meta- molecules; and in para- molecules, the radicals are across from each other on the ring.

¹⁶⁶ Isakovics 1908: 6-7.

¹⁶⁷ Isakovics 1908: 6.

¹⁶⁸ Isakovics 1908: 6.

Isakovics was aware that the reputation of synthetic materials among both manufacturers and users needed rehabilitation. “Years ago, like everything new, synthetics had a hard road to travel, because they met a certain amount of prejudice among manufacturers.”¹⁶⁹ The poor reputation was partially earned; the quality of these materials on the market varied widely. Aromatic materials act on us in extremely small quantities, delivering scent in minute concentrations. Manufacturers of aromatic chemicals thus had to be stringently careful in their production, as trace impurities that escaped chemical detection could be undeniably present to the nose.

The value, and risk, of synthetic aromatics was intimately connected to their power in small quantities. Minute concentrations of specific substances could not only condemn a material as unusable, but also distinguish and glorify it. This observation was central to Isakovics’ model for synthetically producing a high-quality scent or flavor. The skillful utilization of trace constituents, especially newly developed ones, in multi-component blends was integral to Isakovics’ conception of a well-made flavor.

FROM CHEMICAL TO FLAVOR

How did a chemical become a flavoring material? How much of a role did chemical research play in the development of new synthetic flavoring materials? As noted, in the nineteenth century, the components of “artificial fruit essences” were esters,

¹⁶⁹ Isakovics 1908: 10.

most often synthesized from fusel oil and related chemicals.¹⁷⁰ Other types of materials were also used in flavorings, including essential oils, botanical extracts, and tinctures, prepared from spices, roots, leaves, fruits, and other botanical materials. Although these were not, properly speaking, synthetic chemicals, their production depended on chemical techniques and technologies, including distillation, expression, and extraction using alcohol or other solvents. Further, buyers and users of essential oil utilized chemical methods to detect adulterations, verify claims about identity, and assess value.

Determining boiling point, measuring specific gravity, or adding reagents that reacted in certain ways with known adulterants supplemented organoleptic (ie, sensory) evaluations of essential oils. Books such as Ernest J. Parry's *Chemistry of Essential Oils and Artificial Perfumes* became essential texts, providing tables of physical and chemical constants for various commercially important substances, as well as instructing readers in techniques of analysis, including newer methods such as refractometry.¹⁷¹

Some new flavoring materials were introduced to the market due to analytic research conducted within the essential oil industry. Flavorings have always been closely linked to fragrances and perfumes, connected by raw materials, craft processes, and technologies, as well as shared cultural meanings. As the essential oil and perfume trades industrialized in the nineteenth century, they began producing aromatic materials on a

¹⁷⁰ "Compound ether" is a synonym for esters, organic compounds comprising an oxygen atom bonded to an alcohol radical and an acid radical. Compound ethers with a fatty acid radical were known to have a fruity smell. List some, say where they were sold.

¹⁷¹ Ernest J. Parry, *Chemistry of Essential Oils and Artificial Perfumes*, (Scott, Greenwood & Co., London and D. Van Nostrand, New York, 1899). Parry's *Chemistry of Essential Oils* was reprinted at least four times in the subsequent two decades, in expanded and revised editions that reflected ongoing research in the field.

large scale, at costs suitable for use in mass-market goods.¹⁷² They also began producing new materials — perfume isolates (compounds isolated from “natural” essential oils) and synthetics that claimed to reproduce valuable constituents identified in essential oils, such as citral, piperonal (“artificial heliotrope”), and geraniol (“artificial rose”), from cheaper raw materials. This followed the pattern that Isakovics had described in his Columbia University lecture: analysis followed by synthesis.

These novel perfumery synthetics contributed to a transformation of the sensory qualities of perfumes, as well as to the transformation of cultural and social meanings which diffused with these molecules from the modern, perfumed body.¹⁷³ Meanwhile, many of these new synthetic fragrance molecules also found uses in flavorings, though their meanings and associations varied in these different contexts, and their common presence in perfumes and flavorings was likely unsuspected by consumers.¹⁷⁴

¹⁷² As Eugenie Briot notes, the shift from perfumery as an artisanal trade to one that utilized industrial manufacturing processes did not result in decreasing prices for perfumes, but saw a rise in prices even as their use became more widespread. She argues that this is a result of deliberate marketing strategies by nineteenth century perfumers, who aspired to associate their goods with luxury even as they became more widely accessible. See Eugenie Briot, “From Industry to Luxury: French Perfume in the Nineteenth Century,” *Business History Review* (Summer 2011): 273-294. See pp 279-283 of that article for a survey of some of the technical innovations (including use of steam power, the vertical integration of flower farms with factories, and the adaptation of machines from other industries (such as pharmaceuticals, soap making, and distillation) for use in perfume material factories. See also: Geoffrey Jones, *Beauty Imagined: A History of the Global Beauty Industry*, (Oxford: Oxford UP, 2010), especially chapter one.

¹⁷³ See Jones, 20-9; also, Maksym Klymentiev, “Creating Spices for the Mind: The Origins of Modern Western Perfumery,” *The Senses & Society* 9.2 (2014): 212-31, and Luca Turin, *The Secret of Scent*, (New York: Ecco, 2006).

¹⁷⁴ For instance, Houbigant’s Fougere Royal, an important masculine scent introduced in the early 1880s, established synthetic coumarin as one of the three key basenotes of the

Vanillin, one of the most commercially important flavoring synthetics, is an exception to the general pattern by which new materials became available to the flavoring industry. Although vanillin had been identified in vanilla beans in the 1850s, its correct empirical formula, molecular structure, and synthesis emerged not from further analysis of vanilla beans, but from basic research into the chemical structure of glucosides. In 1874, Ferdinand Tiemann and Wilhelm Haarmann were studying the composition of the glucoside coniferin in the laboratories of August Hofmann at the University of Berlin, when they obtained a substance that they later confirmed to be vanillin. Tiemann and Haarmann partnered with fellow chemist Karl Reimer to manufacture synthetic vanillin from coniferin. The Haarmann & Reimer factory in Holzminden is often celebrated as the birthplace of the synthetic flavor and fragrance industry.¹⁷⁵

In the twentieth century, new materials emerged alongside the development of new synthetic processes. In 1904, Georges Darzens, a French chemist who headed the research laboratory of L.T. Piver, a Parisian perfumery company, described a method for

fougere, a new, modern family of fragrances. Coumarin, a compound originally identified in tonka beans, was first synthesized by Perkin from coal tar in 1868, was an important component of vanilla flavors as well as flavorings added to tobacco products. Methyl anthranilate — a compound most of us now will associate with the musky purple of artificial grape — was first isolated and identified as a key component of neroli (orange blossom) essential oil, and subsequently in other flower oils as well, by Schimmel, in Lepizig. Linalyl formate, which was sold as artificial oil of bergamot or petit grain, was used in formulas for synthetic peach, apricot, apple, and quince flavorings soon after its commercial introduction. Jones, 23. Patricia de Nicolai, “A Smelling Trip Into the Past: The Influence of Synthetic Materials on the History of Perfumery,” *Chemistry and Biodiversity* 5 (2008): 1137-1146.

¹⁷⁵ The process by which vanillin became a viable synthetic alternative or adjunct to vanilla beans, and a source of vanilla flavor, is quite a bit less direct than this summary implies. See Nadia Berenstein, “Making a Global Sensation,” 2016, especially pp. 405-410.

synthesizing aldehydes and ketones which now bears his name.¹⁷⁶ One of the first commercial products produced via the Darzens reaction was ethyl methylphenylglycidate, which, along with its homologue, ethyl phenylglycidate, are described as having a strawberry-like aroma. This compound was sold under the name “Aldehyde C-16” (although it was not an aldehyde, and did not contain 16 carbon atoms.)

Another important new addition to the series was so-called “peach aldehyde,” undecalactone, first synthesized by Russian chemists Shukov and Shestakov in 1908. This was produced and sold under a variety of trade names, including Persicol and Pescol, as well as “Peach Aldehyde” or Aldehyde C-14, although it, too, was not an aldehyde. One 1916 catalog from a New York essential oil and synthetic chemical dealer listed the substance under the name, Aldehyde C-14, noting “similar products are sold in the market as Persicol and Pescon,” before going on to say that their product was “absolutely pure” and guaranteed to contain “no foreign bodies or matters.” The catalogue recommended it for use in flavoring extracts, as well as in talcum powders and creams. The description concluded: “It gives new odors,” and praised its stability and lack of reaction with acids and alkalies.¹⁷⁷

These synthetic ‘aldehydes’ marked a significant shift in the chemical market for flavoring materials. While the “compound ethers” used in flavorings in the nineteenth century bore no verified relationship to the fruit they were intended to suggest, many

¹⁷⁶ Pierre Laszlo, “Georges Darzens (1867-1954): Inventor and Iconoclast,” *Bulletin for the History of Chemistry* 15/16 (1994): 59-65.

¹⁷⁷ George V. Gross & Co. “Essential Oils and Synthetic Chemicals,” [catalog] (New York, 1916): np. Hagley Museum and Library, Delaware.

chemists understood that the reaction process that produced these esters could occur as a result of fruit ripening.¹⁷⁸ But with these new synthetic aldehydes, lactones, and ketones, as one flavor chemist remarked later in 1949, “here then was a really new development, for now the synthetic chemist had developed compounds with flavors similar to those of natural origin, but of vastly greater flavoring power.”¹⁷⁹

Although companies such as Synfleur and Van Dyk manufactured these materials domestically before the war, most of the new synthetic aromatics were manufactured on a very small scale, in laboratory glassware.¹⁸⁰ The First World War, and its disruption of trade networks with Europe, spurred the growth and diversification of an American synthetic chemicals industry, including the production of pharmaceuticals, fertilizers, and petrochemicals.¹⁸¹ It also drove the domestic manufacture of a wider range of synthetic flavor and fragrance chemicals, including materials which had previously been imported from Europe.

Sometimes, the production of an important new flavoring material could be a matter of happenstance, emerging not from directed chemical analysis or exact chemical knowledge but from a close attention to, and capitalization upon, the sensory qualities of chemical materials. A sterling example of this can be found in the story of Fries’ peach

¹⁷⁸ See, for instance, Clemens Kleber, “The Occurrence of Amyl Acetate in Bananas,” *American Perfumer & Essential Oil Review* 7.10 (December 1912): 235.

¹⁷⁹ David E. Lakritz, “Development of Flavors,” *Drug and Cosmetic Industry* 65 (December 1949): 723. Lakritz was the chief chemist at Florasynth, a synthetic flavor and fragrance manufacturer.

¹⁸⁰ Paul Z. Bedoukian, “The Perfumery Aromatics Industry in the United States,” *American Perfumer & Aromatics* 70 (November 1957): 31.

¹⁸¹ Kathryn Steen, *The American Synthetic Organic Chemicals Industry: War and Politics, 1910-1930*, (Chapel Hill: UNC Press, 2014).

flavor, as recounted by James Broderick, a flavorist whose career began in the late 1930s.¹⁸² Fries' peach had been the "target for peach" when he entered the industry. During the war, Fries' had a government contract to process castor oil. During processing, "something went wrong and a powerful odor of peach developed. They repeated the processing exactly and again developed a peach aroma."¹⁸³ At the time, they were unaware that the peachy component in the reaction mixture was a gamma undecalactone; even without analytic knowledge of the identity of the compound in question, they used this substance as the basis of their peach flavor, which gave them an unmatched edge over competitors until the lactone in question became commercially available. Another compound used in Fries' admirable peach flavor was also derived via a similarly inexact process. "For reasons we never ascertained," Broderick writes, using his customary first-person plural, "a strong cheese had been soaked in alcohol and placed in the basement near the furnace." Months later, the cheese gave off an estery-fruity peach scent. Although neither of these compounds would pass contemporary quality control procedures, their use showed an open-mindedness to the sensory potentials of materials, the chemical improvisations necessary to achieve new effects. "The modern flavorist might — the flavor researcher most certainly would — think this strange," Broderick agrees. "But in the days when there were no lactones, no hexenols, no pyrazines, no raspberry ketone, etc., the flavorist had to resort to various modifications to

¹⁸² James J. Broderick, "Reflections of a Retired Flavorist Before He Forgets: Peach," *Perfumer & Flavorist* 17.1 (Jan/Feb 1992): 35.

¹⁸³ Broderick 1992: 35.

achieve desired nuance.”¹⁸⁴ The virtues of a well-made flavor, he concludes, derive from the skillful use of synthetics.

THE VIRTUES OF THE SYNTHETIC

During his lecture at Columbia University, Isakovics posed a question that he knew to be on the minds of his listeners. “Why is it necessary to make substances by synthesis on a *commercial* scale, when these same bodies may be found in nature?”¹⁸⁵ His answer to this sheds light on how organic chemistry had reshaped the contours of commerce.

First, chemical analysis permitted a re-calculation of the sources of value within natural substances, such as essential oils. Nothing in nature is pure or unmixed. An essential oil comprises many different compounds: some are valuable, some are useless, and some are actually undesirable (such as certain terpenes, which take on unappealing aromas when oxidized). Further, all methods of producing essential oils inevitably altered the sensory qualities of the blossom or plant. Something was always altered or lost. Finally, nothing about these substances was certain. The quantity and quality of different essential oils varied from year to year, as did prices on the market. In all of these situations, “synthesis comes to the relief of the manufacturer,” offering ways to reliably produce in pure form and at a stable price “the active constituents imparting either odor

¹⁸⁴ Broderick 1992: 35.

¹⁸⁵ Isakovics 1908: 7.

or flavor, in the most concentrated form, readily soluble, always of the same strength, free from by-products or objectionable constituents.”¹⁸⁶

This reveals a very different view about the sources of value, and the meaning of purity, in aromatic materials than the ones established in the Bureau of Chemistry’s flavoring extract standards, which acknowledged only materials of exclusively botanical origins as ‘pure’ and ‘standard.’¹⁸⁷ Isakovics argued that the value of aromatic materials derived not from their botanical origins (and the types of labor involved in their cultivation and production, as well as the cultural narratives that follow them from bloom to bottle), but from definite and identifiable molecules. Where the Bureau of Chemistry prized purity of origins, Isakovics instead advocated for purity of substance — compounds that efficiently delivered sensory effects unencumbered by useless, insensible materials. These were two rival versions of progressivism, the first supporting an absolute distinction between the products of nature and those of industry, the second celebrating the triumphs of industrial science in surpassing nature’s boundaries and improving nature’s processes.

THE IMPROVEMENT OF NATURE

By now, working with synthetic flavors meant gaining a mastery of specific chemical materials and processes. Increasingly, it also came to include a recognition of

¹⁸⁶ Isakovics 1908, 8-9.

¹⁸⁷ U.S. Department of Agriculture, *Standards of Purity for Food Products* (Circular 19), Washington D.C. (June 26, 1906): 13-5. This subject is discussed at greater length in Chapter Two.

the multisensory and multimodal aspects of flavor perception. Creating successful flavors came to require not only perfecting a specific aromatic formula, but also considering the role that flavor played within particular foods, in interaction with other food components. It also came to mean explicitly taking into account the desires, preferences, and expectations of people as consumers, and the ways that flavor could influence and inform those preferences and desires.

Beginning with Erich Walter's 1916 *Manual for the Essence Industry*, textbooks related to flavor chemistry and manufacturing routinely opened with a chapter addressing the physiology and psychology of flavor perception — topics that had been only haphazardly considered, if at all, in earlier works.¹⁸⁸ In Walter's model, "taste" comprised both the four "basic" sensations perceptible by the tongue (sweet, sour, bitter, and salt), as well as what he called the aromatic taste. These sensations, he explained, were all responses to specific kinds of chemical stimuli. For instance, sourness indicated the presence of acid. The aromatic taste responded to volatile substances, such as terpenes, as well as a category of substances that he described as "extractives," non-volatile compounds present in cell sap, which were associated with bitterness. "The taste is not itself a substance, but is a special property of substances... a phenomenon of energy recognized by our nerves," he explained, somewhat eccentrically. "It is for this reason that it is possible to transfer the taste, or flavors, to our foods and beverages."¹⁸⁹ In other

¹⁸⁸ Erich Walter, *Manual for the Essence Industry*, first edition, (New York: John Wiley; London: Chapman & Hall), 1916.

¹⁸⁹ Walter 1916: 3.

words, to study taste was to study the effect of certain chemical compounds upon the human nervous system.

Although Walter's model of taste did not seem to have been widely adopted, its presence in a book on flavor manufacturing — one written by a self-described “beverage specialist,” and containing chapters on the use of flavoring essences in non-alcoholic and alcoholic beverages, confectionery, and other foods — reflects the broadening scope of the field. People who worked with flavors were beginning to systematically examine the multi-sensory and multi-modal aspects of flavor perception, and to link these to bodily processes, such as appetite and physiological stimulation. Take, for instance, the writings of Melvin De Groote, who worked on three fellowship projects related to flavor chemistry and flavor manufacturing at the Mellon Institute for Industrial Research, where he gained a reputation as an authority on these subjects.¹⁹⁰ A chemical engineer by training, De Groote was also an ardent advocate for the importance of chemical industrial research in the food and beverage industry, and frequently contributed articles to industry trade journals on the subject.

¹⁹⁰ De Groote worked on Fellowships 38, 39, and 90. Fellowships 38 and 39, which ran consecutively from November 1920 to November 1923, were funded by the Pittsburgh Brewing Company and the Research Extracts Corporation, and focused on the production of emulsion flavors for non-alcoholic beverages. Fellowship 90, which ran from November 1917 to November 1920, was funded by Procter & Gamble and related to glycerine, an important component of emulsion flavors and an alternative to alcohol as a flavoring menstruum. The fellowship contracts can be found in the Mellon Institute Collection 0000.42, Carnegie Mellon University Archives.

De Grootte began one such article, “Chemical Research In Beverage Ingredients,” by posing the question: what makes consumers decide to purchase a soft drink?¹⁹¹ Was it for the calories? This was surely not the driving motive, as there were many more economic sources of energy. Was it to satisfy thirst? Again, even though a soft drink fulfills this function, a parched citizen can reliably quench her or his thirst more cheaply by other means. “Regardless of other properties,” De Grootte asserted, soft drinks “are sold primarily because they delight the sense of taste.”¹⁹² With this statement, De Grootte definitively associated the value of the drink with its added flavor — which meant that it was critical to get that flavor *right*.

“Many bottlers wonder why they are never successful in compounding a flavor according to some direction found in a trade journal or in a handbook of formulas,” he wrote. By thinking of flavoring extracts as “trade secrets,” they missed the point: modern flavors required vast amounts of technical and scientific knowledge, including knowledge of new materials and processes. Compounding them properly also demanded extensive practical experience, which, when combined with some degree of innate ability. Those few who combined knowledge with experience and a certain degree of innate ability developed “a sort of sixth sense that means in reality an intuitive genius or at least the sense of intuitional creation.” He continued:

¹⁹¹ Melvin De Grootte, “Chemical Research in Beverage Ingredients,” *Beverage Journal* 58, no 5 (July 1922): 50a-h.

¹⁹² De Grootte 1922: 50a.

“The bottler should remember that... in the purchase of an extract he is not paying so much for the materials employed or the cost of manufacture, but rather for that incommunicable technic of the specialist. The expert is placing his product in their hands for their use is evidence of years of difficult, tedious, and laborious apprenticeship, together with the intuitional creative genius of the skilled and gifted aromatician, certified by scientific knowledge of the most modern advances in modern aromatic chemistry.... The manufacturer of bottlers’ extracts must in the future sell his product, not on the basis of a closely-guarded trade secret, but rather on the basis that it is the finest product that science and art can produce.”¹⁹³

The flavor maker’s product was not combinations of chemicals — it was specialized knowledge, material expertise, and creative skill. The peculiar conjunction of artisanal craftsmanship, modern scientific knowledge, and “intuitional creative genius” sums up the unique identity of the workers who developed and formulated flavorings for the rapidly growing food industry. Drawing on models of the past (such as apprenticeship), this new kind of skilled worker was nonetheless a future-oriented participant in modern industrial processes, not bound to protect guild secrets, but empirically creating new knowledge and new sensations, “certified” by science. Although this particular form of expertise was not widely recognized — as the absence of a stable professional appellation for these workers indicates — by the end of the First World War, the skilled flavor maker was known to be more than a chemical mixer or a formula follower by those industries that needed his (and, at the time, it was almost always “his”)

¹⁹³ De Groote 1922: 50g-h.

services. Meanwhile, the sensational mixtures he produced were becoming increasingly familiar and prized by the ever-growing population of Americans who consumed the products of his creative scientific labor.

TTT

CHAPTER 2

A FLAVOR YOU CAN'T FORGET: GENUINE, IMITATION, AND THE MEANING OF “NATURAL” FLAVOR

“At the very first sip, you are happily conscious of the miracle of it,” ran a 1923 newspaper advertisement for NuGrape, a deep-purple-hued grape-flavored soda that was rapidly becoming a best-selling beverage at a time when consumption of carbonated “soft drinks” was increasing due to Prohibition’s restrictions on the hard stuff. The promised “miracle” was that “all the flavor of the Vineyards” — “the aroma, tang, sunny splendor of wide vineyards, and the perfume of growing, ripening grapes!” — were present in each bottle, in each sip, of NuGrape.¹

“It is no mere echo,” the advertisement assured. “It is Reality — as if you had plucked a cluster of purple Concords and were pressing their amber juice between your lips. NuGrape is the liquid flavor of Concords, livened, given champagne-life, by the secret NuGrape process —it leaps and glistens in the glass with the glow of health.” Indeed, the “secret process” that transformed grapes into NuGrape also seemed to cast enchanting effects over the palates, bodies, and lives of its drinkers. “What a zest it provides for other things,” the advertisement murmured. “The most languid hours are brightened and made more endurable.”

¹ “All the Flavor of the Vineyards in this Bottle,” advertisement, *Atlanta Constitution* (April 17, 1923): 7.

No other grape soda tasted quite like NuGrape, according to advertisements, posters, songs, and other promotional material that appeared first in Southern states and then around the nation in the 1920s and 1930s, and no other grape soda offered the same refreshment and pleasure. It was, according to its slogan, “a flavor you can’t forget.” That’s why buyers were warned to “keep a sharp eye on the NuGrape Bottle,” and make sure that it had three embossed rings around its neck. “It is our three-ringed trade-mark guarantee of the REAL THING — and there are many imitations.”²

² “All the Flavor of the Vineyards...” 1923.

*All the flavor of the Vineyards
in this bottle*

At the very first sip, you are happily conscious of the miracle of it—the aroma, tang, sunny splendor of wide vineyards, and the perfume of growing, ripening grapes! It is no mere echo—it is Reality—as if you had plucked a cluster of purple ConCORDS and were pressing their amber juice between your lips.

NuGrape is the liquid flavor of ConCORDS, livened, given champagne-life, by the secret NuGrape process—it leaps and glistens in the glass with the glow of health. And how appetizing! What a zest it provides for other things. The most languid hours are brightened and made more endurable.

At grocers by the case for your home. At soft drink stands and soda fountains for the whims of your thirst at any time, anywhere **5c**

Keep a sharp eye on the NuGrape Bottle. It is our three-ringed trade-mark guarantee of the REAL THING—and there are many imitations.

NuGrape Bottling Company
124 Auburn Avenue IVy 8364

NuGrape

“All the Flavor of the Vineyards in this Bottle,” *Atlanta Constitution*, (April 17, 1923): 7. Digitized on www.newspapers.com (<https://www.newspapers.com/image/26969317>). Downloaded Oct 31, 2016.

In a world of imitations, its makers insisted, NuGrape was the original. But according to federal regulators charged with enforcing the 1906 Pure Food and Drugs Act, NuGrape was itself an imitation — of grape juice and genuine grape flavors. In 1925, regulators took action against the NuGrape Company of America, charging it with

violating the law by falsely presenting itself as “composed in whole or in part of the juice of the natural fruit of the grape... thereby tending to mislead the purchasing public as to the quality of its product and to stifle and suppress competition.”³ The company conceded, and agreed to prominently print the following admission on all of its bottles and in all of its advertising: “Imitation Grape — Not Grape Juice.” Later that decade, NuGrape altered its formulation in an attempt to place itself on the right side of nature. With the help of “Merchandise No. 25,” a flavoring product devised by Fritzsche Brothers, a New York flavor and fragrance manufacturer, NuGrape claimed to derive its flavoring qualities exclusively from grapes themselves. When regulators challenged NuGrape’s claims to authenticity, the company fought back — ultimately losing the case after details about the production of “Merchandise No. 25” were revealed in federal court.

What was the relationship between the flavor of grapes and the flavor of NuGrape? What made NuGrape an imitation in the eyes of the law, and why did it matter to regulators, to the company, and to consumers whether it admitted as much? Could a bottle of NuGrape be the “real thing” — and yet also be an imitation? How was the line between “genuine” and “imitation” defined and policed, and on what grounds was it contested?

³ U.S. Federal Trade Commission, “Complaint No. 1199: Federal Trade Commission v. The NuGrape Co. of America. Charge: Unfair Methods of Competition,” *Annual Report of the Federal Trade Commission for the Fiscal Year Ended June 30, 1925*, (Washington, DC: Government Printing Office, 1925): 179-80.

Since the passage of the Pure Food & Drug Act in 1906, federal agents, armed with evidence produced by chemical laboratories, had intervened to ensure both the wholesomeness and transparency of the food supply.⁴ The law is considered a landmark for public health, keeping putrid beef, watered-down “swill” milk from filthy urban dairies, and dangerous patent medicines out of the national food and drug supply. The law also endeavored to protect citizens by combating consumer fraud: prohibiting commercial misrepresentations, such as the substitution of imitation for genuine goods. The law’s chief concern was to prevent goods of lesser value from passing themselves off as “better than they actually were.”⁵ The premise was that imitations and substitutions were inherently less valuable, and of lower quality, than goods designated “genuine.” The Bureau of Chemistry, a scientific agency within the US Department of Agriculture, was the official arbiter of these disputes, tasked with interpreting the law and using the methods of analytic chemistry to make and enforce determinations not only about the

⁴ The political and social history of Progressive era food legislation in the US has been extensively documented, including by James Harvey Young, *Pure Food: Securing the Federal Food and Drugs Act of 1906* (Princeton: Princeton UP, 1989); Lorine Swainston Goodwin, *The Pure Food, Drink, and Drug Crusaders: 1879-1914* (McFarland, 1999); and Bee Wilson, *Swindled: The Dark History of Food Fraud, from Poisoned Candy to Counterfeit Coffee*, (Princeton: Princeton UP, 2008). The British version of this story can be found in Michael French and Jim Phillips, *Cheated, not Poisoned? Food Regulation in the UK, 1875-1938* (Manchester, 2000). Alessandro Stanziani authoritatively chronicles food regulation in France in his *Histoire de la qualité Alimentaire: XIXe-XXe Siècle* (Seuil: Paris, 2005). For an account that compares how different types of scientific and medical expertise shaped regulations in the US and in German-speaking countries in Europe, see Uwe Spiekermann, “Redefining Food: The Standardization of Products and Production in Europe and the United States, 1880-1914,” *History and Technology* 27 (March 2011): 11-36.

⁵ Peter Barton Hutt and Peter Barton Hutt II, "A History of Government Regulation of Adulteration and Misbranding of Food," *Food Drug Cosmetic Law Journal* 39 (1984): 2-73. The prohibition against a food being made to seem “better than it actually is” came from an influential model law published in the 1880 *Sanitary Engineer*, and the phrase was often cited by pure food advocates in their definitions of food adulteration.

presence or absence of chemical entities, but also about identity, authenticity, meaning, and value. While regulators dictated that even a drop of synthetic flavoring material relegated a food or beverage to the lesser-value status of “imitation,” flavor companies and the food manufacturers who used their products argued that synthetic flavorings were not only safe, but beneficial. Rather than fraudulent concoctions that dishonestly masked unsavory goods, these manufacturers argued that flavor additives were progressive products of scientific research. They added value, increased quality, and made entirely new categories of manufactured products possible and accessible.

What was ultimately at stake in these contested debates about naturalness, authenticity, and identity were questions of value. How should the value of a food be determined, and whose expertise should matter in making these determinations? This chapter begins by considering the 1906 Pure Food Law and the terms under which the state regulated flavoring additives and manufactured foods that used these products. A system of regulatory standards imposed a strict distinction between botanically derived flavorings and products of synthetic chemistry, requiring foods and beverages which included any of the latter to prominently disclose their status as “imitation” or “compound” on packages and labels. Chemists — working on behalf of federal and state governments — were tasked with enforcing the law, but designating the difference between “natural” and “imitation” proved to be far from clear-cut. Rather than a neutral requirements that increased market efficiency and transparency, I show how these regulations simultaneously presumed and imposed a quality and value hierarchy that placed “genuine” products above synthetic “imitations,” one that did not necessarily align

with the way these products were made, used, and experienced, and which was only one of multiple ways of measuring food's value that emerged during this period.

I then turn to the case of NuGrape, tracing the history of the beverage and the changing flavoring materials that gave it its grapiness, alongside the political, economic, and cultural forces that defined its value and its meaning. Often, the interpretation of new synthetic materials is folded into a binary with some prior natural material, where the synthetic material is taken as an inferior substitute for a scarce natural resource.

However, whether celluloid, oleomargarine, vanillin, or synthetic grape flavor, the “substitute” material often has virtues, and affords possibilities, that the “natural” lacks (and vice versa). It is, moreover, embedded in a different network of raw materials, producers, consumers, and calls into being different kinds of expertise.⁶ What I argue here is that synthetic flavor additives were not only used as (and understood to be) cheaper substitutes for the scarce but genuine things of nature, but were called into necessity by the large-scale production of “everyday luxuries” for mass consumer markets. Synthetic flavors did not merely make it possible to deliver a version of an existing sensory experience to broader group of consumers, but instead delivered new kinds of experiences, and new kinds of value, to consumers whose lives, bodies, and senses were being transformed in modernity. Against the interpretation of the imitation as a less-virtuous, imperfect substitute for the “real thing” — NuGrape as less-than grape —

⁶ On the case of celluloid, see Robert Friedel, *Pioneer Plastic: The Making and Selling of Celluloid*, (Madison: UWisconsin Press, 1983) and Jeffrey L. Meikle, *American Plastic: A Cultural History*, (New Brunswick: Rutgers UP, 1995.) On oleomargarine, see: Ruth Dupree, “‘If It’s Yellow, It Must Be Butter: Margarine Regulation in North America Since 1886,” *Journal of Economic History* 59.2 (June 1999): 353-71. On vanillin, see, Nadia Berenstein, “Making a Global Sensation,” *History of Science* 2016.

I instead propose that the effect produced by NuGrape represents a new thing coming into being. In this emerging order, synthetic flavorings were technologies of sensory experience, performing in a new sensual economy, one that valued affective aspects of experience, intensifications of sensation and emotion, and demanded new forms of refreshment and new varieties of pleasure.

I. QUALITY, VALUE, FLAVOR: ADDED FLAVOR AFTER THE 1906 PURE FOOD AND DRUG ACT

The 1906 Pure Food and Drug Act became the law of the land in an era of growing public concern over the hidden dangers lurking in the nation's food supply. Decades of media coverage about food adulteration, especially in women's magazines, muckraking exposés about "swill milk" and filthy meatpacking plants, and well-publicized deaths from "ptomaine" poisoning built political will for the law's substantial expansion of the federal government's regulatory powers. For the lawmakers and the business coalition whose support for the law was essential in securing its passage, rooting out commercial fraud was as pressing an issue as preserving public health.⁷ Testimony about commercial fraud comprised the majority of evidence presented in Congressional hearings in support of the bill, as well as in the reports of state regulatory agencies and the Bureau of Chemistry.⁸ "What we want is that the farmer may get an honest market and the consumer may get what he thinks he is buying," explained Harvey Wiley, the

⁷ Donna J. Wood, "The Strategic Use of Public Policy: Business Support for the 1906 Food and Drug Act," *Business History Review* 59 (Autumn 1985): 403-32.

⁸ Wood 1985: 408-9.

chemist who, as head of the USDA's Bureau of Chemistry, was one of the law's chief architects and most ardent champions.⁹

Wiley's summary of the bill's intent connected a fair market for farmers with a transparent market for consumers, but left out manufacturers, who transformed raw agricultural and chemical materials into an expanding range of commercial goods, and were responsible for an ever-growing share of both the food supply and the national economy.¹⁰ For many reformers, manufacturers were at the root of the problem; their quest for profits coupled with the increasing distance between consumers and producers introduced new opportunities for fraud.¹¹ Unscrupulous manufacturers had a willing accomplice: chemical science. "The development of bacteriological and chemical science contributed to the upsurge of food, drink, and drug adulteration," writes historian Lorine Swainston Goodwin. "Large firms began to employ industrial chemists to develop deodorants for rotten eggs and rancid butter, dyes to enhance color, agents to alter flavor... and ways to keep pickles crisp." For many reformers, she explains, these products of the chemical laboratory were *de facto* evidence of fraudulence, allowing

⁹Harvey Wiley, address to the 1898 National Pure Food and Drug Congress, quoted in Young 1989: 128.

¹⁰ By 1900, a fifth of all goods manufactured in the United States were food products. Beginning in the late nineteenth century, an ever-increasing share of foods were produced by large corporations, such as Heinz, Campbell's, and Nabisco. Harvey Levenstein, *Revolution at the Table: The Transformation of the American Diet* (New York: Oxford UP, 1986): 30-43; Helen Zoe Veit, *Modern Food, Moral Food: Self-Control, Science, and the Rise of Modern American Eating in the Early Twentieth Century*, (Chapel Hill: UNC Press, 2013): 44.

¹¹ Goodwin 1999: 48-9.

profit-hungry manufacturers to produce and sell low-quality goods while consumers remained unsuspecting.¹²

Advances in chemistry were responsible not only for a growing number of synthetic preservatives, flavorings, and other food additives, but also entirely novel food products, such as oleomargarine from the meatpacker's scraps and "glucose" from corn starch — products whose economic legitimacy was questioned by rival agricultural industrial interests, but whose safety was rarely seriously disputed. There was widespread evidence of the use of chemical additives and substitute substances, but also little evidence that these were harmful, except to the bottom line of established manufacturers of butter, honey, and other products perceived to be in competition.¹³ Most advocates for reform, however, did not intend to outlaw the use of all chemical additives or synthetic products in the food supply. By and large, reformers, legislators, and pro-regulation manufacturers agreed that there was a place in the market for low-quality and substitute foods, and that poor consumers should have access to cheaper, albeit inferior, food items. Meanwhile, for manufacturers who used preservatives, flavorings, and other additives, the presence of these substances was not evidence of fraudulence, but represented attempts to improve the eating quality of their products by technical means.

"Transparency" was a fraught question for these new kinds of products. Canned vegetables and meats, boxes of biscuits, condiments in glass jars, candy in tins, soda in bottles: processed foods were packaged foods, and interposed a layer of opacity between

¹² Goodwin 1999: 49.

¹³ Young 1989: 66-92, 104-5;

the consumer and the thing to be consumed, foreclosing the possibility of direct sensory examination. Furthermore, the proof of the pudding was less and less likely to be found in the eating. In a market of sealed containers, distant producers, and unfamiliar additives and processes, how could consumers know not only what their food was, but what it was worth?

For turn-of-the-century consumers, the food market was shot through with uncertainty and risk. Economic and business historians have described the Pure Food and Drug Act as an effort to reduce this risk, and resolve informational asymmetries in order to increase market efficiency.¹⁴ According to these scholars, chemists and other technical and scientific experts were authorized to make official determinations about a food's identity and contents — and thus, by implication, its value — determinations that consumers were no longer equipped to make. In other words, when consumers cannot detect whether they are being “cheated,” official chemists must step in to make the determination on a material, rather than a sensory, level. It has thus been argued that regulations were necessary to restore consumer confidence in fundamental food quality, even as the consumers' susceptibility to the sensible aspects of these distinctions eroded.¹⁵

This line of reasoning presumes that judgments about quality are made against pre-existing norms, that differences in quality are determinable by experts using agreed-

¹⁴ See, for instance, Wood 1985; Marc T. Law, “How do Regulators Regulate? Enforcement of the Pure Food and Drugs Act, 1907-1938,” *Journal of Law, Economics, and Organization* 22.2 (2005): 460-86. Marc T. Law, “The Origins of State Pure Food Regulation,” *Journal of Economic History* 63 (December 2003): 1103-1130.

¹⁵ Law 2003: 1116.

upon methods, and that the meaning of these differences is self-evident. Recently scholars have begun to push back against these assumptions, historicizing not only the meanings of quality but also modes of negotiating and adjudicating disputes about the quality of foods.¹⁶ As Alessandro Stanzioni has observed in his study of the origins of French food regulation, “quality is not an objective, ahistorical category,” it is a contested category, whose meaning not only changes over time, but also reflects different regional, political, social, and economic beliefs and interests.¹⁷ Whether a chemical additive constituted an “adulteration” or an “improvement” — whether it was an “imitation” or an “innovation” — was anything but self-evident, especially at a time of rapid changes in food production, distribution, and consumption. Nor was the meaning of “pure” or “natural” simple to determine. In the case of milk and other dairy products, for instance, some physicians and other reformers opposed pasteurization, on the grounds that it would stall efforts to improve the sanitation of dairies. “Pasteurization, they emphatically repeated, could make milk safe, but it could not make dirty milk clean.”¹⁸ The craving for the “purity” was not necessarily a demand for nature’s raw materials, unaltered.

Furthermore, the authority of scientific experts to adjudicate these disputes was not a given. Scientific authority had to be laboriously and contentiously established, a task often complicated by the ambiguous and indeterminate results produced by

¹⁶ Jerome Bourdieu, Martin Breugel, Peter Atkins, “That Elusive Feature of Food Consumption: Historical Perspectives on Food Quality, a Review and Some Proposals,” *Food & History* 5, no 2 (2007): 247-266.

¹⁷ Alessandro Stanziani, “Negotiating Innovation in a Market Economy: Foodstuffs and Beverage Adulteration in Nineteenth-Century France,” *Enterprise and Society* 8 (June 2007): 375-412.

¹⁸ Kendra Smith-Howard, *Pure and Modern Milk: An Environmental History Since 1900*, (New York: Oxford UP, 2013): 33.

analysis.¹⁹ As Benjamin Cohen has pointed out, when it came to enforcing regulations — for instance, distinguishing what could call itself butter from what could legally not use that name — the context and consequences were both social and scientific. Analytic chemists were “not just detectors of chemical impurities; they were participants in a vital cultural arbitration” that sought to disentangle the authentic from the imitation, the deceptive surface from the genuine interior.²⁰

As governments took a more active and interventionist role in regulating the food and drug supply, the stakes in the debates over how these distinctions were to be made grew more significant.

FLAVOR ADDITIVES AND FOOD STANDARDS

At the time when the market itself was becoming a central presence in not only the economic, but also the social and cultural lives of Americans, rising concerns about food adulteration and quality reflected a growing anxiety about the limitations of market forces to equitably distribute rewards and secure virtuous outcomes.²¹ Can the fair market value of food be established by market forces alone? Flavor additives and other chemical

¹⁹ Spiekermann 2011. In a comparable case study examining the adoption of the hydrometer as the standard tool for determining alcoholic proof (and assessing duties), William Ashworth has illustrated how the scientific authority of the instrument and the power of the state were contested by merchants who had previously relied on sensory expertise to classify spirits. William J. Ashworth, “‘Between the Trader and the Public’: British Alcohol Standards and the Proof of Good Governance,” *Technology and Culture* 42 (January 2001): 27-50.

²⁰ B.R. Cohen, “Analysis as Border Patrol: Chemists Along the Boundary Between Pure Food and Real Adulteration,” *Endeavor* 35 (2011): 66-73.

²¹ Susan Strasser, *Satisfaction Guaranteed: The Making of the American Mass Market*, (New York: Pantheon, 1989): 125.

products and processes aggravated doubts on the matter. Reformers worried that the production and price of foods could be deranged by the superficial and specious appeal of chemically altered and enhanced goods. Because synthetic flavor additives erased the perceptible difference between actual and apparent value, these chemical materials complicated the equation for determining the actual worth of foodstuffs. The law's strategy for protecting consumers from this type of fraud was by prohibiting the sale of foods defined as "adulterated" or "misbranded."

Adulterated food was defined to include contaminants that posed threats to health (such as rotten or diseased meat, or ingredients known to be harmful), as well as various sorts of material manipulations that were perceived to affect food's value. In the latter cases, a food was adulterated, and thus outlawed in interstate commerce, if "any substance has been mixed and packed with it so as to... injuriously affect its quality or strength," "if any substance has been substituted wholly or in part" for the food item, "if any valuable constituent... has been wholly or in part abstracted," or "if it be mixed, colored, powdered, coated, or stained in a manner whereby damage or inferiority is concealed."²²

"Misbranding" concerned the claims made on the package about the food's identity or contents. Foods were misbranded if they were imitations "offered for sale under the distinctive name of another article," or "labeled or branded as to deceive or mislead the purchaser" about its contents or identity by including "any statement, design,

²² *Federal Food and Drugs Act of 1906*, Public Law 59-384, 59th Cong., 1st sess. (June 30, 1906), Section 7, "Adulterations."

or device regarding the ingredients or the substances contained therein” which were “false or misleading in any particular.” The statute’s regulation of misbranding allowed for two exceptions, which made it possible to bring novel types of manufactured food to market. First, products could be sold if they were plainly and clearly marked as such, using terms such as “imitation,” “compound,” or “blend” to indicate their distinction from the standard article. Second, what was known as the “distinctive name” provision allowed manufacturers to sell their products under unique, coined trade names.²³ Court decisions would establish that this provision protected products such as “Bred Spred,” a fruit-flavored jam-like spread, from having to label itself “imitation jam,” as well as products with better-known distinctive trade names, such as “Coca-Cola.”²⁴

The law simultaneously put the contents of food and how it was represented under review, primarily by attending to and policing a distinction between goods of greater or lesser value. The definition of adulteration and misbranding as commercial fraud presumed a stable set of common standards of identity and value for certain foods, which impostor foods undermined by chemical legerdemain and unsuspected substitutions. Yet there were no stable or agreed-upon ways of determining the “valuable constituents” of a food, nor of unequivocally defining “injurious” changes to quality and strength. Chemical presences and absences could be registered, but their meanings and their effects on food’s

²³ *Federal Food and Drugs Act of 1906*, Section 8 “Misbranding.”

²⁴ The standard established by the court was that the name of the product must be “either... so arbitrary or fanciful as to clearly distinguish it from all other things, or one which by common use has come to mean a substance clearly distinguishable by the public from everything else.” See Suzanne White Junod, “Food Standards in the United States: The Case of the Peanut Butter and Jelly Sandwich,” in David F. Smith and Jim Phillips, eds. *Food, Science, Policy and Regulation in the Twentieth Century: International and Comparative Perspectives*, (New York: Routledge, 2013): 167-88.

ultimate value were underdetermined. At the very least, the authority of chemical analysis to distinguish between pure and adulterated depended on the existence of a materialist account of food's identity: what a certain food must contain to properly represent itself as such.

In 1897, the Association of Official Agricultural Chemists (AOAC), the professional organization of regulatory chemists working in state and federal government, began developing and publishing food standards that defined common foods in terms of their contents. This was connected with concomitant efforts by the group to develop standard and uniform methods of food analysis. Generally, the formulation of food standards involved not only regulators, but also manufacturers and other experts who were presumed to be authorities on the foods in question. However, to the chagrin of Wiley, his confrères in the Bureau of Chemistry and state regulatory agencies, and the AOAC, by the time the Pure Food Law was passed, legal authority for the creation of these standards had been stripped from the bill. This was due largely to the efforts of senators sympathetic to the makers of blended whiskey, who believed food standards would either outlaw their product or force it to be labeled 'imitation.'²⁵ Until 1938, when

²⁵ The development of "unofficial" food standards before the 1938 Food, Drug, and Cosmetics Act has yet to be fully chronicled by historians. The most comprehensive historical accounts of food standards in the US can be found in White Junod 2013, as well as in Hutt and Hutt 1984. For a fascinating account of postwar food standards that analyzes the label as information infrastructure, see Xaq Frohlich, "The Informational Turn in Food Politics: The US FDA's Nutrition Label as Information Infrastructure," *Social Studies of Science* (2016): 1-27. Angie Boyce's recent study focuses on debates around the creation of a standard of identity of peanut butter in the 1960s and 1970s, which she uses as a case study to examine the relations between experts and lay consumer activists in the determination and definition of technological artifacts. Angie M. Boyce, "When Does it Stop Being Peanut Butter?" FDA Food Standards of Identity,

the Food, Drug, and Cosmetics Act authorized the establishment of mandatory food standards, these food standards had only “advisory” status, which meant that their legitimacy could be subject to judicial challenge.²⁶

“Circular 19,” published in June 1906, articulated definitions and compositional limits for multiple categories of commodities, staple processed foods, and condiments including meat, dairy, grain, fruit and vegetable products, vinegars, fats and oils; they also specified standards for twenty-three different flavoring extracts, from almond extract to wintergreen.²⁷ These and subsequent advisory standards served as a guide for manufacturers whose foods had to conform to the published definitions (or else be labeled “imitation,” “compound,” or sold under a distinctive name) in order to avoid regulatory action against their products, and were meant to protect the interests of consumers, but were written in “laboratory language,” the terms of art of analytic chemists, specifying upper and lower limits for various chemically measurable constituents.²⁸ Standards were exclusionary: components not listed in definitions were not permitted in standard products.

According to Circular 19, a flavoring extract was “a solution in ethyl alcohol of proper strength of the sapid and odorous principles derived from an aromatic plant, or

Ruth Desmond, and the Shifting Politics of Consumer Activism, 1960s-1970s,” *Technology and Culture* 57.1 (2016): 54-79.

²⁶ Court rulings on the authority of the government’s food standards were inconsistent; some rulings found in favor of the USDA’s standards to guide enforcement actions, others rejected regulators’ authority. See Hutt & Hutt 1984: 59.

²⁷ “Standards of Purity for Food Products” 1906: 13-15.

²⁸ This is in contrast with later, ingredient-based standards, imposed after the 1938 Food, Drug, and Cosmetics Act. White Junod 2013: 168.

parts of the plant, with or without its coloring matter, and conforms in name to the plant used in its preparation.”²⁹ Flavoring extract standards, attempted to set minimum quality requirements by specifying two things: botanical origins — traceable to a plant or its leaves, roots, or seeds — and minimum “proper” flavoring strength. For instance, a product calling itself “vanilla extract” guaranteed that it derived its vanilla flavor exclusively from vanilla beans and that at least 10 grams of beans had been used for every 100 cubic centimeters of extract.³⁰

At the end of 1906, in response to numerous inquiries, the USDA Bureau of Chemistry issued further guidance on labeling flavorings that were excluded from the standards. This included flavorings that included compounds such vanillin and coumarin as well as “numerous preparations made from synthetic fruit ethers intended to imitate strawberry, banana, pineapple, etc.”³¹ “Such products should not be so designated as to convey the impression that they have any relation to the flavor prepared from the fruit. Even when it is not practicable to prepare the flavor directly from the fruit, ‘imitation’ is

²⁹ “Standards of Purity for Food Products” 1906: 13.

³⁰ The vanilla extract standard’s specification of materials used during the production process was an exception to the typical wording of these requirements, one that was made necessary by the availability of synthetic vanillin and the commercial importance of the vanilla industry. Most extract standards specified minimums in terms of volume of valuable components in the final product. For instance, cinnamon extract was required to contain at least 2 percent by volume of oil of cinnamon; oil of cinnamon was defined as the volatile oil from the bark of Ceylon cinnamon, containing no less than 65 percent cinnamic aldehyde and no more than ten percent eugenol. See Berenstein “Making a Global Sensation” 2016.

³¹ James Wilson, Secretary of Agriculture, Food Inspection Decision no. 47: “Flavoring Extracts,” U.S. Department of Agriculture Bureau of Chemistry, (December 13, 1906), Flavoring Extracts General Data, Food Standards Committee, Record Group 88, Records of the Food and Drug Administration, National Archives and Records Administration II, College Park, MD.

a better term than ‘artificial.’” This designation carried over to the foods that these “substitutes” were included in. For instance, ice cream made using a synthetic strawberry flavor could not be legitimately labeled “strawberry ice cream.” Even when there was no comparable flavoring product — no ‘genuine’ strawberry flavoring that the synthetic product was competing with or substituting for— synthetics were *de facto* imitations.

Other standards related to the use of flavorings in food products — such as soft drinks — were elaborated in subsequent published notices of judgment, USDA circulars, and department bulletins, as well as in speeches and other communications between the USDA and trade groups, such as the Flavor and Extract Manufacturers’ Association.³² These attempted to keep pace with the rapidly changing technological, chemical, and commercial conditions of manufactured foods and beverages as new kinds of products came on the market. For instance, when “cloudy” citrus-flavored beverages became popular in the 1920s, regulators moved rapidly to define the legitimate versions of this product. The Bureau of Chemistry specified that the terms -ade, squash, punch, crush,

³² Guidelines indicating the Bureau of Chemistry’s interpretation of statute can be found in the published notices of judgment under the Federal Food and Drugs Act, USDA Circular 21 (Rules and Regulations for Enforcement). Circular 19, “Standards of Purity for Food Products,” was superseded in 1919 by Circular 136, of the same title. In addition to standards for flavoring extracts (which remained largely unchanged from Circular 19), Circular 136 contained standards for soda water flavors. Bureau of Chemistry Bulletins concerning spices and flavoring extracts include Bulletins 63, 132, and 152. Official information about regulations and labeling was also regularly published in trade journals for bottlers, druggists, soda fountain operators, essential oil and fragrance manufacturers, and others. Flavoring manufacturers also communicated directly with the Bureau of Chemistry (and later, the FDA) seeking clarification and advice about appropriate label language. Although the agency demurred from granting approval to proposed labels, it did offer technical advice and guidance. See: Center for Food Safety and Nutrition, Office of Nutritional Products, Labeling, and Dietary Supplements, Record Group 88, Records of Food and Drug Administration, National Archives and Records Administration II, College Park, MD.

and smash could only be used to describe beverages that contained fruit juice; others, including those flavored with essential oils and essences of botanical origin, must be labeled ‘imitation.’³³

Meanwhile, food officials struggled to develop reliable and standard chemical methods for distinguishing “true” products from those which must be labeled as “imitation,” thus providing scientific evidence of adulteration that could carry weight in the federal courts where these charges were adjudicated. This required not only methods of identifying the presence of adulterants, but also the analysis of the chemical components responsible for flavor in foods, spices, and “pure” products. For this reason, some of the earliest published chemical research into the flavor chemistry of fruits was performed by USDA researchers.³⁴ Only by determining the actual chemical components of apples, peaches, and grapes could the presence of synthetic additives be demonstrated. But even the most painstaking chemical analysis could never quite provide unequivocal proof of a substance’s status, as the flavor chemistry of natural foods remained largely unknown. These determinations were particularly fraught in cases where the synthetic

³³ J.W. Sale, “Labeling Beverages and Beverage Materials Under the Federal Food and Drugs Act,” in R.O. Brooks, *Critical Studies in the Legal Chemistry of Foods*, (New York: Chemical Catalog Company, 1927): 267. This paper was originally presented at a meeting of state, local, and federal and food officials in 1924.

³⁴ For instance, see Frederick B. Power and Victor K. Chestnut, "The Odorous Constituents of Apples," *Journal of the American Chemical Society* 42 (7) (1920), 1509-1526; Frederick B. Power and Victor K. Chesnut, "The Odorous Constituents of Peaches," *Journal of the American Chemical Society*, 1921: 1725-1740.

compound was known to be chemically identical to the molecule found in nature, as was the case with synthetic vanillin and vanilla extracts.³⁵

In the majority of cases involving flavoring additives and flavored products, misbranding was a necessary precondition of adulteration. Penalties involved the seizure and destruction of goods as well as the imposition of fines, generally between \$25 and \$100. These relatively small fines did not always “deter the careless or dishonest manufacturer from continuing the adulteration of his products,” but according to Bureau of Chemistry officials, “usually the adulteration of flavors is discontinued when the manufacturer’s or importer’s attention is called to the matter.”³⁶

The elaborate, growing set of food standards and the legal interrelationship between adulteration and misbranding show that the enforcement of the Pure Food law required regulating both language and chemical contents. What concerns and procedures guided these efforts and shaped how regulatory meanings were articulated and implemented? As Dr. William Frear, who served as a technical advisor on the development of food standards, explained to a meeting of flavor manufacturers, standards

³⁵ See Berenstein 2016: 417-8. Discussion of the official methods of vanilla evaluation can be found in: AL Winton and EH Berry, “The Chemical Composition of Authentic Vanilla Extracts, Together with Analytical Methods and Limits of Constants,” in Harvey Wiley and AL Pierce, eds., *Proceedings of the 28th Annual Convention of the Association of Official Agricultural Chemists*, USDA Bulletin 152, (Washington: Government Printing Office, 1912): 146-58.

³⁶ J.W. Sale and W.W. Skinner, “Food Flavors: Their Source, Composition, and Adulteration: Part VI, Conclusion,” *Beverage Journal* (October 1922): 50a. This was the concluding article of a six-part series by Skinner, Assistant Chief of the Bureau of Chemistry, and Sale, the Chemist in Charge of its Water and Beverage Laboratory. Prior articles in the series discussed the chemical composition of both “natural” flavoring materials, such as spices, essential oils, and so on, and the chemical components of synthetic flavors.

must reflect “the generally accepted name in such a way as to make the distinctions the people ordinarily make between the product under consideration and all other food substances.”³⁷ In other words, when the agency had to arbitrate between the language used by the public and the language of food manufacturers, food marketers, and manufacturing chemists, the language of the “ordinary consumer” was statutorily definitive. These usages, although in a certain sense arbitrary, had to be made stable, unambiguous, and precise through the enforcement of these statutes, which relied on chemical analysis rather than assessments of sensory quality. In this way, presumed (though contested) distinctions in market value — between “true” and imitation — were produced and reinforced by the regulations that claimed only to enforce market transparency.

Why were flavorings of botanical origin privileged over products of synthetic chemistry? In part, this derived from deeply held cultural beliefs about naturalness, what Lorraine Daston and Fernando Vidal have termed the “moral authority of nature.”³⁸ Yet the meaning of “natural” in food had never been self-evident, and was even more in dispute as the social and geographical distance between food producers and food consumers increased. For a consuming public that was growing and making less of its food at home and buying more of it in markets, “purity” and “naturalness” were increasingly valued. However, we should not take this to signify a demand for nature’s

³⁷ Dr. William Frear, “Standards for Flavoring Extracts: Address before Flavor Extract Manufacturers Convention, Atlantic City, June 29, 1916,” *Simmons’ Spice Mill* 39 (September 1916), 1035-6.

³⁸ Lorraine Daston and Fernando Vidal, eds. *The Moral Authority of Nature*, (Chicago: University of Chicago Press, 2004).

raw materials unaltered. As Kendra Smith-Howard has shown in the case of milk, milk became “nature’s perfect food” — considered wholesome, safe, and pure — by virtue of technologies that standardized and centralized its production and distribution, even as its marketers cultivated a pastoral ideal of dairying that was rapidly vanishing from the countryside. “Though they credited nature for milk’s purity,” Smith-Howard writes, “reformers altered the very nature of milk and the cows that produced it.”³⁹ The qualities that seemed to indicate the “naturalness” of pasteurized, homogenized milk produced in large-scale dairies, or of creamery butter made in a centralized factory — not only the absence of disease-causing microorganisms but also of off-flavors or flavor variations — were the hard-won goods of technoscientific control rather than natural givens.

The naturalness of “pure food” was associated with authenticity, a virtue whose meaning at this time must be defined within the changing social and economic contexts of American life. The veracity of representation was an increasingly fraught question in nineteenth-century America, when the set of local social relations that validated personal identity began to fray.⁴⁰ With the growth of the industrial economy, doubts swelled to include things as well as persons. Is this item what it purports to be or is there a disjunction between its sensible qualities and its inherent contents? Anxieties around the disjunctions between essence and presentation swelled during this period of rapid industrialization and account in part for the widespread perception of chemical additives

³⁹ Smith-Howard 2013: 15.

⁴⁰ Karen Halttunen, *Confidence Men and Painted Women: A Study of Middle-Class Culture in America, 1830-1870*, (New Haven: Yale UP), 1982; Scott Sandage, *Born Losers: A History of Failure in America*, Cambridge: Harvard UP, 2005.

as a sign of capitalism run amok.⁴¹ Whether or not any food additives posed a definite risk to health, the proliferation of these chemicals was seen as a symptom of a broader threat to national well-being posed by untrammelled competition in an unregulated market.⁴² A pure product, by the definition of Progressive-era reformers, was not only free from hazardous substances; it was also a product with a morally privileged history, associated with agricultural production rather than industrial manufacturing.⁴³

What of flavoring strength, the other property defined in the food standards? If flavoring strength was a virtue when it came to products of botanical origins, it was a suspect quality in synthetic materials. Many flavoring extracts contained both botanically derived and synthetically produced substances. Flavoring manufacturers argued that synthetic compounds only comprised a small fraction of the net contents of a flavoring; moreover, these chemicals played a functional role in the mixture, serving as “fixatives,” preserving the original flavor by forestalling flavor loss to volatility, and as intensifiers, which increased the flavor’s power and strength, increasing its utility to food and beverage manufacturers. Why, on the basis of two percent of a flavoring extract’s total content, should the extract and the product it flavored both be labeled ‘imitation’? “It is conceivable that so little synthetic flavor may be added... that the predominating flavor of the article is genuine fruit flavor,” conceded J.W. Sale, the chief chemist of the

⁴¹ Cohen 2011.

⁴² Goodwin 1999: 48-51.

⁴³ This is not to say that reformers and the consumers they claimed to represent were unequivocally opposed to industrial food production. For an account of how moral sentiments concerning trust and purity were co-opted by a large food manufacturer, see Gabriella Petrick, "'Purity as Life': H.J. Heinz, Religious Sentiment, and the Beginning of the Industrial Diet," *History and Technology* 27 (2001): 37-64.

Bureau's beverage and water laboratory, before continuing: "but as a matter of fact, owing to the great difference in flavoring power between the natural fruit flavors and synthetic fruit flavors, the amount of synthetics which are ordinarily used is such that the predominant flavor of the resulting product is due to the artificial flavor rather than to the natural flavors."⁴⁴ In the context of the food regulations, the efficiency of synthetics — or the sensitivity of the human sensorium to compounds used in synthetic flavorings — was not a valued quality.

According to the food standards, a synthetic chemical could never be pure, regardless of its harmlessness, its pleasant sensory qualities, or its other advantages — not even a chemical such as vanillin, which was indistinguishable from the compound found in 'natural' vanilla beans. The simple presence of synthetically produced substances, no matter how small the quantity or how 'pure' the rest of the materials, was enough to condemn a flavoring and the food that contained it as 'imitation.' But the Bureau of Chemistry's food standards were far from the only way of calculating value and assessing quality in the American marketplace in the Progressive era.

CALCULATING THE VALUE OF FOOD AND OF FLAVOR

At around the same time that reformers were advocating for regulatory oversight of the food system another way of calculating the value of food was rising to prominence: nutritional analysis. The science of nutrition concerned both consumers and consumed, combining the chemical analysis of foods and the physiological determination of caloric

⁴⁴ Sale 1927: 268.

and nutrient needs of organisms. In the US, nutritional science gained authority by affiliating itself with progressive political programs, and was deployed to rationalize both production and consumption to optimize the abilities and capacities of laboring citizens.⁴⁵

By quantifying the value of foods in terms of calories, macronutrients, and later, vitamins, nutritional science made it possible to imagine substitutions among very different kinds of foods.⁴⁶ As Helen Zoe Veit has written, “By arguing that foods that seemed superficially very different could be vehicles for the same needed nutrients, nutritionists transformed food into a variable in a kind of cultural algebra.”⁴⁷ Foods with divergent market values (and distinct social meanings), such as rib roast and baked beans, could be revealed to possess equivalent nutritional value. Maximal nutritional efficiency was achieved when each person received her or his precise set of nutritional units at the lowest possible cost. “Of course,” Veit observes, “this supposedly culture-blind nutritional equivalency was only possible by deemphasizing tradition, habit, and often, the pleasure of eating itself.”⁴⁸ A heap of beans may provide the same caloric energy, and the same quantity of protein, as prime rib, but the sensory experience of the two could not have been more distinct.

⁴⁵ Jessica Mudry, “Quantifying an American Eater,” *Food, Culture & Society* 9.1 (2006): 43-67; Hamilton Cravens, “Establishing the Science of Nutrition at the USDA: Ellen Swallow Richards and Her Allies,” *Agricultural History* 64.2 (Spring 1990): 122-33.

⁴⁶ Gyorgy Scrinis, *Nutritionism: The Science and Politics of Dietary Advice*, (New York: Columbia UP, 2013).

⁴⁷ Helen Zoe Veit, *Modern Food, Moral Food: Self-Control, Science, and the Rise of Modern American Eating in the Early Twentieth Century* (Chapel Hill: UNC Press, 2013): 46.

⁴⁸ Veit: 51.

How did flavor figure into these calculations? Although some valuable ingredients had inherent tastes (e.g., sugar's sweetness), flavor as such was thought to contribute no "food value," at least none that was directly measurable in terms of calories or macronutrients. If a nutritional equivalency between rib roast and baked beans was established, flavor differences between the two could be factored out. According to historian Laura Shapiro, the Boston Cooking School, Ellen Swallow Richards' endeavor to promote the principles of scientific cookery among working-class women, held the sensual aspects of eating in low regard. "Cooking-school cookery emphasized every aspect of food except the notion of taste," she writes. Students learned meal planning, marketing, food chemistry, and nutrition. "But to enjoy food, to develop a sense for flavors, or to acknowledge that eating could be a pleasure in itself had virtually no part in any course, lecture, or magazine article."⁴⁹ The "New Nutrition" prescribed choosing foods on the basis of macronutrient and vitamin content, not on taste; flavor was an obstacle to the accurate comprehension of food's value.⁵⁰

This is not to say that flavor played no role in nutritional theory. Psychophysiological research, such as that conducted by Ivan Pavlov, suggested a link between the psychic phenomenon of appetite and the essentially mechanistic "chemical laboratories" of digestion.⁵¹ Attractive flavor stimulated the appetite which triggered a cascade of physiological changes — most notably, the preliminary flow of digestive fluid — which allowed the valuable nutrients in food to be efficiently assimilated. Foods

⁴⁹ Laura Shapiro, *Perfection Salad: Women and Cooking at the turn of the Century*, (Berkeley: University of California Press, 2008): 68.

⁵⁰ Veit 2013: 51; Levenstein 1986: 72-86.

⁵¹ Daniel P. Todes, "Pavlov's Physiology Factory," *Isis* 88.2 (June 1997): 205-46.

lacking in appetizing flavor, and meals “bolted down” without enjoyment or interest, could lead to digestive stagnation and disease.⁵² “It has long been known that the value of foods in nutrition does not depend solely upon the quantity of nutriment which these foods contain, but also... on the ability of the digestive functions to utilize these nutriments,” explained Harvey Wiley to the readers of *Good Housekeeping*. “The influence of flavor... has long been recognized by physiologists as an exciter of the digestive enzymes, promoting digestion and favoring health.”⁵³ By connecting psychic phenomena with physiological processes, flavor converted the latent, abstract nutritional value of foods into utilitarian value, the currency that could build and sustain actual living bodies.

But flavor’s exciting effects on the body could be taken too far. Food that was too highly flavored, that was over-seasoned, and that mixed different herbs and spices could be dangerously overstimulating, awakening appetites that would seek other stimulating

⁵² This theory of the utilitarian value of deliciousness, that it was necessary for proper digestion and assimilation of nutrients, was widely promulgated at the turn of the century. (For instance, the hope of finding an additive that could facilitate digestion and thus improve national health by improving flavor was one of Kikunae Ikeda’s motives for developing a process of manufacturing MSG in early 20th century Japan. See Sand 2005: 38.) In the United States, one of the most ardent promoters of this theory was Henry T. Finck (1852-1926), who had studied experimental psychology and psychophysics in Berlin, Heidelberg, and Vienna before a long career as a critic for the *New York Evening Post*. Finck’s 1913 book *Food and Flavor*, a fascinating and comprehensive treatise on the utilitarian virtues of deliciousness, made a case for improved health through conscientious, Fletcher-influenced gourmandizing, and advocated for the improvement of American cuisines. “Sensual indulgence,” for Finck, was a “duty,” as appreciating the flavor of food enhanced national health, happiness, and the capacity for hard work. “The most important problem before the American public,” he wrote, in all seriousness, “is to learn to enjoy the pleasures of the table and to insist on having savory food at every meal.” For Finck, gourmandism assumed the status of moral duty: “the highest laws of health demand of us that we get as much pleasure out of our meals as possible.”

⁵³ Harvey Wiley, “Life in the Husk,” *Good Housekeeping* 63.3 (September 1916): 65-6.

pleasures, such as alcohol and narcotics. Spices “pamper perverted appetites,” as one cookbook author wrote in 1917.⁵⁴ As Veit and others have shown, the proscription against “strong” flavors and seasonings emerged in part from a resistance by White Northeastern food reformers to immigrant cuisines as well as to African-American southern foodways.⁵⁵ Even though flavor *per se* was outside of the realm of calculation when it came to assessing nutritional value, nutrition-minded reformers nonetheless promoted the idea that certain kinds of gustatory experiences were wholesome and healthful and others were dangerous and aberrant.

These critiques included artificial flavors and the “adulterated” foods that they made alluring. The widespread consumption of foods flavored with synthetic “coal tar” chemicals was credited not only with physical diseases, such as neuralgia, dyspepsia, and “rheumatic and gouty twinges of nerves and muscles,” but with moral derangements — with a creeping insensibility that threatened the health of the body and of the nation.⁵⁶ “A perverted taste has become so universal that we have lost the exquisite, delicate office of the palate, and the flavors of pure food are not appreciated by the masses,” ran the introduction of an 1896 cookbook by a pure food advocate.⁵⁷ The key word used by many of these critiques was *perversion*. “Reasonable gratification of the palate is not incompatible with health,” one hygienic journal instructed in 1902, “for a healthy taste

⁵⁴ Quoted in Veit: 130-1.

⁵⁵ Veit 2013. E. Melanie Dupuis, *Dangerous Digestion: The Politics of American Deitary Advice*, (Berkeley: University of California Press, 2015): 54-74.

⁵⁶ Quote from Ellen Goodell Smith, *A Practical Cook Book and Text Book for General Use: The Fat of the Land and How to Live On It*, (Amherst: Carpenter and Morehouse, 1896): 15-6.

⁵⁷ Smith 1896: 15.

will not crave artificial flavoring. It is easy enough to distinguish between the promptings of a healthy instinct, and the perverted longings of a diseased appetite.”⁵⁸ Desiring and surrendering to the appeal of “bad” flavors was both a symptom of a poorly-fed body and a sign of a perverse and diseased system, and indicated a troubling lack of self-control, one of the necessary virtues for full democratic citizenship.⁵⁹

ARGUING FOR THE VALUE OF SYNTHETIC FLAVORS

In the mode of calculation used by reform-oriented nutritionists, home economists, and their hygienist allies, flavor additives added nothing of value. Their effect, instead, was inflationary, adding specious allure to food of poor quality or inflaming appetites beyond the capacity of food alone to satisfy. The purpose of the Pure Food Law’s “imitation” labels was not only to prevent consumer deception, but also to protect people from their own appetites and warn them against the deleterious consequences of the substances they may not be able to help but desire.

Makers of flavoring extracts, and some of the food manufacturers who used their products, vigorously contested this condemnation of synthetic flavors. For many flavor and food manufacturers, food reformers’ campaigns for “purity” and against “chemicals” as flavors was based on an ignorance of chemistry and suggested a rejection of science as a progressive force for material and moral advancement. “Some so-called scientists act

⁵⁸ “Sauces,” *The Medical Brief* 30.2 (February 1902): 230.

⁵⁹ Veit 2013; Dupuis 2015: 75-94; Chin Jou, *Controlling Consumption: The Origins of Modern American Ideas About Food, Eating, and Fat, 1886-1930*, (PhD Diss, Princeton University, 2009): 35-6.

like a bull when a red cloth is waved before them at the mere mention of coal-tar products,” railed one beverage manufacturer speaking to a convention of state bottlers’ associations, decrying the lecturers and “yellow journalists” who based their invectives against synthetic flavor and color additives on alleged scientific expertise. For anti-additive reformers, “the fact that today there are 200,000 chemicals made from coal tar to relieve pain in the human system, to stimulate industries, and please untold thousands, the great results obtained by world-renowned chemists stand for naught.” Pure Food advocates, the manufacturer argued, mistook the meaning of purity and spread false information. “The resemblance of these absolutely pure chemicals has no more to do with the raw coal tar than has the candle light with the sun.”⁶⁰ The beverage manufacturer countered the pure food movement’s claim to scientific and chemical authority with a parallel claim on nearly identical grounds: chemical knowledge deployed for the progressive ends of human and national advancement. The dispute between these two factions was a dispute over the legitimacy of these rival claims, one that played out within the community of chemists as well as in the public sphere.

Although there was broad support for the Pure Food law among flavor and food manufacturers, who for the most part wanted uniform federal regulations and standards to protect themselves from competitors’ fraudulent misrepresentations, many took issue with the regulations’ suspicion toward synthetic substances. Alois von Isakovics, whose Monticello, New York company Synfleur manufactured synthetic flavors and fragrances, penned a pair of furious letters to William Frear, head of the Food Standards Committee,

⁶⁰ H.C. Schrank, “Pure Food Laws,” Paper read before the conventions of the Wisconsin and Illinois State Bottlers’ Associations, *American Bottler* 29.4 (April 1909): 20.

and Bureau of Chemistry Chief Wiley in response to the exclusion of synthetic materials from recognition in the flavoring extract standards, especially the exclusion of synthetic vanillin and other materials from vanilla extract. Isakovics claimed to have spent ten years analyzing the chemistry of vanilla extract. Synfleur's vanilla flavoring, Vanillodeur, included vanillin and other chemical flavoring compounds that he said he had isolated from extract and then reproduced by synthetic processes. He appealed to these men as fellow chemists. Addressing Frear, he wrote that by requiring all vanilla extracts to be made exclusively from vanilla beans:

“You shut your eyes to all advances in modern synthetic chemistry.... Our product has now been marketed for years and is used by some of the largest consumers in the country. Yet you step in as a chemist and desire to kill my interests with one stroke, to prevent all further research along these lines.... Why should you as a chemist try to hold back advance in the science instead of encouraging it to your best ability. Our product has come to stay and you know it. No amount of legislation will compell [sic] a manufacturer to pay the grower of bean in Mexico five dollars when he can get the same thing identical in every way made in the U.S.A. for fifty cents.”⁶¹

For Isakovics, the anti-synthetic bias of the standards destroyed the value that had been created in the synthetic product through his scientific labors and discouraged future

⁶¹ Alois von Isakovics to William Frear, May 3, 1905; Flavoring Extracts: 1900-1908; Food Standards Committee Correspondence & Reports, 1897-1938; Records of the Food & Drug Administration, Record Group 88; U.S. National Archives at College Park, MD.

research. Isakovics recapitulated many of the arguments he had made to Frear in his letter to Wiley, but made a further personal appeal to a fellow man of science. (Isakovics had a collegial relationship with Wiley through their common membership in various scientific societies.) He also described the relative cheapness of the synthetic product as a social virtue:

“You are a chemist, a professional chemist who always hails with delight anything new in the science. Yet why discriminate against new work in this line.... If we can give the manufacturer a product that gives the identical same flavor as the bean for one tenth the money, it enables the manufacturer to cheapen the product and the masses can enjoy a good flavor which if pure mexican bean was used could only be afforded by the well to do.... I cannot understand why you as a scientific man, as a progressive and broadminded chemist should oppose any advance in the science and should compell [sic] the American manufacturer to use the old fashioned and out of date raw materials.”⁶²

Why should the law discriminate against chemical progress in flavors, when the government’s agents (rightly) celebrated chemical progress in all other applications? Progress in synthetic flavors would secure a broader and more equitable distribution of pleasures, a democratization of delights for an era of mass luxuries. Where pure food advocates had agitated for “imitation” labeling to protect consumers from deception,

⁶² Alois von Isakovics to Harvey Wiley, May 5, 1905, Flavoring Extracts: 1900-1908; Food Standards Committee, Correspondence & Reports, 1897-1938; Records of the Food & Drug Administration, Record Group 88; U.S. National Archives at College Park, MD.

Isakovics argued instead that the “imitation” label actually harmed consumers by giving them a false impression that the product contained within was of low quality. He elaborated on this in a subsequent letter to Frear:

"The manufacturer of the chemical product does not have the facilities of reaching the public.... If you compell [sic] the manufacturer of flavoring extracts individually to commence to educate the public this will at once cause a barrier that cannot be overcome. The average person using Vanilla does not care what it is made from as long as it gives the true Vanilla flavor. That is all they are interested in. They understand nothing of chemistry and don't want to know about it and you can't teach them — the experiment would could [sic] cost ten times as much in advertising as the total possible sales of the product. You look at the whole question from an entirely unpractical standpoint. On the one hand you have the man who has spent many years in research to produce something really good. He puts it out and has no trouble at all to convince the consumer — the manufacturer — as to the value of his product. Now you step in and say to the manufacturer. You must not use these goods. We will not allow it. What chance have we in that case?"⁶³

Although synthetic products were not forbidden, the label disclosure ‘imitation’ carried a stigma that manufacturers were eager to avoid.⁶⁴ Consumers labored under the

⁶³ Alois von Isakovics to William Frear, May 9, 1905; Flavoring Extracts: 1900-1908; Food Standards Committee Correspondence & Reports, 1897-1938; Records of the Food & Drug Administration, Record Group 88; U.S. National Archives at College Park, MD

⁶⁴ The term “artificial” seems to have been less stigmatizing, and manufacturers seem to have preferred it, but through the 1920s, at least, the Bureau of Chemistry favored the

belief that ‘imitation’ meant low quality, even if this belief was not sustained by their experience with the product. Further, the flavor manufacturer — whose direct customers were food and beverage manufacturers, not the ultimate consumers of flavored products — was in a particularly tricky position. No matter how excellent the sensory and material quality of the imitation flavor was, it would still bear the mark of non-standard, and thus sub-standard, quality.

Regulators’ interposition between the manufacturer and the consumer was not only a problem for manufacturers of synthetic flavors. Among makers of botanical flavoring extracts, there was a widespread belief that the food standards distorted the market by forcing higher-than-standard-quality goods to compete with those that just met the standard. Many of these manufacturers encouraged consumers to put their trust not in the imprimatur of the federal government, but in brands.⁶⁵ For instance, McCormick & Co., the Baltimore spice and extract company, published an educational pamphlet that sought to enlighten readers that “purity” as defined by the Pure Food Law was not necessarily a sign of quality. Under the heading, “Quality v. Purity,” the pamphlet

term ‘imitation.’ In 1922, the National Manufacturers of Soda Water Flavors adopted a resolution at their annual meeting lobbying for a change to the terms “artificially flavored” and “artificially colored” on the grounds that the word imitation “applies to all other ingredients of the beverage as well as to the flavor and color,” ie, might indicate that it contained saccharin rather than sugar, and “is a disparaging term, giving the public the impression of cheapness and inferiority,” thus constituting “a hardship and injustice to the manufacturers of soda water flavors and to the bottlers of soda water.” “Flavor Manufacturers in Annual Meeting,” *Beverage Journal* (Nov 1922): 51.

⁶⁵ This was a common strategy for building trust in (and a market for) unfamiliar processed food before the passage of food regulations as well. See: Nancy F. Koehn, “Henry Heinz and Brand Creation in the Late Nineteenth Century: Making Markets for Processed Foods,” *Business History Review* 73.3 (1999): 349-93; Koehn, *Brand New: How Entrepreneurs Earned Consumers’ Trust from Wedgwood to Dell*, (Boston: Harvard Business School Press, 2001); Strasser 1989.

instructed: “The people have been taught by the laws and the Pure Food propagandists to believe that the word ‘Pure’ upon a package ensures that its contents are all right. Nothing can be further from the truth. An article may be Pure and yet of very Poor Quality.” A Pure Vanilla Extract may be made from low-quality “rank” Tahitian vanilla beans rather than . “The time is coming when consumers will realize that the important thing to look for in the purchasing of foodstuffs is not the word ‘Pure’ — but the name of the reputable manufacturer whose dealings are beyond reproach.”⁶⁶ Both makers of synthetic flavorings and those of botanical products were making the same argument, that the label disclosures imposed by regulators bore little relationship to the actual quality of the goods in question.

