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An Examination of Content Analysis: A Proposal for a General Framework and an Information Calculus for Message Analytic Situations

Klaus Krippendorff

University of Pennsylvania, kkrippendorff@asc.upenn.edu

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An Examination of Content Analysis: A Proposal for a General Framework and an Information Calculus for Message Analytic Situations

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THE GRADUATE COLLEGE

SEPTEMBER, 1967

I HEREBY RECOMMEND THAT THE THESIS PREPARED UNDER MY
SUPERVISION BY KLAUS HERBERT KRIPPENDORFF

ENTITLED AN EXAMINATION OF CONTENT ANALYSIS; A PROPOSAL
FOR A GENERAL FRAMEWORK AND AN INFORMATION
CALCULUS FOR MESSAGE ANALYTIC SITUATIONS

BE ACCEPTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR
THE DEGREE OF DOCTOR OF PHILOSOPHY

Howard S. Mackay
In Charge of Thesis
Theodore B. Litman
Head of Department

Recommendation concurred in†

Howard S. Mackay
Jay Jensen
W. Ross Ashby
Joseph R. Caragrande
J. D. Steiner

Committee
on
Final Examination†

† Required for doctor's degree but not for master's.

AN EXAMINATION OF CONTENT ANALYSIS;
A PROPOSAL FOR A GENERAL FRAMEWORK AND AN INFORMATION
CALCULUS FOR MESSAGE ANALYTIC SITUATIONS

by

Klaus Krippendorff

Thesis submitted in partial fulfillment of the requirements for
the degree of Doctor of Philosophy in social communication sciences
in the Graduate College of the University of Illinois, Urbana, Illinois, 1967.

PREFACE

This thesis is concerned with empirical inquiries into messages, particularly with scientific attempts to assess what messages may convey within a social communication process and how information carried by such messages may be measured.

The advent of the mass media of communication has directed attention to the social significance of communication processes by making changes in social structures dependent on and visible through these media. Their reliance on modern communication technology has, moreover, prompted the coping with complex communication networks from an engineering or design point of view. Numerous social organizations being dependent on knowledge which makes the flow of information more effective have favored the generation of such knowledge. Yet, very little has been developed in the way of a general theory of messages and much less in the way of systematic methodologies for empirical inquiries into their nature.

Cybernetics is perhaps the most recent and certainly the most profound approach to the study of communication processes in relatively large and complex systems. It is the science of communication and control in all possible organizations irrespective of their materiality (12) (13) (209) (211). The abstract nature of the knowledge which this discipline aims to develop accounts for the fact that it has stimulated such divergent activities as the design of communication facilities, the development of electronic computers, the installation

of automatic defence systems, the organization of libraries, social planning and the design of automatic government as well as scientific inquiries into biological and social systems.

Although the social exchange of messages is much older than its reliance on technical means of communication, the point of view of "cybernetics" suggests, as Deutsch put it, "that all organizations are alike in certain fundamental characteristics and that every organization is held together by communication. . . . it is communication, that is, the ability to transmit messages and to react to them, that makes organizations; and it seems that this is true of organizations of living cells in the human body as well as of organizations of pieces of machinery in an electronic calculator, as well as of organizations of thinking human beings in social groups" (50:77).

One of the communication phenomena for which cybernetics has not offered adequate explications is the psychologically and sociologically relevant attribute of signals: "meaning." This is not at all surprising considering the fact that numerous philosophers have struggled for centuries with the problems of meaning, content, symbol and consciousness neither reaching an agreement as to an acceptable definition of the terms, nor providing adequate operational procedures for the empirical specification of the phenomena associated with them. Some have radically rejected certain problems of meaning as "meaningless," others have produced volumes of verbalizations making it almost impossible to filter out some true generalizations

which may be helpful in assessing such message characteristics in a social context.

Such a state of knowledge seems to be all the more dissatisfying as even common sense suggests that signals such as black and white dots on paper, irregular sound patterns, or punched holes in IBM cards are relatively insignificant to the human sender and/or receiver unless he is able to interpret them in certain meaningful ways. It is not the physical signals but the conveyed symbolic content that moves people; not the carriers of a message but the ideas "behind" them that structures individuals into certain organizational forms. Social scientists while basically being in agreement with the cybernetic emphasis on communication in society maintain that the most significant form of human communication is through some kind of symbol, symbol structure or message that means something to the interacting individuals or social groups. "Ideas are expressed by symbols," says Lasswell, "their manifest form is nothing more than a conglomeration of symbols. . . . Symbols are to a culture as money is to an economy" (113:65).