Ultimately, questions of sensory quality were what most sharply distinguished the chemists working in the laboratories of regulatory agencies from the chemists working in the laboratories of flavor companies and food manufacturers. While officials from the Bureau of Chemistry could make credible determinations about chemical presences and absences, they had little authority when it came to evaluating sensory quality.⁶⁷ Flavor

⁶⁶ McCormick & Co, *Spices: Their Nature and Growth; The Vanilla-Bean; A Talk on Tea*, pamphlet, (Baltimore: 1915): 28. Smithsonian Libraries Trade Literature Collection.

⁶⁷ Analytic chemists at the Bureau of Chemistry did, of course, make judgments based on sensory evaluation in the course of their assessments of different flavoring extracts, but these were not held as evidentiary when prosecuting charges of adulteration or misbranding. The one exception to this concerns the standard for “vanilla and vanillin” flavor, which was based on an organoleptic assessment of the relative flavoring power of each substance, to ensure that 50 percent of the flavor sensation was attributable to natural vanilla and 50 percent to synthetic vanillin. (This worked out to equal parts standard vanilla extract and 0.7% vanillin solution.) See: JW Sale, "Labeling of Flavoring Extracts" *American Perfumer & Essential Oil Review*, July 1925. Originally presented at the 16th Annual Meeting of Flavor Extract Manufacturers' Association, Chicago, IL, June 24, 1925.

manufacturers claimed expertise over both the sensory and chemical aspects of flavoring materials, arguing for the virtue and value of their products not only by insisting on their harmlessness and chemical purity, but also by making the case for their integral role in improving the sensory quality of foods.

C.F. Sauer, the head of the Richmond, Virginia extract company that bore his name, outlined a typical case for the necessity of added flavorings at the Flavor and Extract Manufacturers' Association meeting in 1918. Flavor, he explained to his colleagues in the business, was "the basis of all foods," and thus "essential to a great many institutions," from hospitals preparing "delicate and tasty foods for the sick" to food industries with many millions a year in revenue. The important role of flavor in national life was particularly acute during wartime staple rationing. Sauer argued that flavoring extracts were "the most concentrated of all foods. They help to make meatless days a success. They conserve eggs, sugar, flour by stimulating the use of substitutes, as they make more palatable the somewhat insipid foods" that had replaced familiar items in the wartime pantry.⁶⁸ An advertisement for Sauer's Extracts that appeared elsewhere in the trade journal that carried his speech underscored this point. Sauer's Extracts, it read, are "first aids in conservation... make war-time foods and substitutes tempting."⁶⁹ Flavoring extracts were essential components of a rationalized national food system, efficiently improving quality of foods and quality of life.

⁶⁸ C.F. Sauer, "Why Flavoring Extracts are Essential Food Products," *Simmons Spice Mill* (August 1918): 1014. Originally presented at 9th Annual Meeting of Flavor Extract Manufacturers' Association, Richmond Virginia.

⁶⁹ C.F. Sauer Company, "First Aids in Conservation: Sauer's Pure Flavoring Extracts," advertisement, *Simmons' Spice Mill* (August 1918): 1017.

Flavoring additives were not just useful for making minimally acceptable wartime foods more palatable; they had a purpose even in high-quality and standard foods. Recapitulating the Pavlovian argument about the digestive utility of flavor, Sauer thundered, “I do not... think that I exaggerate when I say that flavoring extracts contribute to the health of a nation, as health depends on the enjoyment and the ease with which we digest the food we eat. Few of us realize the part that flavoring extracts play in our daily life.”⁷⁰ Implicitly rejecting the distinction made by food reformers between wholesome “pure” and dangerously overstimulating “impure” flavors, for Sauer and his colleagues, flavor itself was a virtue. To add flavor was to add value.

According to the manufacturers and users of synthetic flavors, the value of these products was not only commercial but also social, physiological, and even patriotic. Countering the scientific authority of reformers and regulators with their own claims to chemical expertise, they argued that flavoring additives were modern, scientific products, exemplars of progressive virtues such as efficiency and purity. Rather than adulterants that harkened back to a risky, dishonest marketplace prior to national regulation, flavorings were necessities in a modern food system, integral to the new kinds of food and beverage products made in factories and to the new kinds of pleasures these delivered. The value of synthetics was located not only in sensory or chemical similarities with “natural” products, but also in their sensory possibilities and material differences. The meaning of these differences in raw materials, in methods of production, and in physicochemical properties cannot be assessed only in terms of their ability to replace or

⁷⁰ Sauer 1918.

substitute for botanical substances, but must also include the new kinds of products, and the new modes of experience, that they made possible.

Ultimately, manufacturers argued that the proper way of assessing the value of flavoring extracts was not in terms of material origins or production costs, but in terms of sensory quality. Or, as a 1921 flavor catalog put it, “In order to arrive at the valuation of an extract, it should not be regarded as a commodity... but rather should be visualized as a potential means of producing 10,000 pleasurable sensations.”⁷¹ Its value was proven not in the chemical laboratory, but in the sensory responses (and commercial behaviors) of consumers:

“A good flavor is an intangible and fugitive thing that is gone almost before it can be perceived; but the real test by which every flavor should be judged is, — does it leave a lasting and favorable impression behind it when the sensation of taste has disappeared? This is the way we judge our Red Seal Extracts and we can honestly say that each one leaves a pleasant memory behind; so pleasant indeed that anyone who drinks a bottle of Red Seal Soda involuntarily craves another so that he can again enjoy the pleasure afforded by its delicious flavor.”⁷²

Beyond pure and imitation, beyond the calculations of nutritional reformers or the analyses of regulatory chemists, there was a unique virtue and value to mass-produced

⁷¹ Warner-Jenkinson Co., *Bottlers' and Ice Cream Makers' Handy Guide*, (St. Louis: Warner-Jenkinson, 1921): 80. A.W. Noling Collection, UC Davis.

⁷² Warner-Jenkinson Co. 1921: 80.

pleasures, to the repeatable charms of an expertly crafted flavor, which could deliver its anticipated delights again, and again, and again, precisely as remembered.

II. NUGRAPE AND NATURE: ADDED FLAVOR IN THE NEW SENSORY ECONOMY

The Bureau of Chemistry's bifurcation of the flavored world into higher-value "pure" or "standard" and lower-value "imitation" failed to capture aspects of value creation, and dimensions of the citizen's sensual and social relations to the products that they bought, that were coming into being in the first part of the twentieth century. The case of NuGrape illustrates both the practical complexities of implementing the Pure Food law, as well as the ways in which NuGrape's unique brand value was built upon the fundamental ambiguity of its relationship to "natural" grapes.

NuGrape, a product of the NuMint bottling company of Atlanta, was introduced just ahead of the 1921 summer season, and rapidly became one of the most popular bottled sodas in the United States. By the time it attracted the attention of federal regulators in 1925, the company was claiming that NuGrape was the second-best-selling

five-cent bottled beverage in the world, with more than a 1.5 million bottles sold every day.⁷³

With the introduction of NuGrape, NuMint may have been looking to capitalize on the growing market for non-alcoholic “soft drinks” during prohibition, as well as on an increasing appetite for grape-flavored sodas, as numerous rivals (such as Grapico, Nehi Grape, and Grape Nip) began to appear on the market, especially in the South and Midwest. NuGrape’s territory expanded with breakneck speed. Within a year, NuGrape was being shipped from Atlanta to more than 100 bottling plants throughout the South, each of which was granted an exclusive franchise over designated territory.⁷⁴ A modernized, fire-proof building allowed for expanded production.⁷⁵ The *Atlanta Constitution* featured photographs of “solid carloads” of NuGrape being shipped by traincar to bottlers, and new trucks were added to the NuGrape fleet.⁷⁶

Almost as soon as NuGrape came on the market, the company took pains to establish its unique brand identity — to position itself as the original, most beloved, and most desirable grape soda pop in a marketplace teeming with lesser imitators. The

⁷³ NuGrape Bottling Co., “At Last — Cincinnati is to Know the Thrill of ‘A Flavor You Can’t Forget,’” [Advertisement] *Cincinnati Enquirer*, (May 5, 1925): 8.

⁷⁴ “Infant Atlanta Industry Grows to Giant in a Year,” *Atlanta Constitution*, (June 25, 1922): 8; “NuGrape Makes a Hit,” *The Re-Ly-On Bottler* 3.1 (January 1922): 11.

“NuGrape Bottling Co. Perfecting Organization, Growing in Favor,” *The [Nashville] Tennessean*, December 2, 1923: 41. A discussion of the beverage industry business model that distributed flavoring products to independently operated bottling plants, which were given exclusive rights to distribute a branded beverage over a certain geographical area, can be found in Elmore, *Citizen Coke: The Making of Coca-Cola Capitalism*, 32-41.

⁷⁵ “NuGrape is Showing Enormous Increase,” *Atlanta Constitution*, (September 10, 1922): 8.

⁷⁶ “Solid Carload of NuGrape Being Shipped to Many Cities,” *Atlanta Constitution*, (April 16, 1922): 8.

company invested heavily in advertising, spending more than \$3 million on ads between 1922 and 1927.⁷⁷ These campaigns spread the message that for the drinker in search of flavor and refreshment, there was no substitute. “The flavor of NuGrape is *unmistakable* — there is no other drink whose flavor is even remotely like NuGrape.”⁷⁸ Advertisements and jingles instructed consumers to “use your eyes to protect your taste,” by looking for the three rings embossed around the neck of the genuine NuGrape bottle. The goal was to build consumers’ exclusive relationship with NuGrape, rather than generate an appetite for grape-flavored sodas in general.

Spurious grape beverages not only lacked the unmistakable NuGrape flavor, they were potentially hazardous. “A Pure Beverage is Non-Injurious! What a Substitute Is, Nobody Knows!” warned one of the earliest newspaper advertisements for NuGrape, from August 1922. These impostor grape sodas contained “unknown — possibly dangerous ingredients.”⁷⁹ But what, exactly, did NuGrape contain? The advertisement reproduced a letter from an Atlanta chemical testing laboratory testifying to the soda’s soundness. “The summary of these tests shows your product to be a pleasant and wholesome beverage in every particular,” read the letter. “It contains nothing that is deleterious or dangerous to health. Neither does it contain anything prohibited by our state or federal laws.... In the light of the facts disclosed by this investigation, we have no

⁷⁷ “An Investment Offering of Unusual Merit! First Public Offering of Stock of NuGrape Co. of Atlanta,” *Greenville News*, (May 7, 1929): 12.

⁷⁸ Nugrape Company of America, “Use Your Eyes to Protect Your Taste,” advertisement, *Atlanta Constitution*, July 19, 1922: 4.

⁷⁹ Nugrape Company of America, “A Pure Beverage is Non-Injurious!” advertisement, *Atlanta Constitution*, Friday August 18, 1922: 11.

hesitancy in recommending Nu-Grape as a pleasant and wholesome beverage.”⁸⁰ Rather than offering assurances based on a disclosure of components, NuGrape’s claim to purity and wholesomeness rested on the trustworthiness of chemical analysis.

But the chemist’s testimonial avoided mentioning the source of NuGrape’s flavor, carefully evading any statement about its relationship to grapes or grape juice. Elsewhere, however, NuGrape’s marketing campaigns were replete with images and language that drew grape and NuGrape close together. Newspaper ads for Nugrape were often framed within garlands of grapevines, and featured messages such as: “NuGrape has the same wonderful flavor of ripe, juicy grapes. You can’t mistake it once you taste the original.”⁸¹ The original NuGrape bottle was plumply embossed with a bunch of grapes, which took on the purple color of the soda contained within. But the proposed dyad of grape and NuGrape was about more than proving a point of taste; these advertisements sought to invest NuGrape with the meaning of grapes as well as their flavor. “The exquisite, delicate flavor of the finest Concord grapes is better duplicated in NuGrape than in any other beverage, and that is why NuGrape has a flavor distinctively its own,” read a 1923 advertisement, beneath an image of a young woman proffering a platter heaped with grapes. She wore a ruffled rustic blouse, and a bonnet tied loosely with a ribbon. Over her right shoulder, neat rows of grapevines receded toward gentle hills; over her left, a marbled counter spread before a gleaming soda fountain. The ad continued, “There are many inferior imitations of the winey NuGrape flavor, but none that is so magically

⁸⁰ Ibid.

⁸¹ Nugrape Company of America, “Warning! Beware of Substitutes!” advertisement, *Atlanta Constitution*, (June 20, 1922): 2.

suggestive — by color, aroma and taste — of real Concords.”⁸² The advertisement staged a relationship between NuGrape and nature that took in not only the grapes themselves, but the bucolic scenario of their cultivation and consumption. The thirst it hoped to spark was not only for the taste of Concord grapes, but a nostalgic longing for a way of life increasingly remote from that of the parched soda-drinkers in an urbanizing and industrializing America, pausing for a drink in the midst of the acceleration all around them.

So did NuGrape deliver the flavor of Concord grapes, a replica, or something “distinctively its own”? The vineyards themselves, or a “magical suggestion” of them? By skillful feats of rhetorical misdirection, these and other advertisements reframed the question of NuGrape’s relationship to grape by putting NuGrape’s authenticity at the center. NuGrape itself was the original, the genuine article. NuGrape, not nature, was the model that other beverages aspired to. Indeed, what NuGrape promised exceeded anything that grapes alone could offer. “NuGrape showed Nature how to improve the flavor of the Concord grape.”⁸³ If NuGrape and nature were not identical, it was not because NuGrape fell short of nature’s model, but because it surpassed it — not only in the quality of its flavor, but in the extravagance of the pleasures that it promised.

Even if the role of grapes in producing NuGrape was coyly evaded in its marketing campaigns, the question of NuGrape’s relationship to genuine grapes was of

⁸² Nugrape, “Their De-Licious Flavor,” advertisement, *Reading [PA] Times*, (August 21, 1923): 6.

⁸³ Nugrape Company of America, “A Thirst-Hitting True-Grape Flavor,” advertisement, *Atlanta Constitution*, (July 14, 1922): 8.

concern to the Federal Trade Commission.⁸⁴ In 1925, the federal agency took action against the company, accusing it of unfair trade practices. According to the federal complaint, the product's name and advertising suggested that the beverage "is composed in whole or in part of the juice of the natural fruit of the grape, when in fact it is not made of the juice of the grape," misleading the public and unfairly competing with beverages made from actual grape juice. Instead of contesting the charges, NuGrape agreed to immediately cease and desist from using "any pictorial representation of grapes or grape vineyards, or any words, pictures, or symbols stating or suggesting that NuGrape is made from grapes or grape juice," in its packaging and advertising. The company also agreed to include "Imitation grape - Not grape juice" in every instance where the word NuGrape was used.⁸⁵ In advertisements, this disclosure fit between NuGrape's trade name and its slogan, "The flavor you can't forget!" The NuGrape bottle retained the three rings around the neck, but the embossed bunch of grapes vanished, replaced by the words "imitation grape."

⁸⁴ Although cases of adulteration and misbranding involving synthetic flavors were most often brought and pursued by the USDA's Bureau of Chemistry, the FTC also had regulatory authority here, although its actions were restricted to cases where a specific (anonymous) complaint had been filed by a competitor.

⁸⁵ U.S. Federal Trade Commission, Complaint No. 1199, 1925: 179-80. The agreement precisely stipulated the size and visibility of this disclosure, requiring that "imitation grape - not grape juice" appear "in close proximity to the word 'NuGrape' and in letters at least one half as high and one half as wide... and of heaviness of color and style of lettering which will render them at least equally as conspicuous in proportion to their height and width" as the brand name of the beverage.

HOW METHYL ANTHRANILATE BECAME GRAPE FLAVOR

But if NuGrape did not derive its flavor (exclusively) from Concord grapes, wherewith was it flavored? The story of the production of synthetic grape flavor in the early twentieth century demonstrates how the flavor and fragrance industries were bound by shared material and business networks, while also showing how the latent potentials, uses, and meanings of materials varied between contexts of use.⁸⁶

Sometime between 1909 and 1914, Gilbert Hurty — Amherst-trained chemist, bachelor, bottling company proprietor — was riding an Indianapolis streetcar when he caught a whiff of destiny in a fellow rider’s perfume. It smelled just like ripe Concord grapes. “Soon after,” according to a manuscript documenting the history of his company, Hurty-Peck, “he canvassed all the essential oil houses for perfume materials and finally discovered that the product he had smelled was methyl anthranilate. He then incorporated it in a grape flavoring oil and had an outstanding product.”⁸⁷ Hurty-Peck’s grape flavor was showcased in Louisville, Kentucky in 1914, at the first exposition of bottlers’ supplies for the American soft drink industry, where it was sold to or sampled by both small and established bottlers from around the country.⁸⁸ It was later advertised to those who sought the “utmost degree of PURITY, STRENGTH, and NATURALNESS,” and

⁸⁶ In this regard, the chemical used in grape flavorings, methyl anthranilate, can be described as a boundary object, whose meaning, qualities, and potentials shift as it passes between these professional and social worlds. See Susan Leigh Star and James R. Griesemer, “Institutional Ecology, ‘Translations’ and Boundary Objects: Amateurs and Professionals in Berkeley’s Museum of Vertebrate Zoology, 1907-39,” *Social Studies of Science* 19.3 (1989): 387-420.

⁸⁷ A.W. Noling, *History of Hurty-Peck & Company: Its First 50 Years, 1903-1953*, annotated manuscript, (Indianapolis: A.W. Noling, 1968). Noling Collection, UC Davis.

⁸⁸ Noling 1968: 7.

appears to have propelled the company from shaky financial standing to a solid foothold in the beverage flavor business.⁸⁹

By the time Gilbert Hurty first sniffed it out, methyl anthranilate was a well-known material in perfumery, albeit one of recent vintage. In the mid-1890s, essential oil chemists in Germany had identified the molecule as the characterizing compound in neroli, the essential oil of orange blossoms, a popular perfume material. The chemical's presence was subsequently detected in other fragrant essential oils: jasmine, tuberose, gardenia, ylang-ylang, and bergamot.⁹⁰ Synthetic methyl anthranilate had been commercially available since the end of the nineteenth century, and by 1913, it was manufactured and sold by numerous chemical suppliers, often listed as artificial neroli.

Hurty-Peck's grape flavor was not the only one to appear on the bottlers' market around this time, and almost certainly not the only one to use methyl anthranilate to deliver its grape effect. Advertisements for grape flavorings begin to appear in trade journals such as the *American Bottler* as early as 1911, with bottlers' supply companies such as Sethness, Twitchell's, Lehman-Rosenfeld, and Warner-Jenkinson highlighting "Concord grape" flavors among other fruit flavorings that were highly concentrated, economical, kept indefinitely, and were "absolutely pure."

The Concord-grape-flavored sodas that these substances produced were destined for consumers who had been steadily gaining a taste for "unfermented wine," non-

⁸⁹ Hurty-Peck Company, "Hurty-Peck Flavors," advertisement, *American Bottler* 37 (April 1917): 61. Noling 1968: 7-9.

⁹⁰ Eduard Gildemeister and Friedrich Hoffmann, *Die Ätherischen Öle*, (Berlin: Springer, 1899).

alcoholic grape juice, a beverage increasing in popularity with the spread of the teetotaling sentiments. (For most of the nineteenth century, Americans mainly consumed fruit juices in the form of home-made hooch.)⁹¹ As more states and counties became “dry” territory, brand-name fruit juices such as Welch’s Concord grape juice were ready to slake American thirsts, chastely. Secretary of State William Jennings Bryan, one of prohibition’s bulldogs, notoriously served the company’s purple juice at a 1913 dinner in honor of the British ambassador. The following year, the secretary of the navy banned alcoholic beverages on ship, substituting Welch’s for sailor’s customary grog.⁹²

Carbonated beverages — “soft drinks” — had also made themselves into temperance beverages, in part to shed now-disreputable associations with the narcotic ingredients and proprietary medicinal purposes of their pasts.⁹³ When the Volstead Act went into effect in 1919, bottled sodas competed directly with bottled fruit juices, and cost a fraction of what fruit juice cost to manufacture.⁹⁴ Both fruit juices and soda pop claimed to be healthful, wholesome alternatives to spirits.

⁹¹ As Andrew Smith explains, fermentation occurred more or less spontaneously in the temperate American climate. Apple juice became cider, or was distilled as applejack; pear juice was enjoyed as perry; peach juice formed a cider known as mobby; grape juice was the raw material for wine and brandies. These alcoholic beverages were produced at home as well as commercially, and were a means of preservation as much as a source of intoxicating pleasures. Although it was common knowledge that fermentation could be stopped or prevented by boiling the juice, there was little apparent interest in or market for “unfermented wine” and other non-alcoholic fruit beverages, except among a few religious communities. Smith 2013: 142-3.

⁹² Smith 2013: 142-3.

⁹³ See Elmore 2015: 111-34.

⁹⁴ Smith 2013: 143.

Yet although Sethness, Hurty-Peck, and others boasted that their flavorings were “pure” products of the grape, they also called attention to the differences between their flavoring extracts and syrups made from grape juice. Twitchell’s Imperial Grape Flavor, for instance, boasted that it allowed bottlers to produce a carbonated drink “that has the delightful taste and delicious flavor of Freshly Pressed Grape Juice” without the “cooked taste” that developed when grape juice was treated to prevent fermentation.⁹⁵ Sethness advertised itself as “makers of the grape that keeps,” in contrast to the juice-based syrups that readily fermented, produced sediment, and altered in color or flavor if kept too long or under the wrong conditions.⁹⁶ Crucially, none of these products were flavoring syrups; these companies were selling a different kind of product — an unsweetened concentrated *flavor*. A series of Hurty-Peck advertisements that ran in the 1914 edition of the monthly trade journal for drugstore operators, *The Pharmaceutical Era*, explained the value proposition. Instead of buying prepared fruit syrup at the beginning of the season, and carrying the risk and burden of that perishable investment, “by the Hurty-Peck method, you buy only the Real Fruit Flavors, and get your sugar and water as you need it,” adding the flavor to the syrup as demand required. Thirty dollars’ of Hurty-Peck’s Real Fruit Flavors could make the equivalent of \$200 of “Old Style Prepared Syrup. Think of the work the \$170 saved could do in capable hands!” the advertisement urged.⁹⁷

⁹⁵ S. Twitchell Co., “Our Leap Year Proposal: Imperial Grape Flavor,” advertisement *American Bottler* 33 (January 1913): 48.

⁹⁶ Sethness Company, “Yes, Sir, We’re the People Who Put Grape in Concord Grape Soda,” advertisement, *American Bottler* 33 (1913): 21.

⁹⁷ Hurty-Peck & Co., “Turn Your Money Over,” advertisement, *Pharmaceutical Era*, July 1914: 41.

The use of synthetic chemicals is not disclosed in any of these advertisements for grape flavorings dating from the 1910s; no mention is made of whether the products should be labeled “imitation.” Indeed, quite the opposite. Sethness assured potential customers that they are “the people who put grape in Concord grape soda,” and that theirs is “the only absolutely true fruit extract.”⁹⁸ Hurty-Peck insisted that its “Real Fruit Extracts contain nothing but the extractive matter of Sound Ripe Fruit without any additions whatsoever, either for flavoring or coloring.”⁹⁹ These flavorings were being sold as “true” fruit flavors, producing carbonated beverages that did not need to be labeled “imitation.”

By 1919, officials at the Bureau of Chemistry were aware that methyl anthranilate was being used to produce grape flavors, and commissioned Frederick B. Power, in the Bureau’s Phytochemical Laboratory, to investigate methods for detecting the chemical’s presence.¹⁰⁰ Adapting techniques developed in the essential oil industry, Power in 1921 outlined a set of steps to determine whether the molecule was present in fruit juice using beta-naphthol as a reagent.¹⁰¹ Across the country, state regulatory chemists began to test commercial grape juices as well as grape-flavored sodas and flavoring extracts. When they found that many juices contained methyl anthranilate, some concluded that the chemical had been added, and that the juices were misbranded and adulterated. “In

⁹⁸ Sethness 1913: 21.

⁹⁹ Hurty-Peck & Co., “You Can’t Reach Big Profits Tied Down By Old Methods,” advertisement, *Pharmaceutical Era*, May 1914: 40.

¹⁰⁰ Power had previously worked as a chemist at the flavor and fragrance manufacturer Fritzsche Brothers.

¹⁰¹ Frederick B. Power, “The Detection of Methyl Anthranilate in Fruit Juices,” *Journal of the American Chemical Society* 43.2 (1921): 377-81.

consequence of these deductions,” Power and his colleague Victor K. Chesnut wrote later that year, “it has naturally become of much importance to determine whether a pure and entirely unsophisticated grape juice may not contain small amounts of methyl anthranilate.”¹⁰² In other words, was the presence of methyl anthranilate in commercial grape juices evidence of adulteration, or was the chemical compound already in the grapes themselves, just as it had been shown to be present in neroli blossoms and other floral oils? Power and Chesnut tested a number of grape juices they made in the laboratory from different varieties of grapes provided by the USDA’s Bureau of Plant Industry. “The observations that have thus far been made enable us to conclude that methyl anthranilate is a natural and apparently constant constituent of grape juice,” with the dark purple juices of Concord grapes richest in the compound. They published their preliminary results “in order that those engaged in the examination or control of commercial products may not be led to wrong conclusions respecting their purity.”¹⁰³ Subsequent research showed that grape varieties of the native *Vitis labrusca* tended to contain methyl anthranilate, while European grapes, *Vitis vinifera*, most often did not.¹⁰⁴ USDA researchers also took methyl anthranilate as a proxy for quality, measuring the quantity of the compound present in grape juice prepared by different methods, and

¹⁰² F.B. Power and V.K. Chesnut, “The Occurrence of Methyl Anthranilate in Grape Juice,” *Journal of the American Chemical Society* 43.7 (1921): 1741-2.

¹⁰³ Power and Chesnut “The Occurrence of Methyl Anthranilate in Grape Juice” 1921: 1741-2.

¹⁰⁴ Frederick B. Power and Vincent K. Chesnut, “Examination of Authentic Grape Juices for Methyl Anthranilate,” *Journal of Agricultural Research* 23.1 (1923): 47-53.

noting that its diminishing quantities after storage could explain the deterioration in flavor in some commercial bottled juices.¹⁰⁵

It would seem that Hurty's recognition of the grapiness of his fellow rider's perfume was more than coincidental; the chemical that scented orange blossoms also lent its aromatic qualities to the Concord, the Scuppernong, and the other foxy *Vitis labrusca* varieties of North America. The availability of synthetic methyl anthranilate for grape flavoring was due to its use in a different sensory and commercial context: floral fashion perfumery. Methyl anthranilate's presence in New World *V. labrusca*, but not in Old World *V. vinifera* grapes, may be why the European essential oil and aromatic chemical supply houses that initially manufactured the chemical did not seize upon the resemblance and advertise their product for uses in grape flavorings. (Its trade name in essential oil catalogs was generally synthetic or artificial oil of neroli.)

This is not to say that methyl anthranilate was, naturally and self-evidently, grape flavor. As noted, not all grapes contain methyl anthranilate, but all grapes do contain many other substances that contribute to their particular flavor and aroma. Methyl anthranilate became grape flavor not only by its presence in grapes themselves, but by its repeated and continued use in grape flavorings, in alliance with other substances, such as tartaric acid, sugar, and, notably, purple coloring, that were made to signify and reinforce the sensation of grape-ness, at a moment when Americans were beginning to consume an expanded variety of grape-flavored things.

¹⁰⁵ J.W. Sale and J.B. Wilson, "Distribution of Volatile Flavor in Grapes and Grape Juices," *Journal of Agricultural Research* 33.4 (1926): 301-310.

So if both “true” grape juice and its synthetic imitation contained methyl anthranilate, then how could regulators distinguish the genuine thing from the pretenders? The answer they found was to measure the quantity of the chemical present in the product. Grape juices rarely contained more than two parts per million of the chemical, and the concentration of the compound decreased significantly during storage.¹⁰⁶ Grape-flavored soda pops contained many times more methyl anthranilate than was found in even the freshest juices. One state health official in 1923 detected concentrations between seven and 17.5ppm in four commercial bottled sodas.¹⁰⁷ Regulatory chemists developed normative standards based on quantities of methyl anthranilate detected in grape juices, and used these calculations to distinguish “pure” from the of the enhancements of the “imitation.”

Armed with a standard method of quantifying methyl anthranilate, regulators in the 1920s took action against a number of manufacturers of grape flavorings and grape-flavored beverages. Sethness, the company which had once touted itself as “the People who Put Grape in Concord Grape Soda,” plead guilty in 1924 after Bureau of Chemistry agents found that its Cosco Grape Soda Water Flavor “was an imitation grape flavor, most of the flavor of which was due to methyl anthranilate,” and contained “little, if any, grape juice.”¹⁰⁸ Hurty-Peck, which had once claimed on its label that its “Superb Brand

¹⁰⁶ Sale and Wilson 1926.

¹⁰⁷ R.D. Scott, “Methyl Anthranilate in Grape Beverages and Flavors,” *Industrial and Engineering Chemistry*: 15.7 (July 1923): 732-3. Scott was a chemist with the Ohio State Department of Health.

¹⁰⁸ U.S. v. Sethness Co. U.S. District Court, Northern District of Illinois, 1924. F.&D. No. 18576. Adulteration and misbranding of Concord Grape soda water flavor. Plea of guilty. Fine: \$100.

True Concord Grape Soda Water Flavor” contained “no artificial flavor,” did not contest the charges of adulteration and misbranding. A default judgment was entered against the company, and the thirty-five gallons of flavoring that had been seized were destroyed by government agents.¹⁰⁹ Other companies who were similarly charged generally plead guilty and paid a fine, or did not contest the charges.¹¹⁰

Indeed, J.W. Sale, the chemist in charge of the Bureau of Chemistry’s Water and Beverage Laboratory, said in 1924 that enforcement actions had convinced him that “there are no true grape flavors for bottlers’ use on the market, although there may be several that are alleged to be of this type.” As far as he had been able to discern, all of the “so-called grape flavors” on the market were in fact mixtures of grape wine (which

¹⁰⁹ U.S. v. 35 Gallons of Superb Brand true Concord Grape Soda Water Flavor. U.S. District Court, Eastern District of Wisconsin, 1924. F&D No. 18813.

¹¹⁰ See, for instance: U.S. v. 69 Barrels of Grapico Syrup. U.S. District Court, Northern District of Alabama, 1923. F&D No 17361. After an interstate shipment of Grapico syrup (“Deliciously Refreshing Grapico Naturally Good Syrup”) was seized by federal agents in Alabama, J. Grossman’s Sons, the New Orleans company that manufactured the grape flavoring, pled guilty to adulteration and misbranding, and paid a bond of \$4,000 to have their merchandise released, on the condition that they change the label to read: “Imitation Grape Syrup Grapico Naturally Good Syrup. Contains Pure Grape Flavor, Artificial Flavor and Color.” The 1925 case involving the Orange Smash Company, makers of Grape Nip Concentrate, was an exception to the general pattern of pleading guilty or failing to contest the charges after government agents had seized allegedly adulterated and misbranded flavorings. In 1923, federal agents in Maryland seized a quantity of Grape Nip Concentrate that had been shipped from the company’s headquarters in Alabama. The label claimed that Grape Nip contained “extract of Ripe Grapes Sugar and Water & Tartaric Acid [sic],” but analysis by the Bureau of Chemistry “showed that it was an imitation grape sirup composed in part of sugar, glycerin, and water, artificially colored with a coal-tar dye, and flavored with methyl anthranilate.” Orange Smash contested the charges of adulteration and misbranding, and the case came to trial before a jury, which ultimately found the company guilty. The court imposed a fine of \$100. U.S. v. Orange Smash Co. U.S. District Court, Northern District of Alabama, 1925. F&D No. 19252.

provided the alcoholic menstruum for the flavor), methyl anthranilate, and other flavoring chemicals.¹¹¹

The use of methyl anthranilate in grape-flavored things was not so much a reproduction of grape, then, but an intensification —an intensification that had affective consequences for consumers.

“WHEN A BETTER GRAPE DRINK IS MADE, NUGRAPE WILL MAKE IT”

This, then, was the context for the 1925 regulatory action against NuGrape.¹¹² NuGrape was one of several manufacturers of grape-flavored beverages that were forced to disclose imitation status — although, as appears clear from Sales’s statement, it was not possible to make a commercially viable grape-flavored soft drink without the use of synthetic chemical additives.

Nonetheless, the resources of regulators were never sufficient to penalize all wrongdoers, and it seems evident that some makers of grape sodas continued to falsely pass their products as statutorily “pure.” In a full-page “Open Letter to the Trade,” published in the June 1927 issue of the *Beverage Journal*, NuGrape positioned itself as an industry leader in “faithful and fair compliance with government rulings,” and railed

¹¹¹ Sale 1927: 269.

¹¹² The prosecuting agency here was the Federal Trade Commission rather than the Bureau of Chemistry. The FTC was charged with preventing unfair competition for goods in interstate commerce, but only took action after a complaint was made. (The complainant remained anonymous.) As far as I can tell, the two agencies often worked together in cases regarding the enforcement of the Pure Food Law, and used the same chemical and commercial findings as evidence. “Imitation Flavors Must Be Designated as Such,” *The Beverage Journal* 63.4 (April 1927): 47-8.

against competitors who have “attempted to make capital of our action and to hurt our product by falsely claiming that their product did not have to be labeled ‘Imitation.’”¹¹³ Promising a “showdown,” NuGrape challenged manufacturers and distributors of grape syrups and concentrates to “TELL THE TRUTH ABOUT THEIR PRODUCTS AND COMPLY WITH GOVERNMENT REGULATIONS,” and the government to compel compliance “IN FAIRNESS TO US AND THE PUBLIC.” NuGrape, the letter alleged, “virtually created a market for grape flavored beverages throughout the United States. Other grape drinks have come and gone, and what temporary popularity they had was to a large extent due to NuGrape advertising and distribution.” NuGrape had earned its popularity because of its quality, flavor, and its other investments in building a market; dishonest competitors were capitalizing on these investments, and making a play for consumers’ favor not by appealing to their senses (by producing a higher-quality grape drink), but to their biases against ‘imitation’ products. Although the letter did not directly criticize the regulations themselves, it undercut them by presenting them as a disproportionate response: “NuGrape is made from real grape wine and grape products, with less than one-tenth of one percent artificial flavor, but on account of even this small percentage of artificial flavor” they were forced to bear the “Imitation” stigma. Paraphrasing Buick’s then-famous slogan, NuGrape closed the letter with a vow: “when a better grape drink is made NuGrape will make it.”¹¹⁴

¹¹³ NuGrape Company of America, “An Open Letter to the Trade,” advertisement, *Beverage Journal* 63.6 (June 1927): 59.

¹¹⁴ Thanks to Anne Boyd for pointing out the source of this slogan.

What was a better grape drink? Would it still be ‘imitation’? NuGrape’s open letter presented a fair playing field as one where all options were ‘imitation,’ and thus one where grape sodas would compete on the sensual flavor experience delivered by the contents of the bottle rather than the false impressions of quality conveyed by its label. As a *Beverage Journal* advertisement for a grape flavoring made by the Fonyo Chemical Laboratories of Chicago put it later that same year: “The Goodness of a Grape Drink Depends on the Quality and Distinction of the Imitation Flavor.”¹¹⁵ May the best ‘imitation’ win.

But the stigma of “imitation grape” was apparently so acute that in 1929, NuGrape changed the formula for “the flavor you can’t forget” to evade that designation. That year, advertisements announced “the Supreme Triumph of the Makers of Nugrape!” one which “marks the final victory of science over the ancient King of all Fruit Juices... King Grape Juice.”¹¹⁶

The copy continued:

“World famous chemists have been telling us for years it couldn’t be done... the difficulties were too great! Fermentation... price of grape juice... variation in flavor — all these things they said made it impossible to produce an exquisite, carbonated soda with the flavor of the grape and sell it for 5c. Nevertheless we’ve done it — by creating and perfecting a secret new process of concentrating grape juice.”

¹¹⁵ Fonyo Chemical Laboratories, “The Goodness of a Grape Drink...,” advertisement *Beverage Journal* (September 1927): 2

¹¹⁶ NuGrape Company, “The Supreme Triumph of the Makers of NuGrape!” advertisement, [Jackson, MS] *Clarion-Ledger*, (January 6, 1929): 19.

The advertisement went on to note that, in addition to concentrated grape juice, NuGrape's other ingredients were tartaric fruit acid ("which itself is a by-product of grapes"), pure cane sugar, carbonated water, and "harmless U.S. Government certified food color, such as is used in making candies, ice-cream and hundreds of other wholesome food products. These ingredients and no other give NuGrape its wonderful flavor of the grape and appearance." This "supreme triumph" meant that NuGrape bottles, labels, and advertisements were no longer emblazoned with "imitation grape." NuGrape was again on the right side of nature.

This restoration was short-lived. Regulatory officials again challenged NuGrape's labeling; this time, the company resisted and took the case to court. The subsequent trial record revealed much about the process of making NuGrape.¹¹⁷ Including this: it was not the NuGrape Company of America that had created the "secret new process," but Fritzsche Brothers, the flavor and fragrance company in New York. Thirty-nine of the forty gallons of NuGrape syrup were water, sugar, tartaric acid, and certified coloring; the final, and crucial, gallon was "Merchandise No. 25."¹¹⁸ What was Merchandise No. 25? This was "Fritsboro True Grape Aromatics, New Process," purchased from Fritzsche Brothers. The base of this was a four-fold grape juice concentrate from California.¹¹⁹ In

¹¹⁷ U.S. Federal Trade Commission Decisions. In the Matter of NuGrape Company of America. Docket 1576. Complaint, Feb 27 1929; Decision, May 19, 1931. 15 FTC.

¹¹⁸ 15 FTC In the Matter of NuGrape... (1931): 118.

¹¹⁹ To make a four-fold concentrate, four gallons of vacuum-distilled juice were reduced to one gallon of concentrate. Achieving further concentration was technically difficult for manufacturers at this time; not only did the concentration process risk unfavorably

order to achieve an eight-fold concentration — a concentration that would be viable for use in bottled sodas, but which was technically extremely difficult to produce without altering or losing flavor — the company testified: “we add aromatic grape concentrate made from grapes by our own secret process.” The company refused to provide any additional information to the investigators about this “aromatic grape concentrate,” on the grounds that these were trade secrets.¹²⁰ In other words, Fritzsche claimed that Merchandise No. 25 was a mixture of highly concentrated grape juices. This meant that it met the USDA’s criteria that it be “derived wholly and without chemical change from grapes or grape juice,” and so was “entitled to be labeled ‘grape flavor.’”¹²¹

However, an analysis performed by USDA regulatory chemists in the Spring of 1930, cited as evidence in the trial, cast doubt on the Fritzsche’s claim that their secret process used only grapes. “Exhaustive analyses” made by USDA chemists of Merchandise No. 25, NuGrape Syrup, and NuGrape soda proved that Merchandise No. 25 “is so changed by the removal of certain solids” such as fruit sugars and acids, and by the addition of alcohol, that “it has ceased to be a pure concentrated grape juice and has become a grape extract.” NuGrape syrup contained less than 4 per cent grape juice, and they found it “does not contain the natural fruit or juice of the grape in quantities sufficient to give it its color or flavor.” NuGrape soda “derives both its color and its flavor chiefly and substantially” from artificial color and tartaric acid, “both of said ingredients being added by respondent to Merchandise No. 25 in the production of

altering or losing the volatile flavor compounds in the juice, the sugar and solid contents of the juice also posed challenges. 15 FTC In the Matter of NuGrape... (1931): 118.

¹²⁰ 15 FTC In the Matter of NuGrape... (1931): 118.

¹²¹ Sale 1924: 270.

NuGrape syrup.” Tartaric acid was not found in grapes or grape juices, but obtained from “crude argols, commonly called wine lees, by-products, or precipitates, obtained in the treatment of grape juice or the manufacture of wine.”¹²² In other words, even if it was not found in grapes or grape juices, tartaric acid was, in a literal sense, a “grape product.” (Indeed, NuGrape argued this point.¹²³)

In the eyes of regulators, however, there was too much distance between grapes and tartaric acid; what was grape about the grape had been transubstantiated, turned into a chemical. NuGrape, artificially colored, flavored with materials once derived from grapes but grapes no longer, is Imitation. The FTC's ruling, handed down in 1931, required the company to change their labeling and marketing to reflect that the product "is an imitation, artificially colored and flavored."

What underlies this chemical judgment is a value judgment: that the flavoring chemical was made, essentially, from garbage — from the wastes of other industries. Although it dates from a decade later, this October 29, 1941 letter from P.B. Dunbar, assistant commissioner of Food & Drugs, to the chief of the central regulatory district, substantially reflects the agency's attitude and policy toward flavoring additives:

¹²² 15 FTC In the Matter of NuGrape... (1931): 118-119. The origins of tartaric acid are obscurely commemorated on the label of containers of cream of tartar, which often feature a wooden wine barrel.

¹²³ Before changing their formula, for instance, NuGrape claimed that its flavor was made: “from real grape wine and grape products with less than one tenth of one percent artificial flavor.” “An Open Letter to the Trade” 1927: 59.

"Heretofore on products of vague identity offered to food manufacturers we have felt that the requirement for the labeling of the ingredients by their most informative names was a means by which the buyer could determine the worth, if any, of these often glorified addition substances. In other words, the mere recitation that the product is a few cheap chemicals and water takes out all the mystery."¹²⁴

The "products of vague identity" are the flavor additives produced by flavor and fragrance companies. By requiring flavor additive manufacturers to reveal their ingredients, regulators at the Food and Drug Administration wanted to demystify these "glorified" and overvalued additives. For Dunbar and his colleagues at the agency, flavoring additives were not innovative products developed by skilled workers, but "a few cheap chemicals and water." Underlying this was a more profound anxiety: that consumers would not be able to tell the difference between — for instance — grape and NuGrape unless "Imitation" was prominently branded on the label. But, if there was a world of difference between the pastoral orchard and the chemical leached from the lees, then shouldn't that difference reveal itself at first sip? If the distinction between "real" and "fake" is somehow no longer self-evident, then what were the prospects for the continued persistence of the real?

In 1932, the year after the FTC's ruling, NuGrape once again tried to get on the right side of nature, this time partnering with another brand name to deliver a "real grape

¹²⁴ P.B. Dunbar, Assistant Commissioner of Food and Drugs, to Chief of Central District, October 29, 1941; Butter, Butterscotch etc. Flavors; Office of Nutritional Products, Labeling, and Dietary Supplements, Center for Food Science and Nutrition; Record Group 88, Records of the Food and Drug Administration; US National Archives, College Park, MD.

drink... deriving its entire flavor and color from Welch's Grape Juice."¹²⁵ The new, new NuGrape was again touted as a scientific triumph. "After years of expensive research our labors are rewarded," read one advertisement, which repeated the identical language used in 1929, proclaiming a "final victory of science over the ancient King of all Fruit Juices."¹²⁶ Naturalness, then, was finally achieved, but only through intensive scientific labor and technological innovation. Naturalness was not a return to the once-familiar, but a new kind of novelty: "never before has there been a drink like this introduced to the American public."¹²⁷

But the new NuGrape did not last. It's difficult to know exactly what happened; one account, provided by the son of a local bottling company owner, recalled that the grape juice fermented in the bottle, destroying the product.¹²⁸ In 1933, NuGrape advertisements all but vanished from newspapers; the once-heavily advertised beverage would not be widely touted until the mid-1950s. Bankruptcy announcements appeared for NuGrape regional plants in Louisville, Kentucky and Charleston, West Virginia; bottling machinery, trucks, bottles, and cases were auctioned off.¹²⁹ The economic depression, and the repeal of prohibition, clearly had consequences for the bottled soda market, but it

¹²⁵ NuGrape Company, "Enjoy a Real Grape Drink," advertisement, *Whitewright [TX] Sun*, (May 19, 1932): 8.

¹²⁶ NuGrape Company, "The Triumph of Beverage Perfection," advertisement, *Kokomo [IN] Tribune*, (June 17, 1932): 32.

¹²⁷ "The Triumph of Beverage Perfection" 1932.

¹²⁸ Bill Baab, "TIP Baby's Father Shares Gary Beverage Co. History," *The Federation of Historical Bottle Collectors Newsletter* (July-Aug 2007): 21. Available at: http://www.fohbc.org/PDF_Files/GarysBev_BBaab.pdf

¹²⁹ "Legal Notice," *Charleston [WV] Daily Mail* (January 13, 1933): 17; "At Auction," *[Louisville, KY] Courier Journal* (July 16, 1933): 35.

is also likely that the repeated pursuits of nature, its attempts to avoid “imitation,” contributed to NuGrape’s tumble.

THE FLAVOR YOU CAN’T FORGET

The NuGrape Twins’ recorded output is tiny: four songs in praise of the Lord, two in praise of NuGrape.

I got a Nugrape nice and fine

Three rings around the bottle is a-genuine

I got your ice-cold Nugrape

Like NuGrape, the NuGrape Twins hailed from Georgia. But while NuGrape came into the world in urban Atlanta at the outset of the booming 1920s, Mark and Matthew Little were born in 1888, in Tennille, a railway stop approximately halfway between the state capital and Savannah. NuGrape’s rise in the world was much steeper and swifter than that of the two African American brothers, of whom little is now known.¹³⁰ “I’ve Got Your Ice-Cold NuGrape” — recorded in 1926, when the purple drink’s territory was spreading beyond the borders of the Southern states — reflected the

¹³⁰ Mark and Matthew Little are recorded, along with their mother Low Little, in the “United States Census, 1900,” database with images, *FamilySearch* (<https://familysearch.org/ark:/61903/1:1:M3J8-JXW> : accessed 17 November 2016).

ways that the meanings and powers that bubbled up in this new carbonated sensation intersected with the daily lives of growing numbers of consumers, reshaping the contours of sensory and affective experience.

The song is, according to the *All Music Guide to the Blues*, “a simultaneous hymn and jingle that advertises the soda as a cure for any earthly or spiritual ailment.”¹³¹ One twin sings in a tinny, determined countertenor, which, at moments, thins to wispieness; the other provides a shuffling baritone accompaniment, sometimes lagging a beat behind. In a series of comic verses delivered in a plaintive, sing-songy cadence, the twins described NuGrape as a tonic that could lift depressed spirits:

*When you're feeling kinda blue
Do not know what's ailing you
Get a NuGrape from the store
Then you'll have the blues no more*

Pacify the rage of a termagant wife:

*If from work you come home late
Smile and 'prise her with NuGrape*

¹³¹ Burgin Mathews, “Sinners and Saints (1926-1931)/Document,” in Vladimir Bogdanov, Chris Woodstra, and Stephen Thomas Erlewine, eds., *All Music Guide to The Blues: The Definitive Guide to the Blues*, 3rd ed., (San Francisco: Backbeat Books, 2003): 672.

Then you'll sneak through in good shape

Or serve as a love-charm in courtship, a token of ardor otherwise inexpressible:

Sister Mary has a beau

Says he crazy loves her so

Buys a NuGrape every day

Know he's bound to win that way

The seductive, spiritual power of NuGrape derived from the incommensurable pleasure it produced, a sensation that emerged from its ice-cold temperature — a differential effect with the summer heat, that, in 1926, would have only recently become technologically possible for leagues of parched Southern drinkers — from its sweetness, and, especially, from its distinctive flavor. “A Flavor You Can’t Forget,” was NuGrape’s slogan, emblazoned on the crimped metal caps of NuGrape bottles, repeated in advertisements, wall-hangers, and other promotional merchandise.

But the most important lesson of the NuGrape Twins’ song is that only genuine NuGrape had these powers:

I got a NuGrape nice and fine

Got plenty imitation but there’s none like mine

I got your ice-cold NuGrape

Historians have convincingly argued that brands originated as a means of overcoming suspicions about canned and packaged foods, and of gaining and sustaining consumer trust in products that could not be directly examined.¹³² Through advertising and other promotional activities, manufacturers such as Heinz and the National Biscuit Company established direct relationships with consumers. As consumers became more confident in the safety and reliability of the food supply, brands became invested with other meanings and values. Advertising and design were powerful technics for creating needs, lubricating the gears of the mass consumer economy by continually renewing and replenishing the sources of desire. (Indeed, some early twentieth century advertising professionals sought to underscore their role in these economic processes by calling themselves “consumption engineers.”)¹³³ By the 1920s, advertisers accomplished this by adopting methods and insights from the social sciences and psychology in order to study consumers themselves — investigating their habits, surveying their preferences, and, increasingly, probing their motivations.¹³⁴ Similarly, the design fields and art industries became affiliated with psychology and other social sciences as they professionalized, in order to develop solutions that encouraged productive consumption and the “smooth

¹³² Koehn 2001; Strasser 1989.

¹³³ Marchand 1985: 26.

¹³⁴ Lawrence R. Samuel, *Freud on Madison Avenue: Motivational Research and Subliminal Advertising in America*, (Philadelphia: UPenn Press, 2011).

flow” of economic activity.¹³⁵ Advertising and design worked on the largest possible scale — messages disseminated through mass media or broadcast over radio-waves, colors, forms, and features stamped into mass-produced and mass-distributed goods — but their effects were meant to be intimately felt.

What role did flavor play in this system of stoking and provoking desire? A product’s flavor comprises part of what David Howes has called the sign-value of a commodity, and is an experiential index to the system of sensory and social relations in which it is embedded.¹³⁶ In other words, a consumer’s relation to and appreciation of flavor involves both her or his direct sensory experience and also the web of social, cultural, political, and historical circumstances, through which the flavor’s meaning and its value are construed, at that moment, for that taster. When food and beverage manufacturers such as NuGrape began deliberately designing the flavors of their products, controlling their material constituents and concomitant sensory effects, they simultaneously sought to shape their meanings.

Just as food companies, and their associated brands, used advertising to build direct relationships with consumers, they used flavor to cement those relationships. Even as regulators prosecuted NuGrape for failing to inform consumers that their product was merely an imitation of grape, NuGrape touted the distinctiveness and originality of the

¹³⁵ Regina Lee Blaszczyk, *The Color Revolution* (Cambridge: MIT Press, 2012); Christina Cogdell, *Eugenic Design: Streamlining America in the 1930s*, (Philadelphia: UPenn Press, 2010).

¹³⁶ David Howes, “Marx’s Skin,” accessed at: <http://www.david-howes.com/senses/marxsskin.html>. Adapted from David Howes, *Sensual Relations: Engaging the Senses in Culture and Social Theory* (Ann Arbor, MI: University of Michigan Press, 2003).

flavor of its beverage. The primary goal of the makers of NuGrape was not for its flavor to be mistaken for that of Concord grapes. It was for it to be recognized, remembered as NuGrape. (In this regard, the “three rings around the bottle” might be taken as an indication of the company’s lack of full confidence in the flavor alone to do this.)

To be clear, none of these things are necessarily more grandiose or remarkable than what foods could do to bodies in the early modern era, when food could treat and cure diseases, temper imbalanced humors, and recalibrate one's relationship with the actual cosmos.¹³⁷

In the final accounting, however, there is something heavenly about NuGrape. "Is there no change of death in paradise?" asked Wallace Stevens. "Does ripe fruit never fall?" "Heaven is a place where nothing ever happens," according to the Talking Heads.

For NuGrape to become "the flavor you can't forget," it must conform itself not to the flavor of grapes hanging heavy on the bough, but to prior memories of NuGrape. To the bodily, social, and spiritual array of pleasures, comforts, and gratifications that affiliate themselves with the sensations that NuGrape provides. Like the unchanging fruits of heaven, NuGrape must always resemble itself.

All the way from Maine to the Gulf of Mexico

From the Atlantic to the calm Pacific shore

NuGrape is the best friend yet

¹³⁷ Steven Shapin, “Changing Tastes: How Things Tasted in the Early Modern Period and How They Taste Now,” Hans Rausling Lecture 2011, Uppsala University.

So try a bottle of NuGrape

The flavor you can't forget

CHAPTER 3

ASSEMBLING THE HUMAN INSTRUMENT: TASTE PANELS, FLAVOR MEASUREMENT, AND THE ORIGINS OF SENSORY SCIENCE

On Friday, November 12, 1937, listeners tuning in to "Housekeepers' Chat" — a weekday radio segment produced by the US Department of Agriculture's Bureau of Home Economics — were given a glimpse of the agency's methods for providing reliable information about food to the public. Usually, these fifteen-minute weekday segments offered recipes from "Aunt Sammy," household tips, and nutrition and family health advice for the effective, scientific housewife.¹ On this day, listeners were assured that even at the Bureau's food laboratories, there were still some tasks that had not been mechanized: "even modern science with all it's [sic] labor-saving machinery hasn't devised a robot that tastes and smells." When it came to evaluating the flavor of food, the

1. Morleen Getz Rouse, "Daytime Radio Programming for the Homemaker: 1926-1956," *Journal of Popular Culture* 12.2 (1978): 315-327. For broader context on the technical and scientific aspects of home economics, see Amy Sue Bix, "Equipped for Life: Gendered Technical training and Consumerism in Home Economics, 1920-1980," *Technology and Culture* 43.4 (October 2002): 728-54, and Carolyn Goldstein, *Creating Consumers: Home Economists in Twentieth-Century America*, (Chapel Hill: UNC Press, 2012).

host announced, "no one but a human being can judge the flavor of the food human beings eat."²

But who were the human beings whose judgments gained the Bureau's official scientific imprimatur? These "taste judges" were USDA staff members who were "regularly employed in other work," but who had demonstrated sound and consistent judgment, as well as the ability "to analyze their own reactions to what they taste... [and] express these reactions on the score sheet they are using." The host explained that the Bureau of Home Economics routinely assembled panels of these specially chosen tasters to scientifically evaluate how changes in production methods affected the quality of different foods, including meat, bread, cakes, canned goods, and dairy products. Tasters, however, were never allowed to know the details of the experiments they contributed their sensory capabilities to: "if they did, it might possibly influence their judgment," undermining the evidentiary validity of their conclusions. "In all of these experiments," the chat's host concluded, "the opinions of taste-testers are really important. Because flavor and aroma are two of the biggest items in food quality, and so far there is no other way to judge them."

This chapter considers the consequences of this proposition: "no one but a human being can judge the flavor of the food human beings eat." With the increasing industrialization of food production in the 1930s, flavor became an object of scientific

2. "How Does It Taste?" USDA Housekeeper's Chat, Bureau of Home Economics. Broadcast date: Friday, November 12, 1937, 1. Emphasis in original.

and technical concern for food manufacturers and the federal government. Researchers from multiple disciplines – including chemistry, agriculture, physiology, psychology, home economics, and food technology – working in different institutional settings, harboring a variety of motives, found it necessary to develop standard tools capable of measuring the “organoleptic” qualities of foods: quantifying the various sensory dimensions of flavor experience, including taste, aroma, texture, and appearance.

The "taste panel" — a small group of individuals (trained, tested, but, crucially not “experts”) producing sensory judgements in specialized settings under controlled conditions — first appeared in research and industrial laboratories in the 1930s. By 1950, the taste panel had become the primary research tool within both government and industry to measure, compare, and evaluate the sensory qualities of foods, including flavor, texture, and visual appeal. Rather than a transitory record of subjective individual preferences, taste panels were expected to produce reliable, stable, and reproducible information about food’s sensory qualities — the type of data that could be evaluated alongside, and correlated with, other, new instrumental measurements and determinations of the chemical and physical properties of foods.

By examining the practices of organoleptic research in their specificities — the formally articulated methods, associated technologies, social structures, and desired outcomes — this chapter tracks a major change in the scientific study of flavor during the 1930s and 1940s. As food-science research increasingly revealed the physicochemical components responsible for the qualities of foods, the sensory aspects of flavor also became the subjects of systematic study and investigation. The interwar and wartime

years marked the convergence of these two modes of research into flavor, which was increasingly studied in the context of food manufacturing and the sensory changes that occurred during production. The development of the taste panel as a laboratory instrument shows us not only how flavor was made into a scientific object during this period, but also marks the formation of a model of the subjective, tasting self that could be incorporated into rationalized, industrialized processes of product development and design.³

The first part of this chapter traces the early days of laboratory taste panels, beginning in the 1930s until the Second World War. I show how this instrument developed at the convergence of multiple research programs and needs, shaped by, but distinct from, both traditional practices of "expert tasters" employed in assessing or grading specific commodities, and from new polling and statistical sampling methods from market research.

The second part of this chapter looks at how sensory evaluation, and laboratory taste panels, rose to prominence in the context of army research at the Quartermaster Food and Container Institute. The seminal status of the Quartermaster Institute has been reinforced by historical accounts from some of the scientists who participated in developing this field — including several who worked at the institute's laboratories in Chicago, and later, Natick, Massachusetts. These accounts often tend to dismiss work

3. Steven Shapin, "Sciences of Subjectivity," *Social Studies of Science* 42, no 2 (2012): 170-184.

done in the 1930s as the pre-history of the discipline.⁴ Beginning this story in the 1930s — when methodologies, research protocols, institutional settings, and disciplinary identities were still in flux — reveals a great deal about the diverse interests that were involved in the project of shaping the taste panel into a scientific instrument. The Quartermaster's Food Acceptance Research Laboratory was dominated by psychologists, and their preeminence there has in some sense foregrounded the contributions from psychometrics and psychophysics, while minimizing the contributions from other fields.⁵ Taking a closer look at the work that preceded the Food Acceptance Research Laboratory exposes the key contributions of chemists, home economists, and food technologists, not to mention the technicians, administrative staff, factory workers, and others who volunteered to serve on panels. Their material technologies, skills, professions, and social arrangements laid the groundwork for the later claiming of sensory science by psychologists.

The chapter concludes by following the path from military food research back into civilian food production. I look at the relatively rapid acceptance of sensory evaluation methods in industry and non-industry laboratories, and consider the consequences both for the ways that industrialized foods are made to taste, and the ways that consumer desires are probed, presumed, configured, and satisfied.

⁴ Herbert L. Meiselman and Howard G. Schutz, "History of Food Acceptance Research in the US Army," *Appetite* 40 (2003): 199-216; Howard G. Schutz, "Evolution of the Sensory Science Discipline," *Food Technology* 52, no 8 (August 1998): 42-6; David R. Peryam "Sensory Evaluation -- The Early Days," *Food Technology* 46, no 1 (January 1990): 86-89. A practitioner's account with a more generous view of work in the 1930s is Rose Marie Pangborn, "Sensory Evaluation of Foods: A Look Backward and Forward," *Food Technology* (September 1964): 63-7.

⁵ Meiselman and Schutz 2003: 200.

I. TESTING THE TASTERS: THE LABORATORY TASTE PANEL BEFORE WORLD WAR II

During the 1930s, the laboratory taste panel emerged in relation to and in distinction from two other contemporary methods of evaluating the sensory qualities of foods: expert tasters and consumer research. Although it is difficult to pinpoint exactly when the first laboratory taste panel was convened, precursors and related forms were thick on the ground in the 1930s.⁶

EXPERT PALATES AND THE APPETITES OF ORDINARY EATERS

The services of expert tasters had long been called upon by manufacturers and traders in particular foodstuffs, especially luxury goods. Tea and coffee cuppers, wine and liquor connoisseurs, vanilla-bean graders: all of these experts assigned grades based on ritualized organoleptic evaluations of sensory qualities, permitting the market to set prices based on established standards of relative excellence.⁷ In the twentieth century, the

6. For an example of the selection and use of a tasting panel in a commercial bakery — also the earliest use I have found of the term "tasting panel" — see H.C. Moir, "Some Observations on the Appreciation of Flavor in Foodstuffs," *Chemistry and Industry* 14 (February 21, 1936): 145-8. For examples of the production of scientific information about food's sensory qualities for the purposes of commodity research, see for instance, W.H. Catchcart and E.J. Killen, "Scoring of Toast and Factors Which Affect Its Quality," *Food Technology* 5 (1940): 308. For an account of the sensory sciences in action, see Larry Owens, "Engineering the Perfect Cup of Coffee: Samuel Prescott and the Sanitary Vision at MIT," *Technology and Culture* 45.4 (October 2004): 795-807.

⁷ A contemporary ethnographic account of the relationship between evaluations of sensory quality and price-setting can be found in: Sarah Besky, "The Future of Price:

evaluation of the sensory properties of foods was extended to commodities, with wholesale markets employing trained graders to assess the quality of farm products and assign scores based on properties including flavor, texture, and appearance.⁸ The 1919 Food Products Inspection Law extended this authority to the USDA, empowering officials to assess the "quality and condition" of perishable staples such as fruits, vegetables, butter, and poultry sold in interstate commerce.⁹ These trained inspectors evaluated the sensory qualities of foods using formalized procedures and following published guidelines, which not only dictated the conditions under which evaluations were to take place, but also described desirable and undesirable sensory qualities, and assigned specific penalties to the latter.

Expert tasters were not presumed to have been born with exceptional senses. Their sensory authority was not general, but acquired, and specific to a particular type of product. "Many professional tasters are people with only normal taste and odor sensitivities who happened, as boys, to take jobs in tea or coffee blending plants, or apprenticed themselves to chefs," observed Ernest Crocker, speaking at the "Flavors in Foods" symposium, held during the 1937 meeting of the American Chemical Society. "Long years of practice at their art has not sharpened their sensitivities to any appreciable degree." Instead, "the art of tasting is one of learning how to concentrate on the

Communicative Infrastructures and the Financialization of Indian Tea," *Cultural Anthropology* 31.1 (February 2016): 4-29.

⁸ For a comparison of different butter standards in use by New York, Chicago, and San Francisco wholesale grocer associations, see Roy C. Potts and H.F. Meyer, *Marketing Creamery Butter*, USDA Bulletin 456, Washington, D.C., February 5, 1917: 17-19.

⁹ USDA Office of the Secretary, "Rules and Regulations of the Secretary of Agriculture Under the Food Products Inspection Law of July 24, 1919," Circular 144, Washington DC: Government Printing Office, 1919.

indications of palate and nose, and particularly of learning what to look for as the 'critical' factor in any article with which one is working."¹⁰ Researchers at Cornell studying the reliability of the judgments made by official milk graders likewise noted that "specialists attain a high proficiency in the art of tasting, mainly because of a knowledge of what signs to look for and how to interpret these signs rather than an increased sensitiveness to stimuli."¹¹ In other words, a taster became an expert by attending to both sensory and social information, learning established signs of quality rather than refining his or her own preferences. This skill was only attained after repeated experience with particular materials in the presence of other experts.¹²

As the food industry became increasingly concerned with the large-scale production of novel kinds of foods, both the practicality and validity of the "expert taster"

10. E.C. Crocker, "Measuring Food Flavors," *Food Research* 2.3 (1937): 282.

11. G. Malcolm Trout and Paul F. Sharp, "The Reliability of Flavor Judgments, with Special reference to the Oxidized Flavor of Milk," *Cornell University Agricultural Experiment Station Memoir* 204 (June 1937): 40.

¹² This bears a close resemblance to the sociology of tasting elaborated by Antoine Hennion and Genevieve Tiel. Hennion and Tiel present the taster's acquisition of knowledge about the qualities of the things he or she is tasting as an ongoing, reflexive, and fundamentally social process, where particular qualities are detected, named, contested, and confirmed by a process of "collective responsiveness" among a community of tasters. An implication is that the flavors of a food or wine are "anything but pure and natural properties" that produce pre-ordained sensory effects that can be universally determined for all tasters in all conditions; flavors are as historically and culturally contingent, and socially produced, as bodies themselves. Although Hennion and Tiel's subject is the development of communities of taste among "amateurs," (by which is meant enthusiasts and connoisseurs, such as audiophiles or vinophiles, rather than naïve consumers), their observations about how knowledge about taste is produced has clear resonances with the practices and forms of authority claimed by officially sanctioned tasters. Genevieve Teil and Antoine Hennion, "Discovering Quality or Performing Taste? A Sociology of the Amateur," in Mark Harvey, Andrew McMeekin, and Alan Warde, ed. *Qualities of Food*, (Manchester: Manchester UP, 2004): 19-37; Genevieve Teil, "No Such Thing as Terroir? Objectivities and the Regimes of Existence of Objects," *Science, Technology, and Human Values* 37.5 (2012):578-505.

approach was called into question. As Rose Marie Pangborn, one of the founders of sensory science, wrote in a 1964 article about the history of her field: "with the growth of food processing and the development of many new products came the realization that there were not enough experts to cover all products, and that it might be statistically unsound to rely on the judgment of only one or two individuals."¹³ Food processors had habitually complained of what they considered the "arbitrary" and unscientific methods of evaluation used by official food-graders, and they searched for new systems of quantifying sensory judgments that were more exact, reliable, and generally applicable.¹⁴

The pursuit of scientific modes of determination and control over phenomena once thought not to be susceptible to exact measurement was not unique to the food industry; it was consonant with a turn towards rationalization, professionalization, and technocratic authority that transformed many aspects of life in the progressive era and the interwar years. The new science of acoustics had brought exact methods and experimental authority to the optimal design of concert halls and the mitigation of noise pollution.¹⁵ Color theorists, industrial designers, and consumer psychologists were rationalizing, standardizing, and operationalizing the hues of fashions, consumer goods,

13. Pangborn 1964: 63.

14. See, for instance, L. Charles Mazzola, "Grading Food by a Descriptive Method," *Food Industries* 2 (May 1930): 214-5; and "How a Formula for Descriptive Grading Was Developed," *Food Industries* 2 (August 1930): 340-44. Mazzola, an erstwhile member of the research staff at New York Cannery Inc. and current general manager of the Genesee Jam Kitchen in upstate New York outlines a scoring method that relies on sensory analysis, and proposes a mathematical equation that captures the accelerating decline in perceived quality as the defects in a product increase in number or intensity — in other words, a logarithmic scale rather than a linear scale.

¹⁵ Emily Thompson, *The Soundscape of Modernity: Architectural Acoustics and the Culture of Listening in America, 1900-1930*, (Cambridge: MIT Press, 2004).

and architectural spaces, developing schemes of “functional color” that could move merchandise, increase productivity, and improve well-being.¹⁶ Heating and ventilation engineers experimentally determined measureable, enforceable standards of comfort, encoded in automatic systems that reproduced, in numberless office buildings, the precise atmospheric conditions deemed to be optimally pleasant to the normalized (male) body engaged in white-collar labor.¹⁷ Similarly, food engineers and technologists sought standard methods of measuring and controlling flavor, in hopes of one day developing optimal standards of quality, so that the sensory qualities of food could be calibrated to the exact register of consumer desire.

The judgments of expert tasters often failed to coincide with the preferences of ordinary consumers.¹⁸ This meant that the evaluations of specialists were often poor guides when it came to product development, forecasting, and market analysis.¹⁹ But how could the preferences of “Mrs. Housewife” be ascertained? Food manufacturers needed reliable information about the preferences and tastes of the consuming public in order to

¹⁶ Regina Lee Blaszczyk, *The Color Revolution*, (Cambridge: MIT Press, 2012).

¹⁷ Michelle Murphy, *Sick Building Syndrome and the Problem of Uncertainty*, (Durham: Duke UP, 2006): 19-34.

¹⁸ See, for instance, Asher Hobson and Marvin A. Schaars, “Consumer Preferences for Cheese,” *University of Wisconsin Agricultural Experiment Station Research Bulletin* 128 (October 1935). The experimenters found that across various groups studied — which included grocery store customers, as well as doctors, nurses, and agriculture students eating in university dining halls — consumers were resistant to the aged American cheese graded highest by experts, and in some cases preferred a low-grade cheese with “an undesirable acid flavor, open texture, and soft body” which was “distinctly objectionable from a trade standpoint,” but which was chosen more often than higher-scoring cheeses. The experimenters proposed that the standards of quality, which were used to grade and price cheeses, “may... not conform wholly to consumer preferences.”

¹⁹ Washington Platt, “Rational Methods of Scoring Food Products,” *Food Industries* 3 (March 1931): 109.

design and manage the sensory aspects of their products. They turned to another set of scientific experts for guidance. As historian Sarah Igo has demonstrated, the interwar period saw a proliferation of attempts to measure, quantify, and statistically analyze the desires, beliefs, and behaviors of U.S. populations. Survey data served not only as a crucible for the formation of the mass public, but also shaped private lives and lived identities.²⁰ Bringing together social scientists, political movements, and industrial enterprises, consumer research claimed to close the circuit between the forces of production and the forces of desire, offering manufacturers "measurable opinions" that could be used to coordinate both assembly lines and advertising campaigns.

As food became a mass-market good, food manufacturers turned to market research and consumer polling firms to establish their competitive position, guide product development, and address lagging sales. Meatpacker Swift & Co., for instance, claimed to have surveyed 100,000 consumers "regarding the flavor, aroma, appearance, or tenderness of a great variety of foods, including ham, bacon, lard, shortening, butter, cheese, sausage, meat specialties and many others."²¹ Controlling this treasury of preferences meant Swift could point to deficiencies in a product that made it less pleasing to shoppers than its neighbors in the grocery aisle. Companies and industry groups also hired pollsters to conduct fundamental research, including large-scale surveys of factors influencing Americans' food choices. When the American Meat Institute hired Elmo Roper's polling firm in 1939 to investigate the causes of declining beef consumption, they

20. Sarah Igo, *The Averaged American: Surveys, Citizens, and the Making of a Mass Public*, (Cambridge: Harvard UP, 2007).

21. Donald R.G. Cowan, "Developing and Improving Foods by Consumer Testing," *Food Industries* 1941: 41.

put these findings to work not by changing their products, but by tailoring their advertising to counter negative perceptions of red meat; they managed to reverse the trend and increase sales.²² In some cases, large companies — most prominently, General Foods and Kroger — skipped the middleman and did their own consumer research, soliciting opinions on new products or advertising campaigns from housewives, and analyzing the results.²³

While food manufacturers continued to seek out and pay dearly for this kind of direct information about the fancies and desires of Mrs. Housewife, incorporating hard-won information about "public tastes" into production processes and product development required the intercession of actual tasters. Tasting panels became a way for manufacturers to apply knowledge about consumer preferences to the improvement of the quality of food.

**“A NEW APPROACH TO THE SUBJECT OF FLAVOR:” JOINING
CHEMISTRY AND PSYCHOLOGY AT THE 1937 AMERICAN CHEMICAL
SOCIETY FLAVORS IN FOODS SYMPOSIUM**

By the second half of the 1930s, researchers were attempting to develop standard laboratory methods that could connect the physicochemical components of foods to distinct, measurable sensory effects, and associate those experienced effects with attitudes and behaviors in consumers. The landmark 1937 Flavors in Foods Symposium,

22. Harvey Levenstein, *Paradox of Plenty: A Social History of Eating in Modern America*, New York: Oxford UP (1993): 74.

23. Igo 2007: 112; Peryam 1990: 85; Schutz 1998: 43.

which took place during that year's annual American Chemical Society meeting held at the University of North Carolina in Chapel Hill, was the earliest scientific conference to take flavor as its subject. The event brought together a diverse group of experts working on problems of flavor measurement and control — not only other chemists, but also home economists and physiologists, hailing from industry as well as agricultural experiment stations and research laboratories. Papers addressed subjects including the flavor chemistry of raw and cooked meat, butter, and alcoholic beverages, the use of activated charcoal to remove off-flavors from municipal water supplies and consumer products, and modern trends in flavoring extract production. Of the ten papers presented at the Chapel Hill symposium, three were explicitly and primarily concerned with techniques for measuring sensory responses to food flavors.²⁴

The fundamental question posed by the symposium's organizers, and engaged with in some degree by each of the ten papers presented, concerned the epistemic and experimental basis for a legitimate, objective science of flavor. Ernest C. Crocker and Washington Platt, who organized the symposium, proposed that flavor science needed to be fundamentally interdisciplinary: "A new approach to the subject of flavor consists in attacking several of its many sides simultaneously, but especially the psychological and

24. Articles presented at the American Chemical Society Symposium on Flavors in Foods (Chapel Hill, NC, April 12-15, 1937) were reprinted in *Food Research* 2.3 (1937). The articles that took as their explicit subject methods for measuring sensory responses to flavor are: Florence B. King, "Obtaining a Panel for Judging Flavor in Foods," Washington Platt, "Some Fundamental Assumptions Pertaining to the Judgment of Food Flavors," and Ernest C. Crocker, "Measuring Food Flavors."

the chemical sides."²⁵ Crocker was a pioneer of industrial flavor and odor consulting at the Cambridge, Massachusetts consulting firm Arthur D. Little. Platt was the head of the Borden milk company's research laboratories. Both were trained as chemists.

The challenge, as they expressed it, was to find a way to determine the relationship between chemical presences and embodied experiences. Although this may have been a new question for the chemists who were posing it, it was not a new problem for psychological research. In the mid-nineteenth century, a group of researchers (based largely in Germany) began to investigate methods of measuring and quantifying the correspondence between objective physical stimuli and the subjective, psychic phenomena of sensation and perception. Psychophysics, in the words of Gustav Fechner, one of the field's founders, proposed to develop "an exact theory of the relation of body and mind," one which could be expressed mathematically. While psychophysics began as a discipline chiefly concerned with the accurate measurement of physical and sensory magnitudes, of determining and quantifying the limits (perceptual thresholds) and increments (just-noticeable-differences) of sensory experience, by the early twentieth century, psychophysical practices had yielded modes of experimental psychology increasingly concerned with producing an objective account of the qualitative, subjective experiences of the sensing subject.²⁶

25. E.C. Crocker and Washington Platt, "Editorial Review. Food Flavors -- A Critical Review of Recent Literature," *Food Research* 2.3 (1937): 183.

²⁶ F. Nowell Jones, "History of Psychophysics and Judgment," in Edward C. Carterette and Morton P. Friedman, eds. *Handbook of Perception*, Vol. II. Psychophysical Judgment and Measurement, (New York: Academic Press, 1974): 2-20; Alexandra Hui,

Around the turn of the twentieth century, Edward Titchener – professor of psychology at Cornell and one of psychophysics’ most prominent American disciples – elaborated methods of experimental introspection that could produce scientifically valid accounts of experience. Through attentive and disciplined self-observation, and aided by laboratory hardware that produced standardized physical stimuli, Titchener claimed that the trained, observing self could accurately and impartially report on subjective experience, from which the general structures of consciousness could be deduced.²⁷ Although these methods had largely fallen out of favor among experimental psychologists by Titchener’s death in the late 1920s, they were to enjoy a sort of resurgence starting in the 1930s in a different disciplinary realm: as foundations for the new field of sensory evaluation.²⁸

But there were challenges in applying the methods of psychophysical and psychological laboratory to flavor research. The first problem had to do with experimentally defining the stimulus. Psychophysical research into sensory perception most often concerned sights and sounds; rarely did it dabble in the messier world of the

The Psychophysical Ear: Musical Experiments, Experimental Sounds, 1840-1910, (Cambridge: MIT Press, 2014).

²⁷ Deborah J. Coon, "Standardizing the Subject: Experimental Psychologists, Introspection, and the Quest for a Technoscientific Ideal," *Technology and Culture* 34.4 (October 1993): 757-783; Christopher D. Green, "Scientific Objectivity and E.B. Titchener’s Experimental Psychology," *Isis* 101. 4 (December 2010): 697-721.

²⁸ For an intriguing account of this recovery of psychophysical methods by sensory science, written by a participant and practitioner, see Howard R. Moskowitz, "How Psychophysics Changed the Food Business, and How the Food Business Forever Changed Psychophysics," *International Society for Psychophysics* 25 (2009). Available at: <http://www.ispsychophysics.org/fd/index.php/proceedings/article/view/104>

“lower” stimuli, smells and tastes.²⁹ Auditory and visual stimuli could be represented, reproduced, and analyzed as energetic waveforms, had agreed-upon standard units of measurement, and scientists possessed tools that could be used to automatically produce and measure stimuli of a given intensity. (Helmholtz, for instance, contrived ingenious devices to reduce auditory stimuli to simple waveforms.) But what were the basic stimuli or units of flavor sensations? Flavor, as Crocker and his colleagues at the 1937 ACS symposium well knew, was a multisensory phenomenon. The experience of flavor involved not only taste and smell, but also “mouthfeel”: chemical sensations (the coolness of menthol, the pungency of mustard), as well as responses to textural qualities, such as smoothness, graininess, and unctuousness.³⁰ Moreover, the sensory modalities of flavor were contested. Crocker, for his part, excluded visual and auditory sensations from his strict account of the experiential constituents of flavor, but others did not.³¹

Even if the assembled chemists agreed to limit their scope to the senses of odor and taste – which were agreed on as the *dominant* sensory modalities involved in flavor –

²⁹ Edward G. Boring, *Sensation and Perception in the History of Experimental Psychology*, (New York: Appleton-Century-Crofts, 1942): 437-8.

³⁰ Crocker “Measuring Food Flavors” 1937: 273-4. Although Crocker describes the relevant tactile sensations, the term “mouthfeel” is used by Platt. Washington Platt, “Some Fundamental Assumptions Pertaining to the Judgement of Food Flavors,” *Food Research* 2.3 (1937): 238.