Inquiries into the meaning of literary works, into the symbols contained in verbal or non-verbal human expression or into the major ideas that dominate the thinking of particular periods in time, are of course no novelty in the humanities. But the recent awareness of the social significance of these message characteristics together with the advancement of empirical methodology have favored inquiries of a

different kind. Systematic and empirical studies of what messages actually convey have become prominent with the increasing dominance of the mass media of communication, particularly within the last few decades. Such investigative attempts have been subsumed under the label "content analysis" and are today considered the primary research tool of communications research. "The technique," as Kaplan puts it briefly, "attempts to characterize the meanings in a given body of discourse in a systematic and quantitative fashion" (96:230), and has by and large been associated with the study of the mass media. Although an ever increasing volume of literature is devoted to such studies there has hardly been a contribution to a theory of messages or a comprehensive theoretical framework for inquiries into their content.

To fill this gap which has been noted in abstract theoretical as well as down-to-earth empirical dealings with the subject, it is conceivable to add another empirical investigation to the volume available in the literature. It is also conceivable to postulate a theory of message content that seems to be intuitively satisfactory and consistent with some other already established theories of the communication process, thereby losing the empirical touch which this interest in messages has heretofore had. We therefore wish to take the empirical inquiries into the content of communications themselves as the raw data of our analysis. In this way we may not be able to formulate a theory that could be deduced from the

fundamental postulates of cybernetics, for example; we may not be able to say very much about the way particular individuals or social groups recruit the meanings to given physical objects of exchange; but we could abstract, and develop a theoretical framework for, the empirical inquiry into message content and answer such questions as to the suitable goal of such analyses and as to the investigative tools needed to accomplish such inquiries. Although we are very much concerned with socially significant messages, we do not wish to be limited by this empirical domain and therefore aim to include examples of inquiries into messages from other domains as well.

Chapter One attempts to give a historical sketch of studies conducted under the name of content analysis. In this way the scope of the empirical concern of content analysis is introduced.

Chapter Two then aims at a critical examination of this mode of inquiry focussing on the definitional issues, on critical points concerning scientific methodology, and on the relevance of conceivable research results to a theory of communication.

Chapter Three presents ten examples of inquiries into messages which will provide much of the basic data for subsequent elaborations. The examples deliberately include relatively extreme situations of analysis for it is believed that if inquiries are somewhat removed from obvious intuitive interpretations then they tend to exhibit more clearly what is required of an analyst when he attempts to empirically assess the content of given messages.

Consistent with our aim at formulating a general framework for the analysis of given data as messages, it is believed that all messages are alike in certain fundamental characteristics. Chapter Four therefore takes the ten working examples as a basis for discovering and formulating the investigative goal that all such inquiries presumably have in common.

Taking the results obtained in Chapter Four, Chapter Five tries to formalize a concept of information pertaining to message analysis and suggests a measure and a calculus for quantities of such information. In terms of this calculus the goal of message analysis is stated more concisely than in Chapter Four. Some of its measures are demonstrated on one of the examples introduced in Chapter Three.

Chapter Six discusses some of the essential procedures which are required for treating given data as messages. It is an attempt to operationally describe observational prerequisites, investigative methods and evaluative criteria for assessing what messages convey to an analyst. The basic procedures are outlined and their empirical problems are discussed drawing again heavily on practical examples of inquiries into messages.

Chapter Seven then extends the notions developed in Chapter Five to include some of the aspects that have been discussed in Chapter Six. In particular, a quantitative measure for the content of a message is introduced and related to the informational limitations inherent in this mode of inquiry.

Concerned with the investigative possibility of the content of messages of any kind, the work does not suggest a general theory of communication on this level. If it clarifies the issues of empirical inquiries into message content, it lays perhaps the foundation of such a theory as it would be the ultimate aim of a cybernetic "durchmusterung" of social-organizational phenomena. But the work does suggest, although not as its primary aim, a general theory of information which may be more relevant in the social sciences than Shannon's mathematical theory of communication (175) currently is.

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CHAPTER ONE

A BRIEF HISTORY OF CONTENT ANALYSIS

The following is an attempt to sketch the historical development of a particular form of empirical inquiries into messages and their contents. Although some very early incidents of very similar inquiries have been discovered, it will be shown that the evolution of investigative methods for such analyses dates only from the beginning of the twentieth century and is a predominantly North American contribution.

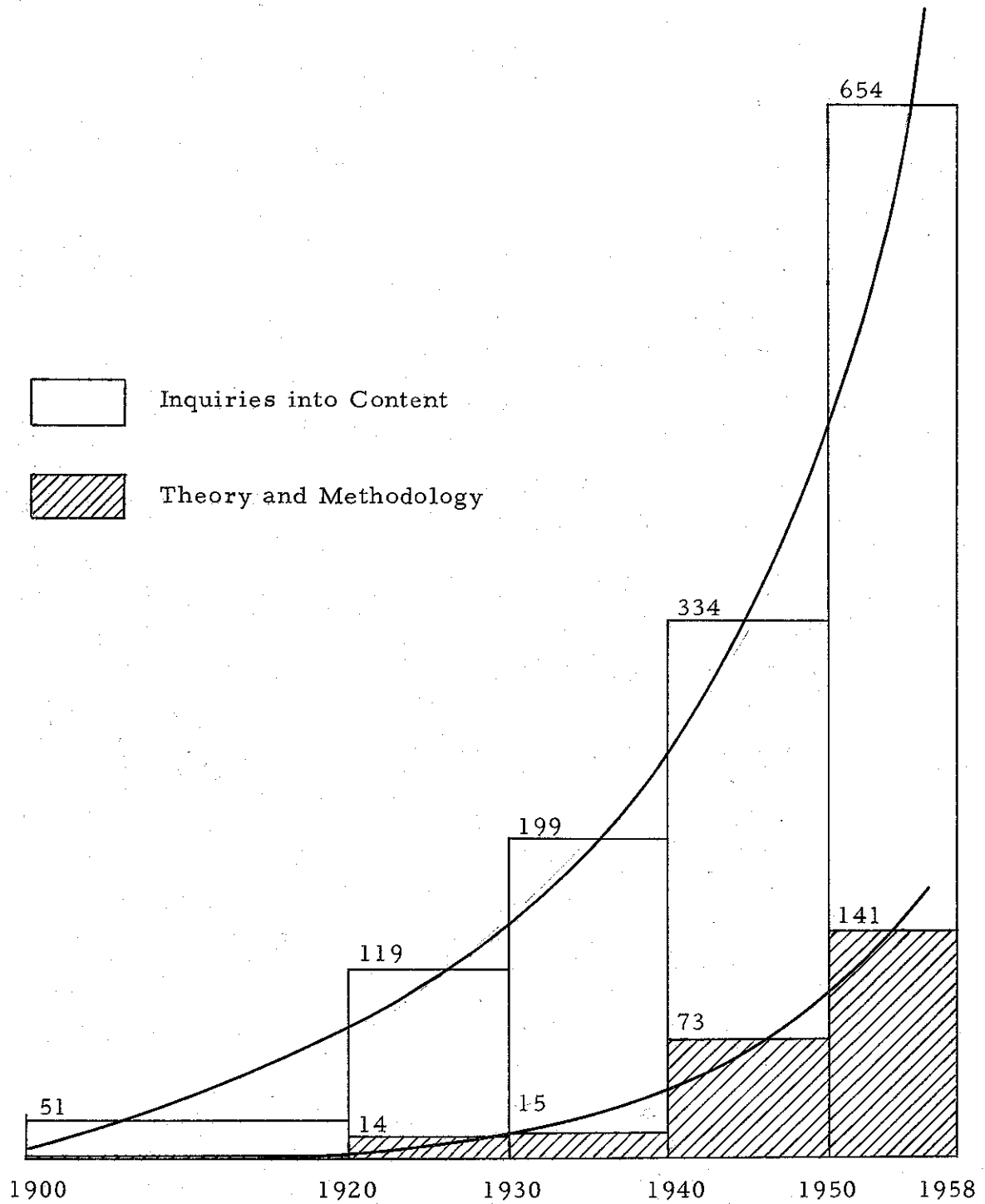
The currently most widely accepted term for systematic inquiries into communications is "content analysis." It emerged in the 1940's. But its first appearance in Webster's Dictionary of the English Language did not occur until the third edition, in 1961, where it is characterized as "a detailed study and analysis of various types of communication (as newspapers, radio programs, and propaganda films) through a classification, tabulation and evaluation of the key symbols and themes in order to ascertain their meanings and probable effects" (204:492).