³¹ Visual cues (especially color) were widely recognized as integral components of flavor perception and sensation by this point. Auditory sensations as flavor factors (eg, the sound of crunchiness) began to gain recognition later on. On the importance of color to flavor recognition: H.C. Moir, “Some Observations on the Appreciation of Flavor in Foodstuffs,” *Chemistry and Industry* 14 (February 21, 1936): 145-8. On auditory cues: Rose Marie Pangborn, “Flavor Perception: Relation of Sensory to Instrumental Measurements,” in DJ Tilgner and A Borys, eds. *Proceedings of the 2nd International Congress of Food Science and Technology*, August 22-27, 1966, Warsaw, Poland: 303-318.

defined the basic stimuli of flavor as chemical compounds, and focused their work on correlating specific molecules with definite sensations, they still ran into trouble.³² The human sensorium responds to complex combinations of molecules. Further, pure compounds are rarely encountered in the world, which is filled instead with odoriferous stews of sensible compounds, whose fluxing concentrations deliver sensory experiences of varying qualities and intensities. As historian of chemistry Carsten Reinhardt has described it, the scientific study of smell has been fractured by the problem of defining the boundaries of the olfactory object.³³ Should attention be directed to an analysis of individual chemical components? Or should it instead focus on understanding the “whole thing,” the integrated perception of a smell produced by combinations of volatile molecules? While the latter would be more directly useful for manufacturers and others who sought to apply this knowledge, it “does not easily enable the scientific aim of theory building.”³⁴ Some approached this problem by turning to an analogy with vision, seeking primary taste or odor sensations that could be used as the building blocks of more

³² It should be pointed out that the categorization of smell and taste as the “chemical senses” — ie, the place of chemists in this discussion — was not at all established at this point. (It was through professional symposia, such as at the 1937 ACS meeting, that the foundations of this claim were laid.) Chemists’ authority to turn the study of smell and taste into an objective science was not uncontested. For instance, Boring (1942) writes: “Although smell is always said to be one of the two chemical senses, there is no clear evidence that *chemistry* will eventually provide the knowledge of the essential nature of the olfactory stimulus. The mere fact that different substances have different smells and also different chemical constitutions does not make a smell a chemical sense. Different substances have likewise different colors and different chemical constitutions, and yet color vision is for not this reason a chemical sense.” (p. 446-7).

³³ Carsten Reinhardt, “The Olfactory Object: Toward a History of Smell in the 20th Century,” in Ursula Klein and Reinhardt, eds. *Objects of Chemical Inquiry*, (Sagamore Beach, MA: Science History Publications, 2014): 321-340.

³⁴ Reinhardt 2014: 321-2.

complex experiences.³⁵ Others, such as chemist Marston Bogert at Columbia University in the late 1920s, pursued theories that linked particular molecular architectures (such as functional groups) with discrete categories of sensations.³⁶

These experimental and epistemological challenges were compounded by the lack of a standard vocabulary for describing flavor sensations, especially those related to odor. Various systems of classification had been proposed over time, ranging from descriptive Linnaean taxonomies to experimentally derived systems, such as the olfactometrically derived lexicon proposed at the end of the nineteenth century by Dutch physiologist Henrik Zwaardemaker, and the spatial representation for smell developed by German experimental psychologist Hans Henning in 1915.³⁷ Crocker himself, with his erstwhile

³⁵ At the symposium, Crocker described work that he and Henderson (1932) did to reproduce a more complex taste sensation by combining taste primaries. Crocker and Henderson attempted to duplicate the taste of monosodium glutamate through combinations of basic solutions of sour, salty, sweet, and bitter (work they deemed rather successful, but which would be called into question in the following decade, when chemists at Arthur D. Little began conducting contract research for International Minerals and Chemicals, after the company bought a factory manufacturing MSG), but say that attempts to duplicate odors in terms of fundamentals have been “less successful.” Crocker 1937: 188.

³⁶ Marston Bogert and Arthur Stull, “Odor and Chemical Constitution in the Benzoselenazole Group,” *American Perfumer and Essential Oil Review* 22.2 (April 1927): 63. As has been the case for much basic research on odor and taste, Bogert and Stull conducted this research in an industrial, rather than academic, laboratory context, in the laboratories of the American Manufacturers of Toilet Articles. This line of research would be carried forward, most prominently by John Amoore, at the USDA Western Regional Research Laboratory, who, beginning in the 1950s, developed a stereochemical theory of odor that linked the architecture of molecules with specific sensory experiences, mediated by the shape of olfactory receptor sites, which would accept some molecular couplings but not others. See Reinhardt 2014.

³⁷ Boring 1942: 437-449. Zwaardemaker developed and used precise quantitative tools of olfactometry to study the human responses to different odors. Henning mapped the set of possible human odor responses on the surface of a six-sided, three-dimensional polygon,

colleague Lloyd Henderson, had devised a numerical system for describing odor that proposed to comprehensively describe each extant odor as a four-digit number, indicating both odor qualities and intensities. The system, which became commercially available as a kit with odor standards in the late 1940s, attracted some attention, but was never widely used.³⁸

In addition to the problem of defining and standardizing the stimulus, flavor researchers had to concern themselves with the subjects, the necessary bodies that formed the instruments of flavor measurement. How could researchers ensure and confirm that particular bodies produced accurate, reliable knowledge about flavor, undistorted by the “personal equation”?³⁹ Psychophysical techniques of experimental introspection demanded intensive training. “In order to standardize themselves as experimental observers,” writes Deborah Coon, “psychologists resorted to long and rigorous introspective training periods... necessary to bring all observers up to a comparable level of expertise, a *standard* level of expertise. Only if introspectors themselves were standardized could they become interchangeable parts in the production of scientific psychological knowledge.”⁴⁰ For Titchener, accurately and disinterestedly reporting

whose corners represented what Henning had determined to be the six principal qualitative classes of odors, and whose planes indicated mixtures of those sensations.

³⁸ For more on this, see: <http://nadiaberenstein.com/blog/2014/8/25/is-there-a-dewey-decimal-system-for-the-library-of-smells>

³⁹ Simon Schaffer, “Astronomers Mark Time: Discipline and the Personal Equation,” *Science in Context* 2.1 (1988): 115-145. The “personal equation” is the technical term for differences in time measurement recorded by observers in the same situation, which became an object of psychophysical study and quantification in the nineteenth century.

⁴⁰ Coon 1993: 775.

internal psychic experiences was a technical skill, one that could be acquired only with long effort.

But the situations where flavor measurement and control were needed were profuse and diverse, and often encountered in industrial settings, rather than the closed chambers of the experimental psychology laboratory. Coon aptly describes the method of introspection as an “artisanal” method. Part of the reason for its decline in experimental psychology was that, as the discipline turned its attention to industrial problems, such as human management and social control, it needed “industrial” methods, such as mass studies of behavior, that could operate at scale.⁴¹ How could psychophysical methods be adapted to the needs of food manufacturers and allied researchers, who were more interested in determining the sensory qualities of foods than the structures of consciousness? Moreover, the judgments of exquisitely trained experts were one of the things that researchers in both academic and industrial contexts were trying to move away from. What training, tools, or methods would be appropriate in the scenarios of flavor research?

The 1937 Flavors in Food symposium at the ACS conference was not the first time that these issues were raised, but it signified a convergence of expert attention on the matter. In particular, the symposium organized and crystallized attempts to address these two experimental problems: the challenge of stimulus definition and control, and the challenge of forming human tasters into reliable instruments of sensory measurement. The symposium also underscored the ways that the problems of flavor in industrial food

⁴¹ Coon 1993: 760.

production (rather than, say, in agriculture) would come to dominate the research in this field. The small laboratory taste panel, which was first comprehensively described at the 1937 symposium, would emerge as the tool best suited to managing the inherent experimental problems of flavor measurement, within the context of industrial food production.

Operationally, the concern with measuring sensory experience led to the development of experimental methods that not only captured the sensory qualities of foods, but also the sensory acuity of the humans doing the tasting. Measurements and records of the sensory acuity of tasters became a defining feature of laboratory taste panels, distinguishing them from consumer research and expert evaluations. Although the explicit purpose of taste panels was to measure food's qualities, the senses of the tasters who comprised the panels were also captured in researchers' evaluations, measurement, and scrutiny.

FIRST, TEST THE TASTERS: LABORATORY TASTE PANELS

Florence B. King, a food researcher at the USDA Bureau of Home Economics, was frustrated. She and her research group were comparing the results of two common methods of home bread-making: the 'sponge' method, which required a fermentation period between two mixing stages, and the 'straight-dough,' single-mix, method. Which method produced the better loaf?⁴²

⁴² King 1937: 207-219.

In order to find out, King and her colleagues convened a panel of nearly one hundred men and women — laboratory workers, statisticians, clerks, stenographers, and executives — demographically "fairly representative of one consumer group." These tasters were asked to record differences in flavor, texture, and appeal between breads made with two different manufacturing processes on scorecards. But there were irreducible problems. The group was "not sufficiently discriminating" to detect the small differences between samples, and "only a very small percentage" could duplicate a previous judgment when given the same sample. Even worse, the sixteen individuals with prior experience with food tasting performed no better than their inexperienced peers.⁴³ The large panel's judgements was both inaccurate and unreliable.

It was commonly known that capacities for sensory discrimination varied widely across the population. Indeed, recent studies had documented the presence of smell and taste "blindness" among individuals.⁴⁴ Could choosing tasters with greater sensory acuity improve the consistency and reliability of results? King outlined a multi-stage process to cull the panel so that it included only those with the sharpest capabilities. The selection process began with a questionnaire. The original 96 judges were surveyed about their age, gender, smoking habits, and susceptibility to head colds, as well as how much bread they typically ate and whether they had any "prejudices" against the flavor and odor of bread. Excluding the head-cold-prone and bread-averse left 64 tasters. Next, experimenters deployed established techniques from experimental psychology — psychophysical methods of measuring sensory thresholds and perceptual gradations of

43. King 1937: 207.

44. See, for instance, Blakeslee 1936.

intensity — in order to measure the basic sensory capabilities of their prospective pool of judges. Prospective tasters were asked to identify simple solutions by taste, and then to rank them in order of intensity; they were similarly evaluated on the acuity of their senses of smell.⁴⁵ The fourteen best performers were re-tested on the original experimental bread substances. The results were mixed: this smaller, more acute group was not any better at detecting differences between the two types of bread. However, the group was more consistent: better at duplicating previous judgments when re-tested with the same sample.

The significance of King's paper lay not in her findings about bread qualities, but in her conclusions about the tasting instrument that she had assembled. A small, select panel of tasters could provide experimental data about both preferences and sensory differences that was comparable to that produced by a larger group that was more demographically "representative" of the general population. King's paper was also one of the first in this field to distinguish difference testing — which used the senses as an instrument for determining sensory properties of foods — from preference testing, which registered the reactions of the taster, rather than the qualities of the food.⁴⁶ In her paper, King outlined a practice that would become standard in taste-panel research: systematically testing prospective panel members to assess their basic sensory-

45. The test solutions for taste sensitivity were chemically pure solutions of sodium chloride, sucrose, lactic acid, and caffeine, at different dilutions in water. The sample scents were benzaldehyde, citral, coffee, menthol, oil of turpentine, and a 10% aqueous solution of ammonia. Experimenters also tested subjects for their ability to recognize the scent of a yeast dispersion in water, and a 95% alcohol solution, since these are important aromatic components of bread. King 1937: 208-210.

46. Pangborn 1964: 64.

discrimination capabilities. In other words, her research established a protocol wherein the tasters were tested, before the food could be.

King's protocol for selecting tasters reflected an epistemic shift in the purpose of the tasting panel. While earlier users of small panel techniques had suggested selecting tasters based on the correspondence of their preferences with those of the general public, King's selection standard was experimentally determined, normative sensory acuity and reliability.⁴⁷ Rather than serving as a small-scale model of consumer behavior, the tasting panel could be used as an instrument for detecting and measuring sensory qualities independent of preference. Tasters were expected to act as neutral instruments, registering the qualities of the food rather than personal reactions.⁴⁸ In other words, King's taste panel was a group that represented and reproduced general human sensory *capacities*, rather than human sensory communities. This had important consequences. While a consumer panel was at risk of becoming less typical and less representative as it became more "professional," a laboratory tasting panel could potentially improve its reliability, accuracy, and consistency with experience and training.⁴⁹ After all, expert tasters were understood to have acquired their proficiency through practice.

Crucially, however, taste panel members were not being trained to be "expert tasters" – specialists in particular commodities – but to improve their capacities for

⁴⁷ For a discussion of the use of small consumer preference panels, see Platt 1931.

⁴⁸ Pangborn cites King as one of the earliest to disaggregate difference testing from preference testing. Pangborn 1964: 64.

⁴⁹ On the hazards of "professionalization" of consumer panels, see Paul Lazarsfeld and Marjorie Fisk, "The 'Panel' as a New Tool for Measuring Opinion," *Public Opinion Quarterly* 2.4 (October 1938): 600.

sensory discrimination and reliability more generally. King's method of using standard solutions to test sensory acuity were also applicable to training regimens to improve this skill, and thus to increase the accuracy and reliability of the tasting panel as an instrument. Dairy researchers at Cornell had concluded that, by prescribing exercises that improved a taster's capacity to identify and discriminate among "basic" taste and aroma sensations — using simple solutions representing, for instance, bitterness, saltiness, sourness, and sweetness at increasing intensities — one could improve a taster's general "proficiency," meaning accuracy and reliability.⁵⁰ Crocker addressed this point in his remarks at the symposium, noting that expert tasters in industrial contexts were not trained to detect "ultimate sensation elements," but rather for substances or qualities "known or believed to be present." So, for instance, tasters at a processed meat plants may be trained to taste for vinegar, spice, or smoothness. He suggested "in the training of flavor judges, to familiarize them with the principle of the more classical *sensation* detection as against the more industrial *ingredient* detection."⁵¹ Calibrating taste panels in this way was a strategy for producing an instrument that could be standardized across research contexts and locations, a general tool for sensory measurement rather than one which reflected local conditions and individual particularities.

Flavor researchers also developed methodologies that, by strictly controlling the conditions of the experiment and constraining the parameters of the test, buttressed the validity of taste-panel results, while also further distinguishing the laboratory taste panel from methods reliant on "expert tasters." An example of this can be found in the work of

50. Trout and Sharp 1937.

51 Crocker, "Measuring Food Flavors," 1937: 285.

Sylvia Cover, a home economics researcher at the Texas Agricultural Experiment Station, who in the late 1930s was studying the effect of cooking temperatures on the palatability of meat.⁵² The National Cooperative Meat Investigation (NCMI) committee, an industry group that studied meat quality, had established standards for meat evaluation. Their expert tasters were asked to judge palatability by grading ten factors – such as aroma, flavor of fat, and flavor of lean – in terms of intensity or desirability. Cover’s group of tasters, drawn from staff members at other labs in the Station, had "little training in subjective tests."⁵³ (Cover makes no mention of testing her tasters’ sensory acuity prior to using them as judges.) Their understanding of what sensory qualities comprised each of the NCMI’s factors was evidently vague; asking them to assign scores would mar her results with fatal inconsistencies and subjective distortions. Cover needed a method that would be simple enough for these inexperienced tasters to use, while also producing useful, objective, and reliable results.

Instead of requiring tasters to score all ten factors, she asked her judges to attend to only one factor: tenderness. Each was given a pair of numbered samples, taken from the different sides of the same animal, cooked at different temperatures. Blind to the method of cooking used for each sample, the judges were asked to record only whether they found a difference, and if so, to indicate which was more tender.⁵⁴ “By this method,” Cover wrote, “differences are easily detected and recorded by the judges and the results

⁵² Sylvia Cover, "A New Subjective Method of Testing Tenderness in Meat -- The Paired-Eating Method," *Food Research* 1.3 (May-June 1936): 287-295.

⁵³ Cover 1936: 293.

⁵⁴ In later iterations of this research, the score sheet was modified to allow judges to indicate the degree of difference – none, slight, or decided. Cover 1936: 289.

of the judgments may be interpreted with little doubt as to the actual differences involved.”⁵⁵ The objectivity and reliability of the results were obtained by rigorous control of both the sample and the instrument. The sample varied in only one factor (temperature); the human instrument measured only one dimension of experience (tenderness).

Cover’s techniques bore strong resemblance to the method of paired comparison, and the determination of least noticeable difference — both with roots in the psychophysical laboratory.⁵⁶ It shared with these earlier experimental techniques similar strategies to limit subjective interference and obtain scientifically valid results: tight control over experimental conditions and disciplinary control over the operation of the human tasters. Both of these concerns would remain central to laboratory taste panel research. But Cover differed from later researchers in her relative lack of concern for the influence of social factors. For instance, tasters were permitted to chat while tasting, as long as they did not know which of their samples represented the same experimental conditions.

⁵⁵ Cover 1936: 289.

⁵⁶ Cover does not trace her “paired eating” technique to experimental psychology, but calls it an adaptation of a method used in nutritional science. She cites a 1930 paper that studied the effects of specific nutritional deficiencies by feeding animal pairs diets that were identical but for the nutrient (eg, vitamin B, cysteine) under investigation. The somewhat tortuous feats of adaptation necessary to suit this technique to Cover’s own research, and the multiple disciplinary fields crossed by these experimental techniques, demonstrates the nonstandard routes by which these standard psychophysical methods entered sensory science. H. H. Mitchell and Jessie R. Beadles, “The Paired Feeding Method in Nutrition Experiments and Its Application to the Problem of Cystine Deficiencies in Food Proteins.” *Journal of Nutrition* 2.3 (January 1, 1930): 225-243.

For Cover, biases could be managed by another strategy that would be used by flavor researchers to secure the objectivity of taste panel experiments: statistical control over the results.⁵⁷ Cover used simple statistical methods – binomial and chi-square techniques – to eliminate aberrant data and produce results that seamlessly reflected aggregate acts of tasting.⁵⁸ Later researchers would apply statistical methods not only to validate the accuracy of the flavor measurements, but also to monitoring the performance of individual tasters. For instance, by the use of "control charts," a technique imported from industrial process engineering that uses statistical calculations to identify judges whose performance was inconsistent, skewed, or unreliable. This information could then be used to investigate the cause of unreliability — whether it was because of a health issue, or a deficiency of training, or because of some fundamental problem with the design of the testing conditions.⁵⁹ By these acts of statistical maintenance, the taste panel could be trusted to remain a standard instrument.

57. Christopher Phillips provides a detailed examination of how statistical methods were used in the sensory evaluation of wine in the postwar; he demonstrates that the statistical processing of taste panel results manufactured a collective objectivity from the aggregation of subjective reports. Christopher J. Phillips, "The Taste Machine: Sense, Subjectivity, and Statistics in the California Wine World," *Social Studies of Science* 46.3 (2016): 461-481. For the definitive account of how techniques of quantification, such as statistics, gained validity, authority, virtue, and social power in modernity, see Thomas Porter, *Trust in Numbers*.

⁵⁸ Sylvia Cover, "Some Modifications of the Paired-Eating Method in Meat Cookery Research," *Food Research* 5 (1940): 385.

⁵⁹ Sophie Marcuse, "An Application of the Control Chart Method to the Testing and Marketing of Foods," *Journal of the American Statistical Association* 40.230 (June 1945): 214-222.

THE PSYCHOPHYSICS OF QUALITY CONTROL: TASTE PANELS IN INDUSTRY

Laboratory taste panels were not only used in basic research at agricultural research stations, but also in industry, where they were applied to both quality control and product development. In the late 1930s, management at Joseph E. Seagram & Sons Distillers, in Louisville, Kentucky, became disenchanted with the results they obtained from professional tasters. Seagram, one of the largest producers of alcoholic beverages, needed a system for ensuring that the sensory qualities of their blended whiskies remained consistent from batch to batch – a tremendously complicated sensory and chemical question – as well as methods for developing improved blends.⁶⁰

In the late 1930s, Seagram management put Edward H. Scofield, a psychologist whose doctoral work investigated the classic psychophysical phenomena of taste thresholds, in charge of the research department at their Louisville plant.⁶¹ Under Scofield's leadership, the "poorly defined methods employed by the traditional taste artists" were dumped, and their "sniff, sip, snort, and spit technique[s]" replaced by a psychological program that put the measurement of quality on a sound scientific basis.⁶² His program combined rigorous experimental control with the use of trained and disciplined subjects in order to measure sensory qualities and correlate them with preferences, producing "data possessing the properties of discriminability and

⁶⁰ David R. Peryam, "Sensory Evaluation: The Early Days," *Food Technology* (January 1990): 86-9.

⁶¹ Peryam 1990: 87.

⁶² H.F. Willkie and E.H. Scofield, "Some Factors Influencing Determination of Relative Preferential Values of Distilled Alcoholic Beverages," *Institute of Food Technologists, 1941 Proceedings*, (Champaign, IL: Garrard Press, 1941): 204, 208.

reproducibility.”⁶³ The primary psychophysical method he used was that of paired comparison: depending on the experimental situation, tasters were asked to identify which of two samples they preferred, or, in difference tests for quality control, to indicate whether they perceived a difference. In order to secure the validity of these results, Scofield made sure that all variables that appeared to have an effect on taste judgments — the temperature of the sample, its alcohol content, and color — were made consistent across samples, and that tasters consumed identical quantities of each sample for each evaluation. He designed laboratory equipment that allowed for the automatic control of many of these variables, thus rendering the testing system both more reliable and more efficient.⁶⁴ In order to ensure that tasters produced judgements that accurately reflected perceptual experience, unclouded by subjective biases, they were allowed only twenty seconds of judgment time per pair. “The employment of a long-time interval merely allows the observer to confuse himself,” Scofield wrote. “This results in sheer guesswork and later self-contradiction.”⁶⁵ For this same reason, tasters were not encouraged to identify the type of beverages which they had expressed a preference for during testing, in order to avoid “the development of fixed ideas which almost invariably accompany identification.”⁶⁶

Scofield also used techniques from experimental psychology to define and measure quality factors that had previously been tacit. For instance, “lightness” and “heaviness” were often used to describe alcoholic beverages, and clearly influenced

⁶³ Willkie and Scofield 1941: 208.

⁶⁴ Willkie and Scofield 1941: 206.

⁶⁵ Willkie and Scofield 1941: 204.

⁶⁶ Willkie and Scofield 1941: 204.

quality judgments, but there was little agreement as to what exactly these terms referred to. Yet, Scofield reasoned, “if such properties actually exist they must be measurable.” After much research, it was determined that heaviness and lightness were descriptors of flavor intensity. But how could flavor intensity be measured? Scofield employed a classic psychophysical procedure, the method of limits. Tasters were presented with a series of whiskey-water mixtures, in which the concentration of whiskey increased by discrete increments, and were asked to indicate the sample where the flavor of whiskey was just perceptible. This threshold concentration was defined as the lightness value of the whiskey. Once lightness was made measurable, it could then be correlated with preference using paired sample comparisons.⁶⁷

In Scofield’s difference tests and preference tests, tasters reported on only one factor, such as odor, taste, or color. The integrity of this monofactorial analysis was vouchsafed by a rigorous control over the conditions of tasting, attending to the ambient environment and physiological limits of the body, as well as the standardized conditions of the sample. When a quality, such as ‘lightness,’ seemed perilously vague and ill-defined, it was made exact and measurable. Rather than relying on the sensory skill and committed effort of tasters to report reliably on sensory experience, Scofield developed strategies and deployed technologies to engineer maximal control into the experimental design of his tasting protocols.

⁶⁷ Willkie and Scofield 1941: 207.

THE STATE OF THE LABORATORY TASTE PANEL JUST BEFORE THE WAR

By the early 1940s, small panels of selected and trained tasters were used in diverse institutional settings: industry research and development laboratories and quality control facilities, agricultural experiment stations – especially in home economics research into the effects of cooking and preparation methods – and in psychological and psychometric laboratories studying human sensory physiology. Across these settings, three features had come to define the laboratory taste panel as a standard, reliable instrument. First, panel members were selected based on assessments of sensory acuity using standard samples and procedures. Second panel members were trained in general techniques of sensory evaluation, which reflected an expectation that the panel was not an ephemeral entity, but would serve in an ongoing and recurrent role.

Finally, researchers used experimental testing methods that restricted taste panel considerations to one sensory factor, and constrained output to schematized and statistically analyzable forms. Whereas expert tasters judged quality by assessing multiple sensory factors (for instance, evaluating aroma, tenderness, and color in meat), laboratory taste panels were expected to register differences or degrees of intensity along only one sensory dimension. Early users of taste panel methods, such as Frances King and Sylvia Cover, attempted to achieve this by instructing their judges and tailoring response forms to minimize ambiguity. Scofield, at Seagram, sought to produce monofactoral sensory data via experimental design. He placed his tasters within highly controlled experimental systems engineered to ensure that the human senses attended to only one factor at a time.

The Quality Control program at Seagram would serve as the direct model for the protocols at the Quartermaster Food Acceptance Research Laboratory. As will be seen, the evolution of sensory evaluation methods at the Quartermaster involved increasing the control over both tasters and the experimental spaces where their sensory labor occurred.

II. THE IMPORTANCE OF TASTY RATIONS: FOOD ACCEPTANCE RESEARCH IN THE US ARMY

When is a chocolate bar not a chocolate bar? When it is Field Ration D, the emergency ration developed in the late 1930s by the Hershey Chocolate company for the US Army Quartermaster's Subsistence Research Laboratory (SRL). Intensively engineered by Hershey's chief chemist to meet the anticipated needs of a mobile army deployed in combat zones around the globe, Field Ration D was no ordinary chocolate bar. Super durable, it would not melt at temperatures below an infernal 120F. At six hundred calories per four-ounce bar, it provided a dense caloric payload in a pocket-size package. A triad of these, in poison-gas-proof wrappers, was the standard issue for a day's field rations. More than a quarter-billion bars were shipped and stockpiled overseas between the attack on Pearl Harbor and D-Day.⁶⁸

There was another important way in which Field Ration D was unlike ordinary chocolate bars: Field Ration D was not designed to taste good — “just a little better than a boiled potato,” was how Colonel Paul Logan, head of the SRL, (allegedly) put it. He

⁶⁸ Anastasia Marx de Salcedo, *Combat-Ready Kitchen: How the U.S. Military Shapes the Way You Eat*, (New York: Current, 2015): 86-7; Kawash 2013: 222-3.

even suggested adding kerosene powder to “throw the product off flavor.”⁶⁹ Col. Logan worried that making the emergency ration too tasty would impair its functionality, as soldiers would glut themselves on chocolate rather than sticking to a regimented feeding schedule. This was not perversity on Col. Logan’s part, but reflected the priorities of the military at the time: nutritive value, stability, and utility outranked acceptability in the design and development of field and emergency rations.⁷⁰

As heaps of abandoned and discarded military rations accumulated in war zones, the problem of acceptability rose to the fore. The uneaten rations were not only a waste of money and material; the situation had real consequences for military preparedness. Improperly fed soldiers were underperforming soldiers. Morale, an attitudinal factor that psychologists associated with victory on both the homefront and the front lines, was also strongly correlated with ration satisfaction.

The Quartermaster’s Food Acceptance Research Branch, founded in 1944 as a division of the SRL, signaled the recognition of the functional importance of good flavor to military readiness, national advancement, and even human survival. The methods, purposes, and scope of “food acceptance” research encompassed physicochemical research on food and flavor, taste panel determinations of the sensory qualities of foods, and the study of human behavioral responses to those qualities. But the goal of this work was not simply to identify the conditions and qualities that divided what would be eaten

⁶⁹ Alissa Hamilton, “World War II’s Mobilization of the Science of Food Acceptability: How Ration Palatability Became a Military Research Priority,” *Ecology of Food and Nutrition* 42 (2003): 327.

⁷⁰ Hamilton 2003: 330.

from what would not. As one of the division's scientists explained in 1957, the ultimate criterion of food acceptability was not consumption alone, but “‘consumption with pleasure’ — we might say, ‘the nutrition of body and soul.’”⁷¹ In other words, the goal of food acceptance research was not to determine the lowest threshold of palatability, but to discover the factors that influenced desire, renewed appetite, and increased satisfaction.

Trained taste panels played a central role in the Food Acceptance Branch's research protocols. However, the war reoriented sensory research toward the evaluation of new kinds of food products. Pre-war taste panel research on the sensory qualities of foods had typically focused on familiar fare — bread, meat, milk, canned vegetables, and fruits — items which, though they may be somewhat changed by processing, had a pre-established record of acceptability. Wartime conditions altered the objects and objectives of flavor research. “For the first time in history,” observed W. Franklin Dove, the first chief of the Food Acceptance Research Branch, about the diet of soldiers during the war, “large groups of men lived for long periods of time solely on commercially produced and processed foods.”⁷² The food substances that concerned the military were often anything but familiar, and sometimes unprecedented: dehydrated milk, eggs, and potatoes, hydrogenated fats, soy oils, vitamin-enriched flours. The question was not how to meet

⁷¹ Francis J. Pilgrim, “The Components of Food Acceptance and Their Measurement,” *American Journal of Clinical Nutrition* 5.2 (1957): 171.

⁷² W. Franklin Dove, “Developing Food Acceptance Research,” *Science* 103.2668 (Feb 15, 1946): 188.

some given (if arbitrary) standard of quality, but to shape these new substances into appetizing forms.⁷³

As a center of coordinated research, the Quartermaster division was critical in articulating the basic research modalities that would be mobilized to study the problem of flavor in food. The Food Acceptance Research Branch included statisticians, physiologists and psychologists studying sensory thresholds and attitudes, researchers studying physical and chemical components of food quality, and home economists and food technologists working on experimental cooking techniques.⁷⁴ In particular, food research at the Quartermaster connected organoleptic testing methodologies to ongoing anthropological studies of regional and national food habits, as well as to psychophysiological studies that delved into the mechanisms of appetite, thirst, hunger, and satiety.⁷⁵

One discipline would come to predominate at the Quartermaster Food Acceptance Research Branch: psychology. This would profoundly affect the shape of the emerging field of sensory science. Although prewar home economists, chemists, and food technologists who used taste panels may have tested their tasters' sensory acuity, their focus was the accurate measurement of sensory qualities in foods, not the determination

⁷³ Backer argues that the work of the SRL and Food Acceptance Branch was shaped by (and produced) a normative ideology of "American food," reconstituting novel substances into forms that reflected "standard" American habits. Backer 2014: 51-87.

⁷⁴ Dove "Developing Food Acceptance Research" 1946: 189.

⁷⁵ George Gelman and Charles S. Lawrence, "Foreword," in Quartermaster Food and Container Institute for the Armed Forces, *Committee on Food Research Conference on Food Acceptance Research*, Quartermaster Corps Manual QMC 17-9 (Washington, D.C.: War Department, Office of the Quartermaster General, 1946): 5-6.

of psychic states or attitudes in tasters. The Food Acceptance Research Branch sought to link the measurement of sensory qualities of food with both physicochemical components and behavioral and affective outcomes; the taster was the subject as much, if not more, than the thing tasted. “The observer is the key, and not the product,” explained one prominent researcher, speaking at a 1953 Quartermaster-sponsored symposium on food acceptance testing methods. “To state this another way, when evaluating a food product, it is human behavior and not succotash, bologna, or dehydrated milk that is being investigated.”⁷⁶ Psychology would be the primary disciplinary orientation of those involved in this new field of study, especially psychometric and psychophysical approaches to sensation, perception, and preference.

The Quartermaster’s Food Acceptance Research Branch should also be understood as part of a broader national program of food research that ultimately sought to reshape food habits in order to most effectively utilize available resources to fill known human needs. Food acceptance research drew from and complemented other wartime research on food habits and nutrition also supported by the National Academy of Sciences’ National Research Council: the Food and Nutrition Board, which coordinated biochemical and physiological research on nutritional needs, and the Committee on Food Habits (CFH).⁷⁷ Led by anthropologist Margaret Mead, the CFH studied food

⁷⁶ Dean Foster, “Purpose and Scope of the Conference,” in David R. Peryam, Francis J. Pilgrim, and Martin S. Peterson, eds. *Food Acceptance Testing Methodology: A Symposium Sponsored by the Quartermaster Food and Container Institute for the Armed Forces*, Palmer House, Chicago, October 8-9, 1953, (Washington: National Academy of Sciences, National Research Council, October 1954): 3.

⁷⁷ George Gelman and Charles S. Lawrence, "Foreword," in Quartermaster Food and Container Institute for the Armed Forces 1946: 5-6.

consumption patterns and attitudes toward food from the perspective of cultural anthropology. Its goal was not merely descriptive, but advisory: to guide the development of government food policy, and, in particular, “mobiliz[e] anthropological and psychological insights as they bear upon the whole problem of changing food habits in order to raise the nutritional status of the people of the United States and ultimately of other people of the world.”⁷⁸ As Amy Bentley has observed, this was a form of “democratic social engineering,” that aimed to change behavior by “voluntary” rather than compulsory means.⁷⁹ While the CFH pursued this by developing a deep understanding of the ideologies and cultural structures that guided Americans’ eating habits, the Quartermaster’s Food Acceptance Research Branch’s program instead zeroed in on the consuming body, its sensations, drives, affects, and behaviors.

THE SOCIAL ARCHITECTURE OF TASTE PANEL RESEARCH AT THE QUARTERMASTER FOOD ACCEPTANCE RESEARCH BRANCH

Taste panels were used throughout the Food Acceptance Research Branch laboratories, both as an instrument of research and a subject of study. Army scientists attempted to refine methodologies and procedures in order to be able to quickly evaluate products, determine food preferences, and assist in product development and improvement. The first chief of the new branch, Dr. W. Franklin Dove, a biologist from the University of Maine, had a background in studying human and animal food

⁷⁸ Quoted in Amy Bentley, *Eating for Victory: Food Rationing and the Politics of Domesticity*, (Urbana: University of Illinois Press, 1998): 25. See also: Brian Wansink, “Changing Eating Habits on the Home Front: Lost Lessons from World War II Research,” *Journal of Public Policy and Marketing* 21.1 (Spring 2002): 90-99.

⁷⁹ Bentley 1998: 27.

preferences using psychophysical techniques.⁸⁰ Dove, who headed the Branch between 1945 and 1949, was instrumental in establishing the small trained panel as the premier functional unit for determining the acceptability of a food.

Dove naturalized the small, trained panel's origins, inscribing both the authority and necessity of the tasting panel within a narrative about humanity's historical relationship to food production. Prior to the industrialization of agriculture, he wrote, "the family taste panel passed judgment upon many characteristics conceded important in today's scientific panels," providing a set of judgments about the flavor of different crop varieties, cooking methods, storage practices, and keeping qualities, that "came... to shape the pattern of agriculture in every region."⁸¹ The rise of commercial agriculture and the industrialization of food production not only severed the direct connection between grower and consumer, but also substituted new values for old when it came to making decisions about production. For instance, family seed-stock was replaced by varieties developed for disease resistance and high yield; home-canned and preserved foods were replaced by standardized commercial products. This system had conferred numerous benefits, including the efficient, centralized production of more, and more nutritious foods. But, he said, "we have left out the relationship — we have left out the *connecting link* between the living subject (the consumer) and the stuff of life (food) he lives on: *that*

⁸⁰ Dove is perhaps best known today for his experiments surgically manipulating the horn buds on the brows of immature bulls so that they would grow up to be one-horned creatures, artificial unicorns. See Dr. W. Franklin Dove, "Artificial Production of the Fabulous Unicorn: A Modern Interpretation of an Ancient Myth," Scientific Monthly 42.5 (May 1936): 431-6.

⁸¹ W. Franklin Dove, "Developing Food Acceptance Research," Science (February 15, 1946): 188.

*link is acceptability.*⁸² In this new industrial food system, there was no clear route by which “unorganized” consumer knowledge about food preferences could exert influence on food production. “Now is the time,” Dove urged, “for the *essence* of the family taste panel, now lost, to be returned — not as it was, but in a modern scientific form.”⁸³ With the obsolescence of the family taste panel, the scientific taste panel had to take its place — playing the same role the family taste panel once did, but rather than operating from below, at the level of the disaggregated household, it now operated from above, inserting experimentally produced knowledge about taste, flavor, and acceptability into technoscientific planning and decision-making processes concerning agriculture, food manufacturing, storage, and consumption.

What did it mean to bring a “modern scientific form” to the taste panel? Dove formally outlined the elements of what he called the “Subjective-Objective Approach” to measuring food acceptability, stabilizing and elaborating many of the previously mentioned psychophysical techniques of taste-panel selection and methodology into a set of standard principles and practices.⁸⁴ The central psychophysical technique used by Dove was the method of paired comparisons, where tasters were given two samples and asked either whether there was a detectable difference between them, or whether one was preferable to the other. Studies of difference were only in support of studies of preference, the ultimate goal of research.

⁸² Dove 1946: 188-9. Emphasis in original.

⁸³ Dove 1946: 189. Emphasis in original.

⁸⁴ W. Franklin Dove, “Food Acceptability: Its Determination and Evaluation,” *Food Technology* 1.1 (January 1947): 39-50.

Dove created a dedicated facility for taste panel evaluations at the Food Acceptance Research Branch in Chicago, based, in part, on observations of the panel room at Seagram.⁸⁵ However, design of the Food Acceptance Research laboratory in Chicago set a new standard for these spaces, providing a pattern for other research facilities, and shaping the atmospheric, architectural, and social conditions under which the sensory labor of trained tasters would take place.

The architecture of the sensory evaluation facility was designed to permit maximum experimental control over testing conditions and subjects, as well as the efficient, routinized management of panel activities. The room included five isolation booths, each with a wall hatch that opened into the adjoining sample prep room, so that researchers could deliver the samples with a minimum of human contact, as well as its own food-disposal unit and water fountain for mouth-rinsing between sample pairs.⁸⁶ Walls, table tops, and other features of the space were colored a "natural gray, which does not add color to the foods."⁸⁷ The isolation booths excluded social sources of bias as well as possible sources of distraction, allowing the taster to devote her or his undivided attention to the task of sensory discrimination. In their rigorously controlled austerity, the booths also provided the warrant for experimental replicability in other laboratories, with equivalently equipped spaces. The panel testing facility was "entirely air-conditioned,"

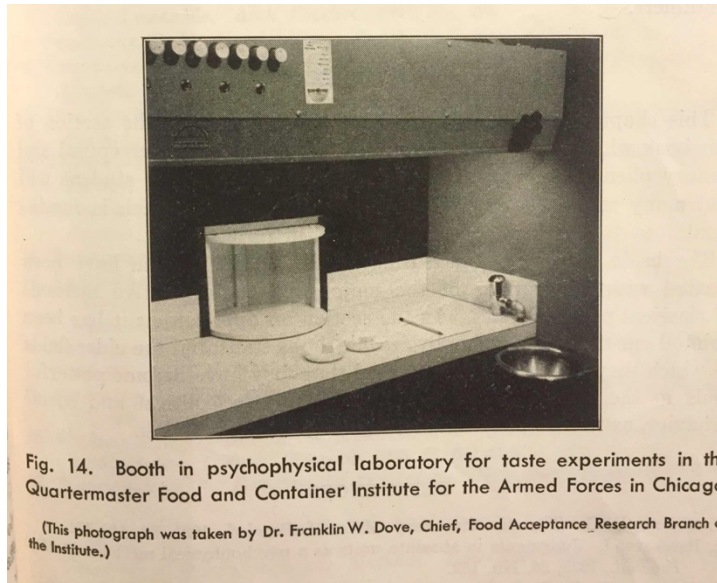
⁸⁵ Meiselman and Schutz 2003: 200.

⁸⁶ Five booths are prescribed as maximally efficient, as two series of tests will provide "the ten records required of a carefully selected group of judges," and one operator can effectively attend to five subjects at a time. Dove warns against a single booth, which would make it impossible to test a food such as soup, which must be offered at the same temperature to all tasters. Dove 1947: 45.

⁸⁷ Dove 1947: 45.

and had its own ventilation system to eliminate any atmospheric contaminants. The room also gave experimenters some operational flexibility. Dove's innovation was to install a system of spotlights in each of the individual tasting booths at his lab, with "three degrees of natural light and two degrees of colored lights (red to blue), plus control of intensity." This allowed the experimenter to control and alter the apparent color of foods, augmenting or eliminating differences, thus segregating judgments based on color from those based on other aspects of flavor.⁸⁸

Tasting booth at the Quartermaster Food Acceptance Research Branch. Note the hatch in the wall for the impersonal conveyance of samples from experimenter to tasting subject,



the pencil atop the standard evaluation form, and the faucet and bowl for rinsing the mouth between tasks. Image source: L.L. Thurstone, "Psychophysical Methods," in T.G. Andrews, ed., *Methods in Psychology*, (New York: John Wiley & Sons, 1948): 155.

⁸⁸ Dove 1947: 45. In a footnote, Dove credits the Cleveland General Electric Company with assistance in developing this lighting scheme, which was based in part on his experiments using red lighting to prevent cannibalism among experimental animals.

The sensory evaluation laboratories were designed to extract reliable sensory information from tasters, and certify its scientific validity, by a system of external controls and disciplining procedures. The artificial conditions of the room – its silence, neutral palette, piped-in and odorless atmosphere – created a scenario where the taster seated in the booth was stripped (as much as possible) of the distorting scrim of social relations that came between the basic perceptual response to a food and her or his awareness of that response.⁸⁹ The architecture of the room aspired to form the taster into a sensing machine, not a human eating but a taster tasting (then spitting and rinsing), neutrally registering binaries of difference or preference between samples that were designed to vary along only a single vector of sensation.

The epistemology of food acceptability at the Quartermaster Food Acceptance Research Branch was also indicated by the sensory laboratory's location within a networked complex of other laboratories, research spaces, and technical facilities. Acceptability research, Dove emphasized, "is a cooperative venture whereby technologists, commodity specialists, and packaging specialists join in the discussion of the purpose, plans, and conduct of the experiment."⁹⁰ For instance, the sensory labs had a close working relationship with the nearby physical-chemical laboratory, where the same foods whose qualities were being studied in the sensory laboratory were analyzed

⁸⁹ For a critical discussion of the consequences of this artificiality on the validity of food and flavor research, from the perspective of food science but informed by anthropology, see Jacob Lahne, "Sensory Science, the Food Industry, and the Objectification of Taste," *Anthropology of Food* 10 (2006). See also: David Howes, "The Science of Sensory Evaluation: An Ethnographic Critique," in Adam Drazer and Susan Kuchler, eds., *Social Life of Materials: Studies in Materials and Society*, (London: Bloomsbury, 2015).

⁹⁰ Dove 1947: 45-6.

chemically, and where researchers could obtain the standard chemical solutions used to test tasters' sensory thresholds. The work of the sensory labs was also linked to that of research groups studying vitamin and mineral content of foods, bacteriological conditions, and packaging materials and design.⁹¹

The constant circulation of information, discussion, and results between the “subjective” sensory laboratories and the spaces where “objective” physicochemical and biochemical research took place were supposed to create cycles of rectification by which the results of both subjective and objective forms of research would be brought closer to true and useful knowledge. “Alternate movement is essential to progression,” Dove instructed, unleashing his inner Hegelian. “So too in science, the alternate emphasis upon the subjective and then the objective will in the end fuse into one process whereby all unessential objective tests and all incoherent subjective responses will be exfoliated and fall into discredit and disuse.”⁹² The “Subjective-Objective Approach” elaborated by Dove claimed to produce more reliable and relevant information about both subjective, sensory effects and their objective, material causes by treating the two forms of knowledge as fundamentally interdependent. Although Dove helmed the Quartermaster Food Acceptance Research Branch for only four years, his leadership helped to establish the study of the sensory qualities of food as a legitimate scientific field, and to position the chosen, trained taste panel operating within specially designed, rigidly controlled conditions as the standard instrument for that work.

⁹¹ Dove 1947: 45-6.

⁹² Dove 1947: 44.

MEASURING PLEASURE: THE HEDONIC SCALE

Dove's system of difference-preference testing measured acceptability and preference only indirectly, in relation to a system of comparative relationships. His expectation was that, as test series were repeated, results could then be compiled into "Tables of Experience," from which basic attitudes toward foods could be deduced.⁹³ But could investigators experimentally measure preferences directly? Attempts to accomplish this resulted in the Quartermaster Food Acceptance Research Branch's other major contribution to sensory evaluation: the hedonic scale.⁹⁴

The hedonic scale was developed under the leadership of David Peryam, who was brought on to head the Food Acceptance Research Branch in 1949 after Dove left the military and returned to the academy. Peryam, a psychologist, remained at the Quartermaster until 1957, when he left to found Peryam & Kroll, an influential consumer testing and market research firm. Peryam had been in charge of quality control at Seagram, where he had worked closely with Scofield in developing a psychological program for flavor evaluation and management.⁹⁵ His tenure at the Quartermaster not only helped build "the largest collection in the world of researchers working on both

⁹³ Dove 1947: 48.

⁹⁴ David R. Peryam and Francis J. Pilgrim, "Hedonic Scale Method of Measuring Food Preferences," in "The Methodology of Sensory Testing: Contributions to the Institute of Food Technologists Symposium in Pittsburgh, Sponsored by the Committee on Taste Testing and Consumer Acceptance for the 17th Annual Meeting of the IFT," *Food Technology* 11 (September 1957): 9-14.

⁹⁵ Meiselman and Schutz 2003: 200.

theoretical and applied areas in food acceptance, appetite, and hunger,” but definitively established the centrality of psychology to the field of food acceptance research.⁹⁶

Peryam and his colleague Frank Pilgrim, a psychologist and chemist whom he hired to head the psychophysiological division, insisted that the hedonic rating scale was not an entirely new tool, but a special application of a psychometric technique that had been in wide use since the nineteenth century.⁹⁷ (The psychometric and psychological testing of soldiers was particularly well-established in the Army, where it had been used since the First World War to test intelligence, personality, and other capabilities.⁹⁸) The Quartermaster’s earliest study using a hedonic scale preceded Peryam’s arrival at the Quartermaster; in 1947, a seven-point scale was used as part of a field survey of soldiers to determine preference for different menu items. The scale was shelved until 1949, when researchers returned to it in search of a method of evaluating preference under the more controlled conditions of the laboratory.⁹⁹

The hedonic scale presented liking as a continuum, a vertical gradient whose nine intervals ranged (in the final, validated scale) from “dislike extremely” to “like extremely”; its midpoint was indifference (“neither like nor dislike”). Tasters were asked to “show your reaction” to a food by checking the point on the scale that “best describes your feeling about the food.” The rating scale, and the language used to designate its

⁹⁶ Meiselman and Schutz 2003: 200.

⁹⁷ Peryam and Pilgrim 1957: 9.

⁹⁸ Daniel Kevles, “Testing the Army’s Intelligence: Psychologists and the Military in World War I,” *Journal of American History* 55.3 (1968): 565-581; Michael Sokal, ed. *Psychological Testing and American Society, 1890-1930*, (Rutgers UP, 1987).

⁹⁹ Peryam and Pilgrim 1957: 9.

intervals, was further refined in collaboration with L.L. Thurstone's psychometric laboratory at the University of Chicago. The goal was to develop a scale where "no one would question that the successive intervals are in the proper ordinal position, and where all subjects understand and use the intervals in about the same way," — ie, one that minimized any ambiguities around lexical meanings, and that smoothly conformed to subjects' own understandings of the degrees of affective response.¹⁰⁰

More important, possibly, than the scale, were the printed instructions given to the tasters prior to the evaluation session. The tasters who participated in hedonic scale testing were not tested, selected, and trained judges, as in taste panel evaluations, but larger groups, generally totaling around forty individuals. The standard instructions cast the taster as a self-defining, autonomous, authoritative subject, who was providing a valuable service to the experimenters:

"You will be given several servings of food to eat and you are asked to say about each how much you like or dislike it. Use the scales to indicate your attitude by checking at the point which best describes your feeling about the food. Keep in mind that you are the judge. You are the only one who can tell what you like. Nobody knows whether this food should be considered good, bad or indifferent. An honest expression of your personal feeling will help us to decide. Take a drink of water after you finish each sample and then wait for the next."¹⁰¹

¹⁰⁰ Lyle V. Jones, David R. Peryam, and L.L. Thurstone, "Development of a Scale for Measuring Soldiers' Food Preferences," *Food Research* 20 (1955): 512-20.

¹⁰¹ Peryam and Pilgrim 1957: 10.

What investigators were aiming to capture was a sort of stimulus-response to food that preceded judgment: “the emotional aspects of mental life as opposed to the intellectual.”¹⁰² Ideally, the scale would yield the basic cognitive units of “like” or “dislike.” The instructions were intended to “encourage [the taster] to report his immediate naive response without any conscious effort to remember or to judge.”¹⁰³ This was a restatement of the method of introspection used by experimental psychology at the turn of the twentieth century. However, rather than obtaining objective accounts of the structures of consciousness from subjects rigorously trained to be good phenomenologists, Food Acceptance Branch researchers relied on a combination of experimental design and positive disciplinary procedures to extract reliable data. Underlying the design and deployment of the hedonic scale was “the theory that it is the uncomplicated response which determines pleasure in eating and governs the formation of attitudes and future preference choices.”¹⁰⁴ As was the case with the design of the sensory-evaluation facilities, the assumption here was that there was a fundamental human response to food quality that operated outside the realm of social relations. The hedonic scale went further, explicitly locating this response prior to conscious reflection. The affective responses to food that it sought to record and quantify were akin to instincts

¹⁰² Peryam and Pilgrim 1957: 9.

¹⁰³ David R. Peryam and Norman F. Girardot, “QM Pins Food ‘Likes’ and ‘Dislikes’ with Advanced Taste-Test Method,” *Food Engineering* 24.7 (July 1952): 59.

¹⁰⁴ Maynard Amerine, Rose Marie Pangborn, and Edward Roessler, *Principles of Sensory Evaluation of Food*, (New York: Academic Press, 1965): 372.

or reflexes; they were completely unlike the fully considered, educated tastes of the connoisseur.¹⁰⁵

Peryam and Pilgrim cautioned that the hedonic scale was not a measure of acceptance, but of preference — which was, however, strongly correlated with, and could be used to predict, acceptance.¹⁰⁶ In other words, the hedonic scale should not be used as a tool to measure of one individual's pleasurable responses, but as a device to study “human behavior potential” in aggregate, a future-oriented forecasting tool designed for the problems of mass feeding.¹⁰⁷

III. FOOD ACCEPTABILITY AND THE POSTWAR MILITARY-FOOD-INDUSTRIAL COMPLEX

The problem of food acceptability, observed Quartermaster Captain R.O. Raub in 1946, would become increasingly important in a "peacetime Army... because the average soldier will have increasing opportunities to decide which foods he will consume and which ones he will refuse."¹⁰⁸ As the distinction between “soldier” and “consumer” eroded within the military, the civilian food system also came to show the stamp of the

¹⁰⁵ I suspect that this has deeper connections to contemporary trends and ideologies in psychology, but following those leads is outside of the scope of this dissertation, and will be pursued in future research.

¹⁰⁶ Peryam and Pilgrim 1957: 14.

¹⁰⁷ Peryam and Pilgrim 1957: 12.

¹⁰⁸ Captain R.O. Raub, "Food Acceptability Tests in the Army," in Quartermaster Food and Container Institute for the Armed Forces 1946: 12.

army's research.¹⁰⁹ Food technologies such as freezing and dehydration, and chemical additives such as MSG, that had been key to the production of wartime rations, found continued use in processed foods after the war.¹¹⁰ Meanwhile, the processes by which a new ration component was developed in the Quartermaster and a new frozen TV dinner was developed in a private food company came to resemble each other more and more. The postwar food industry readily adopted the sensory evaluation procedures and practices formalized at the Quartermaster. By the early 1950s, laboratory taste-panels, and the psychophysical and psychometric methods that had been refined in the army's Food Acceptance Research branch, had become standard tools used in the development of new consumer products, quality control procedures, as well as in basic research conducted in non-industry laboratories at the USDA and university food science and technology programs.¹¹¹

One reason for the rapid acceptance of sensory evaluation methods was the circulation of scientists among Army labs, industry positions, and academic appointments. The researchers who passed through the Quartermaster Food Acceptance

¹⁰⁹ Marx de Salcedo's recent book provides a detailed account of the connections between military and industry, and links various consumer products (energy bars, lunchables) directly to army food research. Marx de Salcedo 2015.

¹¹⁰ Backer documents the intimate relationships between the food industry and the military in his dissertation.

¹¹¹ Dove noted that the taste panel could also be a source of valuable information for food marketers and advertisers. In addition to a record of differences and preferences, taste panel research also produced "a record of words that express... differences" -- the language that judges themselves used to describe the distinctions they sensed. These records could "supply the advertising bureaus with substantial gustatory appeal to supplement the more apparent eye appeal" of foods. Army research thus had implications not only to for how food was made to taste, but also how food was sold to American consumers. Dove 1947: 50.

Research Branch between 1948 and 1957 went on to careers in both industry and academy, disseminating the Branch's methodology and philosophy, and helping it become standard in the field.¹¹² Quartermaster funds also supported external research at physiological and psychological laboratories studying taste and smell at Florida State, the University of Chicago, and the University of North Carolina, among other sites.¹¹³ Further, sensory evaluation practices were publicized in conference proceedings and scientific publications, including a 1947 Quartermaster-published bibliography on the use of taste panels in palatability testing, comprising about 400 titles, and available on request, without charge.¹¹⁴

In the late 1940s and early 1950s, the material and social infrastructure of sensory evaluation was assembled in food and flavor industry research and development facilities, as well as in the growing network of non-industry laboratories. Tasters were recruited, tested, and trained for service on taste panels; dedicated rooms were outfitted with isolation booths, special lighting, and sophisticated climate control systems; researchers and technicians prepared samples, operated the human tasting-instrument to assess sensible qualities, and analyzed the results. Even as best practices and standard methodologies continued to be developed and debated, by the early 1950s, the laboratory

¹¹² Meiselman and Schutz 2003: 204. Quartermaster veterans went on to direct market and field research programs for companies including Coca-Cola, Pillsbury, and Lipton. Schutz went on to UC Davis. David Peryam and Beverly Knoll found their own sensory evaluation consumer research firm.

¹¹³ Meiselman and Schutz 2003: 201.

¹¹⁴ Bureau of Human Nutrition and Home Economics, Agricultural Research Administration, *Sensory Methods for Measuring Differences in Food Quality: Review of Literature and Proceedings of Conference*, Agriculture Information Bulletin No. 34, (Washington, D.C.: U.S. Department of Agriculture, August 1951): 49.

taste panel was widely accepted as a reliable instrument in food and flavor research, and its system of disciplined human tasters was credited with providing objective information about food qualities, detectable differences, and preferences.¹¹⁵ A 1952 article in *Fortune*, reporting on the new scientific techniques that were “taking the guesswork out of flavor,” described the extensive sensory evaluation procedures that had recently been adopted by four of the largest food and beverage companies: Heinz, Nabisco, General Foods, and Seagram, in order to develop products that “meet the public taste and maintain flavor uniformity.”¹¹⁶

The rapid spread of taste-panel testing is notable because sensory evaluation demanded substantial investments: of personnel, time, and square footage. In many cases, available facilities were retrofitted to meet the new requirements of food research. In 1951, Helen Moser, a food technologist at the Northern Regional Research Laboratory in Peoria, described converting an 11x16 foot windowless storage room into a taste panel room equipped with four isolation booths and a separate preparation area. Panel members entered the room from the corridor, and sat down in one of the booths, which triggered a light in the adjoining preparation area. Researchers transferred heated samples of soybean oil to panel members through sliding hatches in the back of each booth, ensuring there

¹¹⁵ For an account of standard practices and ongoing issues in sensory evaluation, see Mildred M. Boggs and Helen L. Hanson, "Analysis of Foods by Sensory Difference Tests," *Advances in Food Research* 2 (New York: Academic Press, 1949): 219-258. Best practices in sensory testing continued to be discussed and debated among professional groups, such as the Institute of Food Technologists and the American Society of Testing and Materials, into the late 1960s.

¹¹⁶ “What has Happened to Flavor?” *Fortune* 45 (April 1952): 130-3, 146-52.

was no contact between the person in the preparation area and the panelist.¹¹⁷ The room was kept at a steady temperature of 78°F and 40 percent humidity.¹¹⁸



FIG. 2. The preparation area of the taste panel room at the Northern Regional Research Laboratory. The attendant is passing samples of oil in a heated aluminum block to the taste panel member on the opposite side of the partition.

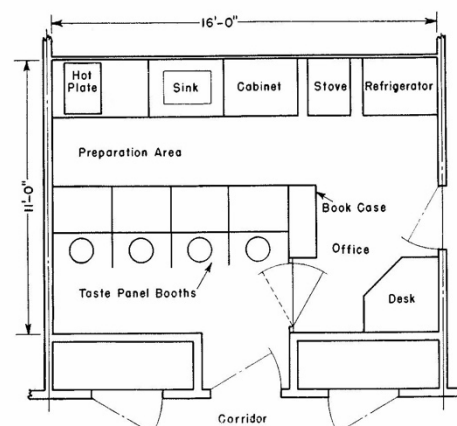


FIG. 1. Floor plan of taste panel room.

Floor plan of taste panel room and preparation and distribution of samples, from Moser et al, "Conducting a Taste Panel for the Evaluation of Edible Oils," *Food Technology* (March 1950), p. 106

At large food companies, laboratory taste panels and sensory evaluation procedures were integrated into research and development and quality control programs, where they were used to study problems such as flavor changes during storage, strictly ensure flavor consistency, and develop new products and lines. The *Fortune* article

¹¹⁷ Helen A. Moser, H.J. Dutton, C.D. Evans, and J.C. Cowan, "Conducting a Taste Panel for the Evaluation of Edible Oils," *Food Technology* 4 (1950): 105-109. Dawson and Harris, "Sensory Methods for Measuring Differences in Food Quality," 87.

¹¹⁸ Bureau of Human Nutrition and Home Economics 1951: 87.

describes panel testing procedures to evaluate the detectability of formula changes at Nabisco, includes a photograph of Jell-O tasters working under red lights in individual booths at General Foods' Central Laboratories in Hoboken, and explains the quality control system at Heinz. "Hourly samples from all of Heinz's twelve factories are shipped daily to the Pittsburgh 'organoleptic' department, run by Marie Pierkowski. She makes sure products do not vary from one factory to another," by using triangle tests and other psychophysical methods to ensure standard qualities.¹¹⁹

At General Mills, sensory testing facilities built at the company's central research laboratories outside of Minneapolis in the early 1950s were used intensively. A 1953 feature in the company's newsletter, *Progress Thru Research*, claimed that the taste panel room was in use nearly eight hours a day as tasters and other experts worked "under controlled conditions to develop tastier food products for your dinner table."¹²⁰ General Mills' taste panel facilities were designed to maximize both experimental control and efficiency. An advanced HVAC system controlled both temperature and humidity; an ozone lamp handled the "big job of destroying odors" that wafted in from the surrounding area or that lingered from previous tastings.¹²¹ Windows were blacked out to exclude changeable natural illumination; a carefully designed lighting system allowed for a range of flexible possibilities, including color filters. There were eight isolation booths, "separated by partitions to eliminate conversation and reduce any other distractions which would interfere with the important business at hand." But "in a manner of minutes

¹¹⁹ "What has Happened to Flavor?": 131.

¹²⁰ Gloria Gershun, "Taste Testers," *Progress Thru Research* 7.4 (Summer 1953): 7.

¹²¹ Gershun 1953: 7.

these private booths can be folded into wall cabinets,” to make room for conference tables and open discussion which were necessary components of flavor profile evaluation (to be discussed in Chapter Five). In addition to the sensory evaluation room itself, the sensory laboratory also included “fully-equipped modern kitchen” and preparation center, which shared space with a working area for record keeping, telephoning, and “other detail operations which keep taste panel work running smoothly.”¹²²

The details of General Mills’ tasting laboratory sheds light on the considerable labor and substantial investment that were required to operate these facilities. For food manufacturers that did not have the resources to install and maintain their own sensory evaluation facilities, contract-consulting laboratories advertised and offered a range of organoleptic-testing services.¹²³ In the late 1940s, established chemical consulting firms and contract laboratories, such as Arthur D. Little, Inc. in Cambridge, Foster D. Snell, Inc. and Wallerstein Laboratories, in New York, and Food Research Laboratories, in New Jersey, began offering sensory evaluation as part of their portfolio. These companies had their own testing rooms, highly trained tasters, and other resources, such as libraries of odor samples and flavor and fragrance materials. Sensory evaluation and testing was increasingly seen as a necessary part of product design and development, not only for foods and beverages, but for an expanding range of consumer products — from cosmetics to rubber tires to refrigerators. The varied criteria of sensory quality, “too elusive to be

¹²² Gershun 1953: 6.

¹²³ L.C. Cartwright and Robert A. Nanz, "Flavors Improved, Sales Boosted Through Organoleptic Tests," *Food Industries* 20. 11 (November 1948): 1608-9; “Human Analyzers,” *Chemical Industries* 67 (November 1950): 721-2; Arthur D. Little Papers [MC579] MIT institute Archives. Box 7, Folder 39. History: Flavor Laboratory [memo].

caught in the analytical control laboratory,” one article on the subject explained, “can make or break a product.” But organoleptic control, provided by sensory panel testing, “can make it,” providing the key to commercial success.¹²⁴

MANAGING THE HUMAN INSTRUMENT

Ultimately, a taste panel is an assemblage of human beings, and this presented unique challenges to the experimenters who had to manage these sometimes reluctant instrumental components. Finding the right people to serve as members of a taste panel took logistical and experimental labor. In designing experiments or planning tasting sessions, researchers had to be mindful of the sensing capacities of human bodies — including how the senses may be affected (or not) by environmental and experimental conditions. Researchers were dealing not only with the tasters' senses, but also their perceptions. Just as they had to accommodate the intractable requirements of bodies, they also had to concern themselves with mental states, such as attitudes and motivations. Finally, the task of managing tasters had different implications depending on the site of research and the relationship between the panel members and the researchers. In an industrial setting where panel members were often factory employees, the utilization of the tasting panel could be more coercive than in USDA research facilities or private research laboratories. All of these considerations required investigators to use various inducements, coercive tactics, and surveillance of performance to obtain usable results.

¹²⁴ “Human Analyzers” 1950: 722.

Researchers also needed to separate the able from the merely willing, eliminating, when possible, individuals with limited discriminatory capacities or sensory deficits. But as an individual's sensory capabilities varied from day to day, this meant that the screening and evaluation process was ongoing. Researchers obtained two kinds of data from taste panel experiments: a record of the perceptible sensory qualities of foods, and a record of the performance of individual tasters. Monitoring the latter was necessary to assure the panel's adequate function; "checking should be frequent, preferably every day."¹²⁵ Tasters were asked to abide by certain behavioral restrictions, such as refraining from smoking or eating for several hours prior to tasting.¹²⁶

Researchers were also conscious of the need to arrange the conditions of the test to prevent compromising each taster's sensory acuity. Tasters could be fatigued by the presentation of too many samples, or at a too-rapid pace; results could also be compromised if stronger-tasting samples were introduced before more subtly flavored items. Investigators in the field had long been aware of physiological research demonstrating that the sensate body had physical limits, and that as the senses became fatigued, they became less responsive to stimuli and less capable of distinguishing differences.¹²⁷ Taste-panel experiments had to be designed to respect these limits, and to provide recuperative accommodations, such as mouth rinses, to preserve discriminatory capacities throughout the duration of the test.

¹²⁵ Bureau of Human Nutrition and Home Economics 1951: 81.

¹²⁶ Trout and Sharp (1937) quote one dairy plant manager, who prohibits not only smoking and heavy meals prior to tasting, but also the consumption of chewing gum, cough drops, "or other strongly flavored materials." Trout and Sharp 1937: 43.

¹²⁷ Trout and Sharp 1937.

The management challenge takes on a new aspect when one considers the conditions of the labor required from taste panel members. At commercial companies and in research laboratories, taste panelists were essentially volunteers, extracted from other professional obligations and responsibilities to perform this function.¹²⁸ As General Mills explained in *Progress Thru Research*, the personnel who served on its taste panels weren't "casual guinea pigs; they're hand-picked observers who are whisked away to a spanking new laboratory equipped with modern conveniences to help them concentrate on the job at hand."¹²⁹ Volunteers might include chemists, bakers, food engineers, packaging experts, and other employees who were involved in distinct research and development work at the company's laboratories. "As an added feature," the company added, "taste panel participants work in a comfortable room which increases their efficiency as objective observers."¹³⁰

How much of a pleasure should the sensory labor of taste testing be?¹³¹

Throughout the literature, the importance of maintaining a "comfortable" panel room is emphasized, but rarely elaborated, beyond the stipulation that the room should be quiet

¹²⁸ This differentiates the situation of these workers with that described by Simon Schaffer, in his comparable account of the management of astronomical observers at Greenwich. As volunteers, taste-panel members retain some power in the labor arrangement. See Schaffer 1988.

¹²⁹ Gershun 1953: 6

¹³⁰ Gershun 1953: 6.

¹³¹ Some projects were certainly less pleasant than others. One Quartermaster Food and Container Institute investigator, attempting to determine the reason why fish was so loathed in army mess halls, observed that the popularity of her research section "fell several degrees when tasters found that they were launched on a long-term fish program." Marion Bollman, "Influence of Food Preparation Methods on Acceptance in the Army," in Quartermaster Food and Container Institute for the Armed Forces: 17.

and "free from distractions."¹³² This did not, however, ensure undistracted panel members. L.C. Cartwright, of Foster D. Snell, Inc., a New York contract laboratory that offered organoleptic evaluation services, observed that calling panel members away from "their usual jobs may result in mental block. Panel members who are usually good may be immersed in a piece of work which is interrupted by the judging and may give judgments out of line on that occasion. They may be careless because they want to get back to the job." His solution was accommodation. "We try to fit panel members into the sessions most convenient for them."¹³³ Although some judges may have found taste panel duties to be a nice change of pace, it is evident that others were more ambivalent about the task.

Mildred Boggs and Helen Hanson, of the USDA Western Regional Research Lab, expressed an increasingly common sentiment when they wrote: "it is generally agreed among those who direct research doing difference tests that the attitude of the judges is of

¹³² The recommendation that the sensing subject be provided with comfortable surroundings may come from laboratory practices in experimental psychology, especially those studying the basic structures of sensation and consciousness. For instance, in his 1898 textbook, *Primer of Psychology*, E.B. Titchener stipulates that the experimental psychologist studying the structures of consciousness through introspection must "be comfortable" in order to obtain access to pure sensations, images, and feelings untainted by personal meaning. "Do not begin to introspect till all the conditions are satisfactory; do not work if you feel nervous or irritated, if the chair is too high or the table too low for you, if you have a cold or a headache. Take the experiment pleasantly." He also advised that investigators "stop working the moment that you feel tired or jaded." Titchener's manual of laboratory practice is cited by several of my sources, despite the claim by Christopher Green that his methods had fallen into disrepute among psychologists by Titchener's death in 1927. Unlike the researchers in my account, however, who attempted to elicit information about the senses of others, Titchener was prescribing this (easeful) disciplinary regimen to the experimenter, who was his own subject. See Christopher D. Green, "Scientific Objectivity and E.B. Titchener's Experimental Psychology," *Isis* 101, no. 4 (December 2010): 697-721.

¹³³ Bureau of Human Nutrition and Home Economics 1951: 70.

great importance to the success of the experiment." Maintaining the proper attitude among panel members, they explained, meant balancing two competing needs: the need to stimulate judges' interest in the experimental project — and sustain it — in order to ensure conscientious performance, and the need to avoid introducing potential sources of bias, "which may result when there is too much knowledge about the problem under investigation."¹³⁴ Panel members must be interested, but not wise; trained, but not knowledgeable. The researchers were to remain the experts in this scenario, not the tasters.¹³⁵

One way to maintain interest was to share experimental results with judges after the experiment was completed. Helen Moser, of the Northern Regional Research Laboratory, remarked that the practice in her lab was to allow each judge to learn the identity of the samples, and to compare his or her tasting results with others, as soon as he or she had left the panel room. "This opportunity for comparing his scores helps to maintain an interest in the judging," she said, adding, "we also bribe the judges with cookies at this period."¹³⁶ Boggs explained, "We find that our tasters like to be right, they like to be consistent and reproducible, so they will take advantage of every solitary bit of information they can garner. We therefore do not give them much information in advance, but keep up their interest by giving them the full results of every experiment

¹³⁴ Boggs and Hanson 1949: 239-40.

¹³⁵ In Daston and Galison's model of "trained judgment" as the 20th-century version of objectivity, the researchers -- not the tasters -- would be the objective observers here, utilizing their own tacit expert knowledge to derive objective results from the subjective mesh of responses provided by the tasters.

¹³⁶ Bureau of Human Nutrition and Home Economics 1951: 87-88.

after it is finished, as well as their own individual performance in the test."¹³⁷Moser's and Bogg's comments show that experimenters deliberately used social and interpersonal dynamics in their relations to their tasting subjects to improve the instrumental performance of the taste panel. Competitive feelings among judges would inspire them to put forth their best effort, and provide a motivation for continual improvement. *We find that our tasters like to be right.* Cookie-bribes could be effective in rewarding and sharpening those instincts.

In research settings, where judges were drawn from staff at a college or from adjoining laboratories, experimenters had to accommodate the scheduling and professional needs of panel members, just as panel members were asked to abide by the abstentions and other practices required by researchers. When taste panels were deployed in industrial settings, the power dynamics could be less egalitarian. David Peryam, who worked at Seagram prior to heading the Quartermaster Food Acceptance Research Branch through the 1950s, described his tactics for managing tasters in a distillery's quality control department:

"Motivation is important. To make the system work, the observer must consider each unknown pair a challenge.... At the end of each test the observer is told the results and a continuous record is kept of each observer's percentage correct. He knows that the penalty for falling significantly below the performance level of the group is banishment from

¹³⁷ Bureau of Human Nutrition and Home Economics 1951: 67.

the attractive laboratory job to the comparative Siberia of the bottling lines."¹³⁸

Rather than fully eliminating the "human equation" from the taste panel, experimenters utilized (or perhaps manipulated) human motives, desires, and drives as a means of eliciting the best results from their laboratory tool.

CONCLUSION: TAKING THE MEASURE OF TASTE

The taste panel, a laboratory instrument for measuring flavor, also made flavor measurable. In other words, the instrument defined the boundaries of the object — the thresholds of human sensory perception — and the conditions under which any discovered difference might be taken as meaningful. It endowed flavor with a complex materiality, registering its multi-sensory, psychological, and social dimensions even as experimenters attempted to control and constrain which factors it measured.

But what kind of instrument was a taste panel? It comprised multiple, heterogeneous parts: human bodies; dedicated and designed spaces with technologies for illuminating, deodorizing, controlling climate, and excluding social influence; utensils for food preparation and consumption; standardized paperwork. Managing a taste panel

¹³⁸ David R. Peryam, "Quality Control in the Production of Blended Whiskey," *Industrial Quality Control* (November 1950): 19. This paper was originally presented at the Baltimore Section meeting of the American Society for Quality Control on November 15, 1948, while Peryam, a former Seagram quality control staff member, was employed at the Calvert Distilling Company in Baltimore. By 1950, when the article was published, Peryam had succeeded Dove as Chief of the Food Acceptance Division at the Quartermaster Food and Container Institute.

demanded the coordinated efforts of various groups of scientists and technicians, as well as the cooperation of the humans that provide the detecting function of the instrument. Experimenters understood the taste panel to be a kind of scientific instrument or tool, which, like any other scientific apparatus, had to be consistently calibrated, and had discernible limits of precision and accuracy.¹³⁹

Further, the taste panel must also be understood as one component of a broader laboratory ensemble. It became increasingly common practice to correlate taste panel output with instrumental readings from a battery of laboratory machines — colorimeters, tenderometers, shortometers, and other instruments that measured texture, viscosity, shear, and other physical properties — as well as a growing number of chemical tests for measuring food qualities and constituents.¹⁴⁰ Although these devices provided useful results, and were sometimes more efficient and simpler to operate than panel tests, many researchers continued to believe that "a physical or chemical method may be superior to an organoleptic method in precision but not in accuracy."¹⁴¹ That is, the human senses were the most reliable guide to detecting qualities in food, which machines or chemical processes might not be able to register or measure. Further, machines and chemical tests could not provide a measure of "over-all quality" — only indices and correlates.¹⁴²

As a laboratory technology, the taste panel operated across several different categorical divides: between human being and instrument, expert and non-expert, the

¹³⁹ Platt 1937: 243.

¹⁴⁰ Bureau of Human Nutrition and Home Economics 1951: 105-6.

¹⁴¹ Bureau of Human Nutrition and Home Economics 1951: 106.

¹⁴² Bureau of Human Nutrition and Home Economics 1951: 106.

sensory and the semiotic, and the laboratory and the field. The taste panel mediated between and joined together disciplines, professions, and institutions concerned with food flavors, the sensory qualities of food that contribute to beliefs about its value. Methods and techniques were shared between different kinds of laboratories — basic research, product development, quality control — at different sorts of institutions — government agricultural experiment stations, military research centers, food factories, commodity research institutes.

Along with the methods and material accoutrements of sensory research, the food industry also adopted its premises and purposes. First among these was the notion that both the sensory qualities of food and the human responses to those qualities were measurable. By accepting the accuracy of the human instrument to register the qualities of foods, they also accepted the idea that human responses, behaviors, and preferences were more than merely personal, and could be understood as universal and objective, at some deep level.

The spread of the laboratory panel and the science of sensory evaluation in the food industry indicated a renegotiation of the division of authority about the qualities of food. The proper personnel to organize and conduct the work of sensory evaluation were not commodity experts, the “expert tasters” of coffee and whiskey and butter and cheese, but scientific and technical workers whose authority derived from psychology and statistics. Further, as flavor chemistry became an increasingly established subfield of chemical research, it would be joined with scientific practices of food acceptance

research and sensory evaluation, allowing for the connection between physicochemical properties of flavor and psychological aspects of behavior.

The science of flavor is never only about the qualities of foods; it also comes to require the study and surveillance of sensing bodies. The conflation, or perhaps confusion, of these two objects of scientific investigation will come to fuel critiques of the food industry's methods and ambitions. As the sciences of sensory evaluation are applied to the purposes of enhancing acceptability, are food companies becoming better at giving consumers the choices that they desire, or are they honing their abilities to manipulate the sensible qualities of foods (and other things) in order to exploit irresistible, subconscious instincts — provoking complex, elemental hungers that only they can satisfy?

CHAPTER 4

FRESH, EASY, NEW: POSTWAR TECHNOLOGIES OF FOOD AND FLAVOR

Leaving their ration cards behind and entering an unprecedented era of prosperity, postwar consumers began to spend more money on food than ever before. In 1941, Americans spent \$20 billion on food. In 1953, “to the stupefaction of just about everyone who thought he understood the food market,” in the words of *Fortune* magazine, food spending topped \$60 billion.¹ Only a fraction of this increase could be explained by population growth and inflation. The larger cause was readily identified: consumers were buying far more processed and packaged “convenience” foods, and paying more for them.²

Why were Americans buying more processed foods, and spending more for them? Historians of the American postwar period typically weave the ascendancy of processed food into the complex tapestry of social, technological, economic, and cultural changes that shaped American life during these decades. Rising incomes and a growing white middle class; suburbanization, with its attendant sociotechnical menagerie of automobile, refrigerator-freezer, television, supermarket; a regressive ethos of female domesticity paired with an outsized faith in the goods of technological progress, and aggressive

¹ “Fabulous Market for Food,” *Fortune*, October 1953, 137-9; quoted in Kellen Backer, *World War II and the Triumph of Industrialized Food*, PhD Diss, University of Wisconsin-Madison, 2012.

² Harvey Levenstein, *Paradox of Plenty: A Social History of Eating in Modern America*, (New York: Oxford UP, 1993): 109.

marketing campaigns for convenience foods that rang both those bells.³ But few, if any, accounts of this period confront, head-on, the contradiction between the growth of the food industry and the reigning, received wisdom about the poor quality of its products.⁴ Weren't the 1950s a gastronomic nadir? Wasn't postwar processed food just plain lousy?

Historians writing about the history of processed foods tend to wax dismal when it comes to the flavor of these products. Laura Shapiro describes postwar processed foods as reflecting “culinary values bred in the factory — blandness and uniformity, interrupted by sudden jolts of novelty,” which nonetheless “became pleasing to many appetites,

³ On the social and cultural history of the postwar, see: Lizabeth Cohen, *A Consumer's Republic: The Politics of Mass Consumption in Postwar America*, (New York: Knopf, 2003); Elaine Tyler May, *Homeward Bound: American Families in the Cold War Era*, (New York: Basic Books, 1988); Karal Ann Marling, *As Seen on TV: The Visual Culture of Everyday Life in the 1950s* (Cambridge: Harvard UP, 1994). Tracy Deutsch has argued that the shift to supermarkets and mass-retailing changed not only the kinds of foods that were widely available, but also produced a new kind of passive, disengaged, depoliticized consumer. See Tracy Deutsch, *Building a Housewife's Paradise: Gender, Politics, and American Grocery Stores in the Twentieth Century* (Chapel Hill: UNC Press, 2010). For scholars who have probed the tensions, contradictions, and complications in middle-class women's social roles in the postwar, the modern kitchen well-stocked with convenience foods has emerged as particularly fraught territory. See: Ruth Schwartz Cowan, *More Work for Mother: The Ironies of Household Technologies from the Open Hearth to the Microwave*; Erika Endrijonas, “Processed Foods from Scratch: Cooking for a Family in the 1950s,” in Sherrie A. Innes, ed. *Kitchen Culture in America: Popular Representations of Food, Gender, and Race*, (Philadelphia: UPenn Press, 2001); Katherine J. Parkin, *Food is Love: Advertising and Gender Roles in Modern America*, (Philadelphia: UPenn Press, 2011).

⁴ One important exception can be found in the work of Rachel Laudan, a historian of technology and of food, whose work scrupulously avoids declensionist narratives about the state of food in the present, both by unseating the myth of an idealized “natural” food past innocent of technoscience, and by making a serious accounting of both the technological systems and the human labor that are necessary for all food production. See Rachel Laudan, “A Plea for Culinary Modernism: Why We Should Love New, Fast, Processed Food,” *Gastronomica* 1.1 (Winter 2001): 36-44.

while subtleties of flavor and texture lost their importance.”⁵ For Shapiro, this was not a case of sudden-onset loss of discernment. She argues that the prior half-century of factory-made food had a debilitating effect on American tastes, literally reshaping consumer appetites and rendering them more complaisant. “During the first decades of the twentieth century, millions of American palates adjusted to artificial flavors and then welcomed them; and consumers started to let the food industry make a great many decisions on matters of taste that people in the past had always made for themselves.” And while Shapiro’s sensitive account of American postwar cooking and eating deftly undermines the notion that consumers readily and passively accepted industrialized foods, she nonetheless concedes that their acts of resistance were not on the grounds of taste. “There wasn’t much the food industry could do to repel a nation that was already stirring chopped tomatoes and pickles into Strawberry Jell-O for a Red Crest Salad.”⁶

This narrative sets the stage for an enlightened rump of Europeanized experts — Julia Child, James Beard — to reeducate the American palate, and to reintroduce real, “authentic” habits of cooking and eating, a mission that would be carried forward by Alice Waters, the Slow Food movement, all the way to the locavore foodies of the present day. Although Shapiro meticulously documents the differences between industry and media representations of convenience foods and how middle-class American women actually cooked and ate, she never examines her premise that processed foods were

⁵ Laura Shapiro, *Something from the Oven: Reinventing Dinner in 1950s America*, (New York: Penguin, 2005): 56-7.

⁶ Shapiro 2005: 57.

inherently *worse* than other food options. In this narrative model, then, mass American tastes, deranged by the food industry, are always in need of a redeemer.

Other historians have explained the lousiness of postwar processed food by concluding that flavor was of little concern to the postwar food industry. Mark Schatzker, describing the A&P's Chicken of Tomorrow contest, which sought to breed bigger, more efficient broiler chickens, asks: "How did these miracle chickens taste? No one knows. The judges didn't measure flavor. The point of the contest... was to create a chicken that looked like a wax model."⁷ Taking a similar tack, Harvey Levenstein laments that "the so-called advances" in food processing after the war "were in economics of production, not in taste. It was widely acknowledged that in practically all spheres taste had been a casualty of processing." When big business did acknowledge consumer preferences, it was to disdain them; "food industry moguls had a generally low opinion of consumers' taste buds," he states.⁸ Further, there was little that was actually new in the "new and improved" foods of the postwar; indeed, he argues, the food processing industries "consistently ranked near the bottom in the proportion of sales invested in research and

⁷ Schatzker, *Dorito Effect*, Chapter 2. Schatzker's insistence that the food industry doesn't care about "flavor" rests on a rigid nutritional and moral distinction between "real" and "fake." The substance of his argument is that the processes of industrialization depleted the authentic flavor of "real" foods (meat, vegetables, fruits), while adding synthetic, substitute flavor to processed foods; in this way, he says, the food industry uses our innate, evolutionary attraction to flavor against us.

⁸ Levenstein 1993: 110-1.

development.”⁹ The pretense of novelty was just another aspect of these ersatz products’ sham appeal.¹⁰

At best, the Jell-O salads and TV dinners of the era get the nostalgia treatment — evoked by garish reproductions in coffee-table books whose prose drips with fond sarcasm, the lifeblood of kitsch. To know that it was all awful, and that we should laugh, is to reassure ourselves not only of our own gastronomical sophistication, but also of the integrity of our personal standards of taste. The earnest and deluded homemakers of the 1950s! Serving up that tasteless muck to eager, suit-clad husbands, to smiling, wholesome children — *and thinking that it’s good!* When we distance ourselves from the caricatured food of that era, we also distance ourselves from the possibility that we might be similarly susceptible (misled by advertising, by the food industry, or by our own unreliable appetites) to finding trashy food delicious. By expressing disgusted amusement at the food of the 1950s, we perform a pantomime of “knowing better,” inoculating ourselves against the destabilizing anxiety that we may not recognize bad food for what it is.

⁹ Levenstein 1993:111.

¹⁰ Historians of technology have produced more nuanced accounts of the interplay between technoscientific innovations and consumer appetites in food product development in the postwar. See J.L. Anderson, “Lard to Lean: Making the Meat-Type Hog in Post-World War II America,” in Belasco and Horowitz, eds. *Food Chains: From Farmyard to Shopping Cart*, (Philadelphia: UPenn Press, 2009), 29-45; Paul Josephson, “The Ocean’s Hot Dog: The Development of the Fish Stick,” *Technology and Culture* 49, no 1 (January 2008): 41-61.

Approaching postwar food from the perspective of flavor research and flavor science tells quite a different story. Food manufacturers were well aware that the sensory qualities of foods were affected by every aspect of food production, and, in the postwar, were exquisitely concerned with improving the flavor of their products. Increasingly, food manufacturers believed that flavor was the factor that made the difference between a successful product and a flop. After the war, a growing and diverse group of experts contributed to the knowledge, practices, materials, and technologies that shaped how food was made to taste.

The food industry's fixation on flavor during this period may have escaped the notice of many previous scholars because the dynamics, disputes, controversies, and challenges of shaping the sensory qualities of foods were largely addressed either internally, before finished products made their way to supermarket shelves, or in the context of intrabusiness relationships with producers of additives, packaging materials, and processing machinery, where food manufacturers were the clients and customers. In this regard, the food industry's "investment" in research and product development — which Levenstein dismisses as paltry — cannot be properly calculated without acknowledging the substantial investments made by auxiliary industries and businesses that served and supplied food manufacturers, the heterogeneous network of entities that underwrote the integrity of the 'food chain' and comprised the totality of the food production system.¹¹ Although this chapter's focus is on flavor manufacturers, one

¹¹ For more on the notion of the "food chain," and the heterogeneous networked assembly of producers, manufacturers, institutions, technologies, knowledge, and capital that

should also consider the contributions of other chemical companies (that developed other food additives meant to improve sensory qualities such as texture, preserve the appearance of food, or forestall decay, as well as plastics and other packaging materials that enhanced stability and improved shelf-life), companies that built processing and filling machinery that preserved food qualities during manufacturing, packaging companies, trucking and shipping companies, and manufacturers of commercial freezers and refrigerators — not to mention the federal government, which, through the USDA Agricultural Research Service, the US Army Quartermaster Food & Container Division, and other scientific entities, undertook research directly intended to address problems faced by the food industry related to the qualities of food. Food manufacturers were thus the beneficiaries of huge public and corporate investments in technology, infrastructure, and research all along the food chain, which helped underwrite and make possible the development of new products, and which reflected the considerable attention devoted to enhancing and improving the sensory qualities of foods which reached consumers.

What I hope to demonstrate in this chapter is not only that flavor mattered to the food industry, but also *how* it mattered. By illuminating both the challenges and opportunities that flavor offered to food manufacturers, and the role that flavor companies played in developing flavor solutions for the food industry and its ramifying

comprise it, see Belasco and Horowitz, eds. *Food Chains: From Farmyard to Shopping Cart*, (Philadelphia: UPenn Press, 2010).

consumer markets, I hope to provide a fuller picture of both “industrial taste” and its meanings in postwar America.¹²

This chapter asks what research and development looked like at flavor companies, using this question to examine the relationship between the flavor and food industries, as well as the consequences of these investments for the way that foods were made to taste in postwar America.

I begin by considering the commercial context for the increasingly close relationship between food manufacturers and flavor companies in the postwar. What factors drove food companies to become more “flavor conscious,” and to find technical and material solutions in the flavor industry and its products? How did flavor companies strategically leverage their research and development operations to integrate themselves

¹² The concept of “industrial taste” as a set of qualities produced by industrial processing, and distinct from the sensory possibilities of homemade foods, comes from Gabriella Petrick, “The Arbiters of Taste: Producers, Consumers, and the Industrialization of Taste in America, 1900-1960,” PhD Diss, UDelaware, 2006. Petrick examines the emergence of this set of qualities in the early twentieth century food industry, categorizing it as the “good enough” flavor that emerged as the result of a compromise between food safety and food quality in canning and other processing. Another aspect of the story of “industrial taste” can be found in Amy Bentley’s *Inventing Baby Food: Taste, Health, and the Industrialization of the American Diet* (Oakland: University of California Press, 2014). Bentley argues that the flavors of processed foods are something that consumers must develop an appetite for, and that the “early consumption of commercial baby food may have helped to prime Americans’ palates for the highly processed industrialized products that have contributed to our health problems today.” (p.6). While both of these conditions — the negotiations between flavor and safety, the effects of familiarity and exposure on shaping appetites and preferences — form important parts of the story of processed foods, this chapter instead considers the deliberate design and development of flavors and other sensory qualities of foods.

into the food product development and manufacturing process? By examining the contours of this intrabusiness relationship, I show that flavor companies positioned themselves as expert interpreters of both chemical materials and consumer markets, savvy not only to the possible uses for the rapidly expanding list of available synthetic flavor chemicals but also to the commercial potential of new kinds of products.

I then turn my attention to flavor additives themselves. Flavor additives are technologies, deliberately designed artifacts whose complex composition reveals a convergence of chemicals with diverse material, sociocultural, and scientific “life histories.” How did particular chemicals come to be entangled with each other, brought together to deliver certain sensory effects? What purposes were these technologies designed to serve? How were they deployed in consumer products?

My attempts to answer these questions reveals the intricacies and breadth of “flavor research” in the postwar period. As the flavor industry developed its technical capabilities, it invested not only in the improvement of the sensory qualities of flavors (the formulations of creative flavorists), but on the enhancement of flavor performance in foods. Focusing on flavor performance meant considering factors related to the utilization of flavoring materials during manufacturing — factors such as dispersability (how uniformly a flavor could be distributed through a food matrix), reactivity with other compounds in a food, and ability to withstand processing conditions — as well as to the stability and durability of flavors in finished packaged foods. Often, optimizing flavors for food manufacturing entailed attending to the material components of flavoring products that were not, strictly speaking, “flavor chemicals.” Synthetic solvents,

emulsifying agents, vegetable gums, and related materials played an increasingly important role in the production of flavoring products and processed foods, with chemical companies such as Dow and Atlas Powder supplying these compounds to flavor and food manufacturers. As such, flavoring additives were not only participants in, but beneficiaries of, what historian Suzanne White has dubbed the “chemogastric revolution,” the increasingly close association between the food and chemical industries in the postwar U.S.¹³

My first case study concerns postwar pineapple flavor. I trace the dynamic set of relationships among agricultural research, the production of petrochemical intermediaries, and the utilization of these sources of chemical materials and knowledge by flavor manufacturers. I then place this supply-side story in the context of market demand, examining the cultural and social causes of growing pineapple-appetite among postwar consumers.

But there’s more to the picture. Understanding the material substance of flavor additives — the capabilities and affordances of these products as wholly designed objects, i.e., not just what a flavor “tasted like” but how it was expected to perform — is a crucial but overlooked part of the story of how foods were made to taste in the postwar period. I include two stories here: one successful, one less so. First, the development of encapsulated flavors, “spray-dried” flavor powders that were crucial components of processed foods including cake mixes, frozen foods, and beverage mixes. Encapsulated

¹³ Suzanne White, “The Chemogastric Revolution and the Regulation of Food Chemicals,” in Seymour H. Mauskopf, ed. *Chemical Sciences in the Modern World*, (Philadelphia: UPenn Press, 1993); 322-55.

flavors “locked” volatile flavor compounds within stable, non-reactive containers of vegetable gums and other chemical components, protecting them from the effects of time and environment until the moment of preparation or consumption. The development and widespread acceptance of these products profoundly shaped the sensory capabilities of processed food in the postwar. Second, I examine a case where research and development failed to realize commercial success. Givaudan’s Aerosol Research Laboratories positioned the company as an industry leader, and a central node for the network of manufacturers concerned with the development of “push-button” foods. Despite substantial investments by Givaudan and others, the product category flopped with consumers.

In my concluding story, I look at the production of flavorings for “nationality” specialties, examining how the flavor industry facilitated a strategic shift from mass markets to market segmentation.

I. “YOUR FLAVOR PROBLEM IS OUR FLAVOR PROBLEM:” RESEARCH AND DEVELOPMENT IN THE FLAVOR INDUSTRY

“NOTHING SELLS LIKE FLAVOR”

Supermarkets differed from earlier grocery stores not only because they were organized around ideas of self-service, branded goods, and volume sales, but also because of the dazzling variety of products that they carried. Cultivating the appearance of limitless abundance was the defining style of the supermarket, as well as its business

strategy. In Allen Ginsberg's 1955 poem, "A Supermarket in California," the poet trails an earlier bard of American plenitude, Walt Whitman, down the aisles of a Berkeley supermarket, passing peaches, avocados, and "brilliant stacks of cans," fancy artichokes and "every frozen delicacy," families and possible angels, sustained (but also depleted) by it, possessing it all without consuming it, "never passing the cashier."

Which came first, the supermarket, or the dizzying array of products to occupy every inch of shelf space in these replete, orderly, vertiginous emporia? According to *Progressive Grocer*, a trade magazine that compiled industry statistics, while a "good" food store in 1928 might have stocked some 800 different items, by 1946 this number had swelled to 3,000, and continued to climb. In 1955, a typical "well-stocked supermarket" could be expected to carry 5,000 different items.¹⁴ By 1962, this number topped 6,000.¹⁵ Although this increase also reflected the inclusion of non-food items — such as cleaning products, housewares, and toiletries — within the standard scope of supermarket goods, a substantial portion was due to new food product lines, "primarily convenience foods characterized by built-in maid and chef service."¹⁶ New types of products appeared — such as frozen foods, cake and mixes, diet foods, ethnic specialties, and new kinds of baby food. Older, established brands also expanded their offerings with new sizes, products, and flavors. While grocers welcomed these new packaged products, in part because of their higher prices and greater margins, they also acknowledged that the hypertrophic expansion of inventories could not continue forever. As was noted by

¹⁴ *Facts in Grocery Distribution: Published as a Service to the Food Industry by Progressive Grocer, the Magazine of Super Markets and Superettes* (1956 edition): 6.

¹⁵ *Facts in Grocery Distribution* (1963 Edition): 3.

¹⁶ *Facts in Grocery Distribution* (1955 edition): 6-7.

Progressive Grocer: “Many retailers... are finding that inventory of a store cannot expand indefinitely and as a result there was a greater weeding out of poor sellers than ever before.”¹⁷

In the postwar era, merchandisers began attending to the sensory environment of the supermarket, attuning its qualities in accordance with psychological research about behavioral impulses and drives, such as that popularized by Ernst Dichter’s Institute for Motivation Research.¹⁸ These strategies of sensual persuasion were thought to be particularly effective on women. “Leaders in the supermarket business... deliberately targeted what they saw as women's base physical desires,” writes historian Adam Mack, “contending that female consumption derived not from rational calculations, but rather from irrational 'impulses' encouraged by sellers who knew how to manipulate the female sensory apparatus.”¹⁹ Colorful displays, artful lighting, spacious floor-plans, softly piped in music, strategies of odor control and design: the supermarket itself became an invitation to desire and to buy, a plea made not through explicit advertising, but implicitly, through sensory design.

Food manufacturers also began to understand flavor in terms of its psychological and affective appeals to the consumer. A 1947 article by A.D. Hyde, General Mills’ vice

¹⁷ *Facts in Grocery Distribution* (1955 edition): 7.

¹⁸ Adam Mack, “Speaking of Tomatoes’: Supermarkets, the Senses, and Sexual Fantasy in Modern America,” *Journal of Social History* 43:4 (Summer 2010): 815-842; Lawrence R. Samuel, *Freud on Madison Avenue: Motivational Research and Subliminal Advertising in America*, (Philadelphia: University of Pennsylvania Press, 2011). For a comparable case study, where companies drew on psychological research to “put color to work” to move merchandise by appealing to unconscious motives and drives (especially those of women), see Blaszczyk 2012: 215-64.

¹⁹ Mack 2010: 817.

president for research, spotlighted the increasing importance of flavor in product design and development.²⁰ In Hyde's account, supermarket aisles were the battleground in a war of all against all, as products contended with each other for consumer favor in a marketplace constrained by the inevitable limitations of human appetite. "A vegetable soup," Hyde observed, "must vie for the consumer's dollar not only with other vegetable soups, but with every other food."²¹ In this overheated marketplace, where consumers were free to choose between growing numbers of appealingly packaged items lining the wide, well-lit aisles of self-service supermarkets, he contended that a product's success or failure depended largely on its flavor.

But it was no longer enough for flavor merely to be "appealing," Hyde warned. It also had to be unique and different, adding "a new 'note' to the 'symphony' that modern families demand in their meals. If a new product tastes exactly like a dozen or so other established foods, the housewife will have little incentive for buying it." Further, the flavor should be distinctive: easily identifiable and memorable. A flavor that was "readily recognized" and "conjured mentally" had "inestimable value," serving as "a built-in trade-mark which will invariably be identified with its brand name and its producer."²²

The direct relationship between flavor and sales was reflected in the marketing campaigns of flavor and fragrance firms. Flavor companies had long advertised the advantages of their products as: cost, uniformity, compatibility with manufacturing

²⁰ A.D. Hyde, "How General Mills Develops Its New Food Specialties," *Food Industries* 19 (October 1947): 110-12, 212-15.

²¹ Hyde 1947: 212.

²² Hyde 1947: 213.

processes, and a sensible naturalism impossible to achieve with only natural materials. Starting in the 1940s, and through the 1950s and beyond, they also touted the direct relationship between flavor and sales in advertisements that proliferated in pages of trade journals such as *Food Engineering*, *Food Technology*, and *Food Product Development*. “Nothing Sells Like Flavor!” was flavor and fragrance manufacturer Fritzsche Brothers’ slogan in the late 1950s. A 1959 advertisement for Polak & Schwarz featured a photograph of a woman, holding a child by the hand, in front of shelves full of different cake mixes; she reaches for a box of cake mix perched on the very top shelf, high above her head. “A sale is made,” the tagline read, “thanks to P&S flavors.”²³ The message here was that flavor could reliably connect with consumers to move a product, overcoming disadvantages, such as poor placement in a grocery store, that may be beyond the manufacturer’s control.

A 1956 advertisement for the flavor and fragrance firm Dodge & Olcott vividly dramatized flavor’s role in winning customers:

“Your customer goes to the store and brings your food product home. Packaging, promotion or impulse-buying may account for this first-time sale. But you haven’t really sold her — not yet! You’ve just *contacted* her. Only quality food with unique taste-appeal can be counted on to bring her back again and again — and keep those registers ringing. Flavor goes out of the store with your customer — it goes to the table and becomes in essence your personal ‘door to door’ salesman. The final impression this

²³ [Polak & Schwarz], “A Sale is Made,” [advertisement], *Food Technology* 13 (February 1959): 6.

salesman creates decides the ultimate fate of your product. Let the D&O Flavor Laboratories make your silent salesman, FLAVOR, the best you've ever had!"²⁴

Flavor was an agent that extended the food manufacturer's control over the customer to the most intimate realms of private life. While the inducements of advertising, merchandising, and sales promotions ended at the border between public and private, flavor crossed the ultimate threshold, carrying the manufacturer's influence not only into the home, but into the body itself, reliably yielding subsequent behavioral and economic outcomes (bringing her back again and again, keeping those registers ringing.)

Flavor, then, was no longer chiefly a problem of standardization and quality control for food manufacturers. It had become the "silent salesman," the factor that could make the difference between a product's success and failure. Further, flavor design and development was recognized as the domain of scientific experts, who had a mastery not only of production processes and market conditions, but also of the growing number of chemicals available to extend shelf life, and improve the texture, appearance, and flavor of foods.²⁵ Although large companies, such as General Mills, maintained flavor research and development divisions in-house, smaller companies had to seek out these services elsewhere.

²⁴ [Advertisement, Dodge & Olcott], *American Perfumer & Aromatics* 67 (April 1965): 61.

²⁵ White 1993.

These commercial conditions, as well as the growing acceptance of flavor's deep role in shaping consumer behavior, set the stage for an increasingly close relationship between food manufacturers and flavor companies. As we have already seen, since the beginning of the twentieth century, flavor companies had offered direct technical assistance and expertise to users of their products. In the postwar era, flavor companies continued to tout their investments in research, and expanded laboratory and manufacturing facilities that allowed them to produce not only an expanding variety of flavor effects, but to offer flavor additives in new material forms with new performative capabilities.

“YOUR FLAVOR PROBLEM IS OUR FLAVOR PROBLEM:” RESEARCH AND DEVELOPMENT IN THE FLAVOR INDUSTRY

After the war, flavor manufacturers increasingly emphasized technical assistance and in-house research programs, as well as specialized product lines intended for specific applications. This is reflected in the organization of flavor catalogs and price lists. Prior to the Second World War, companies that manufactured both flavors and fragrances — such as Dodge & Olcott, Givaudan-Delawanna, and Fritzsche Brothers — tended to publish catalogs that included merchandise in both categories. Generally speaking, flavors took a back seat to perfume products and essential oils, which commanded higher prices and more catalog pages. After the war, these companies and others began to publish separate catalogs flavors and fragrances, which not only accommodated an expanded selection of flavoring products, but also allowed for a more acute targeting of specific groups of flavor users.

“Your flavor problem is our flavor problem,” Givaudan-Delawanna’s 1949 catalog assured manufacturers. “Let the Givaudan Flavor Research Laboratories assist you in its solution.” Givaudan, a venerable fragrance and flavor firm with corporate headquarters in Switzerland, had manufactured aromatic materials and products at its Delawanna, New Jersey facility since 1924; however, this was only the company’s second catalog devoted exclusively to its flavoring products. Although the flavors listed in the catalog “have been carefully created for specific purposes, your product or manufacturing process may require special study. Aided by years of experience and a wide range of raw materials, our Flavor Research Laboratories — with its technical sales staff and skilled chemists and technicians — will thoroughly investigate your product, in order to develop the *flavor* ideally suited for your needs.”²⁶

In other words, Givaudan was offering to place their research and development capabilities at the service of food and beverage manufacturers. In the late 1940s and 1950s, many flavor and fragrance companies redoubled their commitment to flavor research and development — expanding research facilities, hiring new personnel, building dedicated laboratories for specific product applications (such as spray-dried flavors and flavors for aerosol foods), and assembling in-house taste panels to evaluate materials and products. For companies such as Givaudan, where fragrance materials had long dominated, this reflected a bet on the continuing growth of the market for flavoring

²⁶ Givaudan Flavors, Inc. “Flavors: Catalogue Number 2,” (New York, NY: Givaudan, 1949): [interior back cover]. Smithsonian Libraries, Trade Literature Collection, Washington, D.C.

additives, driven in part by new types of food products that would need specialized flavorings.

Givaudan's increasing investment in flavors is evident through the 1950s and 1960s. Givaudan hired three new flavor chemists in 1952 — younger, American-born flavorists James Broderick, Earl Merwin, and Jerry DiGenova — to supplement their existing staff of two older, European-trained flavor chemists.²⁷ Beginning in 1953, the company began publishing, on a more or less quarterly basis, the *Givaudan Flavorist*, an eight-page newsletter for the beverage and food manufacturers that were its clients. The *Flavorist* described the latest research in flavor chemistry, promoted particular product lines, and made a sustained case for the professional and scientific status of the flavor industry, its complexity, and the importance of leaving flavor problems to the experts rather than handling them in-house. “The diverse nature of flavors requires the full-time energy of many flavor and allied specialists,” was explained in an article about the flavor of coconut, published in 1954. “It is our purpose in *The Flavorist* to keep our readers, who are forced to relegate flavor-development to a secondary role, abreast of the development and trends in the field.”²⁸ This is a recapitulation of a familiar promise that had been made since the early twentieth century, but with the intensification of

²⁷ It should be noted that these younger flavorists did not feel that the company was fully behind them, or fully invested in scientific flavor research and development, at this point in the 1950s. Broderick soon left the company, followed a few years later by Merwin; DiGenova remained at Givaudan for the remainder of his career, eventually becoming vice president of the company's creative laboratories. Further information about this can be found in Chapter 7. [E.S. Merwin], *A Short History of the Flavor Industry*, prepared for the Society of Flavor Chemists and the Chemical Sources Association, 1994: 47.

²⁸ “The Flavor of Coconut,” *Givaudan Flavorist* 2.1 (1954): 2.

technoscientific control over all aspects of food manufacturing, it gained even more force.

In an another article appearing later that year, the *Flavorist* described the coordinated network of scientific labor that distinguished the modern flavor and fragrance company from the flavoring supply houses of the past, which, by its account, relied on closely guarded secret formulas and performed little chemical research. “Today’s aromatic material organizations reek of laboratories and eager young men fired with the zeal of their college inheritance – pushing away the secrecy and romance, doing things scientifically.” Developing a flavor at Givaudan required the work not only of flavor chemists, but also of the organic research laboratory, toxicological laboratory, analytic laboratory, and control laboratory, as well as an “elaborate purchasing department who have world-wide connections for spotting new materials and sources.” Meanwhile, “in the background are the chemists who process the intermediates, the engineers who develop new equipment and the maintenance staff who keep the equipment and processes rolling.”²⁹ As powerful, new analytic chemical technologies — such as gas chromatographs, mass spectrometers, and infrared spectrometry — became available, flavor companies invested in these machines. A two-page photo-essay appearing in a 1958 issue of the *Flavorist* featured images of male and female technicians, garbed in white lab coats, at an array of instruments necessary to make a “Mona Lisa” in the flavor lab — including a gas chromatograph, a Beckman recording spectrophotometer, a multiple reflux assembly, infrared recording spectrophotometer, and

²⁹ “Ol’ Doc,” *Givaudan Flavorist* 2.3 (1954): 3.

“the latest model refractometer” — taking care to also point out that it was not the machines alone, but the combination of advanced instrumentation and specialized skill that made it possible to make a flavor masterpiece.³⁰

Givaudan upgraded its flavor laboratories and testing facilities again in 1959 to include a “testing kitchen which would be the envy of any housewife,” staffed by home economists who used flavor formulations in candies, baked goods, and other foods. Flavorists’ efforts were assessed by both trained taste panels and consumer panels who “evalute[d] the effectiveness of the flavor in the finished media.”³¹ By investing in these types of facilities and procedures, flavor companies like Givaudan hoped not only to close the gap between their products and ultimate consumer market acceptance, but to interject themselves even more deeply within food manufacturers’ product development process. As a 1968 Arthur D. Little, Inc. report on the flavor industry explained, long-term success meant having a “particular flavoring formulation locked-in to the final product formulation,” which would almost certainly oblige a manufacturer to continue relying on the company for the flavoring. This led companies such as Givaudan to invest increasing resources on technical services, and research into applications and consumer

³⁰ “A Mona Lisa in the Making,” *Givaudan Flavorist* 6.2 (1958): 3-4. The claim that expertise in flavor involves not only instruments but also specialized skills is explored at length in Chapter 7.

³¹ “New Laboratories, New Testing Kitchen for Flavor Development Work at Givaudan,” *Food Technology* 13 (May 1959): 48.

responses — work that would have formerly been conducted by food or beverage manufacturers.³²

Givaudan's expansion of its research facilities was not unique, but part of an industry-wide trend. In 1953, Dodge & Olcott touted that its new building on Varick Street in lower Manhattan housed a product development department as well as nine new flavor and fragrance laboratories, including organic synthesis and analytical laboratories and dedicated laboratories equipped to study technical flavor problems in processed foods, confectionery, beverage, and pharmaceuticals. The company also devoted 5,200 square feet of floor space in the building to its flavor compounding laboratories, adjoining a 4,500 square foot area for perfume compounding on the second floor.³³ The same article describing Dodge & Olcott's new facilities also noted that the company "tests its new flavors through an employee 'taste panel.'³⁴" A series of advertisements for Fritzsche Brothers, in *Food Technology* in 1951 and 1952, spotlighted the various "branch[es] of the food field" — baked goods, frozen desserts, salad dressings, luncheon meats — that had benefited from the work of the company's Flavor Research Laboratories "to develop improved ingredients for tickling the consumer's palate."³⁵ This was the company's basic message to food manufacturers: "Whatever your food product

³² Arthur D. Little, Inc., "The US Flavor Industry: Report to The Andrew Jergens Company," (March 26, 1968): 29. AW Noling Beverage Literature Collection, University of California, Davis.

³³ "Seeking Sweet Smells," *Chemical & Engineering News* 31 (December 28, 1953): 5350.

³⁴ "Seeking Sweet Smells": 5350.

³⁵ See, for instance, in *Food Technology* 5 (1951) and 6 (1952): Baked goods, in January 1951: 18; Frozen desserts, March 1951: 25; salad dressings, May 1951: 28; and frankfurters, June 1952: 40. Quote from March 1951.

— whatever the flavor problem it involves — it is more than probable that our laboratories have done the basic research that will enable us to supply a quick solution to your needs.”³⁶

Accelerating a process that had begun in the interwar years, in the postwar decades, flavor manufacturers expanded and diversified their research and development capabilities, making it possible to provide more targeted technical support to food and beverage manufacturers, and increasingly focusing their business on developing specialized flavoring formulations for specific needs rather than the production of commodity flavorings.³⁷

II. THE DESIGN AND DEVELOPMENT OF FLAVOR TECHNOLOGIES

NEW FLAVOMATICS FOR THE FLAVOR INDUSTRY: MAKING A BETTER PINEAPPLE FLAVOR

Flavor manufacturer’s postwar claims to the value added by their specialized workforce of flavorists was corroborated by the increasing material complexity of flavor work, which necessitated the mastery of an ever-increasing number of ‘flavomatics,’ chemical compounds with potential use in foods. The identification of new compounds in nature, and the synthesis of entirely novel chemicals, for use in flavorings and fragrances

³⁶ [Fritzsche Bros.] “It’s Only as Good as Its Flavor,” *Food Technology* 6 (June 1952): 40.

³⁷ Arthur D. Little, Inc. “The US Flavor Industry” 1968. AW Noling Beverage Literature Collection, University of California, Davis.

exploded with technologies of analysis, such as gas chromatography and mass spectrometry. The use of these compounds in foods was only nominally curtailed by the 1958 Food Additives Amendment, which required chemical additives to prove their safety before being permitted in the food supply.³⁸ The rapid expansion of available synthetic flavoring materials preceded the introduction of analytic instruments. Although new instrumental technologies speeded the pace by which promising new molecules were isolated and identified, the pattern of producing synthetic molecules for new flavor effects had been set decades earlier.

Some new flavoring materials and commercial formulations were drawn from basic research into the chemistry of foods, including at the USDA. For instance, in the early 1920s, chemists in the Bureau of Chemistry analyzed the chemical constituents of ripe apples, identifying a handful of esters and alcohols.³⁹ In addition to being published in scientific literature, this information was made available as a public patent for “synthetic apple-oil.”⁴⁰ There is evidence that at least one company— Fritzsche Brothers — used this as the basis for its own apple flavor formulation in the 1920s and 1930s.⁴¹

³⁸ On the 1958 law and its effects on the flavor industry, See Patrick van Zwanenberg and Erik Millstone, “Taste and Power: The Flavouring Industry and Flavour Additive Regulation,” *Science as Culture* (2014): 1-28. Discussed further in Chapter 7.

³⁹ Frederick B. Power and Victor K. Chesnut, “The Odorous Constituents of Apples,” *Journal of the American Chemical Society* 43.7 (July 1921): 1725-1739; Frederick B. Power and Victor C. Chesnut, “The Odorous Constituents of Apples II: Evidence of the Presence of Geraniol,” *Journal of the American Chemical Society* 44 (1922): 2938-2942.

⁴⁰ Patent 1,366,541, Frederick B. Power and Victor K Chesnut, “Synthetic Apple-Oil,” (January 25, 1921); Patent 1,436,290, Frederick Belding Power and Victor King Chesnut, “Improved Synthetic Apple Oil,” (Nov 21, 1922).

⁴¹ [Letters] Between J.N. Farley, Farley Confections, Chicago, and E.K. Nelson, Senior Chemist, Food Research Division, Bureau of Chemistry and Soils, USDA, Dec 8, 1937 - Jan 4, 1938. [National Archives RU 88, Records of the Food and Drug Administration

The Second World War also drove basic research into the flavor chemistry of spices and essential oils, as disrupted trade caused shortages, spurring a search for synthetic substitutes.⁴²

New flavor materials entered the food supply not only as synthetic replicas of compounds identified in nature, but also as entirely novel substances, with no known natural analogues. As materials, techniques, and knowledge relating to flavor chemistry passed between scientists working in distinct institutional contexts — agricultural research in academic or government laboratories, flavor research and development in private industry laboratories— they put this knowledge to work in different ways. The development of imitation pineapple flavors after the Second World War provides a vivid illustration of this. Forces on both the supply side (the flux of available chemical intermediaries and research funds), and on the demand side (the cultural milieu, or “market opportunities,” that the flavor would inhabit), shaped how a particular set of molecules came to be bound together and associated with the taste of pineapple in the years after the war.

Correspondence and Reports, 1897-1938, Box 44]. It is unclear whether the apple flavoring Farley acquired from Fritzsche (‘Fritzsbro Arome-Apple’) was the one whose formula was based on the public patent; in any case, Farley found it quite unsatisfactory. “We think these are some of the old fashioned ether flavors as they do not seem to have the characteristics for which we are looking,” he complained to Nelson. Notably, the 1921 and 1922 patents based on the USDA’s apple research contained mainly esters (which were sometimes referred to as “ethers”), as these had been the compounds that the investigators had been able to identify.

⁴² “Chemistry Supplies Synthetic Food Flavors as War Curtails Imports of Exotic Herbs,” *New York Times*, (May 16, 1942): 9; J.N. Taylor, “Sales of Synthetic Savors,” *Journal of Chemical Education* 1944; “Black Pepper and Cardamom Replacements Announced,” *American Perfumer* (April 1950): 307-8.

“Pineapple” was one of the earliest synthetic flavors. In the 1850s and 1860s, ethyl butyrate and other esters generally performed the role of pineapple in candies and beverages. (It is highly probable that, for most Western consumers well into the twentieth century, the pineapple flavor of these esters was more familiar than the acid tang of the prickly fruit itself, which was more often consumed canned than fresh.) With time, pineapple flavor formulations began to include a growing list of chemical compounds. By the late 1930s, the allyl esters had become popular in synthetic pineapple flavors — in particular, allyl caproate, which was sometimes sold under the name “Pineapple Aldehyde.”⁴³ None of these molecules had been uncovered by basic research into pineapple flavor chemistry.

In the early 1940s, Dr. Arie Haagen-Smit, a biochemist in the William G. Kerchikoff Laboratories of the Biological Sciences at the California Institute of Technology, undertook a study of the flavor chemistry of pineapple at the request of the Pineapple Research Institute, an industry group sponsored by eight Hawaiian pineapple companies. The companies, which grew, processed, and canned much of the pineapple sold in the United States, had come to believe that fundamental knowledge about the chemical constituents of pineapple flavor could be used to improve breeding, cultivation,

⁴³ Although allyl caproate was an ester, not an aldehyde, this trade name reflects a naming convention in the flavor materials market that dates to the 1910s, if not earlier. Particularly potent synthetics, which provided a characteristic note at a low concentration, were dubbed “aldehydes,” possibly to obscure their true molecular composition and, at least initially, prevent rival companies from producing them. Hence, ‘peach aldehyde’ is a lactone, ‘strawberry aldehyde’ is an ester.

and canning processes.⁴⁴ Caltech, at the time, was a center for research on plant biochemistry, and Haagen-Smit was known for his pioneering work on plant growth hormones.⁴⁵

Haagen-Smit and his colleagues started with six thousand pounds of the fruit, from which they distilled a few ounces of “volatile product which had the typical pineapple smell.” After distilling off ethyl alcohol and acetaldehyde, which comprised the majority of the solution, they used techniques of chemical microanalysis, fractionating the remaining grams of solution to identify “the substances more specific for the pineapple flavor.” They found that the mixture consisted of various known ethyl and methyl esters of acids, as well as a previously unknown sulfur-containing compound which they identified as methyl beta-methylthiolpropionate.⁴⁶ They confirmed this identification by synthesis.

“While our research was not intended as a means of obtaining a better artificial pineapple flavor,” wrote Haagen-Smit, “the results of our analysis would naturally lead to improved flavor formulae. For, after isolating the flavor principles, and determining their structure, it was possible to reconstruct the flavor chemically.”⁴⁷ Haagen-Smit, whose

⁴⁴ Arie J. Haagen-Smit, “The Chemistry of Flavor,” *Engineering and Science Monthly* 12 (January 1949): 5.

⁴⁵ James Bonner, “Arie Jan Haagen-Smit,” *National Academy of Sciences Biographical Memoirs* vol 58 (Washington, DC: National Academy Press, 1989): 191-2.

⁴⁶ A.J. Haagen-Smit, Justus G. Kirchner, Clara L. Deasy, and Arthur N. Prater, “Chemical Studies of Pineapple (*Ananas sativus* Lindl). II. Isolation and Identification of a Sulfur-Containing Ester in Pineapple,” *Journal of The American Chemical Society* 67, no 10 (1945): 1651-2.

⁴⁷ Arie J. Haagen-Smit, “The Chemistry of Flavor,” *Engineering and Science Monthly* 12 (January 1949): 5.

earlier work had focused on the effects of endogenous chemicals on plant growth, understood flavor molecules not as commercial end-products, but as the outcome of metabolic processes within the plant. His interest was in the development of flavor molecules from chemical precursors as the fruit grew and ripened. For him, this basic chemical knowledge had a practical application, as it could substitute “for the subjective scale of grading used at present in the fruit industry. In this way, the effects of climatological factors, changes in agricultural methods, and the results of breeding experiments may be investigated.”⁴⁸ In other words, for Haagen-Smit and his colleagues, the flavor chemistry of pineapple would primarily be applied to growing and selecting tastier pineapples, with methyl beta-methylthiolpropionate and other compounds serving as material indices to flavor quality.

How was this knowledge put to use in the flavor industry? One of the tasks of flavor company research departments was to review the scientific and chemical literature, staying abreast of discoveries that may yield commercial applications in food and beverage flavorings. Soon after the publication of Haagen-Smit’s article, flavor and fragrance manufacturers began synthesizing the sulfur-containing molecule, and experimenting with it in pineapple flavor formulations. One such firm was F. Ritter & Company, of Los Angeles. Ritter specialized in supplying aromatic materials — essential oils, natural isolates, and synthetic chemicals — to other companies in the flavor industry, rather than selling finished flavorings to food manufacturers. In the years after

⁴⁸ Haagen-Smit et al. 1945: 1646.

the war, Ritter maintained a productive chemical research program, focused on the synthesis of novel flavor and fragrance compounds.⁴⁹

In a 1949 article reviewing dozens of newly available aromatic chemicals with “odor and flavor promise,” Abraham Seldner, research director at Ritter, cited Haagen-Smit’s recent discoveries about the flavor chemistry of pineapple.⁵⁰ Chemists at Ritter had synthesized methyl beta-methylthiopropionate, and had been assessing its potential by adding small quantities to pineapple ester blends, resulting in “an imitation pineapple reproduction closer than any others previously attempted.”⁵¹ However, Seldner and his team did not use Haagen-Smit’s chemical identifications as a blueprint for their laboratory recreation of “natural” pineapple flavor. “It has been many years since flavor and perfume chemists have limited themselves to the reproduction of chemical bodies found in nature,” he wrote. “Many modifications in flavor and odor can be worked out in the laboratory by synthesizing materials not known to be present naturally.”⁵² In the case of pineapple flavor, chemists at Ritter had created several new molecules that could enhance to the flavor of pineapple or extend its shelf-life. Among them, Seldner recommended two “outstanding pineapple modifiers” the company had developed —

⁴⁹ Alexander Katz and Abraham Seldner, “California Essential Oil Development,” *American Perfumer & Aromatics* 57 (May 1951): 357-60; “New Aromatics to Enhance Fruit Flavors,” *American Perfumer & Aromatics* 55 (January 1950): 45; Katz, “Newly Developed Flavoring Aromatics,” *American Perfumer & Aromatics* 68 (September 1956): 66-70; Katz, “Newly Developed Flavoring Aromatics,” *Perfumer & Essential Oil Review* 48 (March 1957): 131-4.

⁵⁰ Abraham Seldner, “New Aromatics for Flavoring and Perfume Industries,” *American Perfumer & Essential Oil Review* 54 (October 1949): 295-6.

⁵¹ Seldner 1949: 295.

⁵² Seldner 1949: 295.

allyl phenoxyacetate and allyl cyclohexanepropionate, both of which Ritter could supply in commercial quantities.⁵³

A 1957 article from the *Givaudan Flavorist* about pineapple flavors sheds a bit more light on how flavorists worked with new knowledge and new materials to formulate flavorings. When Haagen-Smit's identification of methyl beta-methylthiopropionate was reported, "it was hoped by all who read these papers that here at last was a 'pineapple aldehyde' which could be produced synthetically and which actually gave the pineapple flavor its nature," a single chemical key that could cracking the sensory riddle of pineapple.⁵⁴ But although it was useful in very small amounts, "it was evident that this chemical was not the key to the natural flavor of pineapple." Further, "the instability of it chemically and organoleptically limited its use." On the other hand, allyl cyclohexanepropionate, one of the aforementioned pineapple modifiers, had never been found in nature, but had proven its usefulness pineapple flavors. "These two modern flavomatics" — the nature-identical synthetic, and the unprecedented molecule — "have been added to the repertoire of the flavor chemist," the article continued, "and have enabled him to produce a more accurate synthetic version of pineapple flavor." There was no simple formula or single compound that was the key to a successful pineapple flavor; the accuracy of the reproduction was not dependent on its molecular indistinguishability from the original.⁵⁵ The article concluded with a plea: "The creation of flavors should be

⁵³ Seldner 1949: 296.

⁵⁴ "The Flavor of Pineapple," *Givaudan Flavorist* 5.2 (1957): 2.

⁵⁵ Indeed, there was no unitary "pineapple" flavor. The article observed that "actually pineapple is known by two flavors" — canned pineapple, and fresh pineapple. "Each

left to those who not only have the necessary training, but also have at their disposal the varied raw materials and the research facilities to accomplish the desired end product.” Professional flavorists, and the flavor companies that employed them, were necessary to make chemical knowledge and materials into “safe, modern instruments for giving your products distinctive taste appeal.”⁵⁶

But where did this “constantly increasing... greater variety of aromatic chemicals,” these new modern flavomatics, come from? These new materials were intimately bound up with the shift from coal to petroleum as the primary feedstock for organic synthesis just prior to the Second World War, and the concomitant growth of petrochemicals and their products — polymers and plastics — during the war and after.⁵⁷ Before the war, chemists in the flavor industry had generally used coal-tar-derived chemicals, such as toluene, benzene, and naphthalene, as the basis for many of their synthetic processes. After the war, an expanding range of available chemical intermediaries broadened the molecular scope of synthetic possibilities for flavor manufacturers.⁵⁸ “When an intermediate is developed and priced to fit into the plastics field,” explained Seldner in 1949, “it almost automatically qualifies for use in the aromatics industry.”⁵⁹ Indeed, “the constant stream of new intermediates being developed

flavor requires its own particular combination of flavor materials and each has ingredients which do not occur in the other.”

⁵⁶ “The Flavor of Pineapple” 1957: 2

⁵⁷ Ralph Landau and Nathan Rosenberg, “Successful Commercialization in the Chemical Process Industries,” in Rosenberg, Landau, and David C. Mowery, eds. *Technology and The Wealth of Nations* (Palo Alto: Stanford UP, 1992): 90-98.

⁵⁸ Alexander Katz, “The Development of Aromatics,” *American Perfumer & Aromatics* 68 (July 1956): 31-2, 35.

⁵⁹ Seldner 1949: 295.

by the chemical industry” were “perhaps the largest single source of new aromatics.”⁶⁰ For instance, allyl phenoxyacetate and cyclohexanepropionate, the new pineapple flavor enhancers Seldner had recommended, were both produced by esterification from methallyl alcohol, a petrochemical sold by Shell, among other companies.⁶¹ No longer “expensive laboratory curiosities,” as the production of these intermediaries was scaled up for plastics and other large chemical industries, their cost went down for all users, including flavor manufacturers.⁶²

On the demand side of the equation, a hunger for the flavor of pineapple was likely sharpened by the postwar fascination with Hawai’i and the South Pacific islands. The pineapple had been closely linked with the Hawai’i since the first decades of the twentieth century, when the Hawaiian Pineapple Growers Association began an aggressive and sustained advertising campaign to promote the canned fruit among American consumers. Their stated goal was to “make the word ‘Hawaiian’ mean to pineapple what Havana meant to tobacco,” and soften the reputation of the prickly, eccentric fruit (which was considered tough, stringy, and biting acidic by early twentieth-century consumers) by associating it with the lush imagined pleasures of the Pacific island paradise.⁶³ Pearl Harbor, and the American military’s actions in the Pacific theater, turned these geographies into sites of intense and conflicted interest. After the war, even as they remained heavily militarized zones, Hawaii and the South Pacific

⁶⁰ Seldner 1949: 295.

⁶¹ Harry Cohen, “Foods, Flavors, and Aromatics,” *American Perfumer* 56 (July 1950): 47-49.

⁶² Seldner 1949.

⁶³ Quoted in Gary Y. Okihiro, *Pineapple Culture: A History of the Tropical and the Temperate Zones*, (Berkeley: University of California Press, 2009): 144.

absorbed cultural longings for a pre-Atomic place of redemption and primitivist replenishment, one which found expression in spectacles such as Thor Heyerdahl's 1947 Kon Tiki voyage, as well as in consumer fads such as backyard luaus, Tiki drinks, aloha shirts, hula girl iconography, and exotica music.⁶⁴

In this context, when manufacturers expanded food product lines to include new pineapple flavors — with items such as pineapple-flavored Royal Gelatin (introduced 1948), Borden's coconut-pineapple ice cream (1949), Reiss's "Pineapple Confetti" ice cream (1957), and Jell-O's pineapple cream instant pudding mix (1960) — they were capitalizing on the pineapple's social and sensual association with exotic indulgence: pineapple-appetites that were the poignant reconfigurations of Cold War geopolitical anxieties as well as the cravings of postwar prosperity. They were also relying on the generative and creative capacities of America's allied chemical industries, which promised not only "better things for better living," but also delivered these goods along with an increasingly sophisticated and intensively designed array of sensory effects, chemical mnemonics for absent fruits, intensified pleasures as fantastic as they were real.

⁶⁴ Kaori O'Connor, "The Hawaiian Luau," *Food, Culture & Society* 11.2 (2008): 166; Andrew Cowell, "The Apocalypse of Paradise and the Salvation of the West: Nightmare Visions of the Future in the Pacific Eden," *Journal of Cultural Studies* 13.1 (1999): 138-60; Janet Borgerson and Jonathan Schroeder, "The Lure of Paradise: Marketing the Retro-Escape of Hawaii," in Stephen Brown and John F. Sherry, Jr., eds. *Time, Space, and the Market: Retrospectives Rising*, (London and NY: Routledge, 2003): 219-236; Elizabeth Buck, *Paradise Remade: The Politics of Culture and History in Hawaii*, (Philadelphia: Temple UP, 1993).

SPRAY-DRIED FLAVORS: SOLVING THE PROBLEM OF FLAVOR LOSS

The volatility of flavor — its tendency to “bake out,” to fade over time, to vanish in the wind — had long been a matter of concern for food manufacturers and consumers. A 1935 Housekeeper’s Chat — the radio program produced by the USDA’s Bureau of Home Economics — offered the Depression-era “thrifty housekeeper” scientific experts’ advice on storing and cooking foods to preserve and develop “good natural flavors.”⁶⁵ Calling Americans “a careless and wasteful race when it comes to flavor,” the program lamented: “Every day we let millions of dollars’ worth of taste leave our kettles in steam, or go down sink drains, or be spoiled by too much heat or too long cooking.” Expensive seasonings and sauces were then required to “pep up... abused foods.” The smart, scientific housekeeper could save money and improve the quality of her family’s diet by taking steps such as keeping fresh fruits and vegetables in a cool place and cooking them only briefly, or searing meat before adding it to roasts or stews. In this presentation, flavor was not an abstract quality of foods, but a material resource to be conserved by technical means. This Bureau of Home Economics’ advice reflected an increasing economization of flavor, a growing tendency to cast its value in cash terms.

Food manufacturers also recognized flavor loss as an expensive problem, and sought technoscientific solutions on a vaster scale than those prescribed by home economists to the home cook. A 1934 editorial in *Food Industries* — fittingly titled “Save the Volatiles”— urged manufacturers to set trained chemists and engineers to the task of

⁶⁵ "Saving Flavor: Information from the Bureau of Home Economics, USDA" USDA Radio Service Office of Information, Housekeepers' Chat, Monday, January 28, 1935.

finding ways to retain “that part of our food which adds to the zest of eating,” the flavors and aromas that under current production methods were “most certainly being volatilized and cast into the atmosphere.”⁶⁶ Worrying that Depression-era social and economic forces would lead to more home cooking, the editorial asserted that the only way to sustain housewives’ loyalty to factory-made goods was to “produce better-tasting foods than can be prepared in the kitchen at home.” And the way to do this was by technologically surpassing the kitchen, capturing or retaining volatile flavor molecules with the aid of machines that were anything but domestic — such as “closed vessels equipped with reflux condensers, or evaporation carried out as fractional distillation,” for instance. “Those industries which involve cooking, boiling or evaporation, with noticeable losses of delightful flavors and aromas in the atmosphere, should consider carefully what the food would taste like if they were retained.”⁶⁷

The close of the Second World War not only brought an end to food rationing and a new era of American prosperity, but a host of new technologies and methods in food processing and packaging that protected (or did less damage) to the flavor of foods.⁶⁸ For instance, enhancements in the heat-processing of canned foods, flash-pasteurization of milk and citrus juices, low-temperature vacuum-drying, and new packaging materials all minimized the loss or change of volatile, reactive flavor chemicals during food

⁶⁶ “Save the Volatiles,” *Food Industries* 6 (November 1934): 485.

⁶⁷ “Save the Volatiles” 1934: 485.

⁶⁸ For a compelling account of the role of US military investment in food technology and food processing in creating the postwar industrialized food landscape, see Kellen Backer, “World War II and the Triumph of Industrialized Food,” PhD Diss. University of Wisconsin-Madison, 2012.

production.⁶⁹ Yet flavor loss, and associated changes to food quality, remained a vexing problem for manufacturers, given the variety of insults endured by food products on their journey from factory to consumer. The effects of inconsistent storage conditions on the “eating qualities” of food were a subject of particular concern. General Mills, for instance, used a temperature- and humidity-controlled cabinet, dubbed the “weather room,” to simulate the changing climate of a grocer’s shelf — the heat of the busy day, followed by the coolness of night in the quiet hours after closing — studying the effects of these conditions on packaging and the sensory quality of its formulations.⁷⁰

As has been discussed, flavor companies utilized a growing variety of chemical materials to create additives that gave manufacturers an expanding range of options when it came to designating the sensory qualities of their products. But what of those products when they left the factory, and entered the unpredictable conditions of the distribution chain? When developing new additives, flavor companies attended not only to flavor variety, but also to performance — integration into manufacturing methods, stability, durability — producing flavor technologies that helped extend manufacturers’ control over the sensible qualities of their products until the very moment of consumption.

Consider the cake mix. First introduced in the 1930s, packaged cake mixes offered reliability and convenience to home cooks, as well as a way for manufacturers to address lagging sales of flour. The market for these mixes was middling and mostly regional until 1948, when General Mills introduced its Betty Crocker Gingercake mix,

⁶⁹ E.C. Crocker, “A Flavorist Views Food Processing,” *Food Industries* 17 (March 1945): 69-71, 170-4.

⁷⁰ “Environment by Humidistat and Thermostat,” *Progress Thru Research* (Fall 1953): 7.

and Pillsbury came out with its own boxes of white cake and chocolate cake. Other national brands — including Swans Down, General Foods, and Nebraska Consolidated Mills, which sold its mixes under the name of Duncan Hines — soon followed suit, in a panoply of different colors and flavors.⁷¹ Sales of cake mixes more than doubled in six years, topping \$180 million in 1953, and continuing to grow (albeit at a slower rate) for the remainder of the decade.⁷²

Cake mixes have come to symbolize the compromised conveniences of 1950s processed foods. The lore that these products were saved from initial poor sales by reformulating them to require the addition a fresh egg as a sop to the housewife's guilt over her lax standard of care in the kitchen, as prescribed by Ernst Dichter's Institute for Motivation Research, has entered marketing gospel. (The reformulation is likely to have had more to do with challenges in producing dried eggs with acceptable flavor.)⁷³ But an overlooked key to understanding the proliferation of cake mixes and other dry mixes in the 1950s lies within the flavor industry, and with the concurrent introduction of a new product category: spray-dried flavors.

First introduced by American flavor companies in the early 1950s, spray-dried, or encapsulated, flavors, were a key technology for a food system where products were expected to tarry for increasing lengths of time on supermarket or pantry shelves. Spray-dried flavors promised to keep flavor from loss and change until the moment of consumption, playing a central role in shaping the sensory experience of many products

⁷¹ A detailed history of the cake mix can be found in Shapiro 2005: 68-73.

⁷² Shapiro 2005: 73.

⁷³ Shapiro 2005: 75-7.

that came to define the postwar pantry: not only cake mixes, but beverage mixes such as General Foods' Kool-Aid and Kraft's Tang, instant soup mixes, instant puddings and pie fillings, and frozen foods, as well as chewing gums and pharmaceutical products. As with many of the new products that featured in the postwar food system, the development and refinement of spray-dried flavors was catalyzed by Army food research.

As Susanne Freidberg has shown, "freshness" is a quality produced and defined by food system technologies, from refrigerated rail cars to Frigidaires.⁷⁴ Although the meaning of "fresh food" has changed with technologies of production and consumption, its value to consumers, and its association with other virtues such as authenticity, goodness, and naturalness, has remained. Spray dried flavors capitalized on this dimension of flavor, making it possible for products such as packaged cake mixes to deliver the sensual experience of "freshness"— a vivid immediacy and intensity of flavor — despite the intensive processing necessary to produce them.

Flavored powders had long been used in pharmacy, where they were known as oleo-sacchara.⁷⁵ Until the Second World War, there was not much demand for powdered flavorings. "It should be remembered that it was the ardent desire of the Quartermaster Corps to provide our Armed Forces during World War II with 'luxury' foods, in which category such items as flavored beverages, pancake sirups, candy, pastry, and desserts may be placed, not only for the nutritive well-being of our Armed Forces but also for maintaining their morale at a high level under the most adverse conditions," wrote flavor

⁷⁴ Susanne Freidberg, *Fresh: A Perishable History*, (Cambridge: Harvard UP, 2009).

⁷⁵ Jacobs 1947: 201.

chemist Morris Boris Jacobs in 1951. “Flavoring powders and tablets were very useful in the preparation of the aforementioned foods.”⁷⁶

Although beverage powders — home mixes that, when combined with water, produced a colorful, fruity beverage — had been available before the war, consumer familiarity with the product likely increased during wartime, when these mixes became a standard component of field rations as they made foul-tasting water more palatable.⁷⁷ After the war, when the exigencies that required them were tempered, these were products in search of an application. In the late 1940s, the D&O’s Flavor Department prepared a bulletin for food and beverage manufacturers on the subject of powdered flavors, including formula sheets and other advice on production methods, costs, color, packaging, and retailing, as well as guidance on meeting state and federal labeling requirements.⁷⁸ “From our own survey we believe that there is a great potential market for home drink concentrates. We hope that this bulletin will help the Food Industry to develop this market.”⁷⁹ It was clear that the company was not angling to supply a well-established need, but to promote and facilitate the growth of what it hoped would be emerging market.

⁷⁶ Morris Boris Jacobs, “How to Make Flavoring Powders,” *American Perfumer and Essential Oil Review* 57 (May 1951): 391.

⁷⁷ Franz A. Koehler, *Special Rations for the Armed Forces: 1946-1953*, QMC Historical Studies, Series II, no. 6, 1958.

⁷⁸ Dodge & Olcott Flavor Department Bulletin 130, “Suggestions for Preparing Flavor Bases for Summer Beverages, Home Drink Concentrates, Nectars, Etc.” (New York: Dodge & Olcott, n.d. [Late 1940s?]). AW Noling Beverage Literature Collection, UC Davis.

⁷⁹ Dodge & Olcott Bulletin 130: Introduction [np].

Prior to the early 1950s, powdered flavors like the ones described above were fussy and a difficult sell, necessitating special packaging and formulating practices to ensure that they retained their integrity when they reached consumers. For example, instructions for using D&O's Cosmo line of imitation flavors to prepare a sugar-based summer drink mix warned that the resultant product was "prone to absorb moisture even with the best packaging, and should be protected as much as possible. Should be disposed of as soon as possible after making, keeping stocks at a minimum. Sells best in a transparent package."⁸⁰ Even if the flavor was good when tested at quality control, the chemical changes that occurred between factory and consumer might produce a less-than-desirable impression.

Making flavors in powdered form was a challenge. Typically, liquid flavorings were combined with a dry adsorbent material such as sugar, dextrose, lactose, or cornstarch, in a powder mixing machine, and then dried on drum rollers. Depending on the weather and other factors, the process could take anywhere from ten minutes to as much as an hour, or even longer.⁸¹ This batch process had numerous disadvantages, including flavor loss, oxidative deterioration and rancidity, clumping and caking, and limited production capacity.

Worse, volatile flavor compounds continued to dissipate even after the powder was dry. A patent filed in the early 1940s by two employees of General Foods, makers of Jell-O, describes the extent of the flavor attrition with powders made using this process.

⁸⁰ Dodge & Olcott Bulletin 130: 1.

⁸¹ J.M. Wenneis, "Making Dry Flavors by Spraying," *American Perfumer* (December 1955): 48.

Making flavor powders by the standard method “requires the use of as much as four to ten times the amount of flavor actually needed in the product at the time of consumption in order to allow for the loss occurring during marketing,” they wrote. “Even with this precaution, the rate of flavor loss is so great that such products are not infrequently entirely devoid of flavor when prepared for use by the consumer.”⁸² Their proposed solution — encapsulating flavor molecules in a colloidal gelatin matrix, which was then topped with a protective film (the patent suggested cellophane or polyvinyl alcohol) permeable to water but not to flavor compounds, and dehydrated before being comminuted to form a dry powder — was effective in retaining flavor, but had limited applications due both to the high cost and physical properties of gelatin.⁸³

The crucial step to producing functional powdered flavors without flavor loss involved the adaptation of an existing technology: the spray dryer. Spray dryers were mechanical dehydrators that used high heat to convert liquids into powders. A fine mist of a liquid — such as milk, or fruit juice, or a chemical solution — was sprayed into a whirling flow of hot air in a large cylindrical drying chamber, where moisture evaporated swiftly, often within a few seconds, avoiding most thermal damage. The resulting powder funneled down the cone-shaped bottom of the chamber, where it was collected, cooled, and packaged. Spray dryers had been used since the early twentieth century to

⁸² A.G. Olsen and Edward Seltzer [General Foods Corporation], “Preparation of Flavoring Materials,” U.S. Patent 2,369,847. Filed Dec. 6, 1941. Granted Feb 20, 1945.

⁸³ James J. Broderick, “Blazing the Trail to... Superior Powdered Flavors,” *Food Engineering* (November 1954): 83.

manufacture pharmaceuticals, chemicals, and powdered milk.⁸⁴ But until the Second World War, “spray dryers were... considered novel with limited application,” commented one engineer in the 1950s. “Spray drying was tried only when other methods of drying had failed.”⁸⁵

The war renewed interest in food dehydration, which got a boost from Army Quartermaster research and investment.⁸⁶ Dehydrated foods offered various advantages to Army planners: reduced volume and weight, which meant increased portability, as well as an extended shelf life, without the metal required in canned foods. The War Department worked with the Department of Agriculture and the War Production Board to increase dehydration capacity in US factories, while the Quartermaster promoted and conducted research to improve dehydration processes and increase quality.⁸⁷ Spray drying was particularly well-suited to the production of dried milk and dried eggs, staples of the new army subsistence canteen. After the war, spray dryers were flexible, automated, and compatible with other continuous operation processes in food processing facilities, allowing manufacturers to produce larger quantities of better-quality

⁸⁴ See, for instance, US Patent 1512776A, for a “Drying Apparatus,” assigned to Gerald Lough on October 21, 1924.

⁸⁵ Ralph Reeve, of spray dryer manufacturer Bowen Engineering, quoted in Lyne S. Metcalf, “Spray Drying of Flavors,” *American Perfumer & Aromatics* (April 1955): 65.

⁸⁶ Backer 2012: 81.

⁸⁷ Backer 2012: 82-3.

dehydrated foods with minimal labor costs.⁸⁸ Spray drying was used to dehydrate vegetable purees for soups and baby foods, as well as citrus and grape juices.⁸⁹

When it came to the production of flavorings, spray drying was not just a more efficient, scalable version of batch-drying. Spray-dried flavors were materially different from earlier forms of powdered flavors, in which flavor chemicals were adsorbed by or mixed with a dry material such as dextrose. Strictly speaking, spray-dried flavors were dehydrated flavor emulsions, homogenized colloidal mixtures of flavor chemicals and non-alcoholic emulsifying agents such as vegetable gums, gelatin, and starches such as sorbitol. “Emulsion flavors” had been available since the end of the First World War. At that time, the increasing price of ethyl alcohol — as well as burdensome record-keeping requirements and other restrictions concerning its use, exacerbated by the passage of the Volstead Act — drove a search for suitable substitute media, including glycerine, vegetable gums such as gum acacia and gum tragacanth, and other relatively odorless and flavorless materials, that could produce safe, stable flavorings for various practical applications.⁹⁰ As emulsion flavors provided some advantages for certain product

⁸⁸ Metcalfe 1955: 65.

⁸⁹ Saul Blumenthal, *Food Products*, (Brooklyn: Chemical Publishing Company, 1947): 857-8, 665, 913.

⁹⁰ Melvin De Groote conducted extensive research on glycerine and flavor emulsions at the Mellon Institute in the late 1910s and early 1920s, under research fellowships funded by Procter & Gamble, the Pittsburgh Brewing Company, and the Research Extracts Corporation. His research, which provided a detailed record of the process and materials necessary to manufacture stable, quality emulsion flavors, was published in the *American Perfumer & Essential Oil Review*, *The Spice Mill*, reprinted, and reported widely in other trade journals in 1920. See, for instance, Melvin De Groote, “The Manufacture of Emulsion Flavors,” *American Perfumer*, 1920.

applications, such as beverages, flavor companies continued to manufacture and sell them even after the repeal of Prohibition.

When emulsion flavors were fed into a spray dryer, an effect was produced that would later be termed “encapsulation.” Flavor compounds were enveloped within a thin, protective capsule of the emulsifying agent.⁹¹ What this meant, functionally, was that volatile, unstable flavor molecules were guarded against loss and change, until the dry mixture was combined with water or another fluid, or sheared apart by mechanical pressure, breaking the capsule and releasing the flavor back into the realm of sensibility. This, then, was the promise: an encapsulated flavor persisted undiminished for the duration of its purgatory on the shelf, in order to deliver its full flavor payload to the consumer at the moment of consumption.

Spray-dried flavors had actually first been produced before the war, in the mid-1930s, by A. Boake, Roberts & Co (ABRAC), a venerable British essential oil and aromatic chemicals firm. The company had come upon the process by chance, while searching for ways to utilize the excess capacity of a spray dryer (purchased to dry extracts of saponin, a botanical extract used to add a foamy “head” to bottled beverages).⁹² The process was never patented.⁹³ Although ABRAC’s Drydex flavor powders had seen some success in the UK and Europe, war interrupted production and exports, and it appears that there was little awareness of the spray-drying process or the

⁹¹ Gary A. Reineccius, “The Spray Drying of Food Flavors,” *Drying Technology* 22.6 (2004): 1289-1324.

⁹² “Origin of Powdered Flavors,” *American Perfumer* (March 1956): 62-3.

⁹³ “Origin of Powdered Flavors” 1956: 63.

product in the United States flavor industry prior to the late 1940s, when manufacturing was resumed and ABRAC's Drydex flavors were first marketed in this country.⁹⁴ In the postwar, the applications of this technology were evident. An item in *Food Engineering* announcing the introduction of ABRAC's Drydex flavors to the US noted, "with this type of flavoring material, the shelf life of ready mixes, so far as flavor is concerned, can be extended greatly."⁹⁵

American flavor companies soon jumped in, and began producing their own spray-dried flavors. When Van Ameringen-Haebler introduced its line of spray-dried 'Sealva' flavors to readers of the trade journal *Food Engineering* in the early 1950s, its advertisements took care to differentiate these new products from earlier flavor powders: "Sealva processed flavors appear physically as powders, yet in reality they are minute droplets of pure flavor individually hermetically sealed." Claiming that flavor oils showed no change to their "pure fresh character" even after a year's time, the company assured food manufacturers that "Sealva flavors are protected against the ravages of oxidation and atmospheric change."⁹⁶ The result was "really 'sealed-in' flavors that defy time."⁹⁷

What this meant for manufacturers, advertisements explained, was an enhancement of the possibilities of flavor performance in their products. In gelatin desserts, Sealva Lime flavor "outlasted" competing flavors in shelf-life tests. In boxed

⁹⁴ "New Dry Flavorings Marketed by Britons," *Food Industries* 20 (May 1948): 144.

⁹⁵ "New Dry Flavorings Marketed by Britons," 1948: 144.

⁹⁶ [Advertisement; Van Ameringen-Haebler, Sealva Flavors] *Food Engineering* 26, February 1954, 143.

⁹⁷ *Ibid.*

chocolates, Sealva flavored mints “maintain their original strength and do not permeate other confections.” In pharmaceuticals, Sealva Orange provided “a pleasant permanent taste mask in powders and tablets.” And the capstone: “Sealva fruit flavors have made possible revolutionary new products in Prepared Mixes and Desserts.”⁹⁸ Foods that contained Sealva flavors delivered sensory experiences to consumers precisely as intended, in their full extension and power.

Within the decade, most of the other major flavor companies were selling their own lines of spray-dried flavors. The 1957 volume of *Food Technology* included advertisements for multiple lines of these products, including Sealva, Felton’s Felcofix, Fritzsche Brothers’ Aromalok, Givaudan’s Permaseal Flavor Crystals, and Polak Frutal Work’s Flav-o-lok.

Advertisements for spray dried flavors in food industry trade journals dramatized themes of protection and security. A 1953 advertisement for Florasynth’s “Entrapped” flavors featured an illustration of a visibly anxious man in a gray flannel suit, looking on as a masked burglar filched a segment of an orange. “Is there a FLAVOR THIEF in your house?” the advertising copy asked. Without the assurance of Florasynth’s special spray drying process, “you may have a flavor-thief and not know it. He steals the vital elements of flavor and strength.”⁹⁹ Along the same lines, a 1957 advertisement for Felton’s Felcofix flavors depicted a white-jacketed scientist at the massive circular door of a bank

⁹⁸ [Advertisement; Van Ameringen Haebler, Sealva Flavors] *Food Engineering* June 1953, 104.

⁹⁹ [Florasynth], “Is there a flavor thief in your house?” [advertisement] *Food Technology* 7 (June 1953): 13.

vault, within which floated grapes, cherries, raspberries, and strawberries. “The flavor is LOCKED-IN!” assured the headline, urging readers to insist on Felcofix flavors “for the Safety of your products.”¹⁰⁰ This invocation of “safety” was not a reference to consumer health, but to the integrity of the food’s sensory qualities when it reached the consumer. Only when flavor was reliably safeguarded, could manufacturers fully realize their investments in this aspect of their products.



Felton Flavors. “The Flavor is LOCKED-IN!” Advertisement from *Food Technology* 11, May 1957: 55.

¹⁰⁰ [Felton], “The flavor is locked-in!” [advertisement] *Food Technology* 11 (May 1957): 55.

Making effective encapsulated flavors required more than an emulsion and a spray drier. It necessitated expert knowledge and precise control over the chemical and physical properties of all components of the flavor system. Flavor companies invested in special research programs and production facilities to improve the quality and performance of their spray-dried flavor lines, and distinguish them from competitors' products. In a 1954 article, James Broderick, a flavor chemist at Givaudan, described the two-year research program undertaken by the company's flavor research and analytical laboratories to develop a proprietary emulsifying matrix, one that produced stable, soluble, and economical spray-dried flavors.¹⁰¹ A 1956 article in *Food Engineering* about Norda's spray drying operation explained the "ticklish problem" in designing flavor for spray drying. A single flavor might be comprised of twenty or thirty chemical compounds, each with different structural properties and physical constants, including a range of boiling points. Although the total loss of flavor materials during spray drying was typically under five percent, low-boiling compounds were disproportionately affected, potentially leading to an unbalanced final product. "Laboratory research and pilot plant testing are therefore requisites for initial compounding a flavor," explained *Food Engineering*. "Such study is necessary if the final dry flavor powder is to contain the flavor ingredients in exactly the proportion required — regardless of the evaporation rate of any and all of the flavoring constituents."¹⁰² Production variables, such as droplet size and dryer temperature, could also have significant effects on the ultimate sensory quality of spray-dried flavors.

¹⁰¹ Broderick 1954: 83-4.

¹⁰² "Advances in Spray Drying Improve Flavor Quality," *Food Engineering* 28 (February 1956): 77-8.

As these examples show, flavor companies such as Givaudan and Norda were not only conducting research into aromatic chemicals, but also into materials and machinery corresponding to flavor delivery and performance. That is, flavor was part of a system of material relations within a food product, intended toward a more precise orchestration of ultimate consumer experience.

Spray-drying promised flavor that “defied time,” that could persist on the shelf, delivering its full sensual payload to the consumer only at the moment of consumption. Flavor encapsulation can be considered as a method of preservation, in the same category as other technical interventions intended to extend edibility, such as curing, canning, pasteurization, and freezing.¹⁰³ In other words, it was a technology for controlling time — and it operated both by forestalling time’s deleterious effects on food quality, as well as by extending the manufacturer’s control over the sensory qualities of food over the duration of its temporal life.

But spray-dried flavors were also a technology that, like other forms of packaging, did more than preserve sensation — they permitted new intensifications, mobilizations, and commodifications of experience.¹⁰⁴ In their enlightening history of packaging technologies, Gary Cross and Robert Proctor describe the container’s evolution from a means of storing sensual surplus to a mechanism for re-engineering the

¹⁰³ Ronald Versic, “Flavor Encapsulation: An Overview,” in Sara J. Risch and Gary A. Reineccius, eds. *Flavor Encapsulation*, ACS Symposium Series 370, 1988, p. 2.

¹⁰⁴ Gary S. Cross and Robert N. Proctor, *Packaged Pleasures: How Technology and Marketing Revolutionized Desire*, (Chicago: UChicago Press, 2014).

scale and scope of sensory experience, “optimizing” sensations for bodies increasingly calibrated to receive these new intensities. By understanding spray-dried flavors in the context of other forms of modern packaging, we can see how these technologies liberated flavors from adherence to the boundaries of the natural, and inserted them in “new worlds of sensory access, speed, and intensity.”¹⁰⁵

Spray-dried flavors promised to extend food manufacturers’ control over the sensory qualities of their products, in pursuit of an ideal scenario where the flavor never changed, where a company’s investment in flavor value never depreciated.

A TASTE OF FAILURE: AEROSOL FOODS

Investment in research and development did not always lead to commercial success; consumers proved themselves resistant to new food technologies’ promises of convenience, novelty, and stylish modernity, if they failed to yield calculable advantages in the context of existing technosocial frameworks of food consumption.¹⁰⁶ Givaudan’s Aerosol Research Laboratories offer a case study in a technology’s failure to find a place in consumers’ grocery carts and daily habits, despite sustained and coordinated efforts among container, chemical, and food manufacturers to develop, improve, and promote pressure-packaged food products.

¹⁰⁵ Cross and Proctor 2014: 14.

¹⁰⁶ Ruth Schwartz Cowan, “The Consumption Junction: A Proposal for Research Strategies in the Sociology of Technology,” in Wiebe E. Bijker, Thomas P. Hughes, and Trevor J. Pinch, *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology*, (Cambridge: MIT Press, 1987): 261-80.

The aerosol, or pressurized, container is yet another example of an existing technology given a boost by wartime investment in research and production, later adapted for the consumer market in peacetime. Patents for pressurized packaging, containing both the product and the propellant necessary for its expulsion, date back to the 1860s. In the 1930s, patents were granted for spray-nozzle systems using dimethyl ether, a liquefied gas, as a propellant. A range of products, including lacquers, rubbers, insecticides, fertilizers, fire extinguishers, and cosmetics, became available in these containers, which allowed the user to apply a steady stream or mist of the product over a certain area. In addition to ease of use, these containers could deliver sensory benefits as well; eau de cologne, sprayed from a pressurized container, produced a cooling effect on the skin because of the expansion of the added condensed gas.¹⁰⁷

During the Second World War, soldiers deployed overseas, especially in the Pacific theater, were pestered and sickened by mosquitos and other stinging insects. USDA research into insect control led to the development of a powerful portable aerosol dispenser, the “insecticide bomb,” a heavy metal canister topped with a spray valve, which expressed a mist of bug-killing liquid, propelled by dichlorodifluoromethane. “Although relatively cumbersome,” observed one textbook on aerosols, “they were accepted with relief by members of the Armed Services who were thus introduced to a method of packing which was destined to become a significant feature of peacetime life.”¹⁰⁸ The government’s research became the basis of a public patent, and the heavy-

¹⁰⁷ A. Herzka and J. Pickthall, *Pressurized Packaging (Aerosols)*, 2nd ed. (New York: Academic Press; London: Butterworths, 1961): 2-5.

¹⁰⁸ Herzka and Pickthall 1961: 6-7.

gauge dispensers came onto the market in 1945, subsequently ushering in lighter, cheaper, easier-to-use canisters that, by the middle of the next decade, were used to pack a rapidly expanding range of substances, including roach killers, spray paints, room deodorizers, shaving cream, sun-tan lotions, athlete's foot remedies, and "Christmas snow."¹⁰⁹ According to a survey conducted by DuPont, one of the largest manufacturers of chemical propellants, in 1955, just a decade after their widespread commercial introduction, 91 percent of American families bought and used aerosol products, which saw sales of nearly \$200 million.¹¹⁰ In 1961, boosted in part by the outrageous growth in sales of hairsprays and laundry starches, retail sales of non-food aerosols topped one billion dollars.¹¹¹

In this climate of galloping growth, food in disposable aerosol containers seemed to be a potential moneymaker. One of the first widely successful aerosol products was whipped cream, which effortlessly emerged from the canister fluffy and aerated with nitrous oxide. Thirty million containers of whipped-cream topping sold in 1949, the product's first year on the market.¹¹² Although the rate of growth of whipped-cream topping subsequently slowed, savvy market watchers saw huge potential profits at the intersection of two rapidly expanding postwar industries, aerosols and processed

¹⁰⁹ Ibid; "Markets: Aerosols Reaching New Highs," *Chemical & Engineering News*, (December 19, 1955): 5518.

¹¹⁰ "Markets: Aerosols Reaching New Highs," 1955: 5518.

¹¹¹ "Markets: Aerosols Crack Billion-Dollar Mark," *Chemical & Engineering News*, (May 21, 1962): 36-7.

¹¹² "Aerosols and the Food Industry, Part I: Beverages," *The Givaudan Flavorist* 1 (1957): 1.

“convenience” foods. They envisioned a dawn of “push button” cuisine, where “entire meals... can be oozed forth by a gentle push on a few cans.”¹¹³

Aerosols posed multiple unique challenges for food manufacturers, who had to confront problems that makers of non-food aerosols did not. The container, the nozzle, and the propellant all shaped the sensory qualities of the product, which had to be specially formulated to suit these packaging conditions. “You just can’t put an existing [food] product in a can,” said one aerosol industry expert in the 1960s. “The product must be born in the can.”¹¹⁴ But the can also had to be born for the product; both the propellant dispensing valves and the nozzle had to be designed to allow for the easy and complete dispersal of foods that varied in composition, viscosity, and reactivity.¹¹⁵ New delivery systems had to be developed to suit these needs, such as the Mira-Flo “free piston” container, developed in the early 1960s by the American Can Company’s Aerosol Division, and the Sepro “bag-on-valve” system, which came out of the Continental Can Company’s research laboratories. These containers completely separated the propellant from the product by means of a polyethylene diaphragm, minimizing chemical activity

¹¹³ Sam Dawson, “Aerosol Sprays of the Future to Do Almost Anything,” *Toledo Blade* [Associated Press], August 12, 1964, 55.

¹¹⁴ Earl V. Anderson, “Food Aerosols,” *Chemical & Engineering News* (May 2, 1966): 94.

¹¹⁵ Aerosols perfectly staged the intimate interrelationship between container and the thing contained that emerged in the postwar period: processed food’s dependence on its package, which, in the case of aerosol food, was integral to its very identity.

between food and propellant, and making it possible to pressure-pack high viscosity foods such as cake frosting and cheese spreads.¹¹⁶

Further, while makers of products such as aerosol hairspray and roach killer used light, powerful fluorinated hydrocarbons as propellants, food manufacturers were limited in their choice of propellant. Propellants for food aerosols were required to be nontoxic, but they also had to be odorless and tasteless. They also had to allow the product to be dispensed in a form and consistency compatible with consumer expectations, and to permit complete evacuation of the container's contents.¹¹⁷ Until 1961, when the FDA approved Dupont's Freon C-318 for use in foods, manufacturers were restricted to three gases: nitrous oxide, carbon dioxide, and nitrogen.¹¹⁸

Givaudan made an early bet on the future of aerosol foods. The company began working on aerosols in the late 1940s, setting up the first laboratory in the flavor industry to study the problems of flavoring pressurized foods. In 1959, the company expanded its aerosol research capacities, making its Aerosol Laboratory a centerpiece of its new research facilities and headquarters in Manhattan.¹¹⁹ "It is quite evident that the aerosol container will be widely used in the food industry in the not too distant future," predicted

¹¹⁶ John J. Sciarra, "Types of Aerosol Systems," in Sciarra and Leonard Stoller, eds., *The Science and Technology of Aerosol Packaging*, (New York: Wiley, 1974): 50-5; Gordon L. Robertson, *Food Packaging: Principles and Practice*, (New York: CRC Press, 1998): 201-2.

¹¹⁷ Jerry Di Genova, "Food Aerosols," *The Givaudan Flavorist* 2 (1963): 2; Herzka and Pickthall 1961: 177.

¹¹⁸ "FDA Approves Freon Propellant for Foods," *Chemical & Engineering News* (October 16, 1961), 26.

¹¹⁹ "New Laboratories, New Testing Kitchen for Flavor Development Work at Givaudan," *Food Technology* (May 1959): 48.

a 1957 article in the *Givaudan Flavorist*. “The huge success of this packaging medium in other fields can certainly be duplicated, if not bettered, in the food field, and we are prepared to work closely with food manufacturers to achieve this end.”¹²⁰

Givaudan was certainly not alone in predicting a bright future for push-button cuisine. Canning companies, including American Can, Continental Can, and Crown Cork and Seal, developed new aerosol-ready food containers, and also sponsored symposiums on food aerosol technology and marketing.¹²¹ DuPont, which manufactured the only fluorocarbons approved for use in foods, actively promoted the development of new food aerosols by formulating recipes in the company’s food laboratory, creating new packaging concepts, refining filling techniques, and conducting extensive market research on food aerosol products, which it eagerly shared with food manufacturers.¹²² Givaudan fashioned itself as both a knowledge-broker and necessary intermediary, with its Aerosol Laboratory poised to coordinate among the various industries involved in the production of pressurized foods. “Every known type of can, valve and seal is available,” assured an article in the *Givaudan Flavorist*, “and the aerosol laboratory flavor-chemist is in constant contact with the various manufacturers so that all new components parts can be obtained even before they are actually released for sale.”¹²³ The laboratory also had supplies of “every commercial propellant and mixtures of propellants” as well as new

¹²⁰ “Aerosols and the Food Industry, Part I: Beverages,” 1957: 3.

¹²¹ Anderson 1966: 99.

¹²² Anderson 1966: 94.

¹²³ “Come With Us to Manhattan: A Visit to Our New York Headquarters,” *Givaudan Flavorist* 4 (1959): 5.

propellant chemicals that were still in development, such as Dupont's Freon gases.¹²⁴ Specially designed equipment allowed the company to perform accelerated shelf-life testing, which meant that the Givaudan laboratory personnel could superintend every stage of product development.

This coordination was integral to the company's core business strategy, as it positioned itself to be the go-to source for flavorings for these new products, a necessary point of passage for any of the industrial actors seeking success in this category. Rather than supplying one component for a pre-existing product — a component that could be replaced by a competitor — Givaudan's Aerosol Laboratory positioned the company to be centrally involved in the new product development process, partnering with food manufacturers from the outset. This strategy was not limited to Givaudan or to aerosols, but reflects a broader trend in the evolution of the relationship between the flavor and food industries at this time. New kinds of highly processed foods necessitated the experience and technical skills of flavor chemists, and so the companies that employed them had an interest in promoting the adoption of these products and their success in the marketplace.

Articles in the *Flavorist* promoted Givaudan's expansive vision for food aerosols as a transformative product category, even as pressure-packed products continued to flounder in the market.¹²⁵ In 1963, Jerry Di Genova, the administrator of the company's

¹²⁴ "Come With Us to Manhattan" 1959: 4-5.

¹²⁵ Five articles with aerosols as their explicit subject appeared in the *Flavorist* between 1957 and 1966. Many other articles mentioned the aerosol laboratory in passing, or the

flavor labs, restated an oft-repeated prediction that “new foods will be created just for this packaging medium as was the hair fixative [ie, hair spray] among the non-food aerosols; or perhaps food combinations that have been previously packaged separately will now be pressurized together.” He offered suggestions: “Why not a cream cheese jelly mix ready to put on bread or crackers? Or perhaps specially prepared baby formulas ready to mix with water or milk? We can only guess what food aerosol research will bring.”¹²⁶ Indeed, “the application of aerosols to foods is almost limitless, controlled only by the imagination of the food technologist and the stability and formulation limitations of some individual products.” The category’s continuing lack of success was due not to technical incompetence or high prices, but rather, a “lack of imagination on the part of processors and marketers” and a “failure of key executives among major food marketing firms to visualize their products in pressurized packages.” A final article on the subject, in 1966, continued to insist that food aerosols were a revolutionary product category, “completely revising and changing methods of eating which have gone on for centuries.” Although the promise of food aerosols had yet to be realized, although numerous aerosol food product launches had crashed and burned, and although consumer resistance to novelty and higher prices still needed to be surmounted, Givaudan continued to insist that “the far distant future presents possibilities which are unlimited. The future for food aerosols is, indeed, bright.”¹²⁷

company’s specialized aerosol flavors for beverages, pharmaceuticals, and other products.

¹²⁶ Jerry Di Genova, “Food Aerosols,” *Givaudan Flavorist* 2 (1963): 2, 4.

¹²⁷ “Food Aerosols: The Present and the Future,” *Givaudan Flavorist* 2 (1966): 8.

Ultimately, despite innovations in containers, products, and propellants, aerosol foods never lived up to the high expectations of industry boosters. Even as the variety of non-food aerosol products expanded, with sales racing higher and higher through the 1960s, food aerosols continued to languish, with some short-term faddish successes, but repeated product failures.¹²⁸ In 1966, *Chemical & Engineering News* published an extensive investigation of the disappointing sales and uncertain future prospects for food aerosols. The technical challenges of designing containers and valves, formulating products, and successfully marketing them, combined with higher costs to the consumer, imposed steep barriers to success that only the largest food companies seemed to have the resources to tackle. Besides, there remained a resistance among consumers toward food in a packaging form that still suggested insect repellent. Instead of revolutionizing food production, aerosols found uses in certain marginal products, such as spray cheese. A 1971 news article quoted an aerosol valve manufacturer's lament that whipped cream had so far been the only real success for food aerosols. "All the other attempts to use aerosols for foods have pretty much petered out for one reason or another."¹²⁹ With the growing scientific consensus around CFCs damage to the ozone layer, and subsequent state and federal regulations phasing out non-essential uses of the chemicals to package aerosol products by 1979, the prospects for aerosol products of all types dimmed.¹³⁰

¹²⁸ These failures included some products touted by Givaudan in issues of the *Flavorist*: Whisp, a spray vermouth that was one of the first food products to use Freon C-318; Pet Milk's "Big Shot" aerosol chocolate milk flavor; and Sizzl-Spray, an aerosol barbeque sauce that corroded cans.

¹²⁹ "Aerosol Foods Sought," *Beaver County Times* [UPI], July 16, 1971, 4.

¹³⁰ "Hard Times Hurt Aerosol Industry," *Chemical & Engineering News* (May 19, 1975): 8; "Two Federal Agencies Rule on Fluorocarbons," *Chemical & Engineering News* (Nov

The push-button future that aerosol foods promised, one of effortless convenience, never arrived, despite the best efforts (and substantial investments) of its advocates and promoters. Because its qualities were profoundly affected by every aspect of the product and container, flavor was an integral consideration in the development of new kinds of foods. Even though the category of aerosol foods failed to launch, Givaudan's central and coordinating role in the research, development, and manufacture of push-button-cuisine was typical of the flavor industry's role in the creation of new kinds of food products.

A WORLD OF FLAVORS: FROZEN FOOD SPECIALTIES AND CONSUMER APPETITES AT THE TWILIGHT OF THE MASS MARKET

The 1950s, the golden age of the consumer mass market, was also its twilight. The proliferation of brands, products, and buyers resulted in tremendous economic growth, but also intensifying competition and declining margins. Even as the middle class expanded and broadened its contours, the mass market that supplied these consumers with the material accoutrements of postwar prosperity seemed on the verge of imploding, a victim of its own supersaturated density.¹³¹

29, 1976): 5; "Phaseout Set for Fluorocarbon Aerosols," *Chemical & Engineering News* (May 16, 1977): 4.

¹³¹ An authoritative account of the decline of the mass market and the rise of market segmentation can be found in Lizabeth Cohen, *A Consumer's Republic: The Politics of Mass Consumption in Postwar America*, (New York: Knopf, 2003): 292-344. Thomas Hines provides a portrait of the cultural style of the consumer mass market in its heyday in *Populuxe* (New York: Knopf, 1987).

In the second half of the 1950s, a new commercial strategy began to be articulated: market segmentation. Rather than vying for the dollars of the averaged American, some business strategists descried untapped potentials on the market's fringes, profits that could be realized by attending to buyers and desires hitherto excluded from normalized models of middle-class preferences. As Lizabeth Cohen explains, "the move from mass to segmented markets promised greater, steadier profits through expanding the pool of potential consumers: a wider variety of products, each tailored to a specialized population, would create more buyers in total and less cutthroat competition to win them."¹³² This strategy provoked a substantial reimagining of the American populace. Advertisers and marketers, drawing on consumer psychology and recent sociological research, began to depict the American public as an aggregate of discrete psychographic segments, each driven by its own particular motivations, each seeking to gratify its own incommensurable needs. The normative white middle-class housewife, long the primary object of concern for market researchers and food company executives, was joined in the pantheon of target audiences by teenagers, African-Americans, white ethnic communities, and other discrete demographic tranches, to form the big, variegated pie of the segmented American consumer market.¹³³

¹³² Cohen 2003: 298.

¹³³ The normative "Mrs. Consumer" was herself a construction, an abstraction forged from social scientific research in the interwar decades, and fleshed out by advertisers, marketers, and industrial designers who shaped their messages and products around her imagined needs. A case study that illustrates how the ideal servantless middle-class housewife was configured into, and produced by, the design standards for consumer technologies can be found in: Shelley Nickles, "'Preserving Women': Refrigerator Design as Social Process in the 1930s," *Technology and Culture* 43.4 (October 2002): 693-727.

This kind of market segmentation, Cohen points out, was also made possible by changes in technologies of production. While the move to mass production in the early twentieth century was driven in part by a quest for economies of scale, by the mid-1950s, new manufacturing technologies, including new ways of managing information, had reduced the size of the minimum efficient manufacturing unit, and lowered the bar for the development and introduction of new consumer products. “More and more manufacturers,” she writes, “faced with crushing mass market competition and armed with new technological capabilities, would embrace small batch production as their salvation.”¹³⁴ In other words, frozen food manufacturers could charge a premium for specialty products, and retain more of those profits, as production costs decreased for batch-manufactured goods.

Shane Hamilton has described how the shift from mass to segmented market played out in the frozen food industry.¹³⁵ At the beginning of the 1950s, frozen foods were the fastest growing segment of the food business, as manufacturers supplied quality, low-cost staples to an American mass market — albeit a market whose needs were rather narrowly conceived, to coincide with those of the white, middle-class suburban housewife. By the end of the decade, growth had slowed, leading to a reconsideration of market strategies. Frozen food manufacturers “abandoned the idea of selling a cross-class staple product to the ‘average’ American,” and instead developed products and strategies to appeal to market segments, including working-class urban black communities, ethnic

¹³⁴ Cohen 2003: 306.

¹³⁵ Shane Hamilton, "The Economies and Conveniences of Modern-Day Living: Frozen Foods and Mass Marketing, 1945-1965," *Business History Review* 77 (Spring 2003): 33-60.

and religious populations, and affluent consumers.¹³⁶ In the early 1960s, for instance, Birds Eye began touting a line of “Southern vegetables,” including okra and collards. Elsewhere in the frozen food aisle, “Noah Zark” kosher frozen pizza nestled against frozen knishes, while petite frozen onions in cream sauce made their pitch to well-heeled shoppers willing to pay a premium for luxury foods.¹³⁷

The flavor industry played a crucial role in supporting and enabling this shift from the high-volume production of mass market goods to the batch production of specialties. This is especially evident in the frozen food aisle. As has been discussed, in the postwar decades, flavor companies developed additives that were designed to be readily integrated into existing manufacturing processes, reducing the product development costs borne by food manufacturers and simplifying the expansion of existing product lines and the development of new ones. The 1956 Dodge and Olcott (D&O) flavor catalogue, for instance, was divided into sections that discussed different product lines developed for canned foods and condiments, frozen foods, diet foods, pet foods and animal feeds, oral care products, among others. A glance at D&O’s Spisorama dry soluble flavors developed for the frozen food industry (“one of the newest and most versatile flavoring developments of many years”) reveals the variety of cuisines and dishes represented: in addition to Spisorama seasonings for frozen “Bar-B-Q Beef” and fish sticks, manufacturers could purchase flavors for frozen “Kosher specialties” (“blintzes, knishes, baked stuffed cabbage, etc.”), Italian foods such as lasagna, ravioli, and eggplant

¹³⁶ Hamilton 2003: 35.

¹³⁷ Hamilton 2003: 56-9.

parmigana [sic], Mexican and Southwestern foods such as tamales, enchiladas, and chili con carne, and Chinese foods including egg rolls and chop suey.¹³⁸

Even as marketing experts classified the nation's various appetites in order to guide product development strategies, the fragmentation of consumers along these same lines was not a given outcome. This is particularly evident in the case of "nationality specialties," a newly created category of canned, frozen, and other processed foods that popularized certain "ethnic" dishes and styles, particularly from Chinese, Mexican, Italian, and Jewish cuisines. The 14-ounce "Mexican-style" frozen dinner (enchiladas, "Spanish rice," beans, and chili, along with a "little container of hot sauce in each package") manufactured by the Circle T Meat Company of Dallas was intended to nourish more than just Mexican-American households; Damiano's complete line of frozen Italian specialties offered "a touch of old Italy" to those whose bloodlines bore no trace of Naples or Sicily. (Indeed, the company's frozen manicotti with meat sauce was described parenthetically as "Italian cheese blintzes," offering a helpful guide for cross-cultural noshing.)¹³⁹ Chun King's canned Mushroom Chow Mein ("in Flavor-Guard

¹³⁸ [Dodge & Olcott], *The Changing World of Food*, Reprinted from 1955 and 1956 issues of the D&O News, the monthly publication of Dodge & Olcott, (New York: Dodge & Olcott, 1957): 12-14. [From A.W. Noling Collection, UC Davis Special Collections]; [Dodge & Olcott] "1956 Dodge & Olcott Reference Book and Catalogue of Flavors and Seasonings," (New York: Dodge & Olcott, 1956): 63.

¹³⁹ A description of the Circle T "Mexican-style" frozen dinner, and an advertisement for Damiano's line of frozen Italian specialties, can be found in *Quick Frozen Foods* (December 1957): 86.

Divider-Pak®”) was a “hearty meatless dish” advertised under a headline promising “Oriental Food” as a “New Mood for Lenten Meals.”¹⁴⁰

“While mass production is the economic law of the land,” the 1956 D&O catalog counseled, “specialization is the accepted merchandising formula and it is toward this twin goal... development of an individual product that can be produced and sold to a mass market... that the creative talents and energies of the D&O Flavor Chemists and technical staff are projected.”¹⁴¹ In other words, specialty flavors were not designed to satisfy only niche appetites. They were developed for, and marketed towards, a broader cross-section of Americans — a reconstitution of the mass-middle as a group that was increasingly oriented toward personalized products and consumption as a form of self-expression and differentiation.¹⁴²

“Zooming sales of National Specialties in canned, frozen and dry mix or combination form indicate a vastly increased American interest in the culinary delights of other peoples,” ran an advertisement touting D&O’s specialty flavors in a 1957 issue of the trade journal *Food Technology*. “But here indeed the flavor must be right! If it isn’t, despite the lure of exotic names and places, Mrs. Housewife will not buy a second time. The general popularity of National Specialties can often obtain your first sale... the

¹⁴⁰ “American-Oriental Food News,” [advertisement], *Detroit Free Press* (March 26, 1957): 28.

¹⁴¹ [Dodge & Olcott] “1956 Dodge & Olcott Reference Book and Catalogue of Flavors and Seasonings,” (New York: Dodge & Olcott, 1956): 7. [AW Noling Collection, UC Davis]

¹⁴² Thomas Frank, *The Conquest of Cool: Business Culture, Counterculture, and the Rise of Hip Consumerism*, Chicago: UChicago Press, 1997.

second and all thereafter can only be insured by a quality product that lives up to the family's highest expectations."¹⁴³

For food manufacturers and flavor companies in the postwar, “getting the flavor right” meant something other than what we now know as cultural “authenticity,” one of the most highly valued and fiercely contested attributes that a food can claim to possess.¹⁴⁴ In the case of “Chinese, Italian, and other foreign specialties,” these cultural styles, and historic cuisines, were rendered as additives that could be applied at will to similar basic ingredients, producing the sensory experience of variety, difference, spice, and novelty.¹⁴⁵ In other words, the version of these “traditional” dishes offered by the frozen food industry was distinct from the “originals” — just as other factory produced foods had always been different than home-made versions. But if reference to ‘authentic’ or original models was not the goal when designing the sensory qualities of flavor

¹⁴³ “National Specialties Rate High in the Changing World of Food,” [advertisement], *Food Technology* 11, August 1957: 17.

¹⁴⁴ There is a vast historical, sociological, and anthropological literature on the meaning of authenticity in cuisine, with culinary authenticity generally defined either as a (dynamic) principle that constitutes cultural coherence, or as a valuable designation constantly in threat of being co-opted by commercial forces. See, for instance, Lisa Heldke, “But is it Authentic? Culinary travel and the Search for the ‘Genuine Article,’” in Carolyn Korsmeyer, ed. *The Taste Culture Reader: Experiencing Food and Drink*, (London: Berg, 2007); Josee Johnstone and Shyon Baumann, *Foodies: Democracy and Distinction in the Gourmet Foodscape*, (New York: Routledge, 2014); Meredith E. Abarca, “Authentic or not, It’s Original,” *Food and Foodways* 12 (2004): 1-25.

¹⁴⁵ Describing the expansion of ethnic fast food chains in the 1970s, Warren Belasco notes that most “ethnic” dishes developed for mass consumption were based on familiar dietary staples — ground beef, chicken, fish filet, cheese — and contained few unfamiliar ingredients. He also asserts that companies favored conservatism in spicing, in particular, to avoid unsettling the taste buds of children, an important growth market. Warren Belasco, “Ethnic Fast Foods: The Corporate Melting Pot,” *Food and Foodways* 2 (1987): 1-30.

additives and frozen meals, what guided product development decisions? How did flavor and food manufacturers know whether they had gotten the flavor “right”?

The flavor industry’s investment in research, and in the development of new processes and products, made possible some of the commercial triumphs of the postwar era. The flavor industry obliged food processors with new kinds of products, expanding the scope of what was possible in packaged foods, as well as shaping consumer expectations about how these foods should taste. The following chapter examines the sensory tools that were used to describe and measure the “flavor profile” of foods, to captivate the appetites of American eaters.

CHAPTER 5

DESIGNING FLAVORS FOR MASS CONSUMPTION: THE FLAVOR PROFILE

Television viewers in early October, 1952, tuning into the latest episode of the science fiction anthology series, *Tales of Tomorrow*, would have witnessed a powerful fable about the perils and promises of food technology.¹

“Substance X” opens in the interior of a working-class Queens apartment. Brassy, blonde Salena Marshall, an employee at a cannery, is hanging her nylons up to dry in the living room when she is interrupted by a knock on the door. It is Jerry Carmichael, a “business consultant” representing certain unnamed food industry clients. He has a proposition for her.

Salena, it turns out, is the only person in the entire country with a living relative in Whitman City (population 89), a “small, rural community” on the Gulf of Mexico — “*Small rural community!*” Salena squawks. “Ha! That place is a dump!” — where she was born in 1926, and left behind without a backward glance in 1943. To the consternation of the food industry, the people of Whitman City have recently stopped buying their products, and have responded with hostile secrecy to any inquiries from outsiders. “What are they living on?” Carmichael asks. “If they’ve developed or

¹ *Tales of Tomorrow*, “Substance X,” Season 2, Episode 7, Written by Frank Felitta, ABC, October 3, 1952. Featuring Vicki Cummings as Salena, James Maloney as Carmichael, Charlotte Knight as Salena’s mother, Cora, and Will Kuluva as Samuel. Tremendous gratitude to Mark Martucci, who shared recordings of this and other difficult-to-locate *Tales of Tomorrow* episodes from his personal collection.

discovered a new food, we must know about it.” Carmichael implores Salena to return home, find out what the town is living on, and abscond with a sample of this “new food” for analysis. She accepts the mission reluctantly, only upon Carmichael’s promise of a big payout.

The shabby Gulf town has become even more derelict in her absence. Her former home is in extreme disrepair — cupboards cobwebbed, broken, and bare, and her mother a frail, distracted specter who at first seems not to recognize her, and then responds with a maudlin excess of sentiment at her return. Salena asks for something to eat. Her mother says they must see Samuel, a “great scientist,” for provisions... but Samuel’s figure already darkens doorway. He has a round face, a dark mustache, a high, furrowed brow, and in a plummy voice he gives his blessing: Salena may be fed.

Her mother offers Salena a quivering cuboid of pale loaf that has the appearance and apparent density of angel food cake. Salena recoils from the “filthy junk” that her mother calls ‘manna’ but that Samuel calls ‘Substance X.’ “I said I was hungry for food; not that!” Her mother assures her that it is food, “whatever kind you want.”

Samuel: *“Steak or a roast. Pork, lamb, or veal. Or strawberries in December. Caviar or kale. It’s anything you have ever tasted before.”*

Salena (taking a handful): *“Yeah! It is a steak. A big, thick, juicy steak.... Strawberries!”*

Samuel: *“It’s sweet, it’s sour, it’s anything you want it to taste like. It’s everything and anything you want it to be.”*

The next scene finds Salena and Samuel in the brick building where he churns seawater into Substance X through a low-slung contraption of gears and alembics. (A stack of boxes in the corner bear the familiar labels of Domino's Sugar, Kellogg's, and Lipton's; when pressed, Samuel admits that as the lone remaining "control" in the experiment, he refrains from partaking of his creation.) Substance X, Samuel tells Salena, is a combination of "minute [aquatic] plants" and "other chemical ingredients which I add to it." It is these chemicals that transform Substance X from a nutritious slurry to a delicious one. He explains the principle to Salena:

"When you eat something, the taste buds under [sic] the tongue send an impulse to taste centers in the brain. The brain in turn identifies the food as sweet, sour, bitter, or salty. Now, Substance X just reverses the procedure. It is the brain that sends the suggested impulse to the taste buds. So you see, in that way, Substance X is able to taste like anything the brain remembers."

In other words, the flavor of Substance X is not an inherent quality of the substance, but derives instead from memory and desire. The chemicals added to it create flavor not by triggering definite sensory effects, but by reconfiguring the human sensorium to conform perceptions to appetites.

"You know if you put this stuff in a box, you could make a million dollars!" Salena bumbles. But Samuel is not interested in money. He has a utopian vision of abundance, where the problem of subsistence is solved, as people feed on the nutritious, cheap, and plentiful Substance X. Indeed, since beginning their new regimen, the

townspeople's "physical condition has improved tremendously, and they have become immune to all diseases."

However, there was an unanticipated consequence of Substance X's technological perfection. "So long as there's plenty of Substance X to be had for the asking, why work?" Samuel laments. The town has lost its ambition and incentive, the labor of its citizens has become "callous and slipshod, their habits have degenerated to those of animals." Samuel implores Salena to join him, and somehow use her influence to "rebuild their confidence... bring them out of this mental torpor... [and] restore their sense of pride." She refuses his request, flees his laboratory and her hometown, plundering a hasty handful of Substance X in her suitcase as evidence.

The program then cuts to an urbane restaurant back in New York City, where Salena finishes recounting her story to Carmichael, the business consultant. This sets up the tale's cruelest twist. As Salena tucks into her steak, murmuring, with genuine relish, "Why, doesn't that look wonderful! You can give me the good old-fashioned kind every time," a dissonant chord strikes. Her face registers disgust and disbelief. She spits it out, shoves her plate from the table. It tastes like poison. Having once sampled Substance X, she can no longer tolerate anything else. The episode ends with her return, in tears, to Whitman City, crying: "Mamma! I'm hungry!"

"Substance X" captures an ambivalence that thrummed throughout the Cold War, an ambivalence that flared into acute anxiety when technologies produced consequences

that proved to be more catastrophic than the problems they claimed to solve. This was a moment when dazzling displays of postwar abundance coexisted with escalating warnings about population growth outstripping available resources, when limitless progress and total annihilation were both latent in the same shaking atom.

Samuel's communitarian ideals of food for all, and the food industry's ambitions of total market domination, converge upon the same thing: flavor. "Substance X" reflects an ideal of flavor that was just beginning to be articulated. Beyond the synthetic replica that transgresses nature's limits of season and supply — "strawberries in December" — "Substance X" expresses the dark fantasy of an ideal flavor experience that conforms not to the given outlines of nature, but to the desires of eaters, by acting upon the intimate mechanisms of sensation and perception themselves.

HOW SHOULD OUR FOOD BE MADE TO TASTE?

As discussed in Chapter 4, the war's end marked a new era of "flavor consciousness" among the manufacturers of America's processed and packaged foods and beverages. "All food processing," concluded one textbook on the subject, "must necessarily be governed by the flavor of the marketed product. The consuming public will eat anything it likes regardless of the price, but will not eat anything it does not like even though its food value is higher and its cost is lower." Nutrition, cost, value,

convenience, were all ultimately secondary considerations. “The taste’s the thing.”² Flavor joined other technics of consumer persuasion and inducement — advertising, packaging, retailing — as a means by which food manufacturers courted that elusive goal: repeat sales.

But what principles should guide a company’s flavor design and development decisions? What should processed foods be made to taste like? What made a flavor *good*?

In 1953, Loren “Johnny” Sjöström and Stanley Cairncross, two chemists working in the Food and Flavor laboratories of Arthur D. Little, Inc. (ADL), a venerable Cambridge, Massachusetts contract research and consulting firm, published a paper in the journal *Food Technology* that promised to resolve these disputes over matters of taste by technical means.³ Some food products, the authors observed, were not only more popular than their competitors, but were runaway best-sellers, outselling their two nearest rivals combined. Cases of exemplary “flavor leadership” could be found throughout the supermarket: from condiments to gelatin desserts, there was one product whose sales figures (and, presumably, taste appeal) eclipsed all the rest. Just as there were personality characteristics that “naturally” suited some men for the leadership of corporations or of nations — traits and habits that could be identified and cultivated — Sjöström and Cairncross alleged that there were sensory qualities that made some foods stand apart from their peers in their ability to gratify the desires of mass consumers.

² Kenneth M. Gaver, “Unit Operations and Processes, Part I,” in Morris B. Jacobs, ed. *The Chemistry and Technology of Food and Food Products, Vol. II*, (New York: Interscience, 1944): 5.

³ L.B. Sjöström and S.E. Cairncross, “What Makes Flavor Leadership?” *Food Technology* 7 (1953): 56-8.

The tool that could determine the “common denominator[s] of quality” shared by all market-leading foods was the one that Sjöström and Cairncross had helped develop: the flavor profile. First introduced in the late 1940s, the flavor profile was both a technology of flavor measurement and a powerful tool for flavor design — one that claimed the unique ability to detect and predict the qualities that would make a flavor successful among consumers. Produced by a specially selected, highly trained sensory evaluation panel, a flavor profile was understood to be an accurate, comprehensive record of a substance’s subjective sensory qualities. Rapidly adopted in both industry and academy, it came to form a key part of what Steven Shapin has described as the “vast complex of technical resources that help shape not just our alimentary environment, but also practically everything that is commercially formulated, designed, and marketed.”⁴

The context of the flavor profile’s creation, and the particular set of problems that it was meant to address, illuminates not only a crucial moment in the industrialization of the food system, but also the means by which the subjective qualities of food came under the aegis of technical control and design. The flavor profile configured the sensory and material qualities of flavor into a new kind of scientific object, and provided a framework for understanding (and attempting to manage) the actions of sensible materials upon sensing subjects. This chapter begins by detailing the formation of the flavor profile as a standard tool of flavor measurement and design. I situate the emergence of the flavor profile within a matrix of manufacturers, consultants, chemists, sensory scientists, consumers, and chemical materials in postwar America. I then examine how the flavor

⁴ Steven Shapin, “The Sciences of Subjectivity,” *Social Studies of Science* 42.2 (2011): 179.

profile's model of successful flavor has shaped not only the way foods are made to taste, but also configured a particular set of relations between sensible goods and sensing subjects into the design of things.

“A CONCEPT OF FLAVOR AND A METHOD FOR MEASURING IT:” THE ORIGINS OF THE FLAVOR PROFILE

When Sjöström and Cairncross introduced the flavor profile as “a new approach to flavor problems” at the tenth annual meeting of the Institute of Food Technologists (IFT) in 1949, they were addressing an audience that had been grappling with the challenges of studying flavor for nearly two decades.⁵ Since the 1930s, food researchers in government and industry had labored to find methods to objectively determine and measure the sensory qualities of foods. Flavor was understood as a multisensory phenomenon, a complex perceptual effect arising not only from the activities of the chemical sensors on the surface of the tongue and within the olfactory system, but also appearance, texture, consistency, and oral sensations such as the “coolness” of menthol or the astringency of an unripe persimmon. While instruments such as colorimeters and tenderometers could measure some aspects of a food's sensible qualities, no tool approached the sensitivity of the human chemical senses of smell and taste when it came to detecting the compounds responsible for aroma, the vast majority of which, at that

⁵ The paper was delivered on July 13, 1949 at the tenth annual meeting of the IFT in San Francisco. It was subsequently published in *Food Technology*, the IFT's monthly scientific journal. S.E. Cairncross and Loren Sjöström, “Flavor Profiles: A New Approach to Flavor Problems,” *Food Technology* 4 (1950): 308-311.

point, remained unidentified.⁶ A specialized community of “expert tasters,” such a coffee cuppers and master distillers, provided judgments of sensory quality and value, as did official food graders, but their expertise was generally restricted to a single type of commodity, and there were persistent doubts about the reliability of their reports.⁷

Starting in the late 1930s, many laboratories began using a small “trained panel” of tasters to produce knowledge about flavor and odor qualities. These tasters were screened and tested to exclude the anosmic and the frequently congested, and to establish normative levels of sensory acuity. Adapting methodologies from psychometrics and the psychophysical laboratory, researchers developed a set of standard procedures and practices that were designed to extract reliable, reproducible information about the sensory qualities of foods from the subjective, unconfirmable perceptions of human beings. Tasters conducted their evaluations silently, in isolation booths within temperature and atmosphere controlled rooms, tasting standardized samples delivered (ideally) through wall-hatches that foreclosed any contact between experimenter and subject. They followed routinized procedures, and recorded their responses on standardized forms.⁸ By rigorously controlling experimental conditions, scrupulously

⁶ The introduction of powerful analytic instrumental technologies, such as gas-liquid chromatography and mass spectroscopy in the mid-1950s, would vastly expand the number of known volatile chemicals. Prior to those technological breakthroughs, the isolation and identification of volatile chemicals in foods demanded meticulous, labor- and material-intensive research, and comparatively few groups took it on. See Chapter 6.

⁷ H.F. Willkie and E.H. Scofield, “Some Factors Influencing Determination of Relative Preferential Values of Distilled Alcoholic Beverages,” *Institute of Food Technologists, 1941 Proceedings*, (Champaign, IL: Garrard Press, 1941): 203-8; Rose Marie Pangborn, “Sensory Evaluation of Foods: A Look Backward and Forward,” *Food Technology* (September 1964): 63-7.

⁸ See Chapter 3.

excluding social and atmospheric contaminants, disciplining the sensory labor of tasters, and subjecting data to statistical processing, researchers operated the taste panel as a laboratory instrument, one which used the human senses as a tool of measurement.⁹

But while taste panel methods proved adequate for assessing thresholds of difference and vectors of preference, they offered little information about the content of experience. They were well-suited for quality control purposes — maintaining a consistent production standard — but less useful for problems of product development, improvement, and design, which often involved determining and evaluating the multiple, interrelated chemical and perceptual changes that could occur with a single alteration to the composition of a food product.

These were the scientific methods at the disposal of Sjöström, Cairncross, and their ADL colleagues in the 1940s, when they began contract work for two clients facing quite different flavor problems: one involving multivitamins; the other, monosodium glutamate (MSG). In 1947, Upjohn, a Michigan pharmaceutical company, hired ADL to help make their multivitamin tablets less repulsive. The pills tasted awful, both bitter and

⁹ For a critical discussion, from the perspective of food science, of the consequences of the highly controlled, laboratory conditions of taste testing upon the epistemological claims of sensory research, see Jacob Lahne, “Tasting in Context: Consumer Sensory Perception of Vermont Artisan Cheese,” PhD Dissertation, University of Vermont, 2014. For an anthropological perspective, see David Howes, “The Science of Sensory Evaluation: An Ethnographic Critique,” in Adam Drazer and Susan Küchler, eds. *Social Life of Materials: Studies in Materials and Society*, (London: Bloomsbury, 2015). For a detailed examination of the use of statistical methods in the postwar sensory evaluation of wine, see: Christopher J. Phillips, “The Taste Machine: Sense, Subjectivity, and Statistics in the California Wine World,” *Social Studies of Science* 46.3 (2016): 461-481.

sour, and smelled like a composite of “solvent, old gelatin, fish oil, and yeast.”¹⁰

Experimental work had shown that certain odorants could mitigate one or more of the noisome aromas, but combinations of additives affected the sensory qualities of the vitamins in complex ways. Choosing the right mixture of odorants at the most effective levels demanded iterative work that daunted existing taste panel methods.

The second client was International Minerals and Chemicals Corporation, a large fertilizer and agricultural chemical business.¹¹ In the early 1940s, International Minerals purchased the Amino Products Company of Illinois, one of the first domestic manufacturers of MSG.¹² In order to develop a market strategy for this relatively unknown — in the US, at least — food additive, International Minerals commissioned ADL to conduct basic research into the chemical.¹³ The dynamic, multisensory effects

¹⁰ Loren B. Sjostrom, “Introduction: Case Work,” in *The Flavor Profile*, (Cambridge: Arthur D. Little, 1972): n.p. [3], Arthur D. Little Collection, MIT Institute Archives and Special Collections, Cambridge, MA [hereafter cited as ADL Collection, MIT], Series 6, Box 11.

¹¹ For a history of International Minerals, see Thomas M. Ware, *So Little Soil... So Little Time: The story of the International Minerals & Chemical Corporation*, Newcomen Address delivered at a National Dinner of the Newcomen Society in North America, (Newcomen Society: New York, 1967).

¹² Albert E. Marshall, “History of Glutamate Manufacture,” in Quartermaster Food and Container Institute for the Armed Forces, *Flavor and Acceptability of Monosodium Glutamate: Proceedings of the Symposium*, (Chicago: Food and Container Institute, 1948): 1-14.

¹³ ADL conducted multiple studies of MSG production for International Minerals, including manufacturing processes, fundamental research of its effects on food flavors, and investigations of its potential uses as an additive that could reduce the amount of pepper or salt in foods. For ADL’s work on MSG manufacturing processes, see ADL Report C-57319, “Report on Amino Products Company to International Minerals and Chemical Corporation,” December 2, 1942, and ADL Report C-57505, “Report on Monosodium Glutamate to International Minerals & Chemical Corp,” August 22, 1945. For fundamental research on MSG’s flavor and its effect on various kinds of foods, see ADL report C-57634, “Report on Flavor Studies Related to the Use of Monosodium

that the addition of MSG produced in the flavor of some foods — even at subthreshold levels — was not effectively captured by taste panel methods.

Both of these flavor problems demanded new approaches to sensory evaluation. While borrowing many features of laboratory taste panels, ADL researchers adapted, adjusted, and improvised to develop a procedure that suited their needs.

A flavor profile is a descriptive, semi-quantitative, multisensory record of a product's sensible qualities, produced by a small, specially selected, and highly trained panel of sensory evaluators.¹⁴ Panel members alternate individual tasting sessions under standardized and rigorously controlled conditions — “the same number of sniffs for aroma, the same number and size, of bites or sips for flavor”— with sessions of open discussion where impressions are shared, compared, and validated.¹⁵

During individual tasting sessions, panel members produce a comprehensive list of the “detectable factors” in a flavor — specific, identifiable aroma and taste ‘notes’ such as the citrus in a cola, or the bitterness in a beer, as well as textural factors, color, and other sensible properties. Each panelist also records the order in which these factors

Glutamate to International Minerals and Chemical Corporation,” July 16, 1948. Other ADL reports related to this contract work can be found in: ADL Collection, MIT, Series 4: Technical Reports.

¹⁴ Comprehensive descriptions of the Flavor Profile method can be found in Jean F. Caul, “The Profile Method of Flavor Analysis,” in E.M. Mrak and G.F. Stewart, eds. *Advances in Food Research* 7 (New York: Academic Press, 1957): 1-40; and in Maynard A. Amerine, Rose Marie Pangborn, and Edward B. Roessler, *Principles of Sensory Evaluation of Food*, (New York: Academic Press, 1965): 377-85.

¹⁵ Sjöström 1972: [7].

become perceptible, and the relative intensity of each on a numerical scale that ranged from one to three, with “1”) (“1” indicating a just-perceptible sensation. Finally, using this scale of intensities, the panelist assesses the “total amplitude” of the flavor, the strength of the “over-all impression” that the flavor made upon the taster. (More on this in a moment.)

The final flavor profile reflects a consensus account of a product’s sensible qualities. This information is communicated in two ways. First, as a tabulated list, using “common language terms” to name the detectable factors and a numerical scale to report intensities.¹⁶ (Sjöström called this “a word-facsimile,” a verbal reproduction of how a given substance tasted and smelled.)¹⁷ Second, graphically, as a visual schematic, with aroma and flavor-by-mouth each represented as a semi-circle pierced by radiant lines — “a sort of pin cushion model,” in the words of Cairncross.¹⁸ The total area of the semicircle indicates amplitude; each ray represents a perceived aroma or taste note, whose intensity is indicated by its length. A ray barely crossing the semicircle’s perimeter represents a just-perceptible note, i.e., one of “1”) (“1”) intensity.¹⁹

¹⁶ Cairncross and Sjöström 1950: 308.

¹⁷ Sjöström 1972: [6].

¹⁸ S.E. Cairncross, “The Effect of Monosodium Glutamate on Flavor,” in Quartermaster, *Flavor and Acceptability of Monosodium Glutamate* 1948: 36-7.

¹⁹ Caul explained that the use of the word “profile” in naming the flavor profile was prompted by the use of that term by the *New Yorker* magazine to describe its feature-length character studies. The visual diagram came from Stanley Cairncross’s attempts to adequately explain that flavor comprises both an irreducible element and discernible notes. “Prompted by the *New Yorker* personal profiles, one of the originators (SEC) of the flavor profile held up his hand to aid in describing a flavor. The palm of his hand stood for the portion of flavor so well blended that separate components were not recognizable,

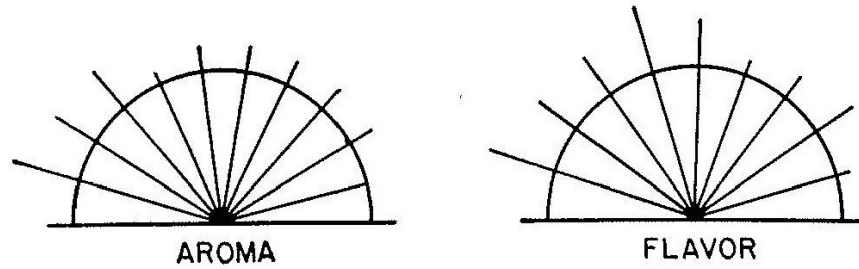


FIG. 2. Diagrammatic representation of the aroma and flavor profiles of a carbonated beverage.

Flavor profiles of aroma and flavor-by-mouth of the same beverage, showing similar amplitude but different patterns of intensities and identities of characteristic notes. From Cairncross and Sjöström 1950: 310.

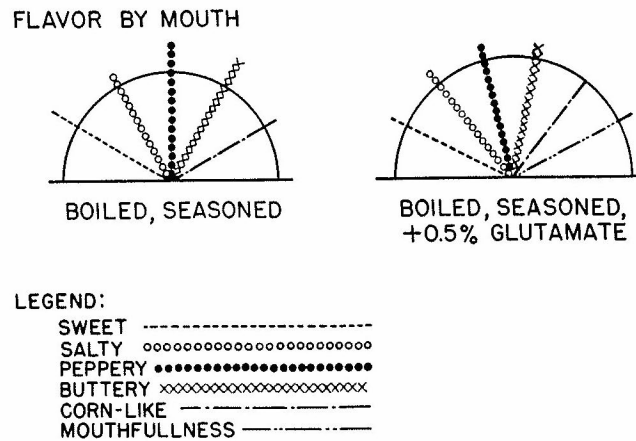


FIG. 3. Diagrammatic representation of the flavor profiles of seasoned summer squash.

Flavor profile of summer squash two ways: seasoned with salt and pepper, and seasoned with salt, pepper, and 0.5% MSG. The MSG increases both amplitude and blending, as seen by the larger diameter of the hemisphere and the evened-out lengths of the rays corresponding to the intensities of individual flavor notes, and also adds a new note: mouthfullness. From Cairncross and Sjöström 1950: 310.

and his fingers represented the notes protruding from that body. A draftsman translated this idea into the sunrise form of the diagrammatic profile.” Caul 1957: 34.

Test # _____	Date _____	Name _____
AROMA		Amplitude <u>3</u>
		Intensity
Hop fragrance		<u>2</u>
Fruity (apple)		<u>2</u>
Sour		<u>1.5</u>
Yeast		<u>) (</u>
Malt		<u>1</u>
Phenylacetic acid (honey)		<u>1</u>
FLAVOR-BY-MOUTH		Amplitude <u>1</u>
		Intensity
CO ₂ tingle		<u>High</u>
Salt		<u>1</u>
Sweet		<u>1</u>
Sour		<u>2</u>
Fruity (winy)		<u>1</u>
Bitter (metallic)		<u>3</u>
Malt		<u>) (</u>
Yeast		<u>1</u>
Others:		
Astringent		
AFTERTASTE:		
Bitter		
Astringent		
Dry throat		

FIG. 69. Response sheet used for profiling a malt beverage (including the panel's composite profile of the beverage). Source: Caul (1957a).

Flavor Profile response sheet for malt beverage, showing “common language” terms used to describe aroma, flavor-by-mouth, and aftertaste. From Amerine, Pangborn, and Roessler 1964: 381.

“Out of our work for Upjohn and Ac'cent,” Sjöström later recounted, “we developed both a concept of flavor and a method for measuring it.”²⁰ The method of measuring flavor captured dimensions of flavor experience that psychometric and psychophysical methods did not, reflecting a new conceptual understanding of flavor as a scientific object. First, rather than a relational study of a single sensible factor, such as bitterness or fruitiness, a flavor profile offered a multisensory portrait, one that could capture dynamic relationships among different sensory modalities with ingredient

²⁰ Sjöström 1972: [3]. ADL Collection, MIT, Series 6, Box 11.

changes — the way that the addition of 0.2% MSG to canned peas, for instance, augmented their fragrance and introduced a buttery aroma, decreased sweetness, increased saltiness, and produced a pleasing mouthfeel.²¹ Second, a flavor profile comprehended flavor perception as a temporal experience. Tasters considered the process of ingestion as a sequence of sensory events, attending to the order of appearance and disappearance of different perceptual elements and the dynamic flux of intensities.

The most radically new aspect of the flavor profile's "concept of flavor" came under the term "amplitude." While psychometric and psychophysical methods used taste panels as analytic instruments, whose tasters properly responded only to definite, distinguishable sensory stimuli, the flavor profile proposed that the perceptual experience of flavor operated both analytically and synthetically. According to the flavor profile's creators, the total experience of a flavor comprised both "perceptible factors" — the distinguishable 'notes' that could be identified by a trained taster — as well as an "overall impression," an integrative response to an "underlying complex of factors not separately identifiable," which constituted the "basic character" of the flavor.²² In a flavor profile of coffee, for instance, bitterness, sourness, astringency, and bouquet were

²¹ Arthur D. Little, Inc. "Report on a Study of the Flavor Characterizations of Certain Food Products Containing Mono Sodium Glutamate to International Minerals & Chemical Corporation," Report C-57634, April 1, 1949: 16. ADL Collection, MIT, Series 4.

²² Jean F. Caul, "The Profile Method of Flavor Analysis," in E.M. Mrak and G.F. Stewart, eds., *Advances in Food Research* 7 (New York: Academic Press, 1957): 2. This aspect of the flavor profile was explicitly indebted to gestalt psychology. For more on the influence of gestalt social psychology on the development of the flavor profile, see Arthur D. Little, Inc. "The Dynamics of the Flavor Profile," [booklet], (nd/1970s): [np/2], ADL Collection, MIT, Series 6, Box 11, Folder 1; Loren B. Sjöström and Benjamin B. Fogler, Oral History Interview, ADL History Luncheon, January 26, 1976, 43-4. ADL Collection, MIT, Series 7.

individually sensed as distinct factors; the unidentifiable chemicals, “which do create a flavor impression, for without them coffee is not coffee,” accounted for the brew’s amplitude.²³ Bread, whether a homemade, hand-kneaded boule or mass-produced loaf, produced a common experience of breadiness; however, the home-baked loaf might register an amplitude of 3, while the mass-produced one might muster a 1.²⁴ Amplitude was not an additive summation of all the intensities of recognizable notes.²⁵ Instead, it was a kind of plenitude of experience, “the total breadth or over-all impression of a flavor.”²⁶ A high-amplitude flavor gave the impression: “‘There’s a lot there.’”²⁷

THE PROFILE’S PROLIFERATION AND THE GROWTH OF ADL’S FLAVOR CONSULTING BUSINESS

The immediate response to the flavor profile method appears to have been positive. Sjöström reported that ADL received more than a thousand requests for reprints after his and Cairncross’ presentation at the 1949 IFT meeting.²⁸ Flavor profile evaluation and panel training also became cornerstone ADL services, establishing the firm’s authority in flavor and other sensory consulting and driving the rapid expansion of its Food and Flavor division.²⁹

²³ Sjöström 1972: [4]

²⁴ Caul 1957: 13.

²⁵ J.F. Caul, S.E. Cairncross, and L.B. Sjostrom, “The Flavour Profile in Review,” *Perfumer and Essential Oil Review* 49 (March 1958): 133.

²⁶ Caul, Cairncross, and Sjostrom 1958: 133.

²⁷ Caul 1957: 36.

²⁸ Sjöström 1972: np [3].

²⁹ “History — Flavor Laboratory” Memo from Jacqueline D. Knowles to Kay Manion, March 2, 1955, ADL Collection, MIT, Series 7, Box 1 [Folder 39]. “70th Anniversary

Founded in 1886 as a consulting chemical engineering laboratory, by the middle of the twentieth century ADL had grown to become one of the nation's largest independent contract research organizations.³⁰ The Cambridge, Massachusetts company offered a global roster of corporate, military, and governmental clients an increasingly diverse range of services, including basic chemical and physical research, operations and systems research, product development and testing, and management consulting.

The company had provided research and consulting services related to odor and flavor problems since the 1920s, efforts that were generally led by E.C. Crocker, an eccentric chemist who was known for his acute, diagnostic sense of smell and his lifelong quest to create a numerical system of odor classification.³¹ But it was not until the

Report,” [memorandum, 1956], 26. ADL Collection, MIT, Series 7, Box 1 [Folder 1]. The latter report claims that the ADL Flavor Laboratory had had “quadrupled” in size since its founding in the late 1940s. When ADL added a new three-story wing to Acorn Park, its principal Cambridge research center, in 1956, almost half the space in the new facility was dedicated to food and flavor technology research.

³⁰ The standard history of Arthur D. Little, Inc. is E.J. Kahn, Jr. *The Problem Solvers: A History of Arthur D. Little, Inc.* (Boston: Little, Brown, 1986). David C. Mowery considers ADL's place in the history of industrial research in: “The Relationship Between Intrafirm and Contractual Forms of Industrial Research in American Manufacturing, 1900-1940,” *Explorations in Economic History* 20 (1983): 351-374. For a discussion of the role that Arthur D. Little and his company played in promoting “the gospel of industrial research” during the progressive era, see David Jerome Rhees, “The Chemist's Crusade: The Rise of an Industrial Science in Modern America, 1907-1922,” PhD Diss., University of Pennsylvania, 1987. A discussion of ADL as a pioneer in management consulting can be found in Christopher D. McKenna, “The World's Newest Profession: Management Consulting in the Twentieth Century,” *Enterprise and Society* 2.4 (December 2001): 673-9.

³¹ For Crocker's role in organizing the landmark 1937 American Chemical Society Symposium on Flavors in Foods, see Chapter 3. For a portrait of Crocker, including a discussion of the development of the Crocker-Henderson System of Odor Classification, see: Robert Yoder, “The Man with the Million-Dollar Nose,” *Saturday Evening Post* 224.13 (September 29, 1951): 27, 110-12.

development of the flavor profile method that ADL formally established its Food and Flavor Division as a formal entity within its organization.

When in 1956 ADL added a new three-story wing to Acorn Park, its principal Cambridge research center, almost half the space in the new facility was dedicated to food and flavor technology research.³² This included pilot plant facilities for testing new processes for food and packaging production; a state-of-the-art analytical chemistry laboratory, which by 1960 would feature instruments for high-vacuum distillation, gas chromatography, ultraviolet, infrared, and mass spectroscopy, and freeze drying; an odor test room, completely lined with polished aluminum, where “micro quantities of odorous materials may be examined in the range of 0.0001 ppm;” and specially designed, atmosphere-controlled panel rooms for flavor profile evaluation.³³ “The new facilities give tangible recognition to the place [the Food and Flavor Division] has established for itself in providing clients with such services as product development and improvement, quality control and evaluation, industrial problem solving, training of taste and odor panels, and pilot consumer acceptance studies,” beamed an internal ADL memorandum, which celebrated the ascendancy of the company’s flavor related business at the seventieth anniversary of the company’s founding.³⁴

ADL used flavor profiles in its work with a motley group of corporate clients, on problems including new product development, product improvement, the investigation of

³² Arthur D. Little Inc., “70th Anniversary Report,” [memorandum] (1956): 26, ADL Collection, MIT, Series 7, Box 1.

³³ “ADL and the Food Industry,” [brochure], Arthur D. Little, Inc. (May 1960): [np/8]. ADL Collection, MIT, Series 6, Box 11, Folder 7.

³⁴ “70th Anniversary Report,” 1956: 26.

off-flavors and off-odors, and the evaluation of packaging materials. For instance, in research for the Dr. Pepper Company, ADL used flavor profiles to evaluate the rapid flavor changes that occurred to the eponymous beverage within the first three days of bottling, testing both traditional cork bottlecap liners and new vinylite seals. It found that despite the material used as a seal, “the characteristic fruitiness of the fresh beverage is lowered along with a change in the delicateness of blending to produce a resulting product that is thin, consisting primarily of strong benzaldehyde with weak notes of vanillin.” Based on this sensory diagnosis, the ADL group identified the likely culprit as “item #9,” a proprietary flavoring component that contained fruit juices, which rapidly lost flavor, and offered several suggestions for improving flavor stability.³⁵

In other cases, ADL combined profile evaluation with an analysis of the competition to deliver specific product recommendations, as in a 1951 report to the Bristol-Myers Company regarding a two-year study conducted on its Ipana toothpaste.³⁶ Ipana, Bristol-Myer’s signature dentifrice, had been the best-selling toothpaste on the market before the war, but formulation changes due to wartime shortages had diminished the product’s minty-spicy appeal and added unpleasant “weedy, garbagey” and “rancid” notes.³⁷ ADL’s goal was not simply to restore Ipana to its prewar glory, but to put it on a stronger competitive footing against its chief rival, Colgate, which surpassed it in postwar sales. ADL created profiles of Colgate, Ipana, and more than 140 Ipana components and

³⁵ R.L. Swaine, Arthur D. Little, Inc. “Report on Preliminary Studies of Dr. Pepper Beverage to Dr. Pepper Company,” ADL Report C-57956, March 24, 1949: 4-5. ADL Collection, MIT, Series 4.

³⁶ Arthur D. Little, Inc. “Report on Flavor Studies of Ipana to Bristol-Myers Company,” ADL Report C-57965, March 21, 1951. ADL Collection, MIT, Series 4.

³⁷ “Report on Flavor Studies of Ipana” 1951: 18.

experimental formulations. ADL approached the challenge of “reblending” Ipana by developing an optimal Ipana flavor profile that maintained the product’s familiar ‘old-time’ qualities while besting Colgate in the areas where it fell short. An ideal Ipana would demonstrate “high amplitude, strong flavor impact, good foaming, mouthfilling properties, sweet spicy spearmint flavor, low to moderate bite, low bitterness, and a pleasant aftertaste.”³⁸ In other words, flavor profiles were not just diagnostic tools to identify sources of problems in products, but also prescriptive, pointing to particular kinds of solutions for commercial problems.

ADL emphasized that the flavor profile had uses beyond food and beverages; it could be applied to any problem of sensory design in product development. A 1960 brochure claimed that flavor profiling had been successfully deployed in the evaluation and development of packaging materials, appliances such as coffee makers, freezers, and refrigerators, and consumer products such as kitchen deodorizers.³⁹ The diverse purposes for which Profile panels were mustered can be gleaned from the 1957 personnel file of Anne J. Neilson, a chemist who joined ADL’s Food and Flavor division in 1949 and remained one of its key employees until her retirement in 1991. By 1957, Neilson had served on or led Flavor Profile panels for more than a dozen contracts, working on projects that included: evaluating natural gas odorants for the American Gas Association, assessing the effect of different containers on orange juice flavor for the Container Corporation of America, working with the F. & M. Schaefer Brewing Company to

³⁸ “Report on Flavor Studies of Ipana” 1951: 7.

³⁹ “ADL and the Food Industry,” May 1960. [ADL Collection, MIT, Series 6, Box 11, Folder 7.]

improve the flavor of their beer, advising Quaker Oats on a new pancake flavor, and helping Wallace Laboratories develop a palatable liquid form for their pioneering anti-anxiety drug, Miltown.⁴⁰

Neilson was also active in ADL's Flavor Profile panel training program, which began sometime in the early 1950s. This program aided the dissemination of the flavor profile and its philosophy by training flavor profile groups at client companies.⁴¹ ADL's flavor profile training program was initially a year-long process, comprising lectures, workshops, demonstrations, and assignments, although the group was considered capable of producing flavor profiles after about six months of training. Training curricula could be customized to the needs and problems faced by particular companies. For instance, Neilson's employment file records that her work with Goodyear Tire & Rubber Company focused on training a panel to perform odor evaluation of films — such as Pliofilm, a new material Goodyear was introducing as food packaging.⁴² By the 1970s, ADL was offering a range of course options, “tailored to emphasize the product or products of greatest importance to you,” from a four-day short course, to three-month, six-month, and twelve-month programs.⁴³ Longer programs prepared a panel to handle any kind of assignment, while shorter courses prepared panels to work on a narrower set of problems

⁴⁰ Arthur D. Little Experience Record: Anne J. Neilson. May 16, 1957. ADL Collection, MIT, Series 1, Box 7.

⁴¹ I have found very little information about the cost of ADL's services. However, one 1962 source claims that ADL charged companies \$15,000 to train a four- to six-person group. W.R. Young, “Cracking the Secret Riddle of Flavor,” *Life* (November 23, 1962).

⁴² Arthur D. Little Experience Record: Anne J. Neilson. May 16, 1957. ADL Collection, MIT, Series 1, Box 7.

⁴³ “Flavor Profile Training Programs,” ADL Food & Flavor Section, [pamphlet] n.d. [1970s]. ADL Collection, MIT, Series TK.

and products. The shortest course was geared “for those who want to sharpen their ability to communicate in precise flavor terms.”⁴⁴

By 1961, ADL had trained 55 flavor profile groups at 34 different companies, including multiple groups at some organizations — for instance, six at General Foods.⁴⁵ The number of groups trained would more than double by the end of the 1960s, and would reach 250 by the end of the 1970s.⁴⁶ Flavor profile panels operated at major food companies, including Campbell’s, General Mills, Schaefer Brewing Company, and Beech-Nut, and at flavor companies including Givaudan and McCormick.⁴⁷

This does not reflect the full extent or contexts in which flavor profile groups operated in American, or indeed global, industry. ADL had no proprietary claim to the technique, and in fact actively encouraged its use, adaptation, and adoption by others.⁴⁸ As Sjöström recounted in a 1976 oral history, “We wanted to come out and tell the profession that it was a usable tool. We didn’t want to hold back and we wanted other

⁴⁴ [Arthur D. Little, Inc.] “Profiles of Success,” *Food and Agribusiness Memorandum* 16 [n.d., 1970s]. [ADL Collection, MIT, Series 6]

⁴⁵ Irving T. McDowell, “ADL’s Panel Training Program,” *ADL Review* (December 1961): 22. [ADL Collection, MIT, Series 3]

⁴⁶ A May 1969 ADL publication claimed that the firm had trained 118 groups at 59 different companies, including firms in Canada, Europe, and South America. “Distinguished Flavors,” *FYI* [ADL internal newsletter] (May 1969): 2. [ADL Collection, MIT, Series 3]. A booklet likely dating from the late 1970s claimed that ADL had trained 250 groups at 120 companies. “The Flavor Profile,” [nd, late 1970s?]: 9. [ADL Collection, MIT, Series 6, Box 11, Folder 1.]

⁴⁷ “How Important is Flavor?” *The Givaudan Flavorist* 1966 (no. 3): 2.

⁴⁸ Pfaffman and Schlosberg, “An Analysis of Sensory Methods for Testing Flavor,” Report to Quartermaster Food and Container Institute for the Armed Forces, Chicago, 1953.

people to try and develop it.”⁴⁹ Indeed, Foster D. Snell, a rival contract research and consulting firm, began advertising a lightly modified version of the Flavor Profile as its own organoleptic panel method soon afterwards.⁵⁰

PANEL SELECTION AND TRAINING: THE PRODUCTION OF INTERSUBJECTIVITY

On what did the flavor profile method rest its claim to authority? First, by an insistent control over the experimental conditions of evaluation. The profile panel worked “in a laboratory environment,” explained one ADL brochure, “one that is free of extraneous odors and has a consistent temperature, a consistent size of samplings, and consistent procedures of tasting.”⁵¹ All of these things served as material and procedural corroborations of accuracy and reliability, and underscored the flavor profile method’s technoscientific credentials.

⁴⁹ Loren B. Sjöström and Benjamin B. Fogler, Oral History Interview, ADL History Luncheon, January 26, 1976, p. 45. ADL Collection, MIT, Series 7.

⁵⁰ L.C. Cartwright and P.H. Kelley, “Sharper Flavor Ratings with Improved Profile Test,” *Food Engineering* 23 (September 1951): 71-3, 215. “Human Analyzers,” a 1950 article in *Chemical Industries* describing the use of new scientific techniques in organoleptic testing, focus on Foster D. Snell, but also naming additional consulting firms offering the techniques, including ADL, Wallerstein Laboratories, and Food Research Laboratories. Two years later, *Fortune* ran a long article entitled “What Has Happened to Flavor?” surveying the uses of organoleptic panels at major food companies, which featured ADL’s flavor profile among its examples. “Human Analyzers,” *Chemical Industries* 67 (November 1950): 721-2; “What Has Happened to Flavor?” *Fortune* 45 (April 1952): 130-3, 146-52.

⁵¹ “The Flavor Profile” [promotional leaflet, n.d. (early 1960s?)] ADL Collection, Series 6, Box 11, Folder 1.

However, rather than statistical certainty as a measure of objective sensory reality, the flavor profile aimed for objective truth through intersubjectivity.⁵² Steven Shapin, drawing on Richard Rorty, defines intersubjectivity as “the achievement... of ‘unforced agreement,’ of coming to free and practical interactional assent about what is, from another point of view, private to the experiencing and knowing subject.”⁵³

Intersubjectivity foregrounds the social aspects of sensory phenomena, and posits sensory knowledge as the social confirmation of private experience — a knowledge produced primarily through engaged dialogue that connects the external objects of sensation with specific perceptual effects. A flavor profile panel, then, was a scientific tool that was also a social entity, one that needed to perform collaboratively in order to operationally achieve the intersubjectivity that would serve as the warrant for the validity of its results.

If the isolation booth was the signature furniture of psychophysical and psychometric methods, the flavor profile’s hallmark was the roundtable. Achieving sensory consensus was a deliberate social dramaturgy, coordinating private, individual tasting sessions with multiple periods of open discussion, which were conducted seminar-style with panel members participating as equals. As Dr. Jean Caul, one of the flavor profile method’s creators at ADL, explained, “the procedure of obtaining a profile might be regarded as analogous to the production of a stage play. First the actors are selected; each studies his part; then there are rehearsals which lead up to the dress rehearsal; and finally, there is the performance of the play” — a performance whose outcome was a

⁵² For an in-depth consideration of the use of intersubjectivity in sensory science, see Jacob Lahne, dissertation.

⁵³ Steven Shapin, “The Sciences of Subjectivity,” *Social Studies of Science* 42.2 (2011): 176.

flavor profile.⁵⁴ For this reason, casting “actors” for roles on a flavor profile panel carried higher stakes than selecting tasters for panels whose members tasted in isolation.⁵⁵

Only certain kinds of people were considered qualified for flavor panel work. Prospective panel members were tested first on basic sensory capacities; exceptional abilities were not required, but those with anosmias and other sensory deficits were screened out. Prospective panelists were then interviewed to assess intelligence, attitude, and personality.⁵⁶ The key measure of intelligence was articulateness — the ability to speak fluently, with precision and confidence, about sensory experience. Interest in the work was also important, as an interested panel member would perform her or his sensory labor more attentively, carefully, and effectively. (“Then, too, there are detrimental attitudes that regard smelling and tasting work as effeminate and unworthy of scientific training,” Caul observed. “These attitudes and opinions are ferreted out in the interview.”)⁵⁷ Most crucial, however, was personality. Timid personalities were contraindicated. “It is not satisfactory to have a panel member who will join the majority despite his own findings,” wrote Caul. “His personal integrity must counteract the herd instinct; he cannot be a yes man and still serve as a panel member.” Domineering

⁵⁴ Caul 1957: 29.

⁵⁵ Although these sensory tests appear to have varied somewhat between locations, the account given by Caul (1957) is typical. Prospective profile panelists were tested to ensure that they could differentiate between and recognize basic taste factors (sweet, sour, salty, bitter), screened for anosmia using an Elsberg olfactometer, and tested for odor recognition of 15 common odors and five rarer ones. In the latter test, prospective panelists were considered acceptable if they performed in the median range. Caul 1957: 15-17.

⁵⁶ Caul 1957: 17.

⁵⁷ Caul 1957: 17.

personalities were also excluded, as they upset the calibrated egalitarianism of panel work.⁵⁸

The particular personal qualities deemed essential for flavor profile panelists, and the means by which the method produced and constituted its intersubjective results as trustworthy, objective, and valid, reflect not only the contingencies of the corporate environment, but also deeply historical and political investments about the nature of scientific knowledge, and the social conditions and individual qualities necessary to “establish the facts.”⁵⁹ Singling out authoritarian or conformist personalities as problematic to the democracy of the flavor profile panel echoes contemporary research in the social sciences and psychology, which, in the postwar period, pathologized both the “closed-minded authoritarian” and conformist personality types as threats to the liberal social order, while also creating a model of the normative ideal citizen as one who was autonomous, socially well-adapted, and creative.⁶⁰

Although each panel had a nominal ‘leader,’ it was emphasized that this person “does not act as a superior in any way.” This democratic social style, with the citizens of

⁵⁸ Caul 1957: 17-18.

⁵⁹ Steven Shapin and Simon Schaffer illuminated the social and political conditions of scientific knowledge production in restive seventeenth-century Britain in their cornerstone work, *Leviathan and the Air Pump*. More recently, Donna Haraway has examined the formation of the “modest witness” in twentieth century laboratories. Steven Shapin and Simon Schaffer, *Leviathan and the Air-Pump: Hobbes, Boyle, and the Experimental Life*, (Princeton: Princeton UP, 1985); Donna Haraway, *Modest_Witness@Second_Millennium. FemaleMan©_Meets_OncoMouse®: Feminism and Technoscience*, (New York and London: Routledge, 1997.)

⁶⁰ See Jamie Cohen-Cole, *The Open Mind: Cold War Politics & The Sciences of Human Nature*, (Chicago: University of Chicago Press, 2016).

the panel acting both independently and collaboratively, was fundamental to the flavor profile method's claims to truth and authority:

Experiments have shown that an 'autocratic' style (as in the classical experimenter role) produces a group behavior which can be irresponsible; lacking in initiative; and with the members experiencing very little enjoyment in carrying out their tasks, and manifesting hostility toward both their autocratic leader and toward one another. A democratic style of leadership, on the other hand, in which the leader merely facilitates group activity and decision making... produces markedly different effects, even on the very same group of individuals.⁶¹

The flavor profile method's egalitarian mode is explicitly differentiated from the implicit coerciveness of other social relations in the sensory laboratory: namely, psychometric and psychophysical panels where the taster was required to instrumentalize her or his senses to provide sensory data for the experimenter to analyze.⁶² Flavor panel members, on the other hand, were entrusted with producing both the raw data and its interpretation. While experimenters who used psychometric or psychophysical panels compelled accurate sensory labor by introducing factors such as competition, surveillance, and discipline, flavor profile panelists were induced to do their best work by the social dynamics of the panel itself.⁶³ "As is the case in medical diagnosis and

⁶¹ Arthur D. Little, Inc. "The Flavor Profile," [Booklet] [nd/late 1970s]: 12. ADL Records, MIT, Series 6, Box 11, Folder 1.

⁶² See Chapter 3.

⁶³ "The ADL Profile approach thus rests upon role relationships which are models of what contemporary social psychologists advocate in the place of the traditional subject-

treatment,” the ADL booklet on the subject explained, “profiling involves professional skills and experience.”⁶⁴

In other words, this was not routine work, but highly trained work — performed by a select group of professionalized individuals. Although disqualifying sensory deficits were rare among prospective panelists, far fewer made the cut when it came to personality. Irving McDowell, writing in 1972, estimated that of the two thousand candidates ADL had interviewed for profile panels, only one-third were found to be acceptable.⁶⁵

Once selected, flavor panel members underwent an intensive training program, which was customized to the needs of each client, and was designed to last as long a full year.⁶⁶ Six or so chosen trainees began their journey toward the “mastery of [this] new language” with a four-day course at ADL headquarters supervised by instructors from the Flavor Laboratory.⁶⁷ They attended lectures and demonstrations on the physiology and anatomy of taste and odor perception, basic flavor chemistry, and best practices for organoleptic evaluation. The four-day session concludes with guided panel sessions, led

experimenter relationship,” elaborated one ADL pamphlet on the subject from the 1970s. “It is interesting to note that the Profile has been employing such role relationships for more than 25 years.” “The Flavor Profile,” [nd/late 1970s]: 12.

⁶⁴ “The Flavor Profile,” [nd/late 1970s]: 12.

⁶⁵ Sjöström 1972: [12].

⁶⁶ Irving T. McDowell, “ADL’s Panel Training Program,” in *The Flavor Profile*, (Cambridge: ADL, 1972), ADL Collection, MIT, Series 6, Box 11.

⁶⁷ “The Flavor Profile,” [nd/late 1970s]: 11.

by ADL panel leaders, where the group produced “rudimentary flavor profiles of products.”⁶⁸

After this immersive introductory session, the trainees returned to their company laboratories with a two-month long work program, a series of assignments profiling products of escalating difficulty. “The products selected for analysis in this part of the program are chosen for their simplicity and because they present certain flavor experiences and problems.”⁶⁹ Each trainee was assigned to be group leader at least once during this period, to familiarize him or herself with the responsibilities of the panel leader and “the cooperation” the leader “requires.” Concurrently, an experienced ADL panel evaluated the same products, and a month into the work-study program the ADL group visited the trainees to compare results, correct errors, and monitor each trainee’s progress and assess suitability for the panel leadership position.

Upon completing the two-month work program, trainees once again returned to ADL for a three-day advanced course, where they learned more sophisticated techniques and trouble-shooting methods. Again, trainees are rotated in the leadership role, “under the close scrutiny of our panel leaders, who evaluate their qualities of leadership.”⁷⁰

Trainees returned to their company with a four-month advanced work program, this time evaluating products “of increasing complexity that are germane to the interests

⁶⁸ McDowell 1972: 12.

⁶⁹ McDowell 1972: 13.

⁷⁰ McDowell 1972: 13.

of their company.”⁷¹ Monthly visits from ADL staff continued. At the conclusion of the advanced work program, around the half-year mark, the panel leader was chosen by ADL.

During the final six months of the program, the flavor profile panel became operational and fully situated in the context of its company. ADL staff continued their monthly visits, but in this case, they were focused on acting as “liaison between the panel and management. Working with the panel leader, we help him to understand and meet the objectives of management. Working with representatives of management, we help them to understand the needs and function of the panel.”⁷² Flavor panel members were almost always employed in other (white collar) roles at the company, and their service on panels was additional labor that had to be accommodated in their work schedules.⁷³ During this lengthy post-instructional guidance period, ADL staff were particularly conscientious about guiding the panel toward a presentation of results that could “mak[e] the data useful for managerial decisions.”⁷⁴

The ultimate composition of the panel was not expected to reflect any particular demographic segment of the consumer base or of the population at large. Flavor panel members were selected and trained to maintain a scientific disinterestedness, to detect sensory qualities rather than express personal preferences. Their sensory labor was privileged and professional, but scrupulously non-elite.

⁷¹ McDowell 1972: 13-4.

⁷² McDowell 1972: 14.

⁷³ “The Flavor Profile,” [nd/late 1970s]: 12.

⁷⁴ McDowell 1972: 14.

PERSUASIVE PROFILES

The lead article in the May 1969 issue of *FYI*, the ADL employee newsletter, described the carefully planned banquet that kicked off the company's two-day Flavor Orientation Program, created the previous year.⁷⁵ Gourmandizing executives, representatives of the food, pharmaceutical, chemical, and packaging industries, were served up the finest continental cuisine, and then interrogated about it:

“What flavor character notes did you detect in the crepes de lise?...How would you describe the aroma of Kahlenburg soup?”⁷⁶

At first, the article observes, the participants “are limited to responses of ‘mmm’ and ‘delicious’; but by the end of the two-day session they can judge flavor character notes to be ‘woody’ and ‘burnt,’ with something of the precision of articulate ADL staff members.”⁷⁷

These industry representatives were not being trained in the flavor profile method, but rather “made more aware of the importance of flavor and odor in product development” over a series of lectures, workshops, and demonstrations led by senior members of ADL's Food and Flavor Section “who have had considerable experience in new product development and in teaching flavor appreciation.”⁷⁸ Despite the luxe cuisine

⁷⁵ “Distinguished Flavors,” *FYI* [ADL Newsletter] (May 1969):1-2. ADL Collection, MIT, Series 3.

⁷⁶ I.e., crabmeat crepes with cream sauce and Austrian dumpling soup. “Distinguished Flavors” 1969: 1.

⁷⁷ “Distinguished Flavors” 1969: 2.

⁷⁸ “Distinguished Flavors” 1969: 2.

sampled, these programs were meant to demonstrate the professional rigor and utility of the flavor profile method, to corroborate it as an expert system of knowledge production. This kind of intensive effort at enlistment shows that the truth value and utility of the method had to be deliberately and conscientiously promoted. The profile method was promoted among fellow research scientists at professional conferences, symposia, and in publications. But the target of many of these demonstrations were not fellow research scientists, but corporate managers. After all, a flavor profile panel represented a significant and sustained investment. Its substantial costs must be justified; its advantages made plain.

It is crucial to keep in mind that the method was developed by a consulting company for use in commercial contexts. For this reason, it is important to understand the flavor profile not only as a scientific tool, but also as a rhetorical device, which made its pitch to specific audiences: managers in competitive consumer-oriented industries where sensory qualities mattered, that were searching for technoscientific means to assess and mitigate the risks inherent in product design and development.

First, the flavor profile method facilitated certain key operations in the product research and development process. For instance, it permitted market analysis to be integrated into the profiling process, allowing for comparisons between competing products. A flavor profile was also expected to have durability, to maintain its meaning over time in order to serve as a reference point for future iterations, and to forestall sensory drift in production. This was important, as food processors were increasingly concerned with maintaining standard product quality over time.

Significantly, however, the flavor profile gained buy-in because of its effectiveness as a tool for communicating sensory experience to organizational decision-makers, not just technical personnel, within a corporation. As Cairncross and Sjöström underscored in their paper introducing the flavor profile, the method could provide management “with greater understanding of their own flavor problems and of alternatives presented by research and production.”⁷⁹ Unlike many examples of contested knowledge production, where specialized jargon is invoked to buttress social and jurisdictional claims to professional expertise, the flavor profile’s persuasiveness derived, in part, from its preference for familiar language over technical terminology. Even as panel members stabilized the intersubjective meaning of sensory descriptors during the flavor profiling process, the legibility of their results to outsiders likely corroborated the credit they were given.

This is why the visual component of the profile was central to the method’s presentation, and indeed, was prominent in discussions of flavor profiles that appeared in trade and popular media after its introduction. It was a graphical correlate of what was repeatedly described as the embodied, performative act of elucidating the profile’s meaning. “Imagine explaining our findings to Upjohn,” explained Sjöström. “Hold up your open hand; your palm represents the body of the capsule flavor and your fingers represent the odor and flavor notes that emerge. One of your fingers is the fishy note, but you have reduced it by adding an essential oil. Fold that finger down into the palm of

⁷⁹ Cairncross and Sjöström 1950: 311.

your hand. You have changed the flavor profile."⁸⁰ The flavor profile could thus make the meaning of difficult to describe sensations immediately comprehensible to non-technicians, reifying the total “flavor concept” the method proposed.

Over time, ADL’s visual renderings of flavor profiles became increasingly stylized and almost decorative, full-color images that depicted perceptible notes as dynamic, brilliant-hued triangles overlaid upon luminous hemispheres. At this point, they ceased to be explanatory resources, and instead became icons of the method’s power, its ability to control and define ephemeral sensations, to shape experience itself.

II. ACHIEVING FLAVOR LEADERSHIP: THE FLAVOR PROFILE AS A TOOL OF SENSORY DESIGN

The flavor profile method’s widespread adoption in the food and beverage industry, its fittingness for industrial applications, came to shape the way that things were made to taste, profoundly affecting the sensory qualities of manufactured foods and beverages in postwar America. The flavor profile was not a neutral tool of measurement, but also represented a historically specific “concept of flavor” — as such, it was a phenomenotechnique that reified a model of flavor that privileged certain aspects of

⁸⁰ Sjöström 1972: [3].

sensory experience and established particular kinds of relations between sensation and behavior.⁸¹

The flavor profile's particular utility as a design tool derived from this: it provided a way of representing flavor that was not grounded in the molecular specificities of individual aromas and tastes. A flavor profile could represent flavor as a temporalized, experiential entity — a pattern or a sequence of intensities — that came into being during the act of consumption. This phenomenological model allowed trained flavor panel members to exclude the personal, social, cultural, and historical particularities of foods and beverages, and inductively deduce “certain generalizations about flavor that serve as guides to product assessment and product improvement.”⁸² That is, the flavor profile claimed to be able to provide a general model for good flavor in foods, one that could be productively applied to the flavor choices made in the manufacture of all types of comestibles, from soup to nuts — as well as the sensory design of inedible consumer goods.

This capacity was not happenstance, but was built into the very foundations of the method. In their 1949 paper, Cairncross and Sjöström described the flavor profile as the

⁸¹ Gaston Bachelard, *The New Scientific Spirit*; Hans-Jorg Rheinberger, “Gaston Bachelard and the Notion of Phenomenotechnique,” *Perspectives on Science* 13.3 (Fall 2005): 313-8.

⁸² L.B. Sjöström, “The Descriptive Analysis of Flavor,” in David Peryam, Francis J. Pilgrim, and Martin S. Peterson, eds. *Food Acceptance Testing Methodology: A Symposium Sponsored by the Quartermaster Food and Container Institute for the Armed Forces*, (Washington, DC: National Academy of Sciences National Research Council, October 1954): 27. Sjöström and others at ADL categorized the flavor profile as a “phenomenological” method, in distinction from psychometric (difference tests) and psychophysical (measurements of reactions and preferences) methods. Sjöström 1972: [8].

basis of “a philosophy of seasoning,” a theory of successful flavor in food. Their IFT paper concluded with the following paragraph:

Inherent in any successful system of seasoning and flavoring is the building of an interesting complex of flavor. This is accomplished by the increase of blending, the building of greater amplitude, and the addition of interest factors.... This concept supplies a working scheme and philosophy to be followed in all problems of flavoring and seasoning. The Flavor Profile method is a means of indicating degrees of success in the development and control of optimum flavor.⁸³

This was a way of comprehending and designing for consumer desirability while minimizing the risky, expensive, and uncertain business of consulting consumers. Or, as explained in a booklet promoting the work of ADL’s Food and Flavor division, the flavor profile is “a disciplined and codified understanding of the elements of flavor,” a kind of knowledge “instinctive to the master chef and to others who have been in the business of creating excellence in food. Using the Flavor Profile method... the process is no longer instinctive, it is under control, and can be used to achieve specific solutions to specific problems.”⁸⁴ Tacit knowledge was thus brought under the scope of technical determination and control. This is also, incidentally, a way of making the case for the value of outside consultants, who often lack local, hands-on experience with a company’s products or culture, and so situate the source of their authority elsewhere, in the ability to descry optimal operational structures and systems.

⁸³ Cairncross and Sjöström 1950: 311.

⁸⁴ [Arthur D. Little, Inc.] “Food and Flavor,” [n.d., but likely 1950s] ADL Collection, MIT, Series 6, Box 11, Folder 5.

Cairncross and Sjöström’s influential 1953 study of ‘flavor leadership,’ mentioned at the outset of this essay, followed through on a suggestion hinted at in their paper to the IFT, and laid out a “working scheme” to build an “interesting complex of flavor.”⁸⁵ In order to determine the qualities that characterized commercial success, flavor profiles were prepared for each flavor leader and its nearest competitors across eight different product classes: catsup, mustard, salad dressing, canned luncheon meat, cola, chocolate bars, peanut butter, and gelatin dessert. The goal was not to compare, say, salad dressings with each other to identify the specific ingredients, sensory notes, or other features that distinguished the top-seller from the also-rans in its category, but to compare sales leaders across categories in order to seek out markers of success. In other words, the study set out to inductively determine a set of general principles about good flavor — to discover a “common denominator of quality” shared by all foods — as well as to gain insight into the “unique factors of flavor and quality responsible for the outstanding success” of particular products.⁸⁶

Sjöström and Cairncross presented their findings as a set of design recommendations. Taken as a whole, these principles offered a choreography of optimized sensory experience, a temporal sequence of perceptions that unspooled during a consumer’s intimate experience of ingestion. A successful flavor began by making an interesting “first impression”: delivering an early-impact note. This was followed by a sequence of other “interest notes” accompanying the rapid development of pleasurable

⁸⁵ L.B. Sjöström and S.E. Cairncross, “What Makes Flavor Leadership?” *Food Technology* 7 (1953): 56-8.

⁸⁶ *Ibid.*: 56.

mouthfeel and full flavor amplitude.⁸⁷ This orchestral swell of sensation came to a clean finale; all “flavor leaders” showed minimal aftertaste, while the taste of many of the second-place finishers lingered on. “The first place cola drink exhibited a quick, clean disappearance of taste which encourages the drinker to take a second sip,” Sjöström and Cairncross explained in one example. “If the sips follow one another steadily, more colas are sold.”⁸⁸ Flavor sensations could be choreographed to encourage continued (and continuing) consumption, the ultimate proof of “good flavor” in a system whose models were chosen based on commercial dominance and sales volume.

This sequence of sensations and intensities was imagined to operate on a consumer’s desires, and guide her or his behavior, beneath the level of conscious awareness. Sjöström dilated on this point in a subsequent paper. The leading brand of catsup, “which incidentally is seldom advertised... had a profile entirely different from the lesser lights in the catsup field, though all are nationally advertised,” he observed. The number-one catsup kicked off with an unexpected baked bean-thiol note, and showed only a hint of sweetness in a complex blend; lesser catsups started with sweetness and sustained it, with little sensory variety. If a typical consumer were asked to choose between sulfury thiol or sweetness, she would almost certainly express preference for the sweet, and describe the thiol as unpleasant. Yet, assured Sjöström, she likely buys the leading brand “and unconsciously values its interest factors.”⁸⁹ The captivating power of these “interest factors” could overcome, with implicit action, the explicit exhortations of

⁸⁷ Ibid: 58.

⁸⁸ Ibid: 58.

⁸⁹ Sjöström, “The Descriptive Analysis of Flavor,” in Peryam et al. 1954: 28.

advertising. The consumer would continue buying her customary brand, without quite being able to explain why she liked it. Sjöström offered no discussion of the chemical origins of the thiol note, nor of the historic, cultural, or material paths by which it came to be found in the top-selling catsup but not in its competitors. It was not so much the definable sensory quality of the interest note, but its timing, intensity, and distinctness, that enchanted the consumer, whose thrill-seeking senses sought out the thiol's timpani in the arrangement, preferring it over the monotonous drone of sweetness.

One factor stood apart as the crucial determinant of whether a product was destined for flavor leadership: high amplitude, “a full body of highly blended flavor.”⁹⁰ Amplitude was directly related to “blend,” the integral, unanalyzable portion of flavor that could not be perceived as distinct “notes.” It was also associated with the sort of flavor balance and “smooth flavor” that was typical of the sensory effect produced by unprocessed foods. As Cairncross and Sjöström noted: “Flavors occurring in nature are often blends, but man must work to achieve a satisfying blend of flavor in any processed food.” However, this effort was always worthwhile, as “blending shouts ‘quality.’”⁹¹

Blending was a longstanding term of art among people concerned with the flavor of commercial goods, used since at least the nineteenth century by highly skilled workers engaged in the production of consumer luxuries that owe a significant portion of their value to sensory quality — goods such as whiskey, coffee, tea, or tobacco. Blending may be used to diminish the perceptibility of sensory faults, increase standardization across

⁹⁰ Sjöström and Cairncross 1953: 57.

⁹¹ Sjöström and Cairncross 1953: 57.

batches, or to impose a distinct “house” flavor on a branded commodity.⁹² Cairncross and Sjöström’s invocation of blendedness as a sensory characteristic of “natural” flavors was likewise not new, but had deep roots among those who worked with synthetic flavor chemicals. One of the earliest American monographs on the subject of flavor additives, Charles Herman Sulz’s 1888 *Compendium of Flavorings*, advised soda bottlers that the success of their beverages “is to a great extent dependent upon the correct blending of various flavors, which should unite in a harmonious whole,” avoiding “a pronounced flavor” or any “roughness to the taste” that might suggest artificiality.⁹³ Flavor and beverage industry trade and technical literature of the 1920s, 1930s, and onwards frequently testifies to the importance of blend, often in language that echoes that of the flavor profile’s description of amplitude.⁹⁴

⁹² As far as I know, the networks of experts, technologies, and practices associated with “blending” have not been studied by historians, and have largely been considered craft practices associated with methods of artisanal production — rather than integral to the large-scale production of foods and other sensible goods. Although beyond the scope of this paper, I believe that attending to these bodies of tacit knowledge could illuminate murky historical questions related to the production of consumer goods and the changing meanings of quality, and reveal ways of working that have remained more or less invisible in most accounts of industrialization. For a set of primary documents that reveal some aspects of this, see: “The English Whiskey Decision,” *American Food Journal* vol 4. (September 15, 1909): 53-56, see esp. 55 on “process”; John H. Blake, *Tea Hints for Retailers*, (Denver: Williamson-Haffner Engraving Company, 1903): Chapter X (“Tea Blending”); and *Tobacco Whiffs for the Smoking Carriage* (Mann Nephews: Cornhill, 1874): 3-17. For a related account of the intersection of historical, technological, and social factors involved in forming an agricultural commodity into a consumer good with particular sensory qualities, see: Barbara Hahn, *Making Tobacco Bright: Creating an American Commodity, 1617-1937*, (Baltimore: JHU Press, 2011).

⁹³ Charles Herman Sulz 1888: 10-11.

⁹⁴ See, for instance, Melvin De Groote, “The Selection of Extracts for Carbonated Beverages,” *The Beverage Journal* 58.3 (March 1922): 52-3; Bernice Challenger, “The Art of Blending and Its Application in the Bottling of Carbonated Beverages,” *Beverage Journal* 58.2 (Feb 1922): 91-3. De Groote portrays a high-quality flavor as one that

A blended flavor, then, was a sign of both genuine “naturalness” and exquisite human skill. In the latter case, a corollary consequence of blendedness was the erasure of the traces of skilled labor involved in its production. Blendedness gave the impression that flavor was immanent rather than externally applied. As a prescription for flavor leadership in processed foods, it put emphasis on control over processes, and on the use of skillfully crafted flavor additives that reproduced the effect of naturalness.

But, as it turns out, there was a chemical shortcut to achieving blended, high-amplitude flavors: MSG.

MSG AND FLAVOR LEADERSHIP

What was the flavor of MSG? In the first decade of the twentieth century, Ikeda Kikune, the Japanese chemist who successfully synthesized and commercialized the chemical, had argued that MSG produced a taste sensation distinct from the recognized four “basic” tastes of sweet, salty, sour, and bitter.⁹⁵ He dubbed that sensation “umami,” deliciousness, although it would not be until the 1990s that Western scientists came to

demonstrates not only a distinct and memorable character, but also ‘roundness’ and ‘smoothness,’ where ‘roundness’ is a balance between different elements within the flavor compound, and smoothness is a balance between the flavor compound and other sensory aspects of the drink, such as sweetness, acidity, and carbonation. Challenger advised that the goal of successful blending is “attaining a harmonious whole. In a blend, no one flavor is dominant, yet all unite to form a distinct different flavor” (92). For a discussion of the importance of blend in the production of synthetic flavors, see Bernard H. Smith, “Modern Trends in Flavors,” *Food Research* 2.3 (1937): 251-253. Smith, a chemist, headed the Brooklyn flavor company Virginia Dare.

⁹⁵ Jordan Sand, “A Short History of MSG: Good Science, Bad Science, and Taste Cultures,” *Gastronomica* (Fall 2005): 38-50.

accept umami as a basic taste modality.⁹⁶ Indeed, until the early 1940s, most US food researchers, manufacturers, and consumers spared little attention for MSG, dismissing it as an “oriental” seasoning unsuitable for Western cuisines.⁹⁷

This began to change in the early 1940s, when several US factories came on line producing MSG from agricultural waste products.⁹⁸ One of the first major American markets for domestically produced MSG was in powdered, dehydrated soups shipped abroad as food aid during the wartime Lend Lease program. In other words, MSG was initially used for the purpose of making minimally acceptable, highly processed foods somewhat more palatable. The Second World War fueled interest in exploring MSG’s potential as a food additive. Much of the research on the chemical was conducted in connection with the US Army Quartermaster Food and Container Institute, the center of military food technology research, which was deeply preoccupied with the problem of enhancing the “acceptability” of foods.⁹⁹

⁹⁶ Sarah E. Tracy, “Delicious: A History of Monosodium Glutamate and Umami, the Fifth Taste Sensation,” (PhD diss., University of Toronto, 2016).

⁹⁷ Although some wide-awake US gourmandisers sought out MSG in Asian specialty markets in the 1930s, it remained obscure and little-known; when mentioned in media, it was often described as an “imitation meat” flavor (and indeed was considered as such by USDA food labeling standards until the early 1940s). This may in part have been related to the presence of other amino acids in less-than-pure MSG, lending a meaty taste, but it also was related to ideas associated with the chemical’s origins. East Asian diets had long been regarded by some Western observers as monotonous and impoverished, meat-deficient poverty cuisine. For more on the history of MSG in the US before “Chinese Restaurant Syndrome,” see Berenstein, “How MSG Became American,” forthcoming. For Western views of Asian diets, see Belasco, *Meals to Come*.

⁹⁸ Marshall, “History of Glutamate Manufacture,” in Quartermaster Food and Container Institute, *Flavor and Acceptability of Monosodium Glutamate*, 1948.

⁹⁹ See Chapter 3. The US Army Quartermaster organized two symposia on the subject of MSG, the first in 1948, the second in 1955. The ADL group’s work was prominently

The work that Sjöström, Cairncross, and the rest of their group at ADL had done on behalf of International Minerals featured prominently in the new field of MSG research. Rather than trying to define the “glutamic taste” by comparing it with other basic tastes, as previous workers had done, Sjöström, Cairncross, and their colleagues used the profile method to determine and describe the parameters of the “glutamic effect,” a multisensory effect including taste, aroma, and tactile sensations, in MSG’s applications to various different foods.¹⁰⁰ Although there were categories of products it did not improve —namely, sweet foods and beverages and dairy — the chemical was found to enhance the flavor appeal of a broad set of foods, including canned, frozen, dehydrated, and other highly processed meat and vegetable products.¹⁰¹ In general, “the principal effect on food flavor was a balancing, blending and rounding out of total flavor.”¹⁰² It diminished the “steam-table flavor” of vegetables that had been left to mangle dismally on self-service buffets; it blunted the unpleasant, earthy flavor sometimes found in potatoes, and the sharpness of onion, in canned soups; eliminated the “fishy” note sometimes found in canned lima beans. It also boosted desirable flavors: intensifying carrot and cauliflower; “it makes meat taste more meaty and potatoes taste

featured at both. Quartermaster Food and Container Institute for the Armed Forces, *Flavor and Acceptability of Monosodium Glutamate: Proceedings of the Symposium*, March 4, 1948; Armed Forces Food and Container Institute, *Monosodium Glutamate: A Second Symposium*, Held at Palmer House, Chicago, June 7, 1955 (Chicago: Research and Development Associates, Food and Container Institute, 1955.)

¹⁰⁰ S.E. Cairncross and L.B. Sjöström, “What Glutamate Does in Food,” *Food Industries* 20 (July 1948): 76-7, 200-1.

¹⁰¹ Loren B. Sjöström, Stanley E. Cairncross, and Jean F. Caul, “Effect of Glutamate on the Flavor and Odor of Foods,” in Armed Forces Food and Container Institute 1955: 31-8.

¹⁰² Cairncross and Sjöström 1948: 33.

more potato-y.”¹⁰³ It provided a highly pleasurable tactile stimulation to the mouth. As one researcher put it, “it is difficult to describe this sensation other than to call it a ‘feeling of satisfaction.’”¹⁰⁴ After swallowing an MSG-containing morsel, a tactile after-effect remained in the mouth that left the eater “in anticipation of the next mouthful.”¹⁰⁵

Further, MSG seemed to perform its effects at subthreshold levels (ie, at concentrations below conscious perception.)¹⁰⁶ Consumers might not taste the MSG, but they did taste the difference. Especially in processed and canned foods, it suppressed undesirable flavor notes, while boosting desirable flavors, and produced a mouth-filling sensation that was highly pleasurable, without raising the awareness of its presence in the mix. “Monosodium glutamate has a very definite effect on consumer preference for foods,” concluded one Quartermaster study, which found that MSG “decidedly improved” the appeal of many of the highly processed foods they added it to.¹⁰⁷

As noted, the flavor profile method has its direct origins in the effort to name and record the effect that MSG had on many foods. The flavor profile was designed to efficiently capture and communicate MSG’s unique consequences: it blended flavor in many savory foods, and increased overall flavor amplitude. In other words, the blueprint for successful flavor, as described by the flavor profile, was modeled on the flavor-

¹⁰³ Sjöström “Descriptive Analysis of Flavor” in Peryam et al. 1954: 28.

¹⁰⁴ E.C. Crocker, “Meat Flavor and Observations of the Taste of Glutamate and Other Amino Acids,” in Quartermaster Food and Container Institute 1948: 28.

¹⁰⁵ Sjoström et al., in Armed Forces Food and Container Institute 1955: 33.

¹⁰⁶ Rosaltha Sanders, “The Significance of Thresholds of Taste Acuity in Seasoning with Glutamate,” in Quartermaster Food and Container Institute 1948: 70-2.

¹⁰⁷ Norman F. Girardot and David R. Peryam, “MSG’s Power to Perk Up Foods,” *Food Engineering* 26.12 (December 1954): 71-2, 181-5.

boosting, mouth-filling richness of MSG-enhanced foods. MSG was a shortcut to flavor leadership.

This is crucial, as Sjöström, Cairncross, Caul, and the rest of the Flavor and Food group at ADL were at the center not only of basic research into MSG, but also of the chemical's promotion and commercialization — on behalf of Ac'cent, the trade name for International Minerals' MSG product. Rather than a chemical salve for the flavor-diminished foods of wartime scarcity, MSG had to be demonstrated as an appropriate and desirable complement to the foods of prosperity, one that could improve the apparent quality, shelf-life, and appeal of many different kinds of products.

MSG was heavily marketed to manufacturers in the late 1940s and 1950s as a chemical that had the effect of reversing “flavor loss” and preserving, restoring, or boosting flavor in canned, frozen, and other processed foods. One advertisement for Ac'cent, published in the trade journal *Food Technology* in 1952, explained that the chemical was:

...the amazing new seasoning that catches — and *holds* — flavor during processing, while flavor's at its peak. Yet it adds no color, aroma, or flavor of its own. There are wonderful *natural* flavors *already in* the foods you process... with Ac'cent, you intensify these flavors. And, what's really important, the flavor-edge your products have over competition gives your salesmen something to talk about! When they cut a can for a customer, they'll have the assurance of not only fine products to back

them up but products with a flavor-edge that means repeat sales for those products.¹⁰⁸

MSG was presented as a chemical solution for a longstanding problem (flavor loss during processing), and one that acted not by masking problems, but by fully capitalizing on the latent value (the “natural” flavors) somehow already present in foods, with the effect of securing repeat business. Ac’cent was not the only MSG product on the market, but the language of ADL reports about the chemical, and the terminology of the flavor profile, permeated advertisements for its competitors, including Zest (manufactured by the Staley Corporation of Iowa, from corn gluten) and Great Western. In particular, MSG was touted as a way of bringing out the “naturalness” of highly processed foods. “Magnify natural food flavor as more and more leading food processors do... with Zest.”¹⁰⁹ “MSG blends, strengthens, and preserves the natural fresh flavors of your product,” ran an advertisement for Great Western’s MSG. “It creates a uniformity of taste, a flavor identity which is the first step in establishing lasting consumer brand preference.”¹¹⁰ The slogan “Ac’cent makes food flavors sing” graced advertisements and MSG tins for much of the latter half of the 1950s. These taglines assume greater meaning when one understands them as lay explanations of the “amplification” effect described by the flavor profile.

¹⁰⁸ Ac’cent, “One of These will be a ‘Best Seller,’” [advertisement], *Food Technology* 6 (April 1952): 7.

¹⁰⁹ Staley Co., “When the Flavor Is There the Customers Are Too!” [advertisement for Zest], *Food Engineering* 26 (February 1954): 108.

¹¹⁰ Great Western, “Is Flavor Control Your Problem?” [advertisement], *Food Engineering* 30 (June 1958).

Efforts to promote the use and consumption of MSG were tremendously successful. Nearly two decades before so-called “Chinese Restaurant Syndrome” was first reported in the letters section of the 1968 *New England Journal of Medicine*, MSG was already becoming a common chemical presence in US processed foods.¹¹¹ Between 1943 and 1955, domestic production of MSG increased from just over three million pounds a year to more than thirteen million.¹¹² By 1962, US production topped thirty million pounds, and would continue to rise; nearly all of this was consumed domestically.¹¹³ Despite concerted advertising efforts to persuade consumers to think of MSG as the “third shaker,” joining the venerable seasoning duo of salt and pepper in the home kitchen, the vast majority of MSG in the American food system was used in the production of “convenience foods” – canned soups, frozen foods, baby foods, condiments, and other processed foods, especially those containing protein.¹¹⁴ Precisely the kind of value-added foods that could be sold at a premium, and carried the largest profit margins. Its pervasive importance in these products was such that in 1964, researchers from Monsanto announced, “MSG dwarfs in dollar importance any other flavoring chemical known to man, with the possible exception of salt.”¹¹⁵

¹¹¹ Ian Mosby, “That Won-Ton Soup Headache’: Chinese Restaurant Syndrome, MSG, and the Making of American Food, 1968-1980,” *Social History of Medicine* 22.1 (2009): 133-51.

¹¹² Donald K. Tressler, “History of the Glutamate Industry,” in *Armed Forces Food and Container Institute* 1955: 13.

¹¹³ This was, however, a fraction of the global production, estimated at 148 million pounds a year, with Japan accounting for more than half. S.A. Heininger and D.J. Jorgensen, “Flavor Potentiators: Economic Considerations,” in Arthur D. Little, Inc. *Symposium on Flavor Potentiation* (Cambridge: ADL, 1964): 14-15.

¹¹⁴ Heininger and Jorgensen, in Arthur D. Little 1964.

¹¹⁵ Heininger and Jorgensen, In Arthur D. Little 1964: 15.

RECONFIGURING THE RECEPTIVE HUMAN SENSORIUM

But how, exactly, did MSG work? Its effects were described not only in terms of its “boosting” of food’s latent flavors — but also in terms of the chemical’s mode of action upon the body. MSG is the sodium salt of glutamic acid, an amino acid known to be neurologically active. Some of the earliest American studies on the chemical involved its central nervous system effects and neuropharmaceutical potential, as a possible treatment for epilepsy and mental retardation in children.¹¹⁶ Indeed, one study in the early 1940s found that treating mentally retarded children with glutamic acid increased IQ and reduced personality and behavioral problems.¹¹⁷ Although there was no evidence of MSG’s benefits upon the cognitive capacities of neurologically ‘normal’ individuals, there was speculation that the chemical could be effective for increasing intelligence in the population more generally; in any case, one pharmacologist wrote, “considering the dosage used in food flavoring” MSG’s presence in the food system “could only be beneficial.”¹¹⁸

One leading hypothesis about how MSG produced its effects drew on its demonstrated neurophysiological activity, and attributed to the chemical the property of

¹¹⁶ Carl C. Pfeiffer, “Pharmacology of Glutamic Acid,” in *Quartermaster Food and Container Institute* 1948: 73-8; Rohland A. Isker, “Notes on the Use and Effects of Monosodium Glutamate,” *Journal of the American Dietetic Association* 25 (September 1949): 760-3.

¹¹⁷ Zimmerman, Bergemeister, and Putnam, “Group Study of Effect of Glutamic Acid on Mental Functioning in Children and Adolescents,” *Arch. Neurol. Psychiat.* 56 (1946): 489-506.

¹¹⁸ Pfeiffer in *Quartermaster Food and Container Institute* 1948: 77.

“increasing the sensitivity of the taste receptors.”¹¹⁹ In other words, MSG operated by increasing the human body’s responsiveness to certain compounds in foods, enhancing its receptiveness to certain forms of sensation. Although there was little direct experimental evidence in support of this hypothesis, researchers continued to pursue it — especially in the absence of a working model that accepted Ikeda’s proposition that MSG triggered a distinct, umami taste modality.¹²⁰

In 1964, ADL organized a symposium on a concept that had emerged from its work with flavor profiles and MSG: flavor potentiation.¹²¹ “Potentiation” was a term borrowed from pharmacology, where it signified compounds that had no direct effect “on a biological system, but which exaggerate[ed] the effect(s) of other agents on that system.”¹²² Rather than producing noticeable sensory effects, flavor potentiators were thought to act directly on the body’s mechanisms of sensation. These were imperceptible agents which reconditioned the human body’s response to other compounds in the environment, magnifying, exaggerating, and synergistically enhancing certain perceptual effects. (Or as one newspaper advertisement for Ac’cent explained it to consumers,

¹¹⁹ Francis J. Pilgrim, Howard G. Schutz, and David R. Peryam, “Influence of Monosodium Glutamate on Taste Perception,” *Food Research* 20 (1955): 310-16.

¹²⁰ Pilgrim et al. (1955) review the experimental record, and find “no evidence... that MSG has any unusual effect on sensory acuity” (316). Sjöström, writing in 1963, cites continuing experiments in search of this effect, and disagrees with Pilgrim et al.’s conclusions. Loren B. Sjöström, “The MSG Story,” in Arthur D. Little 1964: 1-3.

¹²¹ Arthur D. Little 1964.

¹²² “Flavor Potentiation: An Introduction” in Arthur D. Little 1964: [np].

“Scientists...have established that, unlike any seasoning known, Ac’cent urges the taste buds to a quick, intense, and *sustained* appreciation of food flavors.”¹²³

MSG, the “first known flavor potentiator of major significance,” drove the search for similar compounds, including nucleotides such as 5’-IMP and 5’-GMP, which were already in use in Japan, and which received FDA approval for use in foods in 1962.¹²⁴ There were two arguments to be made for the value of these substances. First, potentiators were seen as a means of using less of another ingredient. In dehydrated soups, the addition of a proprietary nucleotide mixture allowed formulators to reduce the amount of (presumably more costly) beef extract used, while maintaining (or increasing) consumer acceptance.¹²⁵ Were one to be found, the presumed economic value of a sweetness potentiator, a compound that enhanced the perception of sugars, was staggering, especially in a marketplace at the beginning of a sustained boom in low-calorie soft drinks.¹²⁶

The second argument for the value of flavor potentiators was entwined with their imperceptibility, their spooky action at subthreshold. Despite the pace of change in the food industry, food manufacturers were, as a whole, conservative. Having built a market for a certain product, they were very reluctant to make any changes to it; indeed, manufacturers hired companies such as ADL to guarantee flavor consistency in cases

¹²³ Ac’cent, “How Much Good Flavor Has a Hamburger Got?” [advertisement], *Washington Post* (November 8, 1950): 4.

¹²⁴ Loren B. Sjöström, “The MSG Story,” in Arthur D. Little 1964: 1; Dudley S. Titus, “The Nucleotide Story: Applications,” in Arthur D. Little 1964: 11.

¹²⁵ Titus in Arthur D. Little 1964: 11.

¹²⁶ Heininger and Jorgensen in Arthur D. Little 1964: 17-8.

where ingredients had to be altered. “The reluctance to change the flavor of an existing product is both natural and logical, since the consumer is very often antagonistic toward any change in a product to which she has grown accustomed” conceded a representative from Merck, who spoke at the flavor potentiation symposium.¹²⁷ Potentiators promised to enhance existing flavors and improve acceptability without detection, influencing consumers’ behavior without alienating or alerting them.

Research into potentiators relied on flavor profiles, which made it possible both to determine the system of synergistic effects produced by the chemicals, and also to predict whether they would enhance food acceptability.¹²⁸ Indeed, the flavor profile made aspects of sensory experience perceptible, and measurable, to experts with the power to shape the qualities of things — precisely those aspects of sensory experience that resisted analytic quantification or conscious awareness. Commanding these molecular relations, by means of compounds increasingly designed to be imperceptible, could yield powerful effects.¹²⁹

¹²⁷ Titus in Arthur D. Little 1964: 12.

¹²⁸ Titus in Arthur D. Little 1964: 10.

¹²⁹ In a certain sense, this may be a special application of what Michelle Murphy has described as the formation of “domains of imperceptibility,” the designation of the material limits of knowledge that is integral to the establishment of scientific authority. “Seeing necessitates the designation of the unseeable, knowing the unknowable, and so on,” she writes. She also observes that: “over the course of the twentieth century imperceptibility itself became a quality that could be produced through the design of experiments or monitoring equipment.” In Murphy’s case study, which concern liabilities for chemical exposures in built environments, instruments and scientific practices were used to deny or cast doubt upon the sensed existence of latent chemical presences. In the flavor and food industries, the imperceptibility of chemical additives was produced alongside (and indeed, as part of the process of) the enhancement and improvement of flavors themselves. The goal was not to cast doubt on the sensations provoked by these chemical presences, but to naturalize them, render them proper to the foods that contained them and the bodies that responded. Michelle Murphy, *Sick Building Syndrome*

“Because of their remarkable behavior, we believe that these and as yet undefined potentiators will soon open up new paths to consumer flavor satisfaction,” enthused the representative from Merck who participated in the symposium.¹³⁰

CONCLUSION: THE FLAVOR BOOM

“Substance X” dramatized the fine distinction between designing foods to perfectly satisfy human desires — the utopian ideal of a place where no needs, even those of pleasure and imagination, go unmet — and configuring consumers to accept the gratifications that were given to them without resistance. According to the flavor profile, flavor was not just a sensible quality of certain forms of matter, a set of definite perceptual effects, or an object of scientific knowledge or connoisseurship, but a persuasive and influencing agent that acted on human bodies, between physiological receptivity, psychic effects, and behavioral response. In the dominant contexts of research into food science and technology — namely, contexts concerned with technics of industrial food production and processing — flavor became a sensory feature that could be designed to directly influence consumer motivations and actions *en masse* by operating on the intimate level of ingestion. The flavor profile would thus light the way toward the search for and identification of other neurophysiological effects, which would act upon and influence human bodies regardless of their particular constitution or specific situation.

and the Problem of Uncertainty: Environmental Politics, Technoscience, and Women Workers, (Durham and London: Duke UP, 2006.)

¹³⁰ Titus in Arthur D. Little 1964: 10.

The flavor profile method was a technoscientific tool that allowed investigators to compare the flavor of a catsup with that of a cola, or of a canned meat with that of a gelatin dessert, despite the fact that the foods or beverages in question may not share any similarities when it came to particular “flavors,” mealtime roles, or other consumer associations. It was a model uniquely suited to the market for processed foods that came into being in the postwar era, a market whose defining features were hypertrophic abundance and competition, where a canned soup must compete for its stomach share not only with other products of its ilk, but with anything else that a body might care to eat.

In successfully providing a general model for mass-consumption flavor, the flavor profile also offered the possibility of targeting niche markets. The obverse of flavor leadership were foods that stoked the passions of a select group of fans. “If a food product does have a dominant flavor that is strong and distinctive, it will usually appeal to cultural backgrounds, or to gourmets,” summarized one article that reviewed the findings of organoleptic studies of flavor. “While these limited groups form faithful markets for such products, the great mass markets can only be successfully exploited if the manufacturer designs his flavors to meet mass approval, and changes them to follow trends in popular taste.”¹³¹

This too, then, was a commercial opportunity. As Raymond Stevens, the Vice President of ADL, said to the Institute of Food Technologists: “We are breeding a nation of gourmets. A critical consumer means opportunity.” As profit margins continued to

¹³¹ “Tailored to Taste,” *American Perfumer & Essential Oil Review* 60 (August 1952): 99.

narrow with competition, finding the right flavor meant the difference between success and failure.¹³² The contemporary hyper-refined palate which disdains the mass produced American food industry could in some ways be said to be the invention of that very industry — sensitized and called into being by the products designed in laboratories of its flavor scientists.

¹³² “Full-Day IFT Symposium Stresses Key Role of Food Engineering,” *Food Engineering* 26 (August 1954): 83.

CHAPTER 6

THE SNIFFING MACHINE: FLAVOR RESEARCH AND THE “INSTRUMENTAL REVOLUTION” IN CHEMISTRY

When Colonel John D. Peterman, the Commandant of the Quartermaster Food and Container Institute for the Armed Forces, welcomed researchers from the food and flavor industry, the military, government, and academic food science departments to the May 1957 symposium on the “Chemistry of Natural Food Flavors,” he was addressing scientists in a field that was in the midst of radical change.⁷⁵⁰ “With the availability and application of our most advanced chemical and physical techniques and processing knowledge,” Col. Peterman predicted in 1957, “it seems reasonable to expect that progress in the next 10 to 20 years can be expected to be much more rapid than in the last decade.”⁷⁵¹ At the Quartermaster, a new program was underway to understand the chemical changes that occurred to food during processing, in order to improve the

⁷⁵⁰ Jack H. Mitchell, Norbert J. Leinen, Emil Mrak, and S. David Bailey, eds. *Chemistry of Natural Food Flavors: A Symposium Sponsored by the National Academy of Sciences National Research Council for Quartermaster Food and Container Institute for the Armed Services and Pioneering Research Division, Quartermaster Research and Engineering Center*, (Washington, DC: Armed Forces Food and Container Institute, May 1957).

⁷⁵¹ Col. John D. Peterman, “Introduction: The Emerging Science of Flavor,” in Mitchell et al., eds., *Chemistry of Natural Food Flavors* 1957: 2.

“acceptability” of military rations and other manufactured foods, a process aided by an infusion of funding and adoption of new technologies.⁷⁵²

Food research, like many other areas of basic research, was benefiting from the surge of Cold War government science funding.⁷⁵³ Flavor research, and indeed all of chemistry, was in the midst of being radically transformed by an array of new machines. The development and technical refinement of gas chromatography, mass spectrometry, infrared and ultraviolet spectroscopy, and nuclear magnetic resonance was one aspect of a broader transformation in chemistry in postwar America, when wartime advances in electronics and precision machinery converged with the needs of booming chemical and petroleum industries, crystallizing into what has been called the “instrumental revolution.”⁷⁵⁴ Those technologies seemed to offer the key to tremendous advances in an area of chemical knowledge that had hitherto remained recondite and obscure. Both army and industry would benefit from advances in flavor chemistry, Peterman emphasized, as the bevy of new physicochemical instruments produced more exact knowledge about the compounds responsible for flavor in foods.

⁷⁵² Donald K. Tressler, “Interest of the Quartermaster Corps in Flavor,” in Mitchell et al., eds., *Chemistry of Natural Food Flavors* 1957: 3. Tressler was the scientific director of the Quartermaster Food and Container Institute.

⁷⁵³ Anastasia Marx de Salcedo, *Combat-Ready Kitchen: How the U.S. Military Shapes the Way You Eat*, (New York: Current/Penguin Random House 2015): 77-8.

⁷⁵⁴ See Peter J.T. Morris, ed. *From Classical to Modern Chemistry: The Instrumental Revolution*, (Cambridge: Royal Society of Chemistry in Association with the Science Museum London and the Chemical Heritage Foundation, 2002); Davis Baird, “Analytical Chemistry and the ‘Big’ Scientific Instrumentation Revolution,” *Annals of Science* 50.3 (1993): 267-90; Carsten Reinhardt, *Shifting and Rearranging: Physical Methods and the Transformation of Modern Chemistry*, (Sagamore Beach: Science History Publications, 2006).

What would progress look like? Perhaps drawing an analogy with the nutritional fortification of foods with vitamins, Col. Peterman ventured that “there appears to be the distinct possibility that the acceptability of certain food items might be significantly improved by fortification with flavor substances.” For instance, “once we know the chemical nature of desirable meat flavor compounds,” those chemical compounds could then be synthesized and added to “meat items, soups, and gravies” in the military canteen, enhancing their sensory appeal to soldiers’ appetites. The loss of flavor in dehydrated foods could possibly be prevented, or fugitive flavors captured and restored. Enzymes might be used to break down flavor precursors in foods, capitalizing on latent flavor to maximize sensory experience. One day, instant coffee might even offer the satisfaction of fresh-brewed.⁷⁵⁵

The emerging science of flavor, then, was located at the intersection of chemistry and desire in the context of food production for the purposes of feeding large groups of people, whether soldiers or civilians. Flavor science, as articulated by the architects of the Quartermaster Institute symposium and as practiced by investigators in a range of institutional settings, aided by powerful new technologies of chemical analysis, explicitly connected physicochemical research with the improvement of the “acceptability” of foods — especially processed foods. Aiming for more than just the restoration of flavor lost during processing, this was a science organized around the optimization of the sensory possibilities of food. The means of accomplishing this optimization would be through the manipulation of the chemical components of flavor.

⁷⁵⁵ Peterman, in Mitchell et al., eds., *Chemistry of Natural Food Flavors* 1957: 2.

Later commentators would fall into the habit of illustrating the progress in flavor research in terms of the growing number of known flavor chemicals. “In the 1950s, only about 500 flavor compounds were known,” wrote USDA research chemist Roy Teranishi in 1989, in his introduction to an American Chemical Society volume reviewing recent advances in flavor chemistry. “Since then, with the advent of modern instrumentation, thousands of compounds have been characterized in hundreds of different foods.”⁷⁵⁶ Although research into the compounds responsible for flavor in food had been proceeding for decades using classical chemical techniques, for Teranishi and others who worked with flavor, the “advent of modern instrumentation” marked an inflection point, an acceleration in the rate of growth of scientific knowledge about flavor that transformed the very foundations of their field.

But even as new technologies facilitated the accumulation of lengthening lists of the chemical components responsible for the flavors of different foods, these machines did not answer questions about perception or about desire — about the sensory effects of these compounds, what each contributed to the total experience of a food’s flavor, and the role each played in determining the “acceptability” of the food. The researchers whose professional lives were devoted to the study of flavor had to find ways of accounting for the sensory meaning of the increasing number of compounds they isolated and identified.

This chapter considers the consequences of the instrumental revolution in chemistry for flavor research. I discuss the introduction and adoption of powerful analytic

⁷⁵⁶ Roy Teranishi, “New Trends and Developments in Flavor Chemistry: An Overview,” in Teranishi, Ron Buttery, and Fereidoon Shahidi, eds., *Flavor Chemistry: Trends and Developments*, ACS Symposium Series 388, (Washington, D.C.: ACS, 1989): 1.

machines — most significantly, the gas chromatograph and the mass spectrometer — which transformed the layout and labor of the flavor laboratory, entwined the study of flavor with other scientific disciplines and chemical industries, and elevated the professional status of the scientists who researched flavor. Although their immense potential was evident from the outset, these analytic machines did not automatically find a place in the flavor laboratory, and flavor chemists did not simply adopt a standard set of techniques developed in other research contexts. The challenges that had long bedeviled research into the chemistry of food flavors — the structural variety of flavor molecules, their minute concentrations in complex mixtures of other substances, their instability — persisted, even as the machines vastly increased the efficiency of chemical analysis and identification. Indeed, flavor chemists often found themselves working at the operational limits of these technologies. Instruments such as the gas chromatograph and the mass spectrometer had to be shaped to the particular problems of flavor research, and had to be proven effective and reliable among those working with this specialized category of materials. Consequently, the adaptations and innovations that originated in flavor laboratories would come to influence how machines would be used in other contexts. Meanwhile, in flavor research, the subjective, sensing body of the investigator would come to be seen as a necessary complement to the powerful analytic machines.

My story here dwells largely on one of the most productive sites of basic flavor research in the postwar decades, the USDA's Western Regional Research Laboratory in Albany, California, one of the four regional hubs of agricultural research created by the

1938 Agricultural Adjustment Act.⁷⁵⁷ These research centers had been commissioned by Congress to develop new markets, products, and purposes for farm commodities and byproducts, and contributed significantly to the industrialization of agriculture.⁷⁵⁸ During the Second World War, the Albany laboratory became a center for research into dehydrating, freezing, and freeze-drying, food preservation technologies that were of great interest in the development of military rations.⁷⁵⁹ The Albany laboratory's special technical capabilities and dedicated engineering facilities, its application of instrumental technologies to the flavor problems related to intensive processing, and its public-facing orientation all contributed significantly to shaping the way these tools would be used.

THE PURE AND THE MIXED: GAS CHROMATOGRAPHY AT THE BOUNDARY OF RESEARCH AND INDUSTRY

Pure compounds are scarce in this world, and often artificially produced; the material world is made up of complex mixtures. The separation of complex mixtures into component fractions — the isolation and purification of matter — has been a primary process for producing knowledge about substance since antiquity, and is a constitutive practice of the science now known as chemistry. The gas chromatograph was, first and foremost, a powerful tool for separating volatile mixtures into individual compounds,

⁷⁵⁷ Since 1953, the regional research laboratories have been known as regional research centers. For the political context, and chemurgical ideologies, that shaped the creation of the Regional Research Laboratories, see Mark Finlay, "The Industrial Utilization of Farm Products and By-Products: The USDA Regional Research Laboratories," *Agricultural History* 64.2 (Spring 1990): 41-52.

⁷⁵⁸ Ruth Coy, "Regional Research Centers: The First Half Century, 1940-1990," in *1990 Yearbook of Agriculture*, (Washington DC: USDA): 121-4.

⁷⁵⁹ H.T. Herrick, "New Uses for Farm Crops," *Yearbook of the USDA* 1942 (1943): 696-98.

which could then be definitively identified by other instruments and techniques.

Compared with prior chemical and physical methods of separation, gas chromatography (GC) offered numerous clear advantages: it was faster, more precise, and required less specialized labor.

Although historians have documented numerous interwar precursors of gas chromatography, it was not until after the Second World War that theory and technical know-how met opportunity and need, resulting in the commercial development and dissemination of these analytic machines.⁷⁶⁰ Scholars identify a 1952 paper by British biochemists A.T. James and A.J.P. Martin, of the National Institute for Medical Research in London, as the crucial publication for both gas chromatographic technology and the theory behind it.⁷⁶¹ A colleague at the Institute, who was working on a tricky problem involving fatty acid metabolism, asked for Martin and James' help in separating these organic compounds. Building on prior work in partition chromatography, the biochemists devised and demonstrated an instrument capable of executing "very refined separations of volatile substances."⁷⁶²

⁷⁶⁰ Keith D. Bartle and Peter Myers, "History of Gas Chromatography," *Trends in Analytic Chemistry* 21.9-10 (2002): 547-57; Leslie S. Ettre, "Fifty Years of Gas Chromatography — The Pioneers I Knew, Part I," *LCFC North America* 20.2 (February 2002): 128-40; Leslie S. Ettre, "The Early Development and Rapid Growth of Gas Chromatographic Instrumentation in the United States," *Journal of Chromatographic Science* 40 (September 2002): 458-72.

⁷⁶¹ A.T. James and A.J.P. Martin, "Gas-Liquid Partition Chromatography: A Technique for the Analysis of Volatile Materials," *Analyst* 77 (1952): 915-932; and James and Martin, "Gas-Liquid Partition Chromatography: The Separation and Micro-estimation of Volatile Fatty Acids from Formic Acid to Dodecanoic Acid," *Biochemical Journal* 50 (1952): 679; Bartle and Myers 2002.

⁷⁶² Quoted in Bartle and Myers 2002: 548.

All chromatographic methods involve a stationary phase and a mobile phase. As the sample (the mixed substance to be separated) is carried by the mobile phase, its components are selectively adsorbed by the stationary phase. In gas chromatography, an inert gas serves as the mobile phase, carrying the sample along the length of a “column,” a tube which has been either packed or coated with a liquid adsorptive media. Each component compound flows at a different rate, depending on its physical and chemical properties. As the mixture travels through the column, its components separate. Ideally, by the time the sample has run the course of the column, its components have disaggregated into pure fractions. A detector at the column’s exit registers both the “retention time” of each compound — the time it took to travel the length of the tube — and its relative quantity. The machine’s recorded output, the chromatogram, unspools as a graphical record of this process of separation, concurrent with the effluent vapor — the fractionated sample — which can be collected for further analysis and sensory examination.

GC found its first widespread application not in biochemistry, but in the postwar petroleum industry, as that substance replaced coal as the primary source of fuels and chemical raw materials.⁷⁶³ The distinguished chemist Carl Djerassi recalled the dramatic renovation of the chemical laboratory by analytic machines during this period:

“Laboratory glassware and reagents have been replaced by ‘black boxes’ — and

⁷⁶³ Bartle and Myers: 548; Leslie S. Etre, “Milestones in Chromatography: Fifty Years of GC Instrumentation,” *Liquid Chromatography Gas Chromatography North America* 23.2 (February 2005): 142.

expensive ones at that!”⁷⁶⁴ As Davis Baird and Carsten Reinhardt have argued, the recession of laboratory wetware into these “black boxes” — metal chassis housing sensors, circuits, control mechanisms, and other components that owed more to electrical engineering and physics than to classical chemistry — signaled and helped to perpetrate a shift in the material culture of the chemical laboratory, the epistemological scale and scope of chemical work, and the professional identity of the research chemist.⁷⁶⁵ Where organic chemists had once sought to identify unknown substances by observing reactions with known compounds, by the 1960s, professionalized analytical chemists largely focused their attention on the physical properties of matter disclosed by instruments.

According to the Leslie Ettore, a chemical engineer who helped develop GC at instrument maker Perkin-Elmer and later became the machine’s chief chronicler, gas chromatographs “represented the first truly automated, complex analytical instruments that did not need specially skilled scientists for their operation and could be used by practically every laboratory.”⁷⁶⁶ What had once taken exquisite skill and care could now be simplified and mechanized. Accordingly, some scholars have placed the changing relationship between chemical worker and analytic instrument within the framework of the industrial labor phenomenon of de-skilling. In the words of one historian of chemistry, what had been a “*craft*, with manual skills learned during an apprenticeship,” became a series of “standardized *procedures*,” steps that could be summarized in a

⁷⁶⁴ Carl Djerassi, “Foreword,” in Morris, ed. *From Classical to Modern Chemistry*: vi-vii.

⁷⁶⁵ Davis Baird, “Analytical Chemistry and the ‘Big’ Scientific Instrumentation Revolution,” *Annals of Science* 50.3 (1993): 267-90; Carsten Reinhardt, *Shifting and Rearranging: Physical Methods and the Transformation of Modern Chemistry*, (Sagamore Beach: Science History Publications, 2006).

⁷⁶⁶ Ettore 2005: 142.

manual and performed by a technician, with a concomitant decline of autonomy and a threat to professional status.⁷⁶⁷

Historians of the “instrumental revolution” have amply documented the central role that private industry played in the story of the development and dissemination of these technologies. Tools such as ultracentrifuges, spectrometers, and gas chromatographs were often designed and developed for industrial applications, such as process control and the production of synthetic materials, before being adopted for basic research in the academy.⁷⁶⁸ Certain industries in particular loom large here: chemical and petroleum companies, such as Dow, Shell Oil, and DuPont, whose investments in research, and decades of spectacular growth, fueled the postwar economic boom and

⁷⁶⁷ Pierre Laszlo, “On the Self-Image of Chemists: 1950-2000,” *Hyle* 12.1 (2006): 99-130. See also, Davis Baird, “Encapsulating Knowledge: The Direct Reading Spectrometer,” *Foundations of Chemistry* 2 (2000): 5-46; and Stuart Bennett, “Production Control Instruments in the Chemical and Process Industries,” in Morris, ed. *From Classical to Modern Chemistry*. Baird, discussing the consequences of the direct reading emission spectrometer (developed in the 1940s), on the nature of chemical work, argues that machines in this period are increasingly presented as “thinking instruments,” embodying the skills that analytical chemists were once required to possess. “To de-skill the analyst,” he writes, “the instrument must be skilled with a material form of knowledge.” (6) Bennett, meanwhile, locates the adoption of chemical control technologies within the framework of Taylorist management strategies.

⁷⁶⁸ See Yakov M. Rabkin, “Technological Innovation in Science: The Adoption of Infrared Spectroscopy by Chemists,” Terry Shinn, “Research-technology instrumentation: The Place of Chemistry,” Charlotte Bigg, “Adam Hilger, Ltd. and the Development of Spectrochemical Analysis,” and Stuart Bennett, “Production Control Instruments in the Chemical and Process Industries,” all in Morris, ed. *From Classical to Modern Chemistry*. For a sophisticated analysis of knowledge transfer between industry and academia, that casts instruments as boundary objects, and technologists/technicians as go-betweens, see Apostolos Gerontas, “Creating New Technologists of Research in the 1960s: The Case of the Reproduction of Automated Chromatography Specialists and Practitioners,” *Science and Education* 23 (2014): 1681-1700.

supplied many of the materials of modern living.⁷⁶⁹ This context is crucial to understanding some scholars' interpretation of these instruments as fundamentally de-skilling, oriented towards purposes of monitoring and control, and implicated in the replacement of the labor of experienced scientific professionals with machine-operator technicians.⁷⁷⁰

However, in flavor research, the introduction of gas chromatography and associated technologies came to be seen as marking a rupture between flavor chemistry's past, and its postwar present and increasingly bright future, a rupture that was observed not only by workers in the flavor industry but also by those studying flavor in academic, government, and military contexts.⁷⁷¹ Rather than diminishing the importance, or supplanting the expertise, of flavor chemists, GC was essential in establishing their professional status as well as the scientific credibility of their discipline.

⁷⁶⁹ Ralph Landau and Nathan Rosenberg, "Successful Commercialization in the Chemical Process Industries," in Rosenberg, Landau, David C. Mowery, eds. *Technology and the Wealth of Nations*, (Stanford: Stanford UP, 1992): 73-119.

⁷⁷⁰ Although variations of this de-skilling hypothesis are proposed by Baird, Bennett, and others, this is by no means the only reading of the impact of these machines on chemical work. In *Shifting and Rearranging*, Carsten Reinhardt meticulously examines the work practices and experimental techniques adopted in different chemical subdisciplines using analytic instruments, concluding that scientists' use of these machines was anything but routine. What he observes, instead, is that "a novel kind of method-oriented chemist came into existence. Their main focus was the development of instrument-based problem-solving methods for the chemical community at large. In doing so, their work contributed to the creative interplay of physical and chemical techniques, concepts, and theories as well as it relied on scientific cooperation and academic-industrial collaboration." (27)

⁷⁷¹ E.g., Roy Teranishi demarcates the "past" of flavor chemistry as "the era before infrared (IR), nuclear magnetic resonance (NMR), gas chromatography (GC), and mass spectrometry (MS) were widely used." In Teranishi, "Development of Methodology of Flavor Chemistry Past, Present and Future," in David B. Min and Thomas H. Smouse, eds., *Flavor Chemistry of Lipid Foods*, (Champaign, IL: American Oil Chemists' Society, 1989).

MAKING GAS CHROMATOGRAPHY A TOOL FOR FLAVOR RESEARCH

Given the centrality that GC would assume in later accounts of the development of postwar flavor science, its usefulness to flavor research would come to seem almost self-evident. Yet despite the recognized analytic power of the machine, establishing a correspondence among the volatile compounds separated by the instrument, and the sensory qualities of foods, was complex, labor-intensive, and fraught with uncertainty. Long after GC had become standard machinery in the flavor research lab, “the human nose” continued and, indeed, continues to be recognized as “the ultimate instrument in flavor chemistry.”⁷⁷²

Making GC useful, trustworthy, and meaningful for flavor research involved the deliberate coordination of researchers, technicians, and machinists, continuous empirical tinkering, and sensory corroborations, as well as the development of new techniques for the preparation of samples, the adaptation and modification of commercial machine components, and the interpretation of results. At the outset, the use of these machines in the study of flavor demanded from the flavor researcher an intimacy with both the chemical constituents of foods, and the mechanical and instrumental components of the devices that purported to reveal them. It is no accident, then, that some of the most significant work applying analytic instruments to fundamental research into flavor chemistry occurred at a site that was equipped with a machine shop in addition to

⁷⁷² Roy Teranishi, Phillip Issenberg, Irwin Hornstein, and Emily L. Wick, *Flavor Research: Principles and Techniques*, (New York: Marcel Dekker, 1971): 137.

conventional chemical laboratories: the USDA Western Regional Research Laboratory in Albany, California.

During the Second World War, the Albany lab became a center for research into dehydrating, freezing, and freeze-drying, food preservation technologies that were of great interest to the developers of military rations.⁷⁷³ Research in these areas continued after the war. Regrettably, these processing methods often resulted in foods that were flavorless, off-tasting, or otherwise unappealing. In order to understand and counteract the factors behind the decline in quality, the laboratory undertook chemical studies of flavor.

Keene Dimick, a chemist working at the Albany laboratory, was part of a group investigating how freezing altered the flavor of fruits. A major impediment to flavor research had always been separating the volatile flavorful essences from the gross material of the fruit — the water, fiber, waxes, and other stuff which comprised the bulk of the fruit's matter, but contributed little of its flavor. Dimick and his colleagues devised and modified instruments that could strip and recover volatile compounds from fruit juices and purees, reliably preserving “the naturally occurring volatiles with as little alteration in composition as possible.”⁷⁷⁴ Once these volatiles were recovered, the

⁷⁷³ Herrick 1943: 696-98.

⁷⁷⁴ K.P. Dimick and Benjamin Makower, “A Laboratory-Scale Continuous Vacuum Flash Evaporator,” *Food Technology* (December 1951): 517-520; K.P. Dimick and Marion J. Simone, “A Laboratory Continuous Distillation Column for Concentration of Aqueous Solutions of Volatile Flavors,” *Industrial and Engineering Chemistry* 44.10 (October 1952): 2487-90; D.G. Guadagni and K.P. Dimick, “Fruit Flavors: Apparatus and Procedure for Separation and Estimation of Volatile Components,” *Journal of*

analysis of their contents proceeded using microchemical techniques very similar to those that had been employed in flavor research at the USDA since the 1920s.

Dimick's special subject was strawberries. Initially, his goal had been to develop "an objective chemical test... for assaying flavor potency" — a means of chemically (and perhaps automatically) determining the intensity and quality of strawberry flavor.⁷⁷⁵ For more than six years, he and colleagues Joseph Corse and Benjamin Makower labored to separate, concentrate, and identify the volatile chemicals responsible for the flavor of Marshall strawberries, processing 30 tons of the fruit to obtain approximately 35 mL of a highly concentrated aqueous solution of volatile compounds.⁷⁷⁶ This concentrate was then divided into two unequal parts. The larger part, accounting for about ninety percent of the volume of the concentrate, comprised low-boiling compounds. This solution was "virtually without a characteristic aroma [of strawberry] and of very low flavor intensity." In contrast, the much smaller volume of high-boiling compounds had an intense aroma "bearing the characteristic fresh-strawberry flavor."⁷⁷⁷ Although the high-boiling compounds were present at levels no higher than 7.5ppm in strawberries, these intensely aromatic and scarce chemicals seemed to hold the key to what made strawberries smell and taste specifically like strawberries, and unlike any other fruit. However, this oily mixture stubbornly resisted the chemists' attempts at analysis, proving

Agricultural and Food Chemistry 1.19 (December 9, 1953): 1169-70. Quote from Guadagni Dimick 1953: 1169.

⁷⁷⁵ KP Dimick and Benjamin Makower, "Volatile Flavor of Strawberry Essence. I. Identification of the Carbonyls and Certain Low Boiling Substances," *Food Technology* 10.2 (February 1956): 73.

⁷⁷⁶ Ettore "The Pioneers I Knew" 2002: 137.

⁷⁷⁷ K.P. Dimick and Joseph Corse, "The Volatile Flavors of Strawberry," *American Perfumer & Aromatics* (February 1958): 45.

itself “almost intractable.”⁷⁷⁸ Dimick and his colleagues had no good way isolate and identify compounds present in this laboriously produced extraction.

Then, in 1953, the researchers got wind of James and Martin’s seminal paper describing the theory, assembly, and utilization of a gas liquid partition chromatograph.⁷⁷⁹ News of the technology may have reached them through the petrochemical industry. Shell Oil maintained an important research center in nearby Emeryville, and Dimick and Corse thanked them for extending technical and material assistance.⁷⁸⁰ Before GC became commercially available, custom-built units were already in operation in the laboratories of petrochemical companies such as Shell and British Petroleum.⁷⁸¹ The Albany lab had a dedicated machine shop, where about half a dozen “very good machinists” assembled scientific instruments, pilot food processing equipment such as dehydrators, and other tools for the center’s researchers.⁷⁸² Working with technicians in the Albany machine shop, using commercially available and custom-

⁷⁷⁸ Dimick and Corse 1958: 45.

⁷⁷⁹ James and Martin 1952.

⁷⁸⁰ In an acknowledgement at the close of their initial publication on GC, Dimick and Corse thank Shell Development in Emeryville “for their friendly and helpful advice in constructing the GLPC [ie, gas liquid partition chromatography] apparatus and, in particular, for the use of the coiled column.” They also thank various WRRC coworkers: Dr. Lloyd Ingraham for the circuit design, Victor Ortegren for engineering suggestions, and EF Jansen, a lab chief, for his encouragement in the entire flavor-analysis program. K.P. Dimick and J. Corse, “Gas Chromatography — A New Method for the Separation and Identification of Volatile Materials in Foods,” *Food Technology* 10.8 (August 1956): 364.

⁷⁸¹ Ettore 2005: 143.

⁷⁸² Personal conversation with Ron Buttery, September 2016.

built machine components, and with assistance from colleagues at Shell Oil, Dimick and Corse had an operational GC unit assembled.⁷⁸³

“The development of gas chromatography,” Dimick and Corse wrote, “opens the door to the flavor chemist to problems which were heretofore essentially unsolvable.”⁷⁸⁴ Their first publication about the device in *Food Technology* included a pair of schematic drawings, a detailed components list including suppliers, and a working drawing of the thermal conductivity cell detector, as well as operational information — how to pack a column, how to calibrate the instrument, how to prepare samples for the instrument. All of this material was intended to guide other researchers in devising and using their own GC units for flavor research.

Dimick and Corse presented the machine not as a radical departure from prior methods, but as a faster and more powerful way to perpetrate a familiar chemical operation: the separation of complex mixtures. “Gas chromatography,” they suggested, “really represents a superlative fractionating column.” They repeated James and Martin’s estimate of the GC column’s “phenomenal” efficiency: “2,000 theoretical plates.”⁷⁸⁵ This was a metaphorical construct, a calculation of the machine’s separating power expressed in terms of the familiar distillation plates of glass fractionating columns, although the GC contained no such components. At the same time, Dimick and Corse insisted that the machine offered functional possibilities unattainable by classical chemical methods.

⁷⁸³ A materials list for the assembly of a GC unit is included in Dimick and Corse 1956: 361.

⁷⁸⁴ Dimick and Corse 1956: 360.

⁷⁸⁵ Dimick and Corse 1956: 361.

Compounds with similar boiling points could be cleanly separated by GC without the frustrating formation of azeotropes, mixtures inseparable by distillation. The machine also allowed for operational versatility. By changing the stationary phase used in the column — replacing a silicone oil manufactured by GE with Union Carbide’s Carbowax coating, for instance — the researcher could use the different polar and chemical properties of these substances to more effectively separate closely related compounds.⁷⁸⁶ Finally, the device created a “permanent record” for each analysis — the chromatogram — whose peaks charted the emergence of each substance, and provided some clues to its identity and quantity.

When Dimick and Corse began publishing the results of their research in 1956, interest in the instrument was growing among chemists working in a range of different fields and industries. “No beautiful movie actress could have drawn a more appreciative and attentive audience... than did the day-and-a-half Symposium on Vapor Phase Chromatography” at the Dallas meeting of the ACS in April 1956, reported the *Journal of Analytical Chemistry*, using an alternate name for GC. More than 600 people crowded into the standing-room-only sessions, as academics, government researchers, and scientists from companies such as Dow, Monsanto, Shell Oil, General Foods, and Phillip Morris discussed theory, design, use, and applications. Corse presented the Albany lab’s work on strawberry volatiles.⁷⁸⁷

⁷⁸⁶ Dimick and Corse 1956: 362-3.

⁷⁸⁷ “Standing Room Only at Dallas Analytical Meeting,” *Analytical Chemistry* 28.5 (May 1956): 13A-14A; “Five-Day Program for Analysts at Dallas,” *Analytical Chemistry* 28.3

The adoption of gas chromatography by chemical researchers was facilitated by the commercial introduction of GC units, which made it possible for laboratories and institutions that did not have a sophisticated machine shop to acquire and use the devices. In 1955, three US companies began selling GC devices; by 1962, twenty-five manufacturers were building the instruments.⁷⁸⁸ (Dimick himself would leave the USDA at the end of 1956 to start a scientific instrument company with his brother-in-law, initially assembling GC units in a former bicycle shop.⁷⁸⁹ That company, Wilkens Aerograph, would be sold to Varian Associates for \$12 million in 1965.⁷⁹⁰) Manufacturers — such as Perkin-Elmer, whose Model 154 was one of the earliest and most widely-used GC units — also promoted the adoption and acceptance of the machines by publishing detailed operational guides, providing technical assistance, and working directly with chemists in different fields to optimize instrumental conditions for different analytic problems. Perkin-Elmer was also the first instrument manufacturer to also provide and manufacture standard packed columns, with different stationary phases.⁷⁹¹

Nonetheless, the reliability and utility of GC for flavor research was not cut and dry. In 1958, Max Winter, a chemist at the important flavor and fragrance company Firmenich in Geneva, published his laboratory's analysis of strawberry flavor, using classical chemical separation techniques including paper and column chromatography.

(March 1956): 25A-26A. The Symposium on Vapor Phase Chromatography begins Wednesday morning, April 11, and runs through the following morning.

⁷⁸⁸ Ettre 2005: 148.

⁷⁸⁹ Ettre 2002: 465.

⁷⁹⁰ Ettre 2002: 466.

⁷⁹¹ Ettre 2005: 146-7.

He pointedly contrasted his laboratory's chemical methods with those obtained by the Albany lab with the GC apparatus. "There is no doubt that gas chromatography is an efficient separation method which is employed in all modern analytical research work," he conceded, before enumerating two objections to using the machine as a basis for determining the chemical contents of strawberry flavor. First, in order to obtain a strawberry concentrate which could be used in gas chromatography, "important preliminary treatment is required, during which flavor alterations and losses often occur." That is to say, GC did not resolve many of the recognized challenges to flavor research, because it continued to require the manipulation of a food into an analyzable flavor sample.

Of particular concern was what happened within the black box of the machine, where the separating sample was inaccessible to the active manipulation and sensory evaluation of the research chemist. "The special physicochemical conditions of gas chromatography (temperature, column activity) may involve alterations of especially unstable substances," Winter fretted, and there was no simple way of knowing whether the chromatogram was registering artifacts produced within the machine, or the unaltered constituents of nature. Although gas chromatography may provide complementary evidence to support results produced by classical chemical methods, Winter argued that it could not be relied upon as the primary method of flavor analysis.⁷⁹²

⁷⁹² Max Winter, "Chromatography on Columns and Paper in the Study of the Volatile Fruit Flavor of Strawberries," in Arthur D. Little, Inc., *Flavor Research and Food Acceptance*, (New York: Reinhold, 1958): 291.

Winter was certainly not the only researcher to worry about the possibility of artifacts and other chemical changes. This remained a concern for flavor chemists using the machines, and they adopted protocols to minimize and forestall these risks. Indeed, one of the things that made GC a persuasive and useful tool for flavor research was that the material under study remained available for sensory and chemical analysis after it had eluted from the machine. For Dimick and Corse, this constituted strong proof of the device's reliability. "After we had developed a satisfactory apparatus," they wrote, "we were able to test the hope that there would be no appreciable change in odor of a sample run through it." To their relief, they found no perceptible difference between the aroma of the "total collection of the effluent fractions" and the starting material.⁷⁹³

A possible explanation for Winter's reluctance to place primary in trust the GC may be found in the distinction between his purposes at Firmenich, and the aims of Dimick and Corse at the USDA. That is to say, the values that guided Winter's chemical research were not equivalent to those that shaped Dimick's program. Winter was exquisitely aware of the fleetingness of fresh strawberry flavor. When strawberries were crushed, he lamented, the finest flavor lingered only for a brief minute. Within five minutes, "a change in the characteristic components is noted." After ten minutes, "this alteration is marked."⁷⁹⁴ His goal at Firmenich was to chemically identify, and reproduce, the evanescent components of that freshness. Classic paper and column chromatographic techniques, which he preferred to gas chromatography, required that these volatile

⁷⁹³ Joseph Corse and Keene P. Dimick, "The Volatile Flavors of Strawberry," in Arthur D. Little 1958: 306.

⁷⁹⁴ Winter 1958: 290.

compounds be converted to nonvolatile derivatives by means of carefully selected chemical reagents. Thus, he explained, “volatile or unstable substances are rapidly fixed and thus protected from changes,”⁷⁹⁵ and remained within the chemists’ attentive and careful control. His concern was not an efficient analysis of the total volatile contents of strawberries — a comprehensive list of all strawberry flavor chemicals, in order to rectify the faults or standardize the quality of frozen strawberry slurries — but the identification of those compounds responsible for certain unmistakable and remarkable sensory impressions produced by certain strawberries. For Winter, pinpointing the material correlates of precise sensory effects took priority over the broader compilation of chemical presences.

Winter’s recalcitrance toward analytic instruments, expressed in his 1958 paper, was one of the last damp squibs of resistance to the machines. The vast analytic capabilities of GC, its accessibility, experimental versatility, and wide professional acceptance across chemical fields, proved persuasive to flavor researchers in government, academic, and flavor industry laboratories. However, Winter’s insistence on the primary importance of sensory evaluation in the chemical analysis of foods reflected concerns that would increasingly come to shape how devices such as GC were utilized to study flavor.

⁷⁹⁵ Winter 1958: 291.

FEEDING THE MACHINE: MAKING FLAVOR AN OBJECT OF GAS CHROMATOGRAPHY

Even as GC became a standard instrument across chemical sub-disciplines, flavor researchers had to develop techniques to make the machine work for their particular purposes. Part of the challenge lay in the relationship between the sample input and the machine. The GC had to be readied to properly accept the sample, to permit its clear transit, accurate separation, and the sharp detection of each of its constituent compounds. Ideally, “the chromatogram would consist of a series of sharp spikes, a dream of all chromatographers,” with each “peak” representing a single compound.⁷⁹⁶ This was rarely the case, especially for flavor chemists, who were attempting to identify molecules present in extremely small quantities, with a wide range of boiling points, and from a variety of structural groups. Quite often, peaks on a chromatogram included multiple compounds, which had to be separated analytically in order to make identifications. Researchers also had to grapple with column “bleed” and other sources of “noise,” from which the “signal” of pure, isolated compounds had to be disentangled.

In the late 1950s, three features were introduced to GC units, expanding the utility of the devices for all users, but with particular consequences for flavor chemistry research.⁷⁹⁷ First, ionization detectors replaced thermal conductivity detectors, vastly increasing the sensitivity of the machine — an extremely useful development for flavor chemists. Second, linear temperature programming, which allowed the researcher to

⁷⁹⁶ Robert L. Pecsok, “Gas Chromatography: Basic Principles and New Developments,” *Journal of Chemical Education* 38.4 (April 1961): 212.

⁷⁹⁷ Ettore “The Pioneers I Knew” 2002: 135.

gradually change the column temperature during analysis, made it possible to separate and isolate compounds over a wider range of boiling points. Third, capillary (‘open tubular’) columns were developed and introduced by the Perkin-Elmer corporation. These columns expanded separation power by several orders of magnitude. However, due to the material constraints of their samples, flavor chemists often had to utilize open tubular columns of larger diameter than those used in other analytic contexts.⁷⁹⁸

Rather than routinizing the ways the GC was used, these features provided further opportunities for hands-on tinkering and modification. Samples often went through the GC multiple times, running separated fractions through the machines again, with columns packed with different liquid media to enhance their separations.⁷⁹⁹ Even after standard packed columns became available, flavor researchers continued to prepare columns themselves, hanging them in stairwells to ensure the even distribution of the liquid

⁷⁹⁸ This was particularly the case when combining headspace analysis (to be discussed below) and capillary columns. The necessary sample size for adequate headspace analysis often overwhelmed the capacity of 0.01-in i.d. standard capillary columns, and so experimenters used larger-diameter, longer capillary columns, sometimes fusing them themselves to obtain the desired dimensions. See Jennings, “The Neanderthal Age of Gas Chromatography.” For a discussion of the headspace/capillary problem in an experimental context, see Ron G. Buttery and Roy Teranishi, “Measurement of Fat Autoxidation and Browning Aldehydes in Food Vapors by Direct Vapor Injection Gas-Liquid Chromatography,” *Agricultural and Food Chemistry* 11.6 (Nov-Dec 1963): 505.

⁷⁹⁹ This is known as “preparatory chromatography,” and was a particularly common practice in flavor research because of the chemical heterogeneity of the substances of interest in foods. By using different liquid phases, and skillful temperature programming, a chemist could resolve what had appeared as a single peak into multiple component fractions in subsequent runs through the GC. Dimick’s GC company, Wilkens Instrument & Research, specialized in devices that simplified preparatory GC. Ettore “Early Development and Rapid Growth of Gas Chromatographic Instrumentation” 2002: 465-6.

phase.⁸⁰⁰ Researchers freely experimented with various liquid phases, searching for substances that helped separate stubborn peaks into constituent compounds. Among commercially available waxes and silicon oils, Tide, the laundry detergent, was found to be particularly effective. “It will not be long before everything in the stockroom has been tried as a stationary phase,” one chromatographer commented in the early 1960s.⁸⁰¹ Glass melting point tubes, standard equipment of any chemical laboratory, were inserted and attached into columns, to create a “sniff port” by which eluted fractions could be organoleptically examined.⁸⁰²

It was not only the machine that had to be tinkered with to make it suitable for flavor research. The sample that was introduced into the machine also raised questions for researchers. A researcher couldn’t just feed a strawberry into the GC, or a slice of roast beef, or a wafer of toasted bread, and await the automated results of the machine’s analysis. Investigators had to produce, from the food, a sample, one that was legible to the GC and conformed to the machine’s technical requirements, while also accurately representing the complex of flavor chemicals as they existed in the food.

One approach to converting opaque food into a sample that the GC could analyze was already very familiar to flavor chemists: careful distillation and extraction, generally with organic solvents such as isopentane and ether, to concentrate the volatile substances of interest and separate them from water, waxes, and other materials that could disrupt

⁸⁰⁰ Walter Jennings, “The Neanderthal Age of Gas Chromatography”; Personal communication, Alfred Goossens, 2015.

⁸⁰¹ Pecsok 1961: 215.

⁸⁰² Jennings, “The Neanderthal Age of Gas Chromatography.”

the sensitivity of the GC. Dimick and his colleagues at Albany had done just this when applying the GC's separating powers to the recalcitrant remnant of strawberry volatiles that they had produced using specially designed flash evaporation and distillation equipment.⁸⁰³

These processes were laborious and material-intensive, introduced the risk of producing chemical artifacts (as Winter had warned), and inevitably resulted in the loss of some compounds and the disproportionate collection of others. Further, even in the best case scenario — one where procedures were followed impeccably, and contained unaltered all the volatile compounds that were present in the food — this sample was only an approximation of the human sensory experience of a food. This is because the volatility of chemical compounds, and thus their apparent sensory qualities, is affected by their immediate material environment — by the food system that they are contained within. This is why adding salt to a broth enhances its aroma (by lowering the vapor pressure), and why a perfume oil smells different than the same compounds in an alcohol-based eau de toilette. When volatiles were isolated from food, “the original quantitative interrelationships of aroma components is destroyed,” as one textbook on flavor chemistry explained.⁸⁰⁴ Although the sensory differences may be subtle, they were inarguable. The chemical composition of the aromatic vapor over a distillate of apple volatiles, for instance, was not equivalent to the compounds that launched themselves

⁸⁰³ Dimick and Corse 1956: 363-4.

⁸⁰⁴ Teranishi et al. 1971: 39-40.

into the atmosphere, entering the olfactory region either through the nostrils with the intake of breath, or retronasally, as the apple itself was consumed.⁸⁰⁵

As flavor chemistry became increasingly successful at extracting information about the chemical composition of food, the desideratum of analysis — the meaning of flavor as a scientific object — also changed. Rather than aiming for the identification of the total content of volatiles present within a certain type of food, flavor researchers increasingly attended to the relationship between the analyzed sample and the human sensory experience of the food.

Flavor chemists at the Albany laboratory played a leading role in the development of a method of flavor sampling that sidestepped many of the more tedious aspects of preparation and also seemed to offer a more meaningful sample — not of the volatiles present within the food, but of the aroma perceptible above it. In the early 1960s, Roy Teranishi, the chemist who had replaced Dimick after he had left to start Wilkens Aerograph, and his colleague Ron Buttery published a paper describing a technique for direct vapor sampling and analysis — what would later come to be referred to as headspace analysis.⁸⁰⁶ Essentially, the method involved placing a portion of food in a closed container — often, a 250mL glass Erlenmeyer flask — and allowing it to stand for several minutes, so that volatile compounds reached equilibrium in the flask's atmosphere. A syringe was then plunged into the container, extracting five to ten cubic

⁸⁰⁵ Teranishi et al. 1971: 19.

⁸⁰⁶ Ron G. Buttery and Roy Teranishi, "Gas-Liquid Chromatography of Aroma of Vegetables and Fruit: Direct Injection of Aqueous Vapors," *Analytic Chemistry* 33.10 (September 1961): 1439-41.

centimeters of vapor, which was immediately injected into the GC column via the input port.⁸⁰⁷

Headspace analysis would not have been possible without the coordination of multiple new technological components within the GC machine complex. Of primary importance was the detector. The first GC units used thermal conductivity detectors (TCDs), which registered differences between the pure carrier gas and the carrier gas mixed with the sample vapor.⁸⁰⁸ The low concentration of volatile molecules in headspace vapor would have been well below the threshold of these devices; moreover, they were sensitive to water vapor and air molecules, which meant that analysis of headspace samples would be distorted by considerable “noise.” In the late 1950s, flame ionization detectors (FIDs) were introduced, which were orders of magnitude more sensitive than TCDs, while also being insensitive to water vapor.⁸⁰⁹

⁸⁰⁷ A comprehensive description of the method can be found in: Roy Teranishi, Ron G. Buttery, T.R. Mon, “Direct Vapor Analyses with Gas Chromatography,” *Annals of the New York Academy of Sciences* 116 (“Recent Advances in Odor: Theory, Measurement, and Control,”) (July 1964): 583-9.

⁸⁰⁸ “In essence, a differential thermal conductivity cell is a Wheatstone bridge in which carrier gas flows over or near two of the resistors (thermistors are sometimes used) and the column effluent over or near the other two.... The cell resistors are heated by passage of current, and the bridge is adjusted so that it is in balance when only carrier gas is coming through the column. Emergence of sample from the column causes a change in the thermal conductivity of the effluent as compared with the carrier gas. This results in a change in temperature, and consequently a change in resistance, of the resistors exposed to the column effluent. The resulting unbalance of the bridge is then applied to the recorder.” This article noted that thermal conductivity cells were commercially available from multiple manufacturers, but also that “their construction is not beyond the ability of a good technician,” particularly as wiring diagrams and designs had been published. John R. Lotz and Charles B. Willingham, “Gas-Phase Chromatography,” *Journal of Chemical Education* 33.10 (October 1956): 487.

⁸⁰⁹ *Ettre* 2005: 148.

Headspace analysis radically reduced the preparatory labor required to introduce a flavor complex to the GC unit. Teranishi and Buttery called it “zero time analysis — i.e., no time lapse for extraction or concentration.”⁸¹⁰ It was also non-destructive. The sampled food remained intact. This opened up the possibility of studying flavor as a dynamic phenomenon, including systematically studying flavor changes due to processing or storage. For instance, Teranishi and Buttery studied the development of off-flavors in stored dehydrated Idaho Russet potatoes and freeze-dried carrots, and also the chemistry of browning reactions in these foods.⁸¹¹ Other researchers studied changes in the composition of onion volatiles over time, tracking via chromatogram of headspace volatiles how the aroma varied between a just-sliced onion and the same onion seventeen hours later.⁸¹² The method also showed the “release” of a spray-dried banana flavor, after being mixed with water.⁸¹³

It also seemed to offer a more meaningful sample — one that directly corresponded with a food’s flavor as it was experienced. This meant being able to make ready comparisons between, for instance, the composition of peppermint oils considered

⁸¹⁰ Roy Teranishi, Ron G. Buttery, and Robert E. Lundin, “Gas Chromatography. Direct Vapor Analyses of Food Products with Programmed Temperature Control of Dual Columns with Dual Flame Ionization Detectors,” *Analytical Chemistry* 34.8 (July 1962): 1034-5.

⁸¹¹ Ron G. Buttery, “Autoxidation of Potato Granules II: Formation of Carbonyls and Hydrocarbons,” *Agricultural and Food Chemistry* 9 (1961): 248-52; Buttery and Teranishi 1963.

⁸¹² Donald A.M. Mackay, David Lang, and Murray Berdick, “Objective Measurement of Odor: Ionization Detection of Food Volatiles,” *Analytical Chemistry* 33.10 (September 1961): 1373.

⁸¹³ Mackay et al. 1961: 1371.

“high quality” and “low quality” by sensory evaluation panels.⁸¹⁴ Or multifactoral comparisons between different varieties of frozen strawberries judged to be of varying quality by taste panels, in order to pinpoint the chemosensory factors responsible for quality.⁸¹⁵ For this reason, Teranishi and Buttery initially presented headspace analysis as a replacement for time-consuming, uncertain taste panel methods of quality control. In this application, quality control would become a matter of reading a chart, and watching for the visual indicators of sensible trouble. Indeed, their paper did not attempt to identify any of the substances whose presence or absence accounted for the changes in the GC curves of the vapors above fresh carrots and those that had been in the freezer for two years; nor of the fresh dehydrated potato granules and those stored a year under inauspicious conditions. Instead, the chromatogram served as a graphical index of sensory quality and sensible change, what they dubbed an “aromagram.”⁸¹⁶ For instance, using headspace analysis, Buttery had identified n-hexanal as a correlate for spoilage in stored dehydrated Idaho taters.⁸¹⁷ It was clear that this compound was not the one responsible for the off-odor that developed in ‘spoiled’ stored dehydrated potatoes. But, as its presence reliably indicated the degree of spoilage, it could be used as an index of quality despite the fact that the chemical compounds responsible for the off-flavors remained unknown.

Other researchers, however, understood headspace analysis not as a replacement for sensory evaluation techniques, but as a means of correlating sensory experience

⁸¹⁴ Mackay et al. 1961: 1370.

⁸¹⁵ Teranishi et al. 1964: 588.

⁸¹⁶ Buttery and Teranishi 1963: 504-7.

⁸¹⁷ Buttery 1961.

directly with a GC sample. In other words, they understood the technique as making possible a direct comparison between the experience of a food's aroma and the analytic account of its components as produced by the machine.⁸¹⁸ This allowed for the application of sensory panel and flavor profiling techniques to captured fractions and GC effluent, with the goal of identifying compounds in terms of both chemical structure and sensory effect. This method was used, to give one example, by a collaborative group of researchers associated with the United Fruit Company (one of the leading Central American banana concerns) and Arthur D. Little, Inc., in order to assess the physicochemical and sensory qualities of bananas that might be chosen to replace the Gros Michel cultivar, given that varietal's apparent susceptibility to fungal Panama disease blight.⁸¹⁹

Headspace sampling, of course, had its limitations, of which flavor chemists were well apprised. Low-boiling compounds were often below the threshold of sensitivity of the machine; artifacts could be introduced in numerous ways; often, columns with less-than-optimal resolving power had to be selected in order to minimize noise.⁸²⁰ But the development and refinement of these techniques alongside other methods of sampling show GC as an instrument that was being honed in on questions of "flavor" rather than

⁸¹⁸ See Mackay et al. 1961: 1374. Their paper concludes: "The odor of large numbers of materials can now be assayed by direct, nondestructive sampling of the vapor above the material. Thus, for the first time, direct correlation with sensory evaluation is possible."

⁸¹⁹ Alice I. McCarthy, James K. Palmer, Carol P. Shaw, and Edward E. Anderson, "Correlation of Gas Chromatographic Data with Flavor Profiles of Fresh Banana Fruit." *Journal of Food Science* 28.4 (July 1963): 379-384.

⁸²⁰ For a discussion of the hazards of headspace sampling and best practices, see: S.G. Wyllie, S. Alves, M. Filsoof, and W.G. Jennings, "Headspace Sampling: Use and Abuse," in George Charalambous, ed. *Analysis of Foods and Beverages: Headspace Techniques*, (New York: Academic Press, 1978): 1-15.

“volatile materials,” and flavor chemists working to make the machine’s results meaningful and sensible.

“TRULY SYNERGISTIC”: GAS CHROMATOGRAPHY-MASS SPECTROMETRY

While GC was a powerful tool for the separation of complex mixtures, it did not provide a ready route to confidently identifying compounds after they had been separated. The chromatogram did offer *some* clues. Because retention time was logarithmically related to boiling point, the boiling point of an unknown substance could be approximated by comparing its retention time with those of known compounds that had been used to calibrate the machine.⁸²¹ In the 1960s, a standardized set of retention indices was compiled, which helped guide these types of identifications.⁸²² In most cases, however, other steps were necessary to conclusively identify the components GC had separated. Here again, chemists ran into a series of difficulties. The quantity of volatile material that comprised each peak was miniscule — generally topping out at only a few micrograms — frequently unstable, and often unknown. Rather than using classical chemical methods to identify these compounds, analytic chemists generally turned to other machines — in particular, to spectrometric instruments, such as infrared, nuclear magnetic resonance, and mass spectrometers. These devices provided information about molecular structure, which chemists interpreted to identify molecules.

⁸²¹ Dimick and Corse 1956: 361.

⁸²² I.e., the Kovats Retention Index.

The most generative instrumental relationship was between GC and mass spectrometry (MS). Based on electrophysical principles articulated by J.J. Thomson in the early twentieth century, mass spectrometers ionize and separate molecules in a vacuum chamber. Particles are then detected and converted into a signal that plots mass-to-charge ratio against signal intensity/relative abundance.⁸²³ These mass spectra can then be used to deduce molecular structure, thus making it an extremely useful tool for the identification of unknown compounds.

The pairing of gas chromatography and mass spectrometry was, in the words of William Stahl, the chief of the analytical section at the Quartermaster's Pioneering Research Division, "truly synergistic."⁸²⁴ Stahl's group had been instructed in the use of GC in flavor research by Joseph Corse, Dimick's partner in the USDA Albany lab. However, rather than using GC to analyze and identify, they used the machine "simply as an elegant means of separation."⁸²⁵ GC fractured complex mixtures into isolated individual components, but fell short in allowing for confident identifications of those compounds. MS excelled at producing structural information that facilitated identification, but interpreting mass spectra could be nearly impossible when the

⁸²³ Simon Maher, Fred P.M. Jjunju, and Stephen Taylor, "Colloquium: 100 Years of Mass Spectrometry: Perspectives and Future Trends," *Reviews of Modern Physics* 87 (January-March 2015): 113-135.

⁸²⁴ William H. Stahl, "Gas Chromatography and Mass Spectrometry in the Study of Flavor," in Mitchell et al. 1957: 58.

⁸²⁵ Stahl in Mitchell et al. 1957: 63.

substance was a mixture of compounds. What GC could purify, MS could readily identify.⁸²⁶

Initially, researchers manually transferred samples collected from the GC's effluent to the MS for identification. In his 1957 presentation at the Quartermaster symposium on the Chemistry of Natural Flavors, Stahl described a series of traps connected to the exit port of the GC. By manipulating valves and stopcocks, these could be used to collect and isolate fractions in separate containers.⁸²⁷ These could then be introduced one by one into the MS, which would then display spectra for the investigator's interpretation.

As can be imagined, this was a fussy, time-consuming, laborious process that demanded close attention and considerable skill. One analytic chemist working at Dow estimated that it took about 20 to 40 minutes to obtain a spectrum for each fraction and to prepare the instrument for the next sample. As he explained: "This would mean that if one had a chromatogram containing 10 peaks whose identity was desired, it would require 3 to 8 hours of mass spectrometer instrument time to obtain the mass spectra of the fractions, in addition to the time required to collect them."⁸²⁸ Because of the

⁸²⁶ Teranishi et al. *Flavor Research* 1971: 27

⁸²⁷ The technique of trapping fractions from the GC effluent for further analysis would become quite common. Trapped "peaks" that were suspected of containing more than one compound could be run through the GC again under different conditions, to improve resolution. However, because most commercially available traps were designed for preparative work that yielded larger quantities of material, these were generally too big for the sample sizes that flavor chemists generally dealt with.

⁸²⁸ R.S. Gohlke, "Time-of-Flight Mass Spectrometry and Gas-Liquid Partition Chromatography," *Analytical Chemistry* 31.4 (April 1959): 536.

instability of many volatile compounds, the time lapse between collection and scan could result in chemical changes and introduced the possibility of erroneous identifications.

The commercial development of a dynamic MS instrument capable of producing a complete spectrum every few microseconds transformed the utility and utilization of both GC and MS, and shaped a conjoined destiny for those instruments in analytic chemistry, including flavor research. In the early 1950s, physicists working at the Bendix Aviation Corporation in Detroit developed a new kind of ion gun which was capable of providing a very high resolution beam. This stable, high-resolution ion source, along with other modifications, made it possible for Bendix to build a Mass Spectrometer with an extremely high scan rate: the Time-of-Flight Mass Spectrometer.⁸²⁹ This machine could produce a complete spectrum every few microseconds. Because it used electronic circuits rather than magnetic fields, it was also smaller, simpler to build, and easier to operate.⁸³⁰

Bendix began custom-building these machines shortly after the introduction of the first commercial GC units in the mid-1950s. The company anticipated two primary applications for these devices. First, the analysis of very fast chemical reactions, which could lead to the more efficient production of synthetic chemicals. Second, the identification of separated components as they emerged from the GC. “Using the Bendix spectrometer,” one of its creators explained, “the identification of the emerging components can be made simply by allowing a portion of the effluent gas to pass into the spectrometer.” As each compound passed into the MS, its spectrum would rise and fall on

⁸²⁹ W.C. Wiley and I.H. McLaren, “Time-of-Flight Mass Spectrometer with Improved Resolution,” *Review of Scientific Instruments* 26.12 (December 1955): 1150-7.

⁸³⁰ Wiley and McLaren 1955: 1150.

the oscilloscope screen, allowing for identifications to be made. A permanent record of the spectra could be made with an oscillographic recorder or on analog magnetic tape.⁸³¹

Bendix believed that these machines were primarily suited for process monitoring and process control in the context of the industrial production facilities, rather than chemical research in industrial or academic laboratories.⁸³² The actual conjugation of GC and MS was initially left to instrument users, especially those working in industrial laboratories within the chemical and petrochemical industries. Conjoining GC and MS meant more than just connecting the GC's effluent stream to the MS's input port. It required deliberately adapting both technologies to each other in order to produce as much reliable (and interpretable) information as possible. Flow rate, pressure, temperature, and other factors had to be adjusted in order to minimize noise and optimize resolving power for both instruments.⁸³³

Once again, the USDA ARS laboratory in Albany played an important role here, developing techniques, refining technologies, and publishing papers about using

⁸³¹ W.C. Wiley, "Bendix Time-of-Flight Mass Spectrometer," *Science* 124 (26 October 1956): 818. In the 1960s, spectra began to be recorded onto reels of magnetic tape. This provided a cost-effective and efficient way of recording continuous spectra produced during long chromatographic separations, allowed for greater flexibility in data handling and analysis, and could be integrated with computer-aided systems of data recording and processing that were just beginning to come into use. For a discussion of the multiple advantages of magnetic tape in this context, see: Phillip Issenberg, Akio Kobayashi, and TJ Mysliwy, "Combined Gas Chromatography-Mass Spectrometry in Flavor Research: Methods and Applications," *Journal of Agricultural and Food Chemistry* 17.6 (Nov/Dec 1969): 1380-1.

⁸³² Wiley 1956: 819.

⁸³³ For a discussion of possible difficulties in joining GC and MS, see Roy Teranishi, R.E. Lundin, and J.R. Scherer, "Analytical Technique," in H.W. Schultz, E.A. Day, and L.M. Libbey, eds. *Symposium on Foods: The Chemistry and Physiology of Flavors*, (Westport, CT: AVI, 1967): 176.

combined GC-MS in flavor research.⁸³⁴ In particular, Teranishi, W.H. McFadden, and other chemists at Albany and at nearby UC Davis refined the use of capillary column GC with Time-of-Flight MS.⁸³⁵ Even though capillary columns had been commercially available since the late 1950s, their use had been limited in flavor chemistry because of the challenges of collecting and delivering the increased number of captured, small-quantity fractions to the MS.⁸³⁶ With the machines conjoined, that difficulty was removed. Capillary column GC also facilitated the use of mass spectra for identification as it was more likely to deliver pure compounds to the machine, resolving what had already seemed like fine separations. As an example, McFadden describes the analysis of a tiny sample — between three and four microliters — of volatile oil that had been obtained, “after a laborious series of chemical and extractive separations,” from five thousand pounds of fresh peas. The pea oil resolved into twenty-two “clear peaks” on a packed column — at first glance, a fine separation. But an analysis on a capillary column GC revealed thirty-nine separate compounds.⁸³⁷

The GC-MS did not just expand the capabilities of the flavor lab, it made the work more efficient — transforming what had been a batch process into a continuous

⁸³⁴ Dennis O’Brien, “Cited for More than 60 Years of Flavor Research,” *Agricultural Research Magazine* (May-June 2013): 15.

⁸³⁵ W.H. McFadden, Roy Teranishi, D.R. Black, and J.C. Day, “Use of Capillary Gas Chromatography with a Time-of-Flight Mass Spectrometer,” *Journal of Food Science* 28.3 (1963): 316-19; W.H. McFadden and Roy Teranishi, “Fast-Scan Mass Spectrometry with Capillary Gas-Liquid Chromatography in Investigation of Fruit Volatiles,” *Nature* 200 (October 26, 1963): 329-30.

⁸³⁶ Teranishi et al. in Schultz et al., eds 1967: 170

⁸³⁷ McFadden et al. “Use of Capillary Gas Chromatography...” 1963: 318.

process.⁸³⁸ This is not to suggest that there was anything ‘automatic’ about the process of separation and identification. Investigators often used both the chromatogram and the mass spectra to make identifications, a procedure that was facilitated by the two gates on the Bendix Time-of-Flight MS Model 12; they also relied on a synthesis of the compound (or a commercially available sample) to confirm identifications.⁸³⁹ Even so, major challenges still remained to making identifications with full confidence using instrumental data alone — isomers, for instance, could be almost impossible to distinguish from mass spectra, and could have substantial sensory consequences.

“GC-MS is a tremendous tool and you can obtain much information from it,” remarked Roy Teranishi at a 1966 symposium on flavor chemistry. “You can determine a large number of compounds with this technique or at least determine which ones are interesting, and go on from there. I think, however, that it is very dangerous to say that you are going to see all and tell all.”⁸⁴⁰

By the late 1960s, the instrumental assemblage of the flavor research laboratory was more or less in place. GCMS, as well as other instruments, including infrared spectroscopy and NMR were routinely used for separations and identifications.⁸⁴¹ The next apparatus to be added to the instrumental assemblage, the computer, was already

⁸³⁸ This comparison is made in: Roy Teranishi et al. in Schultz et al., eds 1967: 170.

⁸³⁹ McFadden et al. “Fast Scan Mass Spectrometry” 1963: 329; Teranishi et al. in Schultz et al. 1967: 172.

⁸⁴⁰ Teranishi et al. in Schultz et al. 1967: 178.

⁸⁴¹ Teranishi et al. in Schultz et al. 1967; Issenberg et al. 1969; Teranishi et al. 1971.

visible on the horizon.⁸⁴² But the machines had their limits. “Even when a computer is added to the system,” one group of flavor researchers based at MIT reported in 1969, “GCMS will produce only vast quantities of uninterpretable data unless all other chemical, instrumental, and sensory methods are considered and applied whenever appropriate to the solution of flavor problems.”⁸⁴³

In particular, the sensible body of the expert flavor researcher was needed as part of the instrumental assemblage, making sense of the growing number of chemical compounds that the efficient analytic machine complex produced.

THE FLAVOR CHEMIST AND THE MACHINE

The analytic instruments of flavor chemistry, GC and MS chief among them, presumed (and produced) a materialist theory of flavor. According to these machines, the flavor of foods is produced by complex mixtures of volatile organic chemical substances, which can be separated into discrete compounds that can be identified by their physical properties.

However, GC stood in contrast to contemporary devices that were explicitly designed to respond like the human olfactory system, simulating theorized mechanisms of olfaction to register the presence, absence, or concentration of certain odors.⁸⁴⁴ For

⁸⁴² Craig B. Warren and John P. Walradt, eds. *Computers in Flavor and Fragrance Research*, ACS Symposium Series 261, (Washington, D.C.: ACS, 1984).

⁸⁴³ Issenberg et al. 1969: 1385.

⁸⁴⁴ Julian W. Gardner and Philip N. Bartlett, “A Brief History of Electronic Noses,” *Sensors and Actuators B* 18-19 (1994): 211-220; R.W. Moncrieff, “An Instrument for Measuring and Classifying Odors,” *Journal of Applied Physiology* 16 (1961): 742-9;

instance, the smelling machines devised by John Hartman, a professor in the Department of Vegetable Crops at Cornell, were grounded in a mechanistic analogy between odor receptors and sensitized electric circuits; “olfactory receptor hairs essentially act as polarized microelectrodes,” he wrote.⁸⁴⁵ His machines deployed a varied array of microelectrodes to obtain differential responses to distinct odorants.⁸⁴⁶ Hartman aspirationally compared his machine to optical machines such as the Color Difference meter, and hoped it could be used as “a device that can characterize a flavor, both for quality and quantity, by the pattern of reactions at a series of sensing elements.”⁸⁴⁷ Once calibrated to and standardized for consumer preferences, it could—he hoped—become a machine for objectively assessing quality.

Dravnieks and Trotter, “Polar Vapor Detection Based on Thermal Modulation of Contact Potentials,” *Journal of Scientific Instruments* 42 (1965): 624.

⁸⁴⁵ Walter F. Wilkens and Hartman, “An Electronic Analog for the Olfactory Processes,” *Journal of Food Science* 29.3 (1964): 373.

⁸⁴⁶ John D. Hartman, “A Possible Objective Method for the Rapid Estimation of Flavor in Vegetables,” *Proceedings of the American Society of Horticultural Sciences* 64 (1954): 335-42; Hartman and W.F. Tolle, “An Apparatus Designed for the Rapid Electrochemical Estimation of Flavor in Vegetables,” *Food Technology* 11 (1957): 130-2; Wilkens and Hartman 1964: 372-8. Interestingly, John Hartman would later achieve another kind of notoriety at Cornell in the early 1970s, when he became the first tenured professor to be considered for dismissal by the University administration. Hartman had refused to teach any classes or conduct any research since 1969. “Instead of using his green thumb,” explained an editorial in the *Cornell Daily Sun*, “Hartman has been writing redneck essays of extraordinary length and incredible obtuseness for several years,” including one condemning the University Senate’s decision to boycott lettuce grown by non-unionized workers in solidarity with the United Farm Workers Organizing Committee, and a “memorable apologia” for police after a brutal response to student demonstrators in 1972. Although the editorial writer clearly had no love for Hartman, he criticized the University’s secret hearings to adjudicate the professor’s case, and their decision to allow Hartman to take early retirement and become an emeritus professor, a status the writer did not think he deserved. Instead, he suggested that Hartman was fit for a position in the University administration. Gordon Chang, “Hartman for Provost,” *Cornell Daily Sun*, September 5, 1973, 4.

⁸⁴⁷ Hartman and Tolle 1957: 130.

The gas chromatograph certainly had the potential to be used in this way. Some early accounts of the gas chromatograph described it as a “sniffing machine,” one that could replace human evaluators in determining food quality, while also producing a “permanent record,” a transcription of aroma that translated evanescent and subjective experience into a scannable visual data chart. As one 1957 article touting the applications of GC in coffee roasting explained, “the ‘picture’ of the various aroma components in each sample comes out as a wavy line on a tape much as human pulse reactions are traced on a lie detector.”⁸⁴⁸ And, just as the lie detector produced the visible “evidence” of subjective internal states of mind, it was hoped that the GC could likewise be used to accurately determine sensory characteristics without relying on the unreliable disclosures of human sensors.⁸⁴⁹ Those who worked with the machine also speculated on its potential as a quality control device, one that could replace the routine labor of human evaluators. For instance, in an early paper describing headspace analysis, Buttery and Teranishi had suggested that the technique could be used to “objectively” monitor product quality, supplanting subjective, uncertain organoleptic evaluations.⁸⁵⁰ In this application, quality control might become a matter of reading a chart, and watching for the visual indicators of sensible trouble.

But while it remained imaginable that GC could supplant certain kinds of routinized sensory labor, it was likewise insisted that the machine could never automate

⁸⁴⁸ W. Schweisheimer, “Sniffing Machine Savors Coffee Producing a ‘Picture’ of Coffee Aroma,” *Perfumer & Essential Oil Review* 48 (September 1957): 443.

⁸⁴⁹ For a history of the polygraph, and instrumental tests of deception, see Ken Alder, “A Social History of Untruth: Lie Detection and Trust in Twentieth-Century America,” *Representations* 80.1 (Fall 2002): 1-33.

⁸⁵⁰ Buttery and Teranishi 1961.

the expert labor of the flavor chemist — who was needed not only to induce the food sample and machine to produce reliable chemical results, but also to interpret those results and make them meaningful. What had long been evident to flavorists working in the flavor industry became increasingly clear to chemists studying flavor in other institutional contexts: an exclusively materialist definition of flavor, one that relied exclusively or even primarily on instrumentally aided separations and identifications, was insufficient.

“NASAL APPRAISAL”

The centrality that instruments had assumed in flavor chemistry is vividly evident in the 1971 textbook, *Flavor Research: Principles and Techniques*.⁸⁵¹ The textbook dealt

⁸⁵¹ Roy Teranishi, Irwin Hornstein, Phillip Issenberg, and Emily L. Wick, *Flavor Research: Principles and Techniques*, (New York: Marcel Dekker, 1971). Authored by two USDA researchers (Teranishi and Hornstein) and two members of MIT’s Nutrition and Food Science department (Issenberg and Wick), this was the first textbook to exclusively focus on methodologies of flavor research. It was also the first title published in a series of food science monographs edited by Owen Fennema, a highly regarded professor of food chemistry in the University of Wisconsin College of Agriculture Department of Food Sciences and Industries. As can be inferred from the institutional position of its authors and its publishing context, this book was intended for students who were anticipating careers in basic or applied research in the food industry, in government laboratories, or the academy, and it reflects the increasing professionalization of food science fields. This textbook did not provide any instruction in or discussion of techniques for formulating flavor additives or designing food flavors. Nonetheless, the anticipated need for the kind of skills the textbook taught were framed in terms of the manipulation and production of flavors for foods. The preface explained: “As the population increases, our caloric and protein requirements inevitably will be supplied by unconventional foods.... Protein foods derived from petroleum, oilseeds, legumes and the like may be man’s dietary lot. The persistence of food preferences for the flavors of traditional foods may prove a major roadblock to the utilization of these new foods. To

almost entirely with the proper use of analytic machines: GC, MS, and combined GC-MS, as well as other spectrometric methods. Students were led through the special considerations and techniques required when using these instruments to study flavor — from preparing the sample, to setting up and operating the instrument, to interpreting the results. There is no discussion of classical chemical techniques of identification; no mention at all of reagents or reactions.

In the midst of its near-exclusive focus on the use of analytic machines, *Flavor Research* repeatedly stressed that the experimenter's attentive, sensible body was indispensable in carrying out this work successfully. Throughout, the textbook prescribed the necessity of continual and careful "nasal appraisals." This was a response to the familiar difficulties that came working with unstable, promiscuous, and volatile flavor materials. At every stage, something crucial may have been lost, or something may have changed. It was critical that the experimenter confirm, for instance, that the headspace sample or aroma concentrate that was delivered to the GC faithfully demonstrated the organoleptic qualities of the food being studied.⁸⁵² It was also important to ensure that the machine's output duplicated the sensory qualities of its input, and that no important component had been adsorbed by the column, or altered during its passage.⁸⁵³

There was also the matter of the nose's superior sensitivity. Even with the improved sensitivity of FID detectors, human subjects could often detect the presence of

incorporate into fabricated foods, flavors acceptable to populations differing in their food likes will add a new urgency to the flavor chemists [sic] efforts." (vi)

⁸⁵² Teranishi et al. 1971: 72, 126-7, 130.

⁸⁵³ Teranishi et al. 1971: 126-7, 262.

chemicals at far smaller concentrations than the machine was able to register. Thus, a fraction eluted from the chromatogram could appear “chemically pure,” when a sniff would reveal that it was far from “organoleptically pure.”

Most crucially, however, the instrument’s response to chemical compounds was not analogous to an embodied response; these were fundamentally different kinds of phenomena. Absent a functional theory of olfaction that could connect molecular structure with sensory quality, the body’s response could not be deduced from the machine’s results. In other words, the issue was not that the nose was more sensitive than the machine, but that the GC was not a body. “The flavor chemist’s job is, in some sense, similar to those of the biochemist, pharmacologist, and toxicologist,” the 1971 textbook explained. “He is interested in small quantities of organic chemicals present in very complex mixtures, the components of which exert some physiological effect. In flavor research, this physiological effect is contribution to flavor.”⁸⁵⁴ The question was not, what compounds are present in this food? It was, which of the compounds present produce detectable effects on a body?

“Flavor is more than a pattern of peaks on a chromatogram,” explained Rose Marie Pangborn, C.S. Ough, and Herbert Stone, in a seminal article on sensory evaluation published in *Advances in Food Research*. “Flavor is an integrated response, the nasal mucosa and the taste buds being the integrators. The chromatograph, on the other hand, is a separator, which, while an extremely useful tool, must have its responses compared

⁸⁵⁴ Teranishi et al. 1971: 136.

with human responses to have a bearing on flavor.”⁸⁵⁵ Pangborn and her colleagues were situated, in terms of disciplinary positioning, within the sensory laboratory, rather than the chemical lab. However, this redefinition of flavor as an integrated, embodied response — rather than an analytically produced set of chemical compounds — was crucial to the turn in flavor chemistry research that occurred in the mid-1960s, one that occurred in response not only to the claims made by sensory researchers such as Pangborn, but also to the results produced by the machine itself.

This was not the nose jockeying for sniff-supremacy over the machine, but a conjugation of the two — a joining of forces. The difference between GC and human body was the source of the power of the ultimate laboratory instrument, which utilized machine and body together in complementary ways. This conjugation was facilitated by a modification to GC units, one which had become common among flavor researchers by the 1960s. The GC split the effluent to an olfactometry port, which allowed a “human sensor” to monitor and characterize and annotate fractions as they exited the machine.⁸⁵⁶ Various modifications were made to these for the comfort of researchers, including the introduction of moisture into the effluent to prevent bloody noses from intensive sniff sessions.⁸⁵⁷

⁸⁵⁵ Herbert Stone, Rose Marie Pangborn, and C.S. Ough, “Techniques for Sensory Evaluation of Food Odors,” *Advances in Food Research* 14 (1965): 19.

⁸⁵⁶ An STS-informed account of GC-Olfactometry can be found in Christy Spackman, forthcoming, *Senses & Society* 2017.

⁸⁵⁷ R.H. Potter and J. Daye, “Apparatus to Introduce Moisture into Effluent Gas,” *Givaudan Flavorist* (1970): 8.

The role of the sensible researcher, then, was to serve as the susceptible, in vivo medium that could distinguish flavor compounds from other chemicals, to allow for “a bioassay of aroma based on the stimulation of the human nose.”⁸⁵⁸ Results would be gauged qualitatively, based on human judgment of the intensity and characteristics of different fractions and their relationship to the odor of the whole. “Somehow, one tends to feel safer with bioassays that use the gain or loss of weight of test animals or the physiological state of rat livers as evidence of biological activity than one does at the prospect of asking impressionable, opinionated, and unreliable human beings to judge aroma in isolates,” the authors conceded. “This attitude must be overcome and very serious efforts made to use sensory evaluation to select the gas chromatographic peaks of importance, thus avoiding the necessity of identifying all components and then determining their flavor contribution.”⁸⁵⁹ In other words, the “nasal appraisal” was important not only for confirming accuracy, but also for managing the (increasingly overwhelming) labor of flavor research. The efficiency of GC’s separations had the consequence of registering the presence of hundreds of compounds, many of them unknown, in coffee, cheese, and other foods. This efficient production of chemical data could overtax researchers.

William S. Ryder, a flavor researcher at the General Food’s Technical Center in Tarrytown, NY, demonstrated how this was done on a chromatogram of concentrated flavor sample (he does not say of what, but possibly concentrated tomato or meat) in a presentation at the 1965 annual ACS meeting. The sequence of sensations noted on the

⁸⁵⁸ Teranishi et al. 1971: 260.

⁸⁵⁹ Teranishi et al. 1971: 266.

peaks reveals a “dinner table” full of odors, shedding light on the various elements that comprise the complex, integrated aroma of a food. Some peaks were annotated with chemical names (butyric acid, furfural); others with sensory observations (“harsh phenolic,” “rubbery sulfur,” “toasted cheese,” “cucumber,” “macaroon.”)⁸⁶⁰ These annotations could guide efforts for identifications, shedding light on the constitutive elements of desirable flavors and suggesting research and development priorities, in a food production context.

“Without sensory evaluations,” the 1971 *Flavor Chemistry* textbook cautions, “chemists have no guideposts and will almost certainly lose their way among the byways of flavor research.”⁸⁶¹ But just as sensory evaluation became recognized as necessary in order to confirm the machine’s accuracy and guide researcher’s efforts, the matter of developing a stable epistemological framework and reliable set of practices for correlating the information produced by the sniffing body with that created by the sniffing machine remained far from settled.

ACHIEVING SUBJECTIVE-OBJECTIVE CORRELATION

Two paths diverged in the chemosensory woods. One approach, referred to as isolation and identification (I&I), prioritized the enumeration of chemical presences.

⁸⁶⁰ William S. Ryder, “Progress and Limitations in the Identification of Flavor Components,” in Irwin Hornstein, ed. *Flavor Chemistry: A Symposium Sponsored by the Division of Agricultural and Food Chemistry at the 149th Meeting of the American Chemical Society, Detroit, April 6-7, 1965*, Advances in Chemistry Series 65, (Washington: ACS, 1966): 82-3.

⁸⁶¹ Teranishi et al. 1971: 58-9.

“After all the compounds have been isolated and identified quantitatively, the flavor workers can begin to put the flavor together and thus discover the compounds of greatest interest in creating the particular flavor.”⁸⁶² The second path, called postulation and proof (P&P), began by compiling the sensory effects related to a food’s flavor, and then directed itself toward “isolating specific compounds responsible for each important flavor characteristic.”⁸⁶³ I&I and P&P were both strategies for bringing chemical and sensory information in line with each other, for directing the course of research that had begun to be overwhelmed by the plenitude and complexity of its output.

Irwin Hornstein, a flavor chemist at the USDA’s Market Quality Research Division, described this challenge in terms of cheese. Temperature-programmed GC analysis of cheddar cheese concentrate had separated approximately 130 compounds, of which MS had, so far, helped to definitively identify fewer than 50 of these. (It was also likely that additional compounds of sensory importance lurked to be discovered, retained by the column or lost in extraction). “It is this task — to evaluate the significance of the data — that is the biggest problem facing the flavor chemist today. Detection and identification of volatile compounds are essential, but the correlation of chemical findings with organoleptic quality is equally important, and progress in this direction has been slow.”⁸⁶⁴

⁸⁶² “Report for Analytical Chemists: Physicochemical Research on Flavor,” *Analytical Chemistry* 30.2 (February 1958): 17A.

⁸⁶³ “Physicochemical research on Flavor” 1958: 17A.

⁸⁶⁴ Irwin Hornstein, “Preface,” in Hornstein, ed. 1966: vii-viii.

By the mid-1960s, quickening the slow progress of “subjective-objective correlation” had become a central concern in flavor research, as scientists working across disciplines and institutional settings attempted to formalize a set of practices for relating instrumentally produced data and sensory experience.⁸⁶⁵ The American Society for Testing and Materials (ASTM) Committee E-18, which worked to develop global standards for sensory evaluation procedures, spawned a Subcommittee on Instrumental-Sensory Correlation to examine the issue. A 1967 symposium on the topic was held during the annual meeting of the ASTM.⁸⁶⁶ Although partly an extension of ongoing efforts to standardize sensory evaluation methods, the focus here was not on the operation of human taste panels but on the integration of human and machine responses.

Bringing together researchers from air and water quality, cosmetics, and foods, the symposium’s purpose was to address the divide between taste panel research and instrumental analysis, which often seemed to run on parallel tracks. Sensory research was usually conducted in absence of corresponding chemical identifications. Similarly, instrumental analysis often simply identified constituents, without attempting to determine the role these constituents played in flavor. When laboratories attempted to find relationships between GC peaks and flavor acceptability, they were daunted by the

⁸⁶⁵ For instance, see David A. Kendall and Anne J. Neilson, “Correlation of Subjective and Objective Odor Responses,” *Annals of the New York Academy of Sciences* (July 1964): 567-75, and Rose Marie Pangborn, “Flavor Perception: Relation of Sensory to Instrumental Measurements,” In DJ Tilgner and A. Borys, eds., *Proceedings of the 2nd International Congress of Food Science and Technology*, (Warszawa: Stampa, 1967): 303-18.

⁸⁶⁶ American Society for Testing and Materials, *Correlation of Subjective-Objective Methods in the Study of Odors and Taste, a Symposium Presented at the 70th Annual Meeting, ASTM, Boston, MA, 25-30, June 1967*, ASTM Special Technical Publication 440, (Philadelphia: ASTM, 1968).

“embarrassing wealth of data,” explained W.H. Stahl, the research manager at McCormick, the Baltimore spice and flavoring company and erstwhile Quartermaster head, who was the symposium’s chairman. The hundreds of components that were revealed by GC analysis led to the adoption of “elaborate statistical procedures... to determine which peaks, if any, have significant relationship to quality in general and to flavor in particular.”⁸⁶⁷ This indirect method of association was not only difficult, it was less than effective (especially given the continuing and perhaps perpetual presence of unidentified compounds, both known and unknown unknowns). Basic techniques that connected organoleptic and chemical information about flavor were sorely needed in order to make the machine’s results meaningful, and to reliably associate sensory responses with chemical presences.

As can be gleaned from the term of art used to describe the pursuit, “subjective-objective correlation” did not seek to expel subjectivity from the process of knowledge-making. The purpose was not to discipline the senses by demanding that the body respond more like the machine, nor to require the machine to authenticate the body’s responses — nor was it to design machines that responded more like bodies. Instead, the goal here was to leverage the differences between body and machine, and coordinate them to produce a “definitive account” of the sensible world, one that encompassed both stimuli (chemicals) and perceptual effects (flavor).⁸⁶⁸ “We recognize that an instrument cannot replace the human senses, but we also recognize that it often can complement

⁸⁶⁷ American Society for Testing and Materials 1968: 2. Stahl was the research manager at McCormick, the Baltimore flavor and spice company.

⁸⁶⁸ Kendall and Neilson 1964: 568.

them,” said Stahl.⁸⁶⁹ But how could this complementarity be structured? How could humans work with machines? What could both elements of the system contribute to the understanding of flavor?

Contributors pleaded for the integration of standard taste panel evaluation methods, including both difference tests and descriptive (flavor profile) methods, with instrumental analysis. So, for instance, flavor profile methods could be used to characterize either specific components, or flavor quality overall. Difference tests, such as the triangle test, could be used when a flavor was reconstructed synthetically, to determine whether there was a perceptible distinction between the reconstruction and the original.

While it became increasingly possible to describe the sensory qualities of different compounds in standard and systematic ways, it became more and more fraught to attribute the ‘cause’ of a quality to a particular chemical compound. Rather, as instruments revealed more of the chemical constituents related to flavor experience, chemosensory phenomena were repeatedly shown to be an emergent property of combinations of chemicals: the complete sensory effect often did not resemble most of its component parts. “The typical peach aroma is due not to one or two compounds,” Loren Sjöström summarized in one of the studies he reviewed for the ASTM volume, “but is

⁸⁶⁹ American Society for Testing and Materials 1968: 1.

probably an integrated response to a wide spectrum of compounds whose individual aromas are not at all peach-like.”⁸⁷⁰

Because of this, the practice of sniffing the GC’s separated compounds to determine significance could be misleading. Many organic compounds have an odor, but the odor’s relation to the total could not be deduced by experiencing it in isolation. “Sniffing the effluent of a GC column can lead to a morass of differing descriptive terms,” warned the 1971 *Flavor Chemistry* textbook. Instead, the textbook advised researchers to try to collect portions of the effluent in cold traps. “In such efforts,” it continued, “it is well to use a relatively ‘poor’ column as well as a ‘high resolution’ column.” The good column could separate compounds “too far apart for their odor-relatedness to be noted,” but the poor column’s muddier separations “may provide guidance about which of the well-separated peaks contain the compounds of interest.”⁸⁷¹ In other words, a “less” efficient resolution could reveal important sensory information about the relationship between different compounds.

Further, sensory quality was also related to concentration; higher levels of a compound produced not just a difference in intensity, but sometimes a difference in kind — shifting not only associations, but also affective responses, from pleasant to unpleasant. The importance of the subjective-objective approach was illustrated by another phenomena that it brought to the fore: the sensory effects of compounds present

⁸⁷⁰ L.B. Sjöström, “Correlation of Objective, Subjective Methods as Applied in the Food Field,” in *American Society for Testing and Materials* 1968: 3-16.

⁸⁷¹ Teranishi et al. 1971: 277-8.

in subthreshold quantities.⁸⁷² These compounds were, by definition, imperceptible to the nose. But their presence could demonstrably affect the organoleptic character of the mixture in various ways: intensifying, suppressing, or changing its qualities.

Determinations of human odor thresholds began to be included in the study of flavor chemistry of foods.⁸⁷³ The interest in flavor chemicals in terms of sensory thresholds reflected what had become the prevailing understanding of flavor: molecular substances defined by their measurable effects on the human body.

The following chapter considers how this scientific knowledge was put to use in the generation of new sensations, new perceptual effects.

⁸⁷² Elizabeth S. Keith and John J. Powers, "Determination of Flavor Threshold Levels and Sub-Threshold, Additive, and Concentration Effects," *Journal of Food Science* 33.2 (1968): 213-8.

⁸⁷³ D.G. Guadagni, Ron G. Buttery, S. Okano, "Odor Thresholds of some Organic Compounds Associated with Food Flavors," *Journal of the Science of Food and Agriculture* 14 (October 1963): 761-5; Kendall and Neilson 1964.

CHAPTER 7

THE CREATIVE FLAVORIST AT WORK

In his introduction to *A Short History of the Flavor Industry*, a history compiled by members of the Society of Flavor Chemists (SFC)¹ – Earl J. Merwin shares the following remarkable anecdote:

At a cocktail party in about 1948, I described my job in flavors to an IBM salesman I had just met. He proceeded to tell me I was wasting my time. He told me that his company had just installed a system which guaranteed uniformity of flavor of the sausage products of a nationwide processed meat manufacturer. ‘Flavor companies will be out of business in five years’, as all manufacturers can avail themselves of computer technology. He had included the variables of fat and protein content, color, salt, cost, and many other factors, but I’m sure that he had not factored in what effect a hurricane might have. Sure enough, it wasn’t long before a hurricane came through the West Indies and severely reduced the availability and cost of one or more of the major flavor ingredients for his customer.” Computers, gas liquid chromatography, and flavor profiling all have had an impact on flavors and flavorists. But they did not eliminate the need for the flavorist. They all made the job a bit easier, and enabled the flavorist to expand the list of new and improved natural and artificial flavors.²

¹ Society of Flavor Chemists, Inc. and Chemical Sources Association, Inc., *The Flavor Industry from 1945 to 1995: A Short History of the Flavor Industry With Emphasis on the USA and the Past Fifty Years*, (Neptune, NJ: Society of Flavor Chemists, 1995).

² Society of Flavor Chemists 1995: 5.

Merwin, a charter member of the SFC who had worked as a flavorist at Fritzsche Brothers, Givaudan, and McCormick, intends this anecdote for younger flavorists who likely entered the field confident in both its professional legitimacy and technoscientific *bona fides*. This mid-century encounter, however, stages a scenario where the flavorist's purpose and prestige is not yet secure, with representatives of the two industries – chemicals and microprocessors – that would come to define the character of American technological dominance in the twentieth century squaring off at a cocktail party. The IBM salesman predicts a situation where his professional counterpart will be done in by technology. In essence, he is offering a version of Harry Braverman's thesis of deskilling, where skilled labor is shunted aside by machines that have total control over the processes of production.³ The man from IBM apparently takes the flavorist to be a sort of artisanal laborer, one whose empirical tinkering on the assembly line of flavors will be replaced by the more precise control of the computer manager.

But the flavorist holds a trump card: he knows that his task cannot be reduced to mere information and information processes. Writing in 1995, Merwin knows that flavorists do not just compound formulas, they create new ones – crafting flavors suitable for the expanding variety of processed food products, smoothing the gaps where the fluctuations intrinsic to natural supply do not adequately meet industry and consumer demands for taste and convenience, at the right price. Indeed, in Merwin's ultimately triumphant account, technology facilitates the tasks and expands the capabilities of the flavorist, making way for “new and improved” products, while in no way reducing the

³ Harry Braverman, *Labor and Monopoly Capital; the Degradation of Work in the Twentieth Century* (New York: Monthly Review Press, 1975), 184–235.

demand for the professional skills she or he provides. The SFC mission statement proclaims that one of the goals of the organization is “to foster and encourage the art and science of flavor technology.”⁴ The machine complex in this respect would prove an ally to the true craftsman.⁵

By the 1960s, the creative flavorist had become the most valuable asset of flavor companies. A 1968 Arthur D. Little, Inc. report on the US flavor industry, prepared for an Ohio cosmetics company that was considering expanding into the flavor business, provides a detailed overview not only of the booming commercial prospects for the flavor sector, but also of the importance of creative flavorists to the reputation, status, and profit margins of successful firms.⁶ According to the report, sales of flavorings had grown at an average annual rate of ten percent over the previous decade, totaling \$130 million in 1967, and growth was accelerating; sales of “specialty flavors,” unique proprietary formulations developed for specific customers, accounting for an increasing portion of the gains in sales.⁷ This booming business was undergirded by the creative labor of flavorists. “The flavor houses’ creative skill has become the principal ‘priceless’

⁴ Society of Flavor Chemists 1995: 32.

⁵ Braverman, in his otherwise pessimistic account of the negative social effects of mechanization on the labor process, does admit that another narrative is possible. “There is no question that from a practical standpoint there is nothing to prevent the machining process under numerical control” – that is, under the control of externally programmed, rationalized and “objective” systems of management – “from remaining the province of the total craftsman. That this almost never happens is due, of course, to the opportunities the process offers for the destruction of craft and the cheapening of the resulting pieces of labor into which it is broken” (Braverman, 199).

⁶ Arthur D. Little, Inc. “The U.S. Flavor Industry: Report to The Andrew Jergens Company,” ADL Report C-69866 (March 26, 1968). AW Noling Collection, UC Davis. The Andrew Jergens Company was a Cincinnati-based manufacturer of cosmetics, lotions, and personal care products.

⁷ Arthur D. Little 1968: 3.

ingredient and allows the flavor company great latitude in setting prices,” the report disclosed.⁸ “The ability to price the flavoring at a premium is directly related to the apparent creativity of the flavor chemist.” The value of the company’s products was so intertwined with skill of its (unnamed and all but invisible) creators, that “if a flavor chemist with a good reputation leaves a flavor house, the overall reputation of the flavor house suffers. The competing firm which the flavor chemist joins benefits by his move, not only from his skills, but by his presence, which may command greater premiums.”⁹ A skilled creative flavorist could also guarantee ongoing revenue for the company she or he worked for. As specialty flavorings were customized for particular products, “long-term success for a flavor house is assured by the development of proprietary flavorings that become successful consumer franchises.” Because the formula for these products was kept secret, even from the customer, and because of the reluctance of food companies to risk any changes to a successful flavor, these accounts led to large numbers of repeat orders.¹⁰

But who, exactly, was the creative flavorist? Despite interviews with representatives from 85 companies that manufactured and used flavoring additives, the authors were unable to describe, exactly, who these people were, how to find them, or even how many of them there were. Estimates of the number of “top-notch” working flavorists ranged from fifteen to one hundred; the authors of the report believed that there were likely fewer than thirty. “No academic credentials are probative; past experiences

⁸ Arthur D. Little 1968: 13.

⁹ Arthur D. Little 1968: 27.

¹⁰ Arthur D. Little 1968: 27.

and associations are the most critical factors.” Like other artisans, these individuals developed their “skill and knowledge... through an apprenticeship system,” but a fundamental “intuitive grasp for what makes a flavor” was also necessary, as was a familiarity with manufacturing and marketing details of different consumer products. Finally, a successful flavorist “must be attuned to the ‘taste’ of his market.” For those who could pull it off, the financial rewards were “high,” with “top notch flavor chemists” generally earning between \$25,000 and \$35,000, and with some even pulling down \$50,000 a year.¹¹

As we have seen, the basic principles, goals, and methods of the creative flavorist had been articulated long before the 1950s. Flavor and fragrance companies such as Synfleur, Fritzsche Brothers, Dodge & Olcott, and dozens of others had relied on the skilled labor of a small number of highly specialized workers, who combined precise chemical and sensory knowledge with improvisatory skill, to formulate distinctive flavorings that conformed to the technical requirements of the manufacturers who used them. Yet until the mid-1940s, when the term “flavorist” was coined just as “flavor chemistry” was beginning to gain recognition as a distinct scientific field, even the nominal identity of these workers was indeterminate, as were their educational credentials, the technical prerequisites for their labor, and their positions and responsibilities within the companies that employed them.¹²

¹¹ Arthur D. Little 1968: 26.

¹² The earliest instance of the word “flavorist” that I have found is in a March 1945 article in the trade journal *Food Industries*: [E.C. Crocker, “A Flavorist Views Food Processing,” *Food Industries* 17 (March 1945): 69-71, 170-4.] Crocker was a chemist at

This chapter tells the story of how flavorists became professionals in postwar America. In *The System of Professions*, his bedrock study of the processes of professionalization, sociologist Andrew Abbott distinguishes professions from craft occupations by allocating to the first abstract, and to the second, primarily technical and tacit knowledge. While Abbott concedes that professional work also depends on tacit skills and often consists of routinized tasks, “here, practical skill grows out of an abstract system of knowledge, and control of the profession lies in the control of the abstractions that generate the practical techniques. The techniques themselves may in fact be delegated to other workers.” Craft occupations, in contrast, “emphasize technique per se” and protect their authority and legitimacy by controlling the transmission of technical and tacit skills.¹³ In Abbott’s system, flavorists would likely be classified as a technical occupation, rather than a “fully” professional one, both because of the apprenticeship model of training that persists in the field to this day and the emphasis on tacit and

Arthur D. Little, Inc. who had, since the 1920s, worked on scientific and technical problems related to sensory quality and control (particularly those related to odor). Crocker claims to have coined the word, explaining: “Since the dictionary lacks a word for one whose profession deals with flavor, there term ‘flavorist’ is hereby offered.” In Crocker’s usage, however, a flavorist is not specifically a creator of synthetic flavor additives. Instead, he applies the term to food technologists and other technoscientific professionals who work to improve the flavor of food products, particularly within the context of industrial food manufacturing, by studying the chemical causes of flavor changes during production or storage and developing new processes and packaging that did less damage to, or improved, flavor quality. The word caught on, at least in trade circles, by the early 1950s, although it had come to refer almost exclusively to workers who developed flavor additives. Although flavorists also often referred to themselves as “flavor chemists,” in this chapter, I do not use these two terms interchangeably, but instead reserve “flavor chemists” for those workers (in government, academy, and industry) whose primary focus was the identification of flavor compounds in food, rather than the creation of flavor additive products in flavor industry laboratories.

¹³ Andrew Abbott, *The System of Professions: An Essay on the Division of Expert Labor*, (Chicago: UChicago Press, 1988): 8-9.

technical skills. For Abbott, the economic salience and persistence of a profession derives from the essentially abstract quality of its defining body of knowledge, from “their abstracting ability to define old problems in new ways. Abstraction enables survival.”¹⁴ Occupations that are too entwined with the particularities of technique, too bounded by the material jurisdictions of their knowledge, are at risk of being shunted aside by real professionals or actual robots. Despite the smooth assurance of the IBM representative, software programmers faced a similar occupational crisis in the 1950s and 1960s. As Nathan Ensmenger has documented, software programming was, during this period, a craft occupation that seemed to bear many similarities to the work of the creative flavorist: based on intuition, tacit knowledge, and idiosyncratic virtuosity.¹⁵ Further, like flavorists in the same period, the occupational identity of the programmer was radically underdetermined; as Ensmenger puts it, “‘programmer’ ... was not a career choice but... a vocational path followed by accident and only retrospectively labeled and understood.”¹⁶ In Ensmenger’s account, the software craftsman was a poor fit in the corporate culture of computer companies, which valued hierarchies of management, standardized skills, and routine processes. As a result, “in the interest of efficient software manufacturing, the black art of programming had to make way for the science of software engineering,” increasingly theoretical, academic, and abstract.¹⁷

¹⁴ Abbott 1988: 30.

¹⁵ Nathan Ensmenger, *The Computer Boys Take Over: Computers, Programmers, and the Politics of Technical Expertise*, (Cambridge: MIT Press, 2010).

¹⁶ Ensmenger 2010: 12.

¹⁷ Ensmenger 2010: 24.

More recently, sociologists of work have argued that technicians should be understood not as “junior” or “paraprofessionals,” but as practitioners of both craft and science, and moreover, as central and coordinating figures in modern organizations, whose occupational importance derives as much from their ability to mediate between multiple social, material, and informational realms, as it does from their technical mastery.¹⁸ For instance, Stephen Barley and Julian Orr describe technicians as “managing the empirical interface,” the point at which a system of production meets the material world, in part by transforming materiality into signs, symbols, and indices, carriers of meaning and value.¹⁹ This central and coordinating role, this translation between realms of experience, emerges not from an abstract view from above, but precisely from “situated practice” — the tacit, embodied, fully sensual “know how” that comes from direct manipulation of basic materials. At flavor companies, flavorists translate between materials and representations, at the juncture between the synthetic compounds produced by fundamental research and the pattern of customer needs and consumer appetites. They assemble distinctive products out of heterogeneous materials: available chemical raw materials, chemical knowledge, customer requests (which may need to be heavily interpreted), information about costs and production processes, and regulatory requirements.

¹⁸ Barley, Stephen R. "Technicians in the Workplace: Ethnographic Evidence for Bringing Work Into Organizational Studies," *Administrative Science Quarterly* 41, no. 3 (1996); Catherine McKercher and Vincent Mosco, eds. *Knowledge Workers in the Information Society*. Lanham: Lexington Books, 2007; Julian E. Orr, *Talking About Machines: An Ethnography of a Modern Job* (Ithaca, NY: ILR Press, 1996).

¹⁹ Barley, Stephen R. and Julian E. Orr, eds. *Between Craft and Science: Technical Work in U.S. Settings*. Ithaca: IRL Press, 1997.

Like software programmers, flavorists in the postwar had to make a place for themselves in corporate structures that are not reflexively welcoming to their way of working — which may have, structurally, favored systematic and routinized knowledge over the idiosyncratic effusions of creative skill. Postwar flavorists found their place, in part, by distinguishing themselves from their “old school” counterparts, enthusiastically embracing instrumental technologies such as gas chromatography, scientific research, and technology. But they also differentiated themselves from analytic flavor chemists, by their insistently embodied and sensual response to the chemical compounds that their powerful machines eluted into the world. In other words, flavorists used instrumental technologies to define and defend the prestige of their jobs and technical knowledge while continuing to insist upon the creative essence of their work lives. I will argue that flavor chemistry constitutes what I will call a “scientific craft profession,” a form of trained, professional labor that self-consciously joins technical mastery, scientific knowledge, and creative skill. Rather than an exceptional or marginal case, I believe that flavorists ultimately demonstrate the importance of tacit, embodied, and situated knowledge to scientific and technological careers.²⁰

This chapter begins by examining the formation of the Society of Flavor Chemists. Flavorists organized as a professional group at a time when the conditions of

²⁰ See, for instance, Natasha Myers, “Molecular Embodiments and the Body-work of Modeling in Protein Crystallography,” *Social Studies of Science* 38.2 (April 2008): 163-199; Lucy Suchman, “Embodied Practices of Engineering Work,” *Mind, Culture, and Activity* 7 (2000): 4-18; H.M. Collins, “The TEA set: Tacit knowledge and Scientific Networks,” *Social Studies of Science* 4.2 (1974): 165-185.

their work were changing rapidly. Commercial circumstances were favorable for the field, and for its claims to recognition as an expert profession. There was a rising demand for the services of flavorists and a growing number of job opportunities, which were being filled by younger workers eager for their share of promised postwar prosperity. Further, the recognition of flavor chemistry as a distinct chemical sub-discipline lent credibility to claims of the scientific basis for this form of work, at a time when science and technology fields were rising in social esteem. Meanwhile, what it meant to hold a “job in flavors” was also in flux. An expanding petrochemical industry, powerful analytic instruments, and developments in food production technologies required an increasingly sophisticated set of skills, and workers who could “make sense of” newly available chemical materials in evolving and diversifying contexts of use. At the same time, cultural and political forces started strongly regulating and limiting the use of new chemical materials in foods, in a certain regard, denigrating the (largely invisible) labor of the specialists who worked with them. The moment was ripe for the workers in this rising field to define themselves and improve their prospects.

Then, I take a detailed look at how flavorists transformed chemical compounds into flavors. By the 1960s, there were more than a thousand potential chemical compounds that were approved for use in flavoring additives. There was also a rapidly evolving chemical knowledge of the constituents of flavor, which not only revealed previously unknown compounds but also shed light on the dynamic interaction between smelly molecules in foods to produce the perceptual effect of “total flavor.” I consider the uniquely probing ways in which flavorists read the flavor chemical literature, their

distinctive use of analytic instrumentation, and their contextual role within the structure of flavor companies. I then consider how flavorists learned to do their work, examining the educational regimes and training programs that produced skilled flavorists.

Finally, I conclude with some thoughts on the moral and historical purpose that flavorists saw in their work. At a time when “chemicals” in foods were attracting increasing concern and even popular abhorrence, flavorists attached their work to a broader, progressive mission of feeding the world at a time of resource crisis.

BECOMING FLAVORISTS: THE ORIGINS OF THE SOCIETY OF FLAVOR CHEMISTS

In 1996, the Society of Flavor Chemists (SFC) published a spiral-bound booklet documenting the history of their profession four decades after the founding of their organization.²¹ The booklet contains dozens of brief biographical recollections submitted by flavorists, testimonials of their own careers in the field, or remembrances of the lives of departed colleagues. Reading through these life stories, one is astonished to encounter again and again variations on a common refrain: “Like most flavor chemists, I got into the industry purely through dumb luck.”²² Some began working for flavor manufacturers in other roles — both blue-collar positions (handyman and “bottle washer,” compounder) or technical positions that required some chemical education (quality control, analytical

²¹ Society of Flavor Chemists 1995.

²² Carl H. Holmgren in Society of Flavor Chemists 1995: 77. Similar “dumb luck” accounts of initiation into the profession can be found in the entries for Baranowski, Clemente, Colovito, DeRovira, Eskin, Farber, Fischetti, Donnarumma, Goossens, Graham, Heinze, Mandel, McBurnie, Merwin, and Mosciano.

chemist), shifting to creative flavor work due to a combination of happenstance, demonstrated skill and interest, and acute labor market need.²³ Others answered classified advertisements or were placed by employment agencies, apparently with few expectations about the nature of the work ahead. After Earl Merwin graduated from NYU with an undergraduate degree in chemistry in 1947, an employment agency sent him to Fritzsche Brothers. “When I told the agent that I had never heard of that company,” Merwin recalled, “he suggested that I not mention that to them.”²⁴ When Harvey Farber graduated Queens College with a degree in applied science a decade and a half later, he had a similar experience when an employment agency placed him at General Foods. “I had no idea about flavor chemists or flavor companies,” he wrote. “By chance I was put in a flavor group. I liked it and I was good at it. I was a junior flavor chemist.”²⁵

The SFC was spearheaded by James Broderick, an ambitious young chemist who was looking for opportunities to develop his skills as a creative flavorist. Broderick began working with flavors in 1939, a year after graduating Brooklyn Technical High School. His first job was as a laboratory assistant at a dessert manufacturer, where he worked alongside a chemist who had some experience in flavor work. “There was an excellent library of flavor samples, several books on flavors, and a number of key flavor materials,” Broderick recalled. When the chemist was fired less than a year later for union-promoting activities, Broderick had the chance to dabble in creating flavors

²³ See, for instance, Thomas J. Bonica, who began as a handyman and bottle washer at Polak & Schwartz in the 1930s (Society of Flavor Chemists 1995: 45-6); Anthony Clemente began as a compounder at Fritzsche Brothers before the war (Society of Flavor Chemists 1995: 52).

²⁴ Earl Merwin in Society of Flavor Chemists 1995: 105.

²⁵ Harvey Farber in Society of Flavor Chemists 1995: 61.

himself. He had good sensory instincts and a keen interest in flavors, and some of his formulations were accepted and used— although he later suspected that this was due to their low cost rather than their quality. Within a few years, he began working at a small Brooklyn flavor company. By the time America entered the Second World War, he was in charge of flavor development.²⁶

War service interrupted his career, and when he returned to civilian life, he actively sought out a mentor. “I felt the need to work with some talented senior flavorist to enhance my flavor knowledge,” he recalled. After seeing a newspaper advertisement for a flavor chemist position at van Ameringen-Haebler, he applied; he had come to admire the creativity and integrity of the company’s flavoring products, and hoped to learn from the flavorist who had created them. After being hired, he found out that the flavorist whose work he had respected had died some time before; his son, whom he had trained to replace him, was in poor health and no longer at the company. (Broderick, in fact, had been hired as his replacement.) Instead, Broderick worked with James McGlumphy, who had recently joined the company from the Iowa State University, where he had been a professor of chemistry. McGlumphy was an analytical chemist with a doctorate in the field; he knew little of the flavor industry when he joined the company. He also, according to Broderick’s account, felt his position threatened by another “practical flavorist” and flavor salesman at the company who had believed that McGlumphy’s job should rightfully have gone to him.²⁷

²⁶ Society of Flavor Chemists 1995: 46-8

²⁷ Society of Flavor Chemists 1995: 103-4.

Restless, Broderick left van Ameringen-Haebler in 1952 for a position at Givaudan, which was expanding its flavor division at the time.²⁸ There, he met two younger flavorists, Jerry DiGenova and Earl Merwin; all had been hired within a year of each other. The working conditions at Givaudan were also not ideal. As Merwin recollected, “We worked in one flavor lab with one technician (Mary Mogavero). Our ‘offices’, with a desk for each, were also all in one room.” Their boss, Hans Kessler, was not a flavorist; he was the sales director at the company. Two older, European-trained flavorists, Carl Jensen and Joseph Merory, divided artificial and “true fruit” flavors between them; both soon left to begin their own companies. “Management had set up a competitive situation” among the three new hires, Broderick complained, “and did not apparently see the longer range potential of keeping all content.”²⁹ Within a few years, both Broderick and Merwin had left the company — Merwin went to McCormick & Co. in Baltimore; Broderick eventually ended up at Kohnstamm, in Brooklyn. DiGenova remained at Givaudan for the duration of his career, eventually ascending to chief flavorist and vice president of the creative laboratories.³⁰

What Broderick and his colleagues were discovering was this: the status and role of the creative flavorist was uncertain within US flavor companies in the immediate postwar. Although many aspects of the flavor industry were changing, in many cases, companies still functioned in traditional ways, passing flavor formulas down along paternal lines, and relying on older, European-trained flavorists. But as the market for

²⁸ See Chapter 4.

²⁹ Society of Flavor Chemists 1995: 47.

³⁰ Jerry DiGenova, Society of Flavor Chemists 1995: 55.

flavoring additives boomed after the war, and flavor and fragrance companies expanded their production of specialty flavorings, there was a need for more skilled workers who could transform the growing number of available flavoring chemicals into distinctive new flavoring products. But where should these new workers come from? Should companies look for individuals with academic credentials in chemistry, such as McGlumphy? Should individuals with sales experience, who knew the needs of clients, be in charge, directing the activities of flavorist-technicians? What sorts of resources, instruments, and personnel should flavorists be granted? Where did their work fit into the company's bigger picture? In this regard, flavorists faced some of the same status anxiety and hostility encountered by software programmers during the same, as described by Nathan Ensmenger. Both software programming and flavor creation were seen as "black arts," practiced by adepts with idiosyncratic capabilities and unique gifts.³¹ Yet just as "the black art of programming had to make way for the science of software engineering," there was a pressing need within flavor companies to put flavor creation on a systematic basis, and a concomitant desire among flavorists entering the field to develop their capacities and define the trajectory of their careers.³²

The 1953 IFT meeting in Boston presented an optimal chance. As Broderick recalled, "a group of us used the opportunity to recruit additional flavorists with the hope of forming the Society of Flavor Chemists."³³ The quorum of flavorists at the IFT

³¹ Ensmenger 2010: 19. For flavor creation as "black art," see "The Art in Imitation Flavors: The Aromatic Constituents of Strawberry," *Givaudan Flavorist* 1953 (2): 1.

³² Ensmenger 2010: 24.

³³ James J. Broderick, "Reflections of a Retired Flavorist Before He Forgets: Strawberry," *Perfumer & Flavorist* 17.3 (May/June 1992): 33.

included Broderick, Merwin, and DiGenova from Givaudan, as well as Thomas Bonica and Charles Fricke, from Polak and Schwarz, Frederick Schumm from Dodge & Olcott, and Louis Strasberger, who Broderick knew from his time at Van Ameringen-Haebler.

The location of this convocation of flavorists from different companies, the IFT meeting, signified the growing cultural divide between younger flavorists and their older counterparts. “Old school” flavorists, such as Merory, formerly of Givaudan, were trained at a time when information about the chemistry of flavor was relatively scarce; they worked empirically, by sense and memory, had little interest in new analytic technologies, and often were expected to be both salesman and formulators.³⁴ Younger flavorists, especially those who entered the field after the war, were more inclined to see their place among scientific and technical workers, contributors to, and beneficiaries of, a growing body of fundamental flavor research. But the Mertonian norm of “communism,” designating the goods of scientific knowledge as common intellectual property among a community of scientists, was a poor fit with the values of flavor companies, which were traditionally extremely secretive. “There was still a strong feeling at the management level in some companies that flavorists should not meet together or even be seen talking

³⁴ The biography of Merory included in Society of Flavor Chemists 1995 describes him as a convincing salesman but a somewhat inept formulator, who “knew a little about a lot of things” but did not have a very ‘scientific image’ among his peers. (Joseph Merory, Society of Flavor Chemists 1995: 104-5). See also, for instance, Merory’s 1960 handbook on food flavorings, where he describes the craft of creating a synthetic flavor that “closely resembles” a natural one in these words: “The development of a close resemblance is creative work and depends on the photographic memory of the flavor technologist to recall aroma and taste of every flavor which passed his sensory and gustatory organs. He has to know which ingredients to select and to be able to harmonize them in a suitable flavor formula.” Younger flavorists writing at this time would indubitably refer to ongoing analytic flavor research as a source for assistance in developing a naturalistic flavor.

together,” Broderick recalled.³⁵ McGlumphy, the head of flavor research at van Ameringen-Haebler, strongly opposed to the creation of the SFC, at least initially.³⁶ In fact, Strasberger, who had served as the first Vice President of the SFC, declined to accept any further positions with the organization, “citing the displeasure he felt such a position would generate with his employer.”³⁷

The group recognized that the legitimacy of their nascent organization (and perhaps their own continued employment) was in question. Strategically, they wanted to choose a leader and president for the SFC that could serve as a credible intermediary. On the one hand, an established “older” flavorist might not represent their values and goals; but selecting one of their own younger cohort would fail to gain credit with the companies they worked for. The first president of the organization, John Bouton, was a transitional figure. Having begun his career in the late 1930s, he was neither “young” nor “old,” but occupied an intermediate generational position, thus bridging the chasm between the older cadre of flavor workers and the rising class, who had largely entered the field after the war.³⁸ Bouton was also widely respected, as he was the recognized creator of Dodge & Olcott’s Dolco 5210 Imitation Strawberry, a distinctive “trade-famous” strawberry flavor that was celebrated as the industry leader at the time.³⁹

³⁵ Broderick “Strawberry” 1992: 33.

³⁶ James McGlumphy in Society of Flavor Chemists 1995: 104. McGlumphy would eventually become an honorary member of the SFC.

³⁷ Louis Strasberger in Society of Flavor Chemists 1996: 127.

³⁸ Broderick “Strawberry” 1992: 33.

³⁹ Broderick “Strawberry” 1992: 33. Broderick later discovered that the flavor’s distinctiveness came from methyl heptene carbonate, which added a green note, as well as a very small quantity of maltol; Broderick believed Bouton was the first to use the

The early meetings of the Society of Flavor Chemists merged social with professional purposes. Starting in February 1954, about a dozen workers in the New York flavor industry convened in restaurants, usually in Little Italy, every other month. “A group of those interested in flavor chemistry have formed the Society of Flavor Chemists,” ran an announcement in the *Journal of Agricultural and Food Chemistry*. “Purpose of the organization is primarily social but informal talks on matters of mutual interest will be scheduled occasionally.”⁴⁰ But the group also hosted scientific talks and other technical information of interest to their field. For instance, Keene Dimick, of the USDA Western Regional Research Laboratory in Albany, California, gave a talk in 1956 to the SFC about his pioneering work using gas chromatography to study the flavor chemistry of strawberries.⁴¹ “This meeting was a turning point not only for flavorists but also for Dr. Dimick,” Broderick later wrote. “For the flavorist it changed his approach and increased his efforts to obtain, evaluate and utilize the hexenyl compounds. For Dr. Dimick it gave the opportunity to travel to the East and line up suppliers to build gas chromatographs and start the Aerograph Company.”⁴²

material. Dolco Imitation Strawberry 5210 is referred to as “trade famous” in the 1951 Dodge & Olcott catalogue, which claims that the flavor has “won wide acceptance in every industry where strawberry flavor is used.” Dodge & Olcott, Inc. *Essential Oils, Aromatic Chemicals, Perfume Bases, Vanilla, Flavor Bases*, [Catalog], April 1951: 32. Smithsonian Institute Trade Literature Collection, National Museum of American History Library.

⁴⁰ “Flavor Chemists Form Society in New York,” *J. Agric. Food Chem.* 2.5 (1954): 266.

⁴¹ See Chapter 6.

⁴² Broderick “Strawberry” 1992: 33.

When the SFC was formally incorporated as a chartered corporation in 1959, its size had doubled to include nearly two dozen “charter members.” The organization soon adopted a Code of Ethics, which asked members to pledge to observe high standards of personal conduct and professionalism, and to recognize certain responsibilities. The first duty was to the self, to maintain a standard of individual integrity and professional honor, which included keeping “in active contact with the progress in my profession.” The second duty was to the flavorist’s employer, “to serve him undividedly and conscientiously on the basis of a clear, mutual understanding of our respective interests, guarding his concerns, reporting fully on all technical matters,” and ensuring that coworkers also respected the demands of confidentiality. The third duty was to the flavorist’s profession: to contribute to its progress and to the mutual exchange of ideas, to recognize the work of others, to observe the highest standards of truthfulness in technical reports, “but in doing so to faithfully guard against the willful and wrongful disclosure of trade secrets of former employers.”⁴³ In other words, the Code of Ethics attempted to strike a deliberate balance between the communal norms of scientific and technical societies, and the obligations demanded by private employers, to confidentiality and secrecy.

⁴³ Society of Flavor Chemists 1995: 32.

FLAVORS ARE CHEMICALS: FLAVORISTS AND THE 1958 FOOD ADDITIVES AMENDMENT

The chemical-material culture of the postwar flavorist was defined not only by the rapid proliferation of intriguingly smelly molecules, but also on the regulatory side, by new laws and requirements that sought to limit and constrain the use of these chemicals in foods.

Concerns about chemicals in the food supply had driven perennial reform efforts, but the precise nature of these worries, the chemical effects that the government was asked to protect consumers from, evolved over time. Although the 1906 Pure Food and Drug Act had been motivated in part by fears about noxious adulterants in the food supply, the law's main regulatory muscle was flexed to prevent economic adulteration, the use of synthetic chemicals to deceive purchasers about the identity or quality of the product they were buying.⁴⁴ But that law's failure to give regulators the power to create legal food standards, and other perceived loopholes such as the 'distinctive name proviso,' came to be perceived by regulators and food reformers as serious shortcomings that limited its effectiveness at protecting consumers. One of the changes introduced by the Pure Food Act's successor, the 1938 Food, Drugs, and Cosmetics Act, had been to formalize the process of developing official food standards of identity, which were seen as essential to protecting "the pocketbooks of consumers" and ensuring that they received "the 'value expected'" from foods.⁴⁵ As defined by the law, food standards were to take

⁴⁴ See Chapter 2.

⁴⁵ Suzanne White Junod, "Food Standards in the United States: The Case of the Peanut Butter and Jelly Sandwich," in *Food, Science, Policy, and Regulation in the 20th*

the form of “recipes,” specifying required ingredients and optional ingredients. The contents of these standards were determined during a series of hearings, which entertained testimony from representatives from various interested parties, including the food industry. Standard foods were required to list only any optional ingredients on their labels. Foods for which no standards existed were required to list all ingredients.

“Ironically,” notes FDA historian Suzanne White Junod, “consumers knew less about the contents of standardized foods than about foods for which there were no standards” and which were required to list all ingredients on their labels.⁴⁶ Although this system allowed the FDA to prohibit some chemicals in some foods by excluding them from the standards — for instance, benzoate of soda, a preservative, was excluded from the “optional” ingredients in canned tomatoes, thus prohibiting its use — the legal framework for challenging the inclusion of these ingredients was economic adulteration — not safety.

This process had worked relatively smoothly at first, as the food standard setting process prioritized staple foods, which tended to include fewer ingredients and were simpler to define.⁴⁷ But as food technology generated new kinds of foods that departed further from anything that could be whipped up in a home kitchen, and with modifications to the hearings process that often turned the proceedings into a forum for

Century, 2000: 179. For more on the 1938 law and the contentious process of developing standards of identity for food products, see: Angie M. Boyce, “‘When Does it Stop Being Peanut Butter?’: FDA Food Standards of Identity, Ruth Desmond, and the Shifting Politics of Consumer Activism,” *Technology and Culture* 57.1 (2016): 54-79; James Harvey Young, “The Government and the Consumer: Evolution of Food and Drug Laws and the 1938 Food, Drug, and Cosmetic Act,” *Journal of Public Law* 13 (1964): 197-203; Gwen Kay, “Healthy Public Relations: The FDA’s 1930s Legislative Campaign,” *Bulletin of the History of Medicine* 75.3 (Fall 2001): 446-487.

⁴⁶ White Junod 2000: 183.

⁴⁷ White Junod 2000: 181.

litigating internecine trade disputes, fractures began to appear in the regulatory system.⁴⁸ What should be the standards for new types of processed foods, such as freeze-dried coffee, instant pudding mixes, frozen dinners? Further, investments in food science and technology research were yielding an increasing number of new ingredients and functional chemical additives, which food manufacturers were eager to integrate into their products, but which regulators were increasingly wary about.⁴⁹ This was dramatized during hearings about the standard of identity for bread, in the early 1950s. In particular, bread companies were eager to have the FDA recognize as optional ingredients a new category of chemical additives: polyoxyethylene monostearates (POEMS). POEMS were shelf-life boosting emulsifiers, that kept loaves softer longer on supermarket shelves. “It was painfully clear to everyone at the hearings,” writes White Junod, “that all 27 emulsifiers had not been subjected to the same level of scientific scrutiny for either safety or suitability in bread.”⁵⁰ But the FDA challenged their inclusion in the standards not because of possible health effects, but on the grounds that their use misled consumers about the freshness of bread. During the prolonged and frustrating hearings debating the standard, swarms of psychologists and social scientists were called to testify, and asked to weigh in on “the task of dissociating softness and freshness.”⁵¹ For many, the spectacle of the hearings proved the wrong-headedness of contesting food additives on the grounds

⁴⁸ In particular, manufacturers and others criticized the food standards system for stifling innovation and technological improvement. See, for instance, H. Thomas Austern, “Food Standards: The Balance Between Certainty and Innovation,” *Food, Drug, and Cosmetic Law Journal* 24 (1969): 440-55.

⁴⁹ Suzanne White, “The Chemogastric Revolution and the Regulation of Food Chemicals,” in Seymour H. Mauskopf, ed. *Chemical Sciences in the Modern World*, (Philadelphia: University of Pennsylvania Press, 1993): 322-55.

⁵⁰ White Junod 2000: 182.

⁵¹ White Junod 2000: 182.

of consumer deception. It became clear to Congress that a new process was needed, one that allowed the FDA to directly address the question of safety.⁵²

In order to better grapple with the growing number of untested chemical additives in the food supply, in the early 1950s, Congress created a Select Committee to Investigate the Use of Chemicals in Food Products, which would come to be led by Representative James Delaney of New York. This investigation culminated in the 1958 Food Additives Amendment (FAA), which became effective in March 1960. While implicitly recognizing the utility (and inevitability) of chemical additives in an industrialized food system, the FAA was an attempt to address the increasing concerns from the public and the scientific community about the possible long-term health effects of these substances.⁵³ It did this by implementing a review process for new food chemicals comparable to the one in place for new drugs.⁵⁴ The law placed the burden of testing onto private industry, requiring manufacturers to submit detailed toxicological test results and other data to the FDA, and obtain pre-market approval from the agency for any new substance before introducing it into the food supply. In particular, the law reflected an emergent consensus in the medical and scientific community about the relationship between dietary habits and the incidence of cancer. A section of the law known as the

⁵² Xaq Frohlich has convincingly argued that the decline of official “standards of identity” constituted the beginning of an “informational turn” in food labeling, as consumers were increasingly made responsible for managing their own health risks by diligently reading labels (and making responsible choices), while the government’s role in ensuring food quality diminishes. See: Xaq Frohlich, “The Informational Turn in Food Politics: The US FDA’s Nutritional Label as Information Infrastructure,” *Social Studies of Science* (2016): 1-27; and “Accounting for Taste: Regulating Food Labeling in the ‘Affluent Society,’ 1945-1995,” *Enterprise & Society* 13.4 (December 2012): 744-61.

⁵³ White 1993: 342.

⁵⁴ White Junod 2000: 183.

“Delaney Clause” withheld approval for any substance that had been shown, in animal experiments, to potentially cause cancer in humans or that was a known human carcinogen.⁵⁵ Crucially, the law allowed this pre-market review process to be bypassed for any substance that was “generally recognized, among experts qualified by scientific training and experience to evaluate its safety, as having been adequately shown to be safe under the conditions of its intended use.” This so-called GRAS (ie, “generally recognized as safe”) provision would be key to the flavoring industry’s response to the law.

The law applied to multiple categories of chemical additives, including preservatives, stabilizers, emulsifiers, surfactants, nonnutritive sweeteners, and food colors. Rather than joining in a general effort with other additive manufacturers and users, the flavor industry’s trade organization, the Flavor and Extract Manufacturer’s Association (FEMA) labored to distinguish its members’ products from other food additives, arguing that “special criteria” should be applied to the evaluation of flavoring materials.⁵⁶ First and foremost, there were simply more chemicals to consider: a far greater number and variety of compounds were used in the production of food flavorings than in all the other types of additives combined.⁵⁷ Conducting a toxicological review of

⁵⁵ For a detailed discussion of the 1958 Law, the Delaney Clause, the challenges of implementing it, and its implications for the relationship between science and policymaking, see Richard A. Merrill, “FDA’s Implementation of the Delaney Clause: Repudiation of Congressional Choice or Reasoned Adaptation to Scientific Progress?” *Yale Journal on Regulation* 5.1 (1988): 1-88.

⁵⁶ Richard L. Hall and Bernard L. Oser, “The Safety of Flavoring Substances,” in *Residue Reviews* (New York: Springer, 1968): 1-17. Collection of the Society of Flavor Chemists, Chemical Heritage Foundation, Philadelphia.

⁵⁷ Richard Hall, the McCormick Research Chemist who served as the first head of the FEMA Food Additive Committee and was instrumental in organizing the GRAS list effort, estimated in 1959 that about 1,100 flavor additives and adjuncts were in use in

all of these compounds would be prohibitively difficult and impossibly expensive. FEMA sought GRAS status for these materials. In order to build its case, FEMA formed a Food Additives Committee, which reached out to its membership of manufacturers, asking them to disclose information that they had long held very tightly: what chemicals they used in their flavorings, the concentrations they were used in, the types of products they were associated with, and the quantities annually produced and sold. FEMA also assembled a panel of recognized experts to review this data, including medical doctors, toxicologists, chemists, and others largely from academia, as well as some employed by chemical companies, including Dow and Eastman Kodak.⁵⁸

On the basis of the results of their survey to manufacturers, FEMA made a case that the risk posed by flavoring additive chemicals was negligible, and the costs of ensuring absolute safety prohibitive. The 1960 survey of flavor manufacturers found that half of the substances on the GRAS list were used in quantities of less than 100 pounds a year in the national food system. Only eight percent were used in quantities greater than 10,000 pounds a year, and these were generally spices and other botanical flavoring materials.⁵⁹ Very few were used at levels exceeding 500ppm. In contrast, sweeteners, emulsifiers, and other types of additives were often used at levels between 1,000 to 100,000 ppm. Their sensory qualities also made them self-limiting. “In all other

food, about twice the number of additives in use for all other purposes. Richard L. Hall, “Flavoring Agents as Food Additives,” *Food Technology* 8.7 (1959): 14. This paper was presented at the Symposium on Food Additives at the annual meeting of the Institute of Food Technologists, held on May 20, 1959.

⁵⁸ Bernard L. Oser and Richard A. Ford, “FEMA Expert Panel: 30 Years of Safety Evaluation for the Flavor Industry,” *Food Technology* (Nov 1991): 86-8, 93-7. A list of members of the expert panel can be found on 87.

⁵⁹ Hall and Oser 1968: 3.

categories of food additives, blandness or absence of flavor or odor is highly desirable and often essential. Thus there is no organoleptic safeguard against an overdose caused by accident or ignorance.” But “with rare exceptions” the use of flavoring materials “at levels substantially in excess of any normal maximum renders food unpalatable.”⁶⁰ Further, while many categories of additives “involve chemical structures not thus far found in the natural foods of man, and with which he has little toxicological experience,” with few exceptions, most flavor additives were either synthetically produced compounds found in nature, or structurally and thus metabolically related. “Unless there is genuine reason, based on chemical or pharmacological considerations, to question its safety under conditions of use, it is neither reasonable nor practicable to place on any substance, used to the extent of only a few hundred pounds annually, the cost burden of chronic toxicity studies,” concluded Richard Hall, a research chemist at McCormick who was the head of the Food Additives Committee and spearheaded the GRAS effort, and Bernard Oser, a consulting chemist who was the non-voting chair of FEMA’s expert panel.⁶¹

Members of the FEMA expert panel were required to be disinterested, with “no connection with the food or flavor industry that might instill any bias.” The experts were tasked with developing criteria for evaluating toxicity of flavoring substances, which came to include the history of the substance’s use (or presence) in foods; predictive assessments based on studies of the metabolism or toxicity of homologous or chemically related compounds, where such studies existed; and the levels of typical use in foods. These experts were given access to “all available information related to safety-in-use of

⁶⁰ Hall and Oser 1968:7-8.

⁶¹ Hall and Oser 1968: 5.

each flavoring substance,” and asked to apply their criteria. Experts were asked to certify not only that they considered a substance safe, but that they expected that their view was shared by other qualified experts.⁶² “From the beginning,” explained Oser and a fellow expert panel member, Richard Ford, in an article about the history of the FEMA panel, “our policy required that all GRAS decisions of the Panel be unanimous, not merely consensual, and published in the open literature for comment by the scientific community at large.”⁶³

The first comprehensive list was published in 1965, in *Food Technology*.⁶⁴ It included 1,124 flavoring chemicals, and also enumerated 267 substances which were to be dropped from use because they did not meet criteria for GRAS substances. The FEMA Expert Panel green-lit about 80 additional materials in 1970; many of these were pyrazines, thiols, and other nitrogen- and sulfur-containing molecules that had recently been discovered through fundamental flavor research, and which were to form important components of meaty, chocolatey, and vegetal flavors.⁶⁵ Subsequent lists are published on a regular basis, and the FEMA GRAS committee reviews new substances submitted

⁶² Oser and Ford 1991: 87-8.

⁶³ Oser and Ford 1991: 88

⁶⁴ This was known as GRAS III, because it followed two earlier preliminary lists.

⁶⁵ Robert J. Eiserle and William J. Downey, “A Review of the Literature Concerned with Flavor Research as it Applies to the Problems of the Flavor Industry,” *CRC Critical Reviews in Food Technology* 2.2 (July 1971): 159-169. Downey was the head flavor chemist at Fritzsche Dodge & Olcott.

by flavor companies.⁶⁶ The FDA accepted the agency’s findings almost in their entirety, and continues to do so to this day.

FEMA’s GRAS committee has been described as a case of “regulatory capture,” as a compromised group of industry-funded experts coopting the regulatory mechanisms of the state, thus subverting the public interest in service of private profits.⁶⁷ The committee’s scientific procedures, the disinterestedness and legitimacy of their findings, and the effects of synthetic flavor chemicals on the human body, are beyond the scope of this dissertation. What I would like to examine here instead are the implications of the FEMA GRAS list for the materiality of flavor additives and the forms of expert labor involved in their production — that is, for the work of creative flavorists.

From the outset, FEMA was committed to ensuring that an expansive and expanding list of chemical compounds were permitted and available for use in flavoring products. The focus of their effort was concerned not with commodity flavoring chemicals in mass-use — vanillin, for instance, or MSG — but the compounds that were produced (and used) in minute amounts. Hall, of FEMA’s Flavor Additive Committee, offered various examples of such compounds. Furfuryl mercaptan, for instance, was a “critically important ingredient of imitation coffee flavor,” but it was used in such tiny concentrations that the total national consumption of the chemical likely did not top 50

⁶⁶ The most recent list, GRAS 27, was published in 2015, and included approximately 2,500 substances.

⁶⁷ Marion Nestle, *Food Politics: How the Food Industry Influences Nutrition and Health*, (Oakland: University of California Press, 2013); Patrick van Zwanenberg and Erik Millstone, “Taste and Power: The Flavouring Industry and Flavour Additive Regulation,” *Science as Culture* (2014): 1-28.

pounds a year. Alpha ionone was a chemical used in concentrations of about 1ppm in imitation raspberry flavors; no more than 250 pounds of the stuff was used per year, in all foods and beverages produced. For a typical consumer, Hall estimated that it accounted for one billionth of their annual diet. With these and other examples, Hall forcefully argued that, even in the case of individuals who consumed abnormal quantities of foods flavored with these chemicals, the levels of consumption could not rise to toxicological significance.⁶⁸

The cases of these and other chemicals used in minute quantities provided rhetorical support for two of FEMA's main arguments: the low toxicological risk posed by these compounds, and the prohibitive cost of conducting a full toxicological review. But FEMA's argument also depended upon the regulatory agency accepting the necessity of all of these chemicals in the food system in the first place. Hall argued that just because these concentrations were not of toxicological significance, did not mean that they were not of sensory — and thus economic — importance. "Who is to determine the commercial importance of a superior flavor as compared to a merely adequate one?" Hall demanded. "Flavor compounding is a mixture of intuition, science, experience, and — let us be candid — hocus-pocus.... The question of whether or not a particular flavor ingredient is important is not a question on which the opinion of an untrained individual is entitled to serious consideration."⁶⁹ The "hocus-pocus" at the core of flavor creation was a kind of expert knowledge that could not be duplicated by other scientific experts. Flavor quality was not easily measured or described; taste panel measurements were at

⁶⁸ Hall 1959.

⁶⁹ Hall 1959: 2.

“best an approximate science.” For these reasons, the expertise of the people who used these materials — flavorists — must be taken into account. By insisting on the significance of molecules used in vanishingly small quantities, FEMA corroborated the specialized authority of those who did have the authority to weigh in on the importance of these materials.

This position derived from, and helped to nurture, an increasingly organized professional culture that recognized a “superior” flavor, and valued the technical and creative skills involved in its production. It protected the interests not only of the companies that used these chemicals in their products, but of the laborers (creative flavorists) who worked directly with these compounds and who, increasingly, derived their professional identity from their skillful use of these materials. Further, by making the production (and protection) of a list of allowable flavoring materials a common project, the FAA, and the GRAS list, also reinforced the bonds between flavorists across companies, as a community with mutual interests in these chemicals. In the past, some flavor companies had gained an advantage because of exclusive access to an otherwise unknown flavoring compound.⁷⁰ One of the consequences of the new regulatory regime

⁷⁰ James Broderick has described several such examples in his “Reflections of a Retired Flavorist Before He Forgets” columns that were published in *Perfumer & Flavorist* in the early 1990s. Some of these “proprietary” compounds were created by chance, for instance the lactone used in Fries’ peach flavor in the late 1930s. Others were the result of basic analytic research into the flavor chemistry of fruits, such as Firmenich’s “raspberry ketone” (para hydroxy phenyl butanone), identified by Coppens and Hoejenbos of Polaks Frutal Works in the Netherlands, and used by both that company and the Swiss-based Firmenich in their prewar raspberry formulations. James J. Broderick, “Reflections of a Retired Flavorist Before He Forgets: Raspberry,” *Perfumer & Flavorist* 16 (Nov/Dec 1991): 13-14; “Reflections of a Retired Flavorist Before He Forgets: Peach,” *Perfumer & Flavorist* 17 (Jan/Feb 1992): 35. In the wake of the FAA

was that there were no longer any “secret” ingredients; every permissible chemical was now openly listed and disclosed. However, just because a chemical was on the GRAS list, did not mean that it was available in the chemical marketplace in a form suitable for use in flavors. Many listed chemicals were, in fact, unavailable; many desirable chemicals were unlisted. Further, because of the sensitivity of the human sensorium to many odor compounds, flavorists required materials that were exquisitely pure. Often, commercially available chemicals failed to meet the extreme standards of purity required for flavor applications. (In practice, this often meant that flavor companies further processed chemicals that they purchased commercially in order to obtain the required purity.)⁷¹

One of the first major initiatives of the SFC was to compile a common database of chemical suppliers for the list of GRAS compounds. The members of the SFC Flavor Chemical Source Committee searched through available chemical catalogues, wrote letters to suppliers asking for updated information, scoured brochures and advertisements, and drew upon their own personal knowledge of unlisted supply lines and other sources. Published in 1968, *Food Chemical Sources* included an alphabetical listing of flavor chemicals (each with its corresponding FEMA GRAS number) and confirmed suppliers,

and GRAS list, some larger, research-oriented companies (such as IFF, Firmenich, and Givaudan) did file for (and obtain) patent protection for chemical compounds they had synthesized — an example is Furaneol, discovered in the mid-1960s in strawberries in the laboratories of Firmenich. Firmenich had a patent on the use of furaneol in fruit flavors — and Unilever had a near-concurrent patent for its use in meat and savory flavors — until the 1980s. While outside the scope of the current dissertation, patent-protected flavoring compounds will be a subject of future research and interest.

⁷¹ A.V. Saldarini, “The Chemical Sources Association — The Pioneers,” *Perfumer and Flavorist* 13 (Aug/Sept 1988):57-8.

as well as a directory of 128 flavor chemical supply companies.⁷² Some flavor chemicals were available from multiple sources. For instance, ethyl methyl phenyl glycidate (FEMA 2444), the compound once known as “strawberry aldehyde,” was available from nine companies, including Dodge & Olcott and F. Ritter in Los Angeles. But quite a few compounds had no known suppliers. For instance, iso butyl iso butyrate (FEMA 2189), a chemical with an odor reminiscent of pineapple, had no known commercial sources. The committee saw this directory as an ongoing project. “We urge all to pass on to us suppliers of various materials which have been left blank in this directory, as well as suppliers other than those listed,” urged the introduction from the committee’s chairman, Frank Fischetti, a flavorist at Fritzsche Brothers.⁷³

With the publication of a second edition of *Food Chemical Sources* in 1971, corresponding to the expanded GRAS list published the previous year, the gaps between “permitted” and “accessible” became even more evident. “For the supplier to justify production, there had to be a demand, a demand by many companies to increase the volume and justify research and production costs,” explained Al Saldarini, the first head of the SFC Flavor Chemical Source Committee, in an article describing its history. Instead of merely compiling known suppliers, the SFC used its collective power to demonstrate demand and actively develop new sources. In alliance with like-minded workers in the fragrance industry, they created a new organization, the Chemical Sources Association (CSA), in 1972. Chemical suppliers were solicited, and invited to SFC

⁷² Society of Flavor Chemists, *Food Chemical Sources*, (New York: Society of Flavor Chemists, Inc., 1968).

⁷³ Society of Flavor Chemists 1968: [np/2].

technical meetings, where they were both educated about existing needs, and invited to present their products to members. The CSA also funded research into chemical synthesis, especially for compounds of interest for which no supplier could be found.⁷⁴

This is not to suggest that flavorists took the toxicological risks of the materials that they used lightly. But while “chemicals” and “foods” are generally perceived to be mutually exclusive categories by many ordinary consumers, flavorists’ attitudes were informed largely by their understanding of their materials as both flavors and chemicals. This also informed the accepting, but generally skeptical, attitude toward the distinction between “artificial” and “natural” flavoring materials that the FDA imposed on labels in the early 1970s. According to flavorists’ ways of working with chemical materials, these categories were logically inconsistent — regrettable signs of chemophobic attitudes among certain sectors of the public, enshrined in regulatory law.

MAKING CHEMICALS INTO FLAVORS: THE FLAVORIST AT WORK

“The problem that exists today, if it can be called a problem, is the rapidity with which new aromatic chemicals have appeared for flavor use,” wrote Frank Fischetti, a flavorist at Fritzsche, Dodge, & Olcott, in 1980.⁷⁵ Although somewhat tongue in cheek, Fischetti is giving voice to his legitimate sense of the scale and speed of the

⁷⁴ Saldarini 1988: 58.

⁷⁵ Frank Fischetti, Jr. “Natural and Artificial Flavors,” in Thomas E. Furia, ed. *Handbook of Food Additives, 2nd Edition*, Vol. II, (Boca Raton: CRC Press, 1980): 307.

transformation of the material-culture of his trade. Fischetti, who began his career as a flavorist in the late 1950s, had witnessed massive changes in flavor chemical knowledge, including the introduction of new families of compounds — pyrazines and thiazoles — formerly unknown as flavoring ingredients.

Postwar flavorists were the beneficiaries of a scientific, technological and chemical regime that provided unprecedented access to the chemical secrets of flavors in foods and the intimate mechanisms of perception, as well as new capacities to obtain and produce synthetic molecules of olfactory interest. But while fundamental research in flavor chemistry produced prolific lists of substances, it was up to flavorists to work out how to apply this knowledge to the creation of distinctive, useful, and compelling synthetic flavors.

In this section, I consider several published accounts of the work-process of flavor development, all of which illuminate distinct aspects of the creative labor of making flavors. The first example I consider dates from the first half of the 1950s, just before the commercial introduction of analytic instruments and their widespread use. Appearing in the *Givaudan Flavorist*, the company's newsletter, this article vividly depicts the flavorist's unique approach to the task of flavor "imitation." The flavorist smells analytically, reads the scientific literature not only for facts, but also for suggestions and clues, and assembles materials to create sensory rhymes rather than produce molecular replicas. I then consider a set of later texts that directly grapple with the consequences of instrumental technologies such as GC for the creative labor of the flavorist, and that sharpen the distinction between flavorists and analytic flavor chemists, while also

elucidating their areas of interdependence. Finally, I examine a case which situates the process of new flavor development within both the institutional structure of the flavor company, and its broader commercial context.

What these accounts demonstrate is that the flavorist possessed a body of knowledge about chemical materials that included the analytic findings of research chemists, but that also exceeded them. Flavorists knew different things about both chemical materials and sensory experience than flavor chemists, asked different things from the stuff and the machines they both worked with. Rather than being bound to the discoveries of analytic chemistry, flavorists put this knowledge to use in ways that changed the contours of the flavored world, not so much forging entirely new species of sensation, as intensifying and modifying the familiar. However, this seeming independence of the creative process, does not mean that flavorists operated as idiosyncratic “genius” type creators, working in eccentric isolation. On the contrary, flavorists were creatures of the particular milieu of the flavor company, indeed, perceived themselves at the very center of it.

**“THE ART IN ARTIFICIAL FLAVORS”: BUILDING A FLAVOR BY
ANALYZING A SCENT**

“To the real scientific mind, one thoroughly trained and schooled to think in precise terms, the creation of flavors has always been looked upon as a mystery, or, kind of ‘black art’ and the flavor chemist as anything but a scientist,” admits the opening paragraph of “The Art in Imitation Flavors,” the feature article in the second issue of the *Givaudan Flavorist*, the flavor and fragrance company’s newly launched newsletter

publicizing the work of its flavor division. “The fear is often subconsciously expressed that these flavor creators are a long step back to the days of the alchemist.”⁷⁶

Like many chemical companies serving the needs of industrial manufacturers, Givaudan put great emphasis on the technological sophistication of its laboratories, factories, and personnel; the promotion of its flavor division was connected to its increasing investment in research and development in that sector.⁷⁷ How could the work of the flavorist find its place within this intensively, even ostentatiously, scientific milieu? After all, the labor of flavor creation — especially the creation of artificial flavors — remained associated with closely guarded “secret formulas,” illusory resemblances, and even deceptions. With “The Art in Artificial Flavors,” the company sought to dispel the suspicions around the nature of the flavorists’ work. Taking the creation of an artificial strawberry flavoring as an example, the article goes on to explain both the flavorist’s methods, and the necessities (and virtues) of his labor.

While the analytic investigations of research chemists into the chemical constituents of flavor had only yielded lackluster results, the flavorist’s power came from the ability to smell analytically. “Although the [flavorist] has trained himself to identify, by odor, hundreds of aromatic chemicals and essential oils, actually he creates by building up a series of basic odors that he identifies in the product he wishes to reproduce synthetically.”⁷⁸ In other words, when a flavorist sniffs a strawberry, the purpose is not to

⁷⁶ “The Art in Imitation Flavors: The Aromatic Constituents of Strawberry,” *Givaudan Flavorist* 1953 (no 2): 1. This article was likely written by Earl Merwin.

⁷⁷ See Chapter 4.

⁷⁸ “The Art in Imitation Flavors” 1953: 1-2.

use the nose to discern which chemicals are present, but to determine the sensory dimensions (“basic odors”) of its aroma. In the case of Givaudan’s strawberry, these were: fruity/estery, green butter, sweet, balsamic, straw/hay, rose-honey, and sour/citrus. Having spliced “strawberry” into these seven aromatic shades, none of which were explicitly strawberry-like, the flavorist then considers the available materials that can produce the requisite effects.⁷⁹

How are these materials known and chosen? “The Art in Imitation Flavors” included ample references to recent findings in the basic chemistry of flavor, presenting an image of the flavorist as up-to-date on the latest scientific literature. The flavorist reads the research not only for facts, but also for clues. While a flavor chemist at the USDA or in a university food science department may see the growing list of identified compounds as an accomplishment in the pursuit of total chemical knowledge, the flavorist, attendant instead upon the total sensory effect and its subtleties, is exquisitely aware of the remaining (innumerable) unknowns. The flavorist uses the research as a starting point, in order to plunge into the negative space of unknown chemicals and unknown relationships: to make deductions about implied presences, and draw sensory analogies with related compounds. For instance, to produce the strawberry’s buttery note, the flavorist might begin with diacetyl and acetyl methyl carbinol — substances that had

⁷⁹ These sensory dimensions were, admittedly, arbitrary. “We do not infer that the breakdown is complete, or that this is the only possible breakdown — such a division will vary with the individual flavor man,” the article noted. (“The Art in Imitation Flavors” 1953: 2.) For another account of how the green note in strawberry flavors was achieved by flavorists at different companies, see: James J. Broderick, “Reflections of a Retired Flavorist Before He Forgets: Strawberry,” *Perfumer & Flavorist* 17 (May/June 1992): 33-4.

been found in both strawberries and butter — and add related compounds to enhance the effect, such as the higher homologs of diacetyl. To lend a “green” and grassy nuance to the buttery note, he might then add other materials, including ethyl acetyl acetate (which had, at that point, only tentatively been identified in strawberries), Siberian Pine Oil (a natural essential oil unrelated to strawberries), and beta-gamma-hexenol (also known as 3-hexen-1-ol), a chemical compound with an intense, green odor, that had been identified in “many green plants,” but had never been found in strawberries.⁸⁰ Thus, the flavorist could borrow a sensory effect from the broader chemical literature, transposing the vivid 3-hexen-1-ol greenness of a clover-leaf or cucumber into his evocation of the *fraicheur* of strawberry.

In some cases, flavorists’ insights led him or her to chemicals that were actually present in the food in question.⁸¹ In an article published the following year, the *Flavorist* reported on a “very interesting paper” at the recent annual meeting of the IFT, where Dimick and Makower, of the USDA Western Regional Research Laboratory in Albany, presented their pioneering work using gas chromatography to investigate the chemical constituents of strawberry flavor.⁸² (This was more than a year before the first official publication of these findings in *Food Technology*).⁸³ Among newly identified compounds was 2-hexenal, an aldehyde that was often found in conjunction with 3-hexen-1-ol, the chemical previously suggested as a green note in artificial strawberry flavors. (Indeed,

⁸⁰ “The Art in Imitation Flavors” 1953: 2-3.

⁸¹ For instance, in the case of methyl anthranilate and grape flavors. See Chapter 2.

⁸² “The Green Note in Fruits,” *Givaudan Flavorist* 1954 (no. 4): 2. See also Chapter 6.

⁸³ KP Dimick and Benjamin Makower, “Volatile Flavor of Strawberry Essence. I. Identification of the Carbonyls and Certain Low Boiling Substances,” *Food Technology* 10.2 (February 1956): 73.

observing that 3-hexen-1-ol “readily” oxidizes to form 2-hexenal, the *Flavorist* article speculated that the ripening of the fruit may correlate with the change from alcohol to aldehyde.) “Work done on natural products has been an aid in creating new flavors, and we flavor chemists anticipate even greater assistance in the near future,” the article concluded. “However, with a deep sense of humility, we would like to state that it is our observation that the ‘art,’ personified in the flavor chemists’ nose and sense of taste, still has the edge on the rapidly approaching science.”⁸⁴

Even as the flavorist’s chemosensory savvy led him to foresee the determinations of the analytic machine, his interest was not constrained within the limits of confirmable chemical presences. The 1954 *Flavorist* article went on to observe that the esters of 3-hexen-1-ol, which (with one exception) had not been identified in nature, “are even more interesting, from a flavor standpoint, than the alcohol or aldehyde. They have a pungent but soft fruity [sic] green odor which has a greater utility in imitation flavors than the parent alcohol.”⁸⁵ That is, the flavorist’s engagement with the material dimension of flavor is not speculation in search of objective confirmation, but sensory extension, invention, and imagination.

One necessary context for appreciating the forms of the flavorist’s work was the vastness of the set of chemical unknowns. Given the lack of certain knowledge about the chemistry of flavor and mechanisms of sensory perception, the creation of synthetic flavors required the highly specialized skills of individuals equipped to negotiate those

⁸⁴ “The Green Note in Fruits” 1954: 2.

⁸⁵ “The Green Note in Fruits” 1954: 2. The exception was the phenyl acetic ester of 3-hexen-1-ol, which had been found in Japanese mint oil.

unknowns in order to produce chemical mixtures that reliably produced desired effects. However, the unknowns of flavor chemistry were not, *per se*, unknowable. Written before the introduction of commercial GC devices, but after Martin and James' seminal paper on the subject, "The Art in Imitation Flavors" clearly anticipates the transformations of analytic chemistry that appeared on the horizon. "It is to be expected," the article foretells, "that at some future date a scientist... will be able to test a given odor in a man-made piece of laboratory apparatus and break down this odor into its component and basic parts, which information can then be used to duplicate the odor from its basic materials or other materials with the same odor characteristics."⁸⁶

But even in the scenario of total chemical knowledge, "even if the complete reproduction of the aromatic constituents of strawberry were possible," the article insists that the flavorist's peculiar capabilities would still be required.⁸⁷ Chemical knowledge is not enough. The same configuration of volatile organic molecules will perform differently in a cellophane-wrapped fruit-creme-filled snack cake on a supermarket shelf, than in a fruit dangling from its stalk in a farmer's field. The flavorist's savvy substitutions can "give the same flavor effect" in the radically different contexts of production and consumption.

Nine years later, the *Givaudan Flavorist* revisited its early articles on flavor creation, reprinting revised versions of the articles, now attributed to Earl Merwin. "Flavor creation is based on science and art," Merwin recapitulated, before continuing.

⁸⁶ "The Art in Imitation Flavors" 1953: 1.

⁸⁷ "The Art in Imitation Flavors" 1953: 4.

“In addition to science and art, there is a third tool that the flavorist must use. The third foot in the triangular base on which the development of flavors stands is ‘technology.’ Neglect any one of these three and the results will be poor — insufficient for application to the present state of our food industry.”⁸⁸ The gas chromatograph (GC) had become an essential tool of the flavorist. However, no matter how sensitive the machine becomes, it “will not replace the flavorist’s nose because it is not hooked up to the flavorist’s brain. It can and does help the flavorist’s nose — implementing the third leg of the triangle — the artistic quality of flavor creation.”⁸⁹

“Fresh-from-the-field flavor!” exclaimed a Givaudan advertisement adorned with a colorized black-and-white photograph of intensely red fruit; it claimed that “nothing has duplicated” the flavor of “fresh wild strawberries... as closely as Givaudan’s Imitation Strawberry.”⁹⁰ The science and technology of flavor creation was put in service of the flavorist’s art, which did not so much duplicate the strawberries of the field, as create unprecedented versions, situational strawberries for specific and proliferating applications, which themselves (at least, ideally) would soon become familiar.

⁸⁸ Earl Merwin, “The Art in Flavor Creation I: True Fruit Flavors,” *Givaudan Flavorist* no. 3 (1962): 5.

⁸⁹ Earl Merwin, “The Art in Flavor Creation II: Imitation Flavors,” *Givaudan Flavorist* no 4 (1962): 3.

⁹⁰ [Givaudan] “For Fresh-from-the-field flavor!” [Advertisement], *Food Technology* 11 (November 1957): 23.

THE FLAVORIST AT THE MACHINE

A 1959 article in the *Givaudan Flavorist* by V.D. Johnston, the company's chief analytic chemist, offered readers a virtual tour of the analytic laboratory, where “conventional chemical and physical methods are being replaced or supplemented by modern instrumental methods.”⁹¹ Photographs of white-jacketed male and female researchers intensely preoccupied with the knobs and registers of various gleaming machines accompanied his descriptions of the different spectrophotometers and gas chromatographs that were constantly in use in the large air-conditioned space. He explained that the machines were used for quality control, process control, and fundamental research, saving the company and its customers both time and money. “But what is most valuable,” Johnston said, “they give more information; sometimes too much information.”⁹²

By the 1960s, most flavor companies — and particularly research-oriented companies such as Givaudan, IFF, and Fritzsche, Dodge & Olcott — employed both analytic flavor chemists and flavorists on staff. The technical instruments of the modern flavor laboratory, particularly the GC, were used by both groups of workers. These machines helped reveal the chemical complexities that produced the effects of flavors in foods, and were integral to the increasing material sophistication of flavoring additives. On the other hand, as Johnston suggests above, the machines often provided “too much information,” disclosing chemical presences that were irrelevant to the sensory qualities

⁹¹ V.D. Johnston, “Instrumental Methods of Analyses Save Time — Give More Information,” *Givaudan Flavorist* 1959 (1): 1-4. For more on the instrumental revolution in chemistry and its effects on flavor research, see Chapter 6.

⁹² Johnston 1959: 1.

of a flavor or that were artifacts. Both analytic research chemists and flavorists had to grapple with the problem of signal and noise when it came to these machines, but their priorities were different.

A 1971 article by Robert Eiserle and William J. Downey, flavorists at Fritzsche, Dodge & Olcott (FD&O), reviewed recent scientific literature on fundamental research in flavor chemistry, meticulously drawing out the points of interest for flavorists in the latest studies on meat flavor volatiles, trace compounds contributing to roasted barley flavor, pyrazines in peppers, potatoes, and more.⁹³ They are insistent throughout that simply having more information about chemical constituents of foods was not of great value. “Finding new components does not always help the flavor chemist to prepare better flavors.”⁹⁴ First, research findings were often impossible to apply directly, at least immediately. “Often such information is useless to the creative chemist since the materials identified as being naturally present are not found on the official lists of approved flavoring ingredients,” they note ruefully.⁹⁵ Further, research chemists often did not include organoleptic evaluations of the compounds they discovered, or attempt to understand the role that various components played in “the total flavor effect” perceived by the “ultimate consumer.”⁹⁶ For this pair of flavorists, research findings in flavor chemistry often provided too much information that was also insufficient for their

⁹³ Robert J. Eiserle and William J. Downey, “A Review of the Literature Concerned with Flavor Research as it Applies to the Problems of the Flavor Industry,” *CRC Critical Reviews in Food Technology* 2.2 (July 1971): 159-169. Downey was the head flavor chemist at Fritzsche Dodge & Olcott.

⁹⁴ Eiserle and Downey: 165.

⁹⁵ Eiserle and Downey: 160.

⁹⁶ Eiserle and Downey: 163.

purposes. In a near-contemporary article, James Broderick, the SFC founder and Kohnstamm flavorist, summarized the distinction between the “basic researcher” and the “practical flavorist”: “the researcher’s goal is to identify *all* components of a flavor, and the flavorist is frustrated by the fact that much of the research has little practical value for him. The flavorist needs to identify the *key* components, and this is an area in which flavorists and researchers should work more closely together.”⁹⁷

The distinctions between the flavorist and the analytic flavor researcher are highlighted in their different occupational attitudes toward GC and its output. It should be noted, first, that GC’s output assumed multiple forms. The machine produced a chromatogram, a permanent graphical record of peaks and valleys that registered detectable chemical presences in the flow of inert vapor as it passed out of the machine, indicating both the time at which the “peak” eluted from the machine, which could help with identification, and also its relative quantity in the mixture. But the GC also produced the separated chemicals themselves. Each peak on the chromatograph indicating a fraction of the initial mixture, ideally, an isolated compound. These fractions could be collected at the GC’s exit with specially designed traps, and then subjected to further instrumental analysis — either subsequent GC separations, or structural identification with spectrometric instruments, such as the mass spectrometer (MS). Beginning in the early 1960s, GC and MS were often directly conjoined in a powerful device that combined separation and identification in a continuous process. But the versatile GC also allowed another modification, the diversion of some of the vapor-stream effluent to a

⁹⁷ James J. Broderick, “Fruit Flavor Research: The Practical Flavorist vs. the Basic Researcher,” *Food Technology* 26 (November 1972): 37.

“sniffer port,” where each fraction could be olfactually evaluated and savored by the sniffing researcher in synchrony with the detector’s production of the chromatogram.

The sniffer port was critical to the GC’s usefulness to flavorists. Broderick described the flavorists’ attraction to the sniffer port in memorable terms. He vividly described an experiment in entomology, where “male moths were strapped to a board at the outlet of a gas-liquid chromatograph, and an extract from female moths was injected into the GLC. The key component was pinpointed by the agitation of the male moths when that component was emitted from the GLC.” He added, “Although this technique is not generally applicable to fruits, I’ve seen some happily agitated flavorists when they sniffed a key component sought in a complex run.”⁹⁸ In other words, flavorists were excited, inspired, fascinated by smells — but in the olfactory panorama that unspooled from the GC, what kind of smell would pique this sort of interest? What, exactly, were flavorists sniffing for?

Increasingly, of course, flavor chemists were sniffing, too — integrating methods of sensory evaluation into experimental protocols, integrating “nasal appraisals” into their work process.⁹⁹ In their review of recent literature in flavor chemistry, Eiserle and Downey reserve praise for studies that combined instrumental analysis with organoleptic panels, or that use specially trained judges to make odor determinations. But even when flavor chemists attended to the sensory characteristics of the compounds they identified, and included trained organoleptic panels in their experimental protocol, their methods

⁹⁸ Broderick 1972: 37.

⁹⁹ See Chapter 6.

and conclusions lacked the insights that flavorists possessed. As an example, Broderick describes recent research into the chemistry of apple flavor at the USDA Western Regional Laboratory in Albany.¹⁰⁰ The Albany team used high-resolution capillary GC and mass spectrometry to separate and identify 56 different volatile compounds in Delicious apple essence. Unlike most analytic chemists, they went further, and attempted to determine which of these compounds contributed to the apple's flavor. Each of the separated compounds was subjected to organoleptic evaluation by a panel specially selected and trained judges, who were asked to indicate which components possessed apple-like aromas. Broderick commends the researchers for demonstrating the sensory significance of several previously unreported volatiles in apples, but also notes that when all of the components identified as "apple-like" were blended together, the result was something other than apple. "Something was missing."¹⁰¹

He elaborates: "the fallacy in this approach is that total apple flavor is far more than just these 'apple-like' components — many important nuances of total apple flavor are not apple-like." Clove-like eugenol, he observes, plays a crucial role in cherry flavors; the honeyed green rose of phenyl-acetaldehyde has an important part to play in strawberry flavor. "A panel cannot pick out all of the key components of apple flavor, although they may pinpoint the apple-like components. Other apple flavor nuances can only be pinpointed by someone with the ability and training to break down the flavor into

¹⁰⁰ R.A. Flath, D.R. Black, D.G. Guadagni, W.H. McFadden, and T.H. Schultz, "Identification and Organoleptic Evaluation of Compounds in Delicious Apple Essence," *Journal of Agricultural and Food Chemistry* 15 (Jan/Feb 1967): 29-35.

¹⁰¹ Broderick 1972: 37.

its various nuances and evaluate the individual components in relation to these nuances, and this person is the flavorist.”¹⁰²

What did the flavorist know that the flavor chemist did not? According to Broderick, the flavor chemist lacked a working sensory understanding of “total flavor.” The flavor chemist thinks in terms of chemical building blocks; the flavorist begins with sensory ones. “The flavorist mentally breaks down a flavor into various nuances and then tries to simulate each nuance with the materials at his disposal, blending them to get a final effect,” he explained. “The quality of the final product is dependent upon the knowledge and artistry of the flavorist and the materials available to him to simulate the flavor nuances.”¹⁰³ This recalls the description offered in “The Art in Imitation Flavors” — which, indeed, was written shortly after Broderick left Givaudan, so the similarity may be due in part to a common company style rather than to a broader occupational praxis. Even more, the flavorist knew that these “sensory building blocks” were often quite dissimilar from the character of the “total flavor.” This was part of the flavorist’s attunement to the contribution of dissimilar, unlikely, and perhaps repugnant sensations to the total perception of a flavor, and it became even more acute as more was known about the chemistry of flavors in nature. Sniffing at the GC could reveal “a whole ‘dinner table’ full of odors” in a tomato, to use a phrase from a flavorist from General Foods: bacon and vanilla, cucumber and macaroon, as well as rubbery sulfur and stale hay.¹⁰⁴

¹⁰² Broderick 1972: 37.

¹⁰³ Broderick 1972: 37.

¹⁰⁴ William S. Ryder, “Progress and Limitations in the Identification of Flavor Components,” in Irwin Hornstein, ed. *Flavor Chemistry: A Symposium*, ACS Advances in Chemistry Series 56 (Washington: ACS, 1966): 82.

The flavorist was sniffing for the rubber and sulfur, the stale hay and the roast meat, in search of difference and distinction. For the flavorist, sniffing was not so much about obtaining certainty about any of the components, as about gaining insight into the whole. Indeed, Merwin explained that each flavorist used the GC “in a slightly different manner, just as he uses every other piece of laboratory apparatus.”¹⁰⁵ While analytic flavor chemists strove for technical mastery of the machine and the chemical world it separated and fractured, flavorists used the GC as a tool to cultivate the total sense of flavor, and to inform their own personal style and approach.

Frank Fischetti, of Fritzsche, Dodge & Olcott, explained how this factored into the process of creating flavor compositions. A flavor can be thought of as consisting of distinct parts: “flavor character items,” ingredients whose “aroma and/or taste is clearly reminiscent of the named flavor”; “flavor contributing items,” compounds which while “not necessarily (and by itself) reminiscent of the named flavor... when used in conjunction with flavor character items, tends to bring it closer to the named flavor,” and finally, “flavor differential items.”¹⁰⁶ Unlike the first two, these ingredients or combinations “have little, if any, character reminiscent of the named flavor. These items are added to a flavor compound to give it individuality, imagination, and difference. These are items a flavorist employs to create special effects,” such as lift, nuance, undertone, and aftertaste.¹⁰⁷ Essentially, the “flavor differential” factors were the flavorist’s signature — the “creator’s mark” — and the signifiers of a house style,

¹⁰⁵ Merwin “The Art in Flavor Creation II: Imitation Flavors,” 1962: 3.

¹⁰⁶ Fischetti 1980: 313.

¹⁰⁷ Fischetti 1980: 316.

“distinguish[ing] the products of one flavor house for another.”¹⁰⁸ Like most marks of style, they also served a distinct commercial purpose: they prevented copying. “Used in extremely small quantities, they render duplication almost impossible,” Fischetti advised.¹⁰⁹ Thus, the flavorists’ way of working was never mere replication; the goal was not to present a sensibly indistinguishable copy of original nature. Instead, the motive and the interest was to create distinction, difference, and variety — to author a strawberry, rather than simply paint its portrait.

Finally, none of the flavorists described present the flavorist’s way of working as superior to that of the research flavor chemist. Though distinct, these were not rival bodies of knowledge jockeying for jurisdiction, but collaborative fields; the relationship between these two professions was not seen as adversarial, but complementary. But the benefit could also extend in the other direction. Broderick estimated that between seventy and ninety percent of the key components of most major commercial fruit have been identified. Rather than simply trying to identify as-yet-unidentified chemicals, the analytic researcher should work with the flavorist to determine “what important effects are missing.” This way, chemical research could be directed towards the identification of these key components, rather than the “trace peaks that have little or no effect” on flavor. “The benefits,” Broderick assures, “will be lower cost/results ratios, better imitations, faster results, and sounder conclusions.”¹¹⁰ The potential applications of this collaboration went beyond the improvement of flavor additives. Broderick notes that

¹⁰⁸ Fischetti 1980: 255, 316.

¹⁰⁹ Fischetti 1980: 316.

¹¹⁰ Broderick 1972: 48.

Oregon and Washington strawberries “have more and better flavor than do California strawberries.” Identifying the chemical components that gave the berries of the Pacific Northwest a flavor advantage would lead not only to better imitation flavors, but also to better strawberries. By understanding the biochemical pathways by which these flavor chemicals are formed within the fruit, “techniques could be developed that would enable the farmer to grow more flavorful strawberries.”¹¹¹

THE FLAVORIST IN THE FLAVOR COMPANY

Finally, the flavorist’s labor of flavor creation should be understood within a commercial and business context. The flavorist’s creative work did not occur in isolation, but was part of a broader, coordinated effort among multiple corporate divisions — including management, R&D, toxicology, legal, sales, purchasing, and production. Increasingly, this work took place in the midst of large research-based flavor companies, which employed multiple flavorists specializing in different product applications.¹¹² The success of a flavor was ultimately determined by its commercial performance: its ability to find a market among food manufacturers, and the ultimate popularity of products that contained it with consumers.

In a 1981 article, Manfred Vock, a senior research flavorist at International Flavors & Fragrances (IFF), located the “creative flavor chemist or flavorist” at the center of the flavor development process. “All flavor research efforts are channeled through

¹¹¹ Broderick 1972: 48.

¹¹² Arthur D. Little 1968: 25.

him, and the flavor which he creates is the link between R&D and sales.”¹¹³ The article, perhaps the most detailed published account of this internal process, tells the story of the development of cocoa flavorings at IFF in the late 1960s.¹¹⁴ IFF, a public company formed in 1961 by the merger of van Ameringen-Haebler and Polak & Schwarz, was known for its robust research and development program.¹¹⁵ The decision to study cocoa flavor began with the company’s management. Market research had concluded that an unmet demand existed for a high-quality synthetic cocoa flavoring designed for use in new types of convenience foods. Further, low-cost cocoa powders fell far short of delivering the flavor of high-quality goods. “The objective was to develop a cocoa flavor which would enhance the cocoa and chocolate aroma and taste of various cocoa products such as instant powders for milk beverages and instant desserts,” Vock explained — a synthetic cocoa flavoring product that could replace low-quality “natural” cocoa powders, both by delivering improved flavor quality and enhanced flavor performance in processed foods. “This need is obvious, because cocoa powder develops full aroma and

¹¹³ Manfred H. Vock, “Development of a Flavor at IFF, Planning, Creation, and Commercialization,” in George Charalambous and George Inglett, eds., *The Quality of Foods and Beverages: Chemistry and Technology*, vol 2. (New York: Academic Press, 1981): 198.

¹¹⁴ Vock 1981: 198-209.

¹¹⁵ According to Dorland and Rogers, when IFF went public in 1961, “the infusion of new capital made it possible to expand in most any direction management selected, and also provided ample funds for research, as well as for equipping plants and laboratories with the sophisticated apparatus required for production and quality control of aroma chemicals under modern conditions.” In 1976, the company spent \$16 million on research on flavors and fragrances, and expected to spend even more in 1977. In 1976, the research staff numbered more than 500 individuals, at the company’s research center in Union Beach, NJ and at laboratories in 20 countries. Dorland and Rogers 1977: 197.

taste after heating, which is naturally not available for instant cold chocolate flavored foods and beverages.”¹¹⁶

The product development process started with a literature search: a review of published analytical studies of cocoa and chocolate flavor, as well as spices and essential oils which were used as cocoa enhancers or extenders, in order to compile a list of all known compounds and materials associated with cocoa flavor. Meanwhile, an IFF flavor profile panel evaluated a variety of cocoa powders, establishing the primary and secondary sensory qualities characteristic of high-quality cocoa — which were used to create an ideal flavor profile of the target flavor. The flavor profile panel then “systematically evaluated” the organoleptic qualities of all of the chemicals identified in the scientific literature, a crucial step given that flavor chemistry research often did not provide reliable sensory characterizations. Only compounds that showed qualities related to the target flavor were considered for further research. This narrowed the field of chemicals under consideration substantially, and also revealed a sensory gap that no identified compound currently satisfied: “the delicate cocoa/rose related aroma of high quality cocoa powders.”¹¹⁷ This guided analytic research at IFF, where chemists succeeded in identifying a quartet of previously unknown unsaturated aldehydes that produced desired cocoa-rose and bittersweet-nutty flavor effects.¹¹⁸ The cocoa flavor project also received “unexpected help... from completely unrelated flavor work.” The

¹¹⁶ Vock 1981: 200.

¹¹⁷ Vock 1981: 206.

¹¹⁸ Vock 1981: 206-7. IFF protected its research by patenting cocoa flavoring compositions using these compounds. US Patent 3,582,360, “Cocoa Flavoring Composition Containing 2-phenyl-2-alkenals and method of using same.” June 1, 1971; US Patent 3,754,038, “2-Phenyl-2-Alkenals,” August 21, 1973.

company's biosynthesis group had produced a new cocoa-like flavor, which delivered some of the characteristic bitterness of good chocolate. As this substance was biosynthetically produced, it was technically a "natural" flavor.¹¹⁹ Identifying significant compounds was not enough, of course. They also had to be produced synthetically. Research chemists at IFF developed syntheses for many of the new or unavailable compounds of interest, including pyrazines, furans, and the unsaturated aldehydes. Then a search of the patent literature was conducted, to ensure that no components or processes violated existing patents.

Once all of these steps were completed, the flavorist was ready to begin doing his (or her) work: the actual labor of flavor creation. Essentially, the preceding steps have assembled a library of possible materials for the flavorist to use. Similar to the examples of flavor creation described above, Vock begins with a sensory portrait of cocoa, and selects chemical compounds that corresponded with those effects. He uses the metaphor of building to describe the work process. First the "corner stones of cocoa flavor structure" were laid down; key chemicals were selected to produce desired primary notes, such as cocoa, floral/rose, and malt, and used at concentrations that correlated to their sensory thresholds. As the sensible building was chemically assembled, the flavorist began to attend to secondary notes and nuances: "'edges' were smoothed and 'holes' were filled by decreasing or increasing the concentrations of the flavorings." It was a gradual process of constant adjustment, especially as new additions could enhance or affect the underlying blend in synergistic ways. All throughout, the flavorist continues tasting

¹¹⁹ Vock 1981: 207.

components and blends in water or sugar water, “until a harmonious cocoa flavor was achieved.”¹²⁰ He subsequently offers another common metaphor for the creative labor of the flavorist, comparing it to fine art painting — “especially... the color combinations of an abstract work.” Just as the painter relies on his (or her) eye and “modifies the available colors and shades until the desired effect is achieved.... Taste and smell are the creative senses of the flavorist.”¹²¹ Quite a few flavorists, Vock remarks, also happen to be excellent painters.

Quite a few steps remain before the flavorists’ “harmonious cocoa flavor” makes it to the production and sales stage. The composition is evaluated in various applications, where its flavor profile is compared with the target flavor profile. Then follow stages of preference testing, stability evaluation, quality control work, and applications development, all of which require the flavorist’s adjustments, modifications, and input.

Vock compares his form of sensory craftsmanship with “other approaches” to flavor creation, both of which, he counsels, are less likely to be successful. The first rival strategy is to begin with the chemicals: combining all the chemicals identified by the analytical work, not only the ones selected by organoleptic panels as significant. This approach is flawed: chemical knowledge of flavor must always be assumed to be incomplete and provisional, thus it is likely to produce a product whose sensory qualities leave something to be desired; further, the synthetic reproduction of all identified chemical components is not economically viable. The second strategy is to work with

¹²⁰ Vock 1981: 208.

¹²¹ Vock 1981: 208.

“total flavors,” rather than individual chemical components; for instance, utilizing a previously produced “malt flavor” rather than chemical compounds associated with that effect to produce the malty quality of cocoa. This leads to snowballing problems, as interactions between components in different flavor mixtures can lead to unpredictable sensory consequences and high production costs.¹²²

Vock’s implicit purpose in including these two rival strategies seems clear. The craftsmanlike method that he favors, where the artisanal flavorist is guided by his or her senses, skill, and experience, superficially appears less systematic and more inefficient than the rival modes he describes — both of which, essentially, ask the flavorist to execute a composition that replicates the findings of more conventionally “scientific” research workers, whether that of the analytic flavor chemists who describe flavor in terms of chemical presences, or of the flavor profile panel, which describes it in terms of sensory qualities. The model that Vock presents continually links the two bodies of knowledge, chemical and sensory, and indeed more than that — as the flavorist must also be knowledgeable about the processes of food production, the requirements of different applications, consumer preferences and desires, as well as regulatory and legal requirements. The creative flavorist was the indispensable, irreplaceable expert figure who mediated among all of these different sources of information within the flavor company, and between the company, its customers, and their (satisfied) consumers. “Science and art are combined into an ideal marriage to give birth to good flavor

¹²² Vock 1981: 208-9.

creation,” Vock pronounced, somewhat non-idiomatically.¹²³ The flavorist’s ultimate obligation is to his or her company, “to make certain that the research dollars have been rightfully spent.”¹²⁴ The flavorist’s “success is due to this team effort,” Vock writes, and in return, his labor is integral to the team’s cohesion and efficiency.¹²⁵

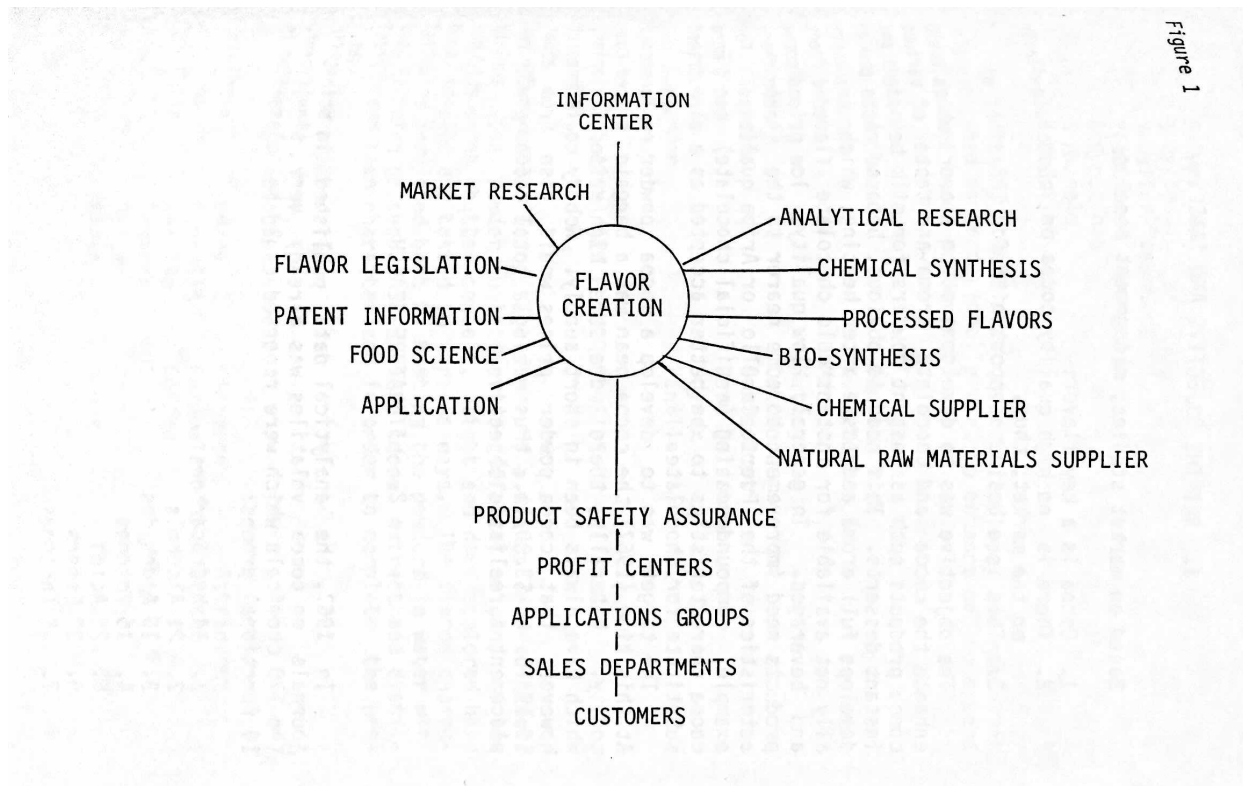


Figure 1

The creative flavorist as the organizing, mediating force at the center of the regulated, scientific flavor company. From Vock 1981: 199.

¹²³ Vock 1981: 208.

¹²⁴ Vock 1981: 198.

¹²⁵ Vock 1981: 198.

LEARNING TO THINK LIKE A FLAVORIST

A 1957 article in *The Givaudan Flavorist* addressed the widespread curiosity about what it takes to make flavors:

We are often asked to comment upon the basic talents, above and beyond a knowledge of chemistry, which are necessary for success in the field of flavor chemistry. We usually reply that there are two qualifications that all good flavorists have in common. These are imagination and a thorough knowledge of raw materials.¹²⁶

How exactly did the flavorists' "imagination and thorough knowledge of raw materials" operate in the real world? The author of the article gives an example. While the "obnoxious" stink of a dead skunk by the side of the road would disgust "the average consumer," the flavorist has a different reaction:

"The flavorist... sends an active imagination to work the minute an aromatic material enters his nostrils and goes through that wonderful process known as smelling. The aromatic ingredient usually recognized as 'skunk' is known to the flavorist to be... n-butyl mercaptan. A dilute solution of this ingredient may be imagined as one of the missing nuances in a coffee flavor he is working on."¹²⁷

The successful flavorist is someone whose sensory capabilities are developed to a degree beyond mere refinement; he (or she) bypasses disgust in favor of informed

¹²⁶ "Sulfur and Aromatics," *The Givaudan Flavorist* 1957 4.4 (1957): 1.

¹²⁷ "Sulfur and Aromatics" 1957: 1.

analysis (the "thorough knowledge" that permits the identification of the n-butyl mercaptan in the skunk's stink) and productive synthesis (the "imagination" that associates it with the roasted odor of coffee). But how does one become the kind of person who thinks of coffee after smelling dead skunk? Or, to use another example from the article, how do you cultivate the capacity to recognize a resemblance between the noxious fumes drifting from an oil refinery, and "a roast loin of beef, a steak smothered with onions, or a special blend of tobacco"?

NIGHT SCHOOL FOR FLAVORISTS

Between 1946 and 1952, while working at the New York City Department of Health, Jacobs taught several evening courses in food and flavor technology at the Brooklyn Polytechnic Institute as an adjunct professor.¹²⁸ His course, "Technology of Food Flavors, Colors, and Synthetic Additives," was first offered by the Department of Chemical Engineering in the Spring semester of 1946. It was described as a professional development course for graduate students in the department of chemistry and chemical

¹²⁸ The 1948-1949 Polytechnic Institute Course Catalog lists him as lead professor of several courses, all of which are indicated as being offered in alternate years: A year-long course on Food Technology; A Fall semester course on the Technology of Dairy Products; a Spring Semester course, "Technology of Food Flavors, Colors, and Synthetic Additives"; a fall semester course on the technology and chemistry of "economic poisons" (ie, insecticides, fumigants, fungicides, and pesticides); and a spring semester course on the technology of alcoholic beverages. [Poly course catalog 1948-9, pp. 66-7.] See also: "Food Coloring, Flavor, Part of Technology Course at Poly," *Brooklyn Daily Eagle* (January 6, 1946): 30; "Spring Course in Food Technology," *Brooklyn Daily Eagle* (January 12, 1947): 22; "Food Technology Courses Offered by Polytech," *Brooklyn Daily Eagle* (September 15, 1948); "Poly to Give Graduate Course on Brewing-Distilling Skills," *Brooklyn Daily Eagle* (January 28, 1950): 3.

engineering, as well as “well-equipped men from industry.”¹²⁹ The course met for two hours on Wednesday evenings, and covered the chemistry and use of food additives, including natural and synthetic colors and flavors, synthetic sweeteners, emulsifiers, stabilizers, preservatives, and vitamins. “There will also be taken up in detail,” the course catalog read, “the compounding of synthetic flavors.”¹³⁰ Jacobs’ teaching appointment ended in 1952, and the course does not seem to have been renewed under a different professor.¹³¹

In the early 1950s, NYU expanded the scope of its existing aromatics course — which covered the industrial applications of aromatic chemicals for the perfume industries — to include the creation and blending of flavors for the beverage, confectionery, food, and tobacco industries. The semester-long evening class, offered through NYU’s Division of General Education (the precursor to its present-day School of Professional Studies) was “intended for persons engaged in the flavor and perfumery industries, for users of such materials and for those interested in the art,” and included hands-on work with aromatic raw materials in order to promote the “development of keen olfactory perception and recognition” as well as how to use them.¹³² It also featured frequent guest lectures from perfumers and flavorists working for regional companies

¹²⁹ “Spring Course in Food Technology,” *Brooklyn Daily Eagle* (January 12, 1947): 22.

¹³⁰ 1948-9 Poly Course Catalog, Course number 2780, p.66.

¹³¹ The circumstances under which Jacobs lost his teaching position are somewhat obscure, but a series of letters in the Othmer archives suggests that an ongoing dispute between Jacobs, one of his graduate students, and Othmer over a method they had developed to process orange and lemon oils may have contributed to this. [Donald Othmer Papers, Chemical Heritage Foundation, Philadelphia]. The course was not continued under a different professor after Jacobs was dismissed.

¹³² In Special Interest Courses, Division of General Education Bulletin for 1951-2. “Aromatics: Perfume and Flavor Evaluation and Blending.”

including Givaudan, Polak & Schwarz, Norda, and Fries Brothers.¹³³ Versions of many of these lectures were published in the flavor section of the *American Perfumer and Aromatics*, which remained under Jacobs' editorship.

The New York City metropolitan area had long been, and remained, a center of the flavor industry, with many companies headquartered in Manhattan, and maintaining production facilities across the river in New Jersey, in the outer boroughs, and in Long Island.¹³⁴ Both of these evening courses seem to have served the career-development needs of local flavor companies, providing introductory training to prospective or current workers at a moment when the demand for flavor creation skills were particularly acute, as the food industry's use of specialty flavorings boomed. However, the failure of these courses to flourish and persist, to spawn intermediate- and advanced-level classes or departmental divisions, should not be taken as an indication of reduced demand for these skills, but rather of alternate routes to their acquisition.

Rather than learning in the classroom, flavorists learned on the job. "There are no text books or university courses in which this art and science are taught," wrote Vock, of IFF, in 1981. "Flavor creation is learned only in industry laboratories by working with experts," senior flavorists at the companies that employed them.¹³⁵ Until at least the late 1980s, these apprenticeship relationships appear to have remained relatively informal,

¹³³ "Aromatics in Food and Tobacco to be Included in NYU Course," *American Perfumer* 56 (September 1950): 229; "Guest Speakers for NYU Course on Aromatics," *American Perfumer* 56 (November 1950): 399; "Guest Speakers for NYU Aromatics Course," *American Perfumer* 58 (November 1951): 383. The conductor of the course was Samuel Klein, consultant perfumer.

¹³⁴ Rogers and Dorland 1977: 171-240.

¹³⁵ Vock 1981: 197.

that is, designed and operated under the discretion of senior flavorists, rather than formalized by management as institutional protocols.¹³⁶

It was this tacit, embodied, sensual knowledge of materials, after all, that defined the jurisdiction of the flavorist, and distinguishes it from that of the research chemist. This required not only mastery of a technical curriculum of chemical knowledge and olfactory acuity, but also the acquisition of a particular attitude towards chemical materials: an open-minded interestedness and curiosity.

“WHAT DOES IT REMIND YOU OF?” THE FLAVORIST-APPRENTICE

Is the flavorist born or made? Do certain individuals have exceptional sensory capacities, and excel beyond others in the field? And can standard training methods produce creative professionals?

¹³⁶ Information about this aspect of flavor industry operations is rather thin in the published records. However, the protocols for training flavorists apparently contrast with programs for training perfumers, who, like flavorists, also learn the work on the job. In the 1970s, several major European companies operated their own schools for perfumers — often in Grasse, the long-standing center of the French perfumery and essential oil business. American companies IFF and Monsanto Flavor/Essence are also reported to have operated training programs for perfumers, which combined formal laboratory training with on-the-job experience. (Dorland and Rogers 1977: 397-404.) I have found no mention of similarly formal, organized programs for training flavorists during this period. At some point, likely in the late 1980s, the Society of Flavor Chemists formalized a certification program for flavorists. Currently, to become a certified flavorist, an individual must apprentice for seven years with a senior certified flavorist, pass an examination and interview, and finally, be voted upon by SFC members. Certified members of the SFC can sponsor and train apprentice members.

<https://flavorchemists.com/become-a-member>

In order to consider these questions, I will examine in detail two brief accounts of programs to train flavorists presented in 1974 at the Society of Flavor Chemists' Twentieth Anniversary Symposium, "The Multifaceted Nature of the Flavor Chemist," held at Rutgers University in New Brunswick.¹³⁷ Harris Shore, a flavor consultant for Fries & Fries, opened the symposium with a description of the "one on one" mentorship relationship between apprentice and master flavorist — preferable, he claims, to batch-processing prospective flavorists in groups via more schematized curricula.¹³⁸ In contrast, Frank Fischetti followed Shore's account of the relationship between mentor and apprentice with a description of the training program that he superintends at FD&O: a schematized, "organized program," complete with sample quizzes and creativity-boosting games.¹³⁹ Despite this key difference, Shore and Fischetti's training methods reveal a similar set of needs, concerns, and challenges. I will compare these with two other accounts – the first by E. Cowley of the British flavor firm Bush Boake Allen, Ltd.,

¹³⁷ These papers were compiled in a post-symposium publication, which is my source for them: Society of Flavor Chemists, "The Multifaceted Nature of the Flavorist: Papers Presented by the Society of Flavor Chemists Symposium Held at Rutgers University, New Brunswick, New Jersey, March 21, 1974," Society of Flavor Chemists Collection, Chemical Heritage Foundation, Philadelphia. The papers were also reprinted in the July/August, September/October, and November/December 1974 issues of *The Flavour Industry*, a British trade journal, and these texts were bound together in a separate booklet. These printed texts likely varied somewhat from the content of what was delivered at the Symposium – several, for instance, include footnotes to research articles. With that caveat, I am taking them as generally reflective of the day's program. Frank Fischetti's program was also described in Earl J. Merwin, ed., *The Development and Application of Natural and Artificial Flavor Systems*, (Wheaton, IL: Allured, 1988).

¹³⁸ Harris Shore, "The Training of a Flavorist – One On One," Society of Flavor Chemists 1974: 2-3.

¹³⁹ Frank Fischetti, Jr. "The Training of a Flavor Chemist – An Organized Programme," Society of Flavor Chemists 1974: 4-6.

published in *The Flavour Industry* in 1973,¹⁴⁰ and the second by Agusti Vidal, of the Spanish flavor and fragrance house Lucta SA, which ran in *Perfumer & Flavorist* in 1989.¹⁴¹ Because these are foreign firms, and factors related to personnel and business structure may vary from the American flavor houses, I will draw on these sources only to point out areas of similarity with the other accounts – which may indicate common trends – or particularly suggestive differences.

Although Shore hints at a preference for sensory acuity, both he and Fischetti are explicit that anyone with “normal” taste and smell can be a potential flavorist. Shore somewhat apologetically excludes those with chronic sinusitis and allergies from the candidate pool. Fischetti assumes that the training program will screen out those who really do not have adequate sensitivity, aptitude, or desire to pursue the field, but consoles listeners that these unfortunates generally opt out on their own and pursue other opportunities within the company. Cowley, of Bush Boake Allen, indicates that candidates are screened for “flavor blindness.”

It is expected that candidates will have some basic knowledge of the sciences, but no advanced degree is specified. Indeed, Fischetti says, “we like a minimum of two years of college, preferably in chemistry.” In his suggested training program, the first stage offers students a basic outline of organic chemistry – with a focus on reactions pertaining to flavor. Cowley looks for candidates with high ratings in both the natural sciences and

¹⁴⁰ E. Cowley, "The Training of a Flavourist," *Flavour Industry* 4 (January 1973): 18-20. Reproduced in Wayne E. Dorland, *The Fragrance and Flavor Industry* (Mendham, N.J.: W. E. Dorland Co, 1977): 417-20.

¹⁴¹ Agusti Vidal, "New Comprehensive Training Method for Perfumery and Flavoring," *Perfumer & Flavorist* 14:2 (March/April 1989): 25-44.

the visual arts. Vidal, of the Spanish firm Lucta, deliberately includes not only prospective flavorists and perfumers in the training program, "but [also] everyone who interacts with the creative team" – including marketing, sales, and purchasing personnel – in order to ensure clear communication within the company and with customers.¹⁴² The inclusiveness of Lucta's program highlights an issue that underlies all the programs: the lack of a standard vocabulary with which to discuss and describe the sensory experiences of flavor and fragrance.

A primary task of these programs, then, is to introduce prospective flavorists to categories that they can use to describe the aromatic universe in a comprehensive and comprehensible way. Although Shore does not mention a specific rubric under which flavor components are presented or taught to the trainee, Fischetti and Cowley specify that they begin by introducing families of natural essences – essential oils – and move from there to synthetic compounds. Both justify this as a way of leading trainees from the familiar to the unfamiliar. That is, apprentices are first taken through the steps of understanding chemicals in terms of attributes or associations – fruity, lemony, summery – before then moving on to chemical structures and families – aldehyde, terpene. Lucta's method operates in a similar manner, dividing the universe of fragrance and flavoring materials into twenty-five categories, and then taking students from a comparison of a natural product with its most significant nature-identical synthetic chemical components, and then proceeding to the artificial chemicals that complement or replace it.¹⁴³ These categories permit prospective flavorists to make comprehensible distinctions among

¹⁴² Vidal 1989: 25.

¹⁴³ Lucta 1989: 26.

materials in the natural world, but they must also permit analysis and recombination of sensory properties of the experience of these materials – something that Fischetti underscores. He describes training prospective flavorists to break "whole" flavors into constituent parts, and to bring those parts together to form new wholes. For instance, a flavorist may be asked to take a strawberry flavor and make it greener, buttery, estery, or jammy –breaking down the barriers between discrete flavor families.

Recognition of flavor families depends upon the acuity of sensory memory. Shore, Fischetti, and Cowley discuss the challenge of helping the aspiring flavorist to build reliable mnemonic techniques. Both Shore and Cowley use the image of a library – a library of tastes and smells – that the flavorist can access to make precise identifications.¹⁴⁴ Fischetti lists “enhanc[ing] the technician’s flavor memory through the use of mnemonic devices” as one of the explicit goals of his program.¹⁴⁵ He trains the technician-flavorist to build associative relationships between odor and experience. For instance, he suggests presenting the trainee with samples of essential oils and asking questions such as: “What oil reminds you of a dentist’s office, sausage, lemon peel, Vicks Vapo-Rub, pizza, chili?” These referential experiences are selected because they are common among the potentially diverse group of trainees. Indeed, “these were the very descriptions the technicians themselves used to describe the oils. What we are attempting to do is reinforce these descriptions in their minds.”¹⁴⁶ Much of Fischetti’s program seems to involve learning to think of a flavor component in all of its potential

¹⁴⁴ Cowley 1973, in Dorland 1977: 418; Shorr 1974: 2.

¹⁴⁵ Fischetti 1974: 5.

¹⁴⁶ Fischetti 1974: 5.

manifestations – as a component of different kinds of flavoring compounds – and associations. To give just one other example from a program rich with them, he mentions a game called “Who do you remind me of?” where the technician is given an aromatic to sniff that is a constituent of an essential oil. The technician must name the oil as well as other aromatics that might be confused with the sample.

Significantly, Shore, Fischetti, and Cowley place strong emphasis on the need to cultivate habits of creativity and imagination, associative reasoning rather than dogmatic thinking. Shore assigns this responsibility to the teacher, suggesting rather vaguely that the empirical methods of the past be modulated with structured knowledge: “His teacher will inculcate in him a blend of logical thinking and the skill of sophisticated artistry.”¹⁴⁷ However, Cowley cautions that “too much instruction” in the advanced stages of the training regimen “can stultify the imagination. We are trying to produce a creative individual who will produce original concepts, and if the flavorist is directed too forcibly into another person’s channel of thinking, then we may defeat the objective we are trying to achieve.”¹⁴⁸ In other words, in order for creative play to be possible and successful, a structured program must give way to a more open-ended framework once the trainee has reached a critical level of material mastery.

In addition to advocating for ample free experimentation time in the course of the training program, Fischetti confronts this as a challenge: “How do you teach [the trainee] to be creative? One doesn’t teach creativity really...you foster it...you set up the

¹⁴⁷ Shore 1974: 2

¹⁴⁸ Cowley 1973, in Dorland 1977: 419.

environment, you give him a minimum knowledge, you suggest ways to remove the cultural, emotional or perceptual blocks he may have and finally you encourage him to create. Creativity is not only an ability, but a pattern of behavior. How do we set up this pattern of behavior? We play games."¹⁴⁹

Fischetti then discusses several training games at length. In his program, for instance, the flavor-chemist-in-training is invited to "go to the shelf and pick up any bottle he chooses and let his mind wander. He is told to write what flavors he thinks it could be used in. We do not ask him what it is, but rather how many flavor uses he can think up for this material.... He is never criticized for his suggestions... We want to encourage a large number of ideas."¹⁵⁰

Free and structured play, habits of daydream, associative thinking, empirical experimentation with materials, a lengthy, somewhat open-ended training process: all of these seem ill-suited to the needs of flavor and fragrance manufacturers, which are, after all, commercial enterprises that need to be able to reliably produce dependable products on a schedule determined by clients. As an attempt to explain how this discrepancy was managed, I would like to draw attention to something that is largely absent from these accounts: instrumental technologies. Although Shore and Fischetti mention instrumentation in passing as a possible later stage of the training program, operation and

¹⁴⁹ Fischetti 1974: 5.

¹⁵⁰ Fischetti 1974: 5-6.

use of these machines, especially GC, was far from simple or self-evident, and they were an increasingly fundamental part of the process of flavor creation.¹⁵¹

Indeed, their use of machines was where flavorist's artistic skill, experienced judgment, and imagination was most evident – the qualities that are at the core of the training program. But this emphasis on craft, and the allegiance between the ultimately commercial work of the flavorist and that of fine artists, is not just a professional necessity, but also a source of professional pride and identity. In "The Flavorist as an Artist," his address to the SFC's twentieth anniversary symposium, Jerry Di Genova, the head of Givaudan's flavor laboratories, describes the work of the flavorist in light of the simulations that attempted to reproduce nature on a molecular level:

A flavor simulation of a natural product that is composed with the qualitative and quantitative ingredients only as found in that product will be nothing else but a comparatively crude simulation and often unlike the natural counterpart. Knowing this, the flavorist/artist makes his modifications to arrive at the desired effect. He must be as exact as a scientist, but, more importantly, as flexible as an artist.¹⁵²

¹⁵¹ See, for instance, V.D. Johnston, "Instrumental Methods of Analyses Save Time -- Give More Information," *The Givaudan Flavorist* 1959 (1), 2; Richard H. Potter, "Vapor Phase Chromatography as a Tool in Flavor Creation," *The Givaudan Flavorist* 1963 (1), 5-6; Potter, "Further Thoughts on the Use of Vapor Phase Chromatography in Flavor Creation," *The Givaudan Flavorist* 1963 (4), 5-6; and Potter, "Gas Chromatography – A Flavorist's Tool," in *Society of Flavor Chemists* 1974: 18-19.

¹⁵² Jerry Di Genova, "The Flavorist as an Artist," in *Society of Flavor Chemists* 1974: 10-11.

He then described the task of flavor chemistry in explicitly synesthetic terms – emphasizing associations with color and sound, and drawing an extended metaphor with painting, where flavor chemicals are the colors on a flavorist's palette. Ultimately, the flavor chemist combines art and science by means of technology, using “the latest scientific knowledge” to “build... a rough flavor frame,” and then “as a true artist, build[s] around it the desired notes, nuances and effects which the instrument has either failed to deliver or the researcher has failed to identify.”¹⁵³

The flavor chemist, then, must be taught to recreate those effects of nature that cannot be fully objectified and quantified – that resist systematization.

CONCLUSION: THE VIRTUES OF FLAVOR CREATION IN A RESOURCE-DEPLETED WORLD

The November 23, 1962 edition of *Life* magazine was a special issue, celebrating the “Bounty of Food.” The cover featured apples, grapes, broccoli, artichokes, and other fruits and vegetables heaped against a jet-black background suggestive of a depthless void, and promised articles detailing “Secrets of Taste... \$50 Billion Spectacle... Harvest Splendor... And other stories on the miracle of our plenty.”¹⁵⁴

But in the midst of all this domestic abundance, loomed the epic and impending fact of future hunger: the Malthusian crisis of resources that seemed to be once again on

¹⁵³ Di Genova 1974: 10.

¹⁵⁴ *Life*, (November 23, 1962).

the horizon, threatening American imperium and global stability.¹⁵⁵ Postwar America's global perspective had laid bare the scale of the problem; it was estimated that "half of the world's population still lives under circumstances where enough food to prevent old-fashioned hunger is a problem of high priority," a problem that population growth threatened to exacerbate.¹⁵⁶ Solutions for this world problem were sought in food technology and synthetic chemistry.

Life mentioned "a variety of bizarre solutions," currently being studied, "each with a distinct flavor problem." Soybeans, petroleum, cottonseed cake, farmed chlorella algae, and other substances were considered potential raw materials for the manufacture of macronutrients, especially protein, but these substances often carried off-flavors and odors that rendered them unpalatable. Other alternative sources of calories and macronutrients were valued for their absence of qualities. For instance, the US Bureau of Fisheries was developing a process to manufacture a fish protein concentrate (FPC) from bycatch ("trash fish" that made up about half of fisheries' harvest'), collateral life that had "no commercial food value" and was routinely thrown back into the ocean for the gulls to feast upon.¹⁵⁷ The Bureau of Fisheries' process transformed "the entire fish, scales and all, into a powder that is tasteless, odorless, chemically pure and rich in vital

¹⁵⁵ The perennial reappearance of Malthusian rhetoric, and its consequences for culture and policy, are discussed in Warren Belasco, *Meals to Come: A History of the Future of Food*, (Berkeley: University of California Press, 2006). See also: Warren Belasco, "Algae Burgers for a Hungry World? The Rise and Fall of Chlorella Cuisine," *Technology and Culture* 38.4 (July 1997): 608-34.

¹⁵⁶ C.G. King, "Nutrition in Relation to Flavor and World Food Acceptance," in David E. Schafer, ed. *Proceedings: Flavor Chemistry Symposium – 1961*, (Camden, NJ: Campbell Soup Company, 1961): 102. King was the head of The Nutrition Foundation.

¹⁵⁷ Warren R. Young, "Cracking the Secret Riddle of Flavor," *Life*, (November 23, 1962): 120; "A Miracle of the Fishes," *Life* (June 29, 1962): 33-4.

animal proteins.”¹⁵⁸ At a cost of half a cent per person per day, this was a dirt-cheap protein source; if processed into FPC, the bycatch from U.S. coastal waters alone could make up for seventy-five percent of the global protein deficit. “The attractive feature of this diet-fortifier” was its absence of sensory qualities; “its flavor can be adjusted to suit local palates,” noted *Life*.¹⁵⁹ The new vanguard of global reformers were increasingly aware that in developing products for global food aid, “one has to be very sensitive to their flavor traditions, not our flavor traditions.”¹⁶⁰

James McGlumphy of IFF, writing in 1966, also emphasized the increasing need for flavor. Efforts to increase food production by the use of chemical fertilizers, hybrid cultivars, and improved farming methods, often came at a cost: flavor. An increase in agricultural yields was “almost always... paired with a decrease in natural flavor levels” — a phenomenon McGlumphy referred to as nature’s “contrary streak.”¹⁶¹

¹⁵⁸ “A Miracle of the Fishes” 1962: 33. Tellingly, the challenge that stood in the way of fully developing this food source (as presented by this article) was not technological but bureaucratic. The FDA’s food standards rejected the inclusion of heads, scales, and entrails in FPC, on the grounds that consumers “would regard the product... as filthy.” The agency thus forbade it from being sold as food in the US. But if the fish were required to be cleaned before processing, FPC would be prohibitively expensive. Although the FDA ruling only applied domestically, there were concerns that shipping FPC abroad as food aid under the FDA’s domestic prohibition would invite Soviet criticism: “The Russians could say, ‘See, the Americans are sending you food they consider too filthy to eat themselves.’”

¹⁵⁹ Young 1962: 120.

¹⁶⁰ King 1961: 105.

¹⁶¹ James McGlumphy, “Progress in Flavor Research,” in “Flavor: Reflections and Directions,” a report from the Flavor Update Symposium (November 16, 1965) at MIT, sponsored by the Northeast Section of the IFT. Published in *Food Technology* (December 1966): 48-50.

If food technologies and advances in agricultural science could produce solutions to the problem of scarcity, could stave off global crisis, they apparently did so at the cost of flavor. But science and technology provide the solution here too: flavor additives. But then again, scenarios, scientific and technical knowledge was not enough. “The skill of the flavorist is in greater need than ever before,” McGlumphy wrote.¹⁶²

Even as a political and cultural establishment turned against the synthetic, increasingly favoring the “natural”, flavorists (and the industries they labored for) attached themselves to the broader purpose of world salvation. An October 1949 editorial in the *American Perfumer & Essential Oil Review* explained:

At recent international scientific meetings the growth of world population has caused considerable speculation about the available food supply. It has been suggested that there is a vast amount of food, other than fish, [ie, algae] in the oceans which should be useful for amplifying the world food supply. This will be a challenge to the flavorist, for it will be his function to make such potential food sources available food sources by making them palatable.¹⁶³

A few months later, David Lakritz, flavorist at Florasynth Laboratories in Brooklyn, restated this professional goal in an article in *Drug and Cosmetic Industry*: “Because of the ever increasing world population with a consequent drain on the

¹⁶² McGlumphy 1966: 50.

¹⁶³ “Flavored Notes,” *American Perfumer* (October 1949): 304.

available food supply, it will undoubtedly be the function of the food flavoring chemist to make flavorsome large potential amounts of wholesome but unpalatable food.”¹⁶⁴

This purpose is restated repeatedly in publications by flavorists, for decades. For instance, in 1971, FD&O’s Eiserle and Downey, calling for fundamental flavor research more attuned to the purposes of synthetic flavor production, wrap up their plea: “In the future, it will help us accomplish our industry’s main purpose, namely, to prepare synthetic flavors, reproducing the type of flavor found in those food products which undoubtedly will be in short supply in the future.”¹⁶⁵

But the long-anticipated seven lean years never arrived, at least not in the industrialized nations of the West where the products of flavorists’ creative labor were most often consumed. Instead, flavor and food science were deployed in a landscape of continued caloric abundance. The meanings of this scenario, the consequences of the imagination of future scarcity for the ways that foods were made to taste, will be one of the subjects of my continuing work in this field.

¹⁶⁴ David E. Lakritz, “Development of Flavors,” *Drug and Cosmetic Industry* 65 (December 1949): 724.

¹⁶⁵ Eiserle and Downey 1971: 169.

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