The most striking evidence for the recency of this mode of inquiry can be found by examining the literature on content analysis itself. If one starts, for example, from the currently available publications on the subject as roughly described above and traces explicit references to literature cited in such publications, a web of citation links is revealed that indicates information flow from the past. Many

original sources appear around the 1920's but none date back further than 1893.

This web of citations further reveals an apparent increase of density over time: as publication dates lie further back, fewer references can be noted and the number of publications, either making use of the method or being otherwise concerned with it has steadily increased. As early as 1948, Berelson and Lazarsfeld noted, in an account of the state of the art, that "the output of content analysis studies has doubled in every five-year interval over the past twenty years" (30:9). Barcus (20) who undertook the task of surveying over 1700 titles concerned with content analysis between 1900 and 1958 found this trend still continuing.

During the first two decades of this century 51 studies were published. This figure rose to 119 during the 1920s to 199 during the 1930s to 334 studies during the 1940s and further increased to 654 studies during the period between 1950-1958 (20:81). It is interesting to note that literature devoted to methodological considerations of content analysis, which indicates awareness regarding the instrumental character of this mode of investigation, follows a similar trend, being equally "explosive" though of a later origin. During the first two decades just one such study was published; during the next three decades respectively 14, 15, 73 studies were published and rose to 141 during the 1950-1958 period (20:79). The volume of currently published studies concerning content analysis seems to be expanding further.



Quantitative Development of Content Analysis Literature

Figure 1

Compared with the growth rates of publications in other fields of scientific inquiry, the expansion of content analysis literature appears quite normal. Studying the development of publication figures in various branches of knowledge Price (165:92-124) argues that the "law of exponential increase" is a common characteristic of unrestricted scientific developments. It is the necessary consequence of cumulative use of information customary in institutions such as science. Smoothing and extrapolating the known publication figures supports the conjecture that the temporal origin of this cumulative growth lies around 1900.

Prehistory and Marginal Developments

And yet, much of the terminology and thinking that permeates contemporary discourses about communications is undoubtedly older, most frequently of Greek origin. Many scholars refer to such well known works as Aristotle's Rhetorica, his De Poetica or Cicero's De Oratore in order to point out the apparent age of the problems that discourses about communications tend to be concerned with. But, these inherited conceptual frameworks largely remain systems of ideas. Such ideas had considerable normative implications concerning appropriate oratory styles, correct human reasoning and logic, for example, but hardly lend themselves to systematic validation. Moreover, such systems did little to explain processes of interaction through messages called communication.

On the other hand it is true that highly reliable quantitative descriptions of written text have already been known to the Masorettes

who, after the destruction of the Jewish state in A. D. 70, devoted themselves to preserving the text of the Bible by counting verses, words, etc. As Yule points out such enumerations are presumed to have been used to detect writing errors efficiently or to assess the required efforts of copying the text (217:7-8). But these quantifications had little to do with the characteristics of messages; other non-communicative objects could have been subjected to the same form of description.

It took the invention of the printing press to develop a critical awareness concerning the nature of written materials, their "powers" and their "dangers." According to Groth (79) it was not before the middle of the seventeenth century that university professors are reported to have made use of newspaper clippings in their lectures on civics, geography and other topics. Concurrently a few "Zeitungs-Kollegien" (newspaper seminars) were founded at some German universities discovering some typical features of messages which had consistently been overlooked when written communication was either a more personal matter or a way of standardizing religious belief. The earliest doctoral dissertations about newspapers date back to 1690, 1695, and 1699. They were written to obtain degrees in theology, a discipline that became interested in the dissemination and content of newspapers because of their presumed effects, but dealt with the subject mainly in moralizing terms (79:26).

Historians in general and literary historians in particular are almost exclusively concerned with information from the past transmitted

to the present in some written form. Considering the peculiarities of historian's data and the age of this profession, it is surprising to learn that the awareness of the message characteristics of such data is only a very recent phenomena. According to Garfield¹ it was as late as the middle of the nineteenth century that von Ranke made the "document" a technical term in inquiries into history. Before, history had been transmitted merely as "a kind of fairy tale." Only since then have historians been concerned with such problems as detecting corrupt texts, deciding among competing attributions of authorship, arriving at the time order in which works were composed, determining the sources relied upon by an author, and inferring historical events from eyewitness reports, social records, and biographies, --all problems which are very closely related to those of a communications analyst.

The first well-documented case of a quantitative analysis of printed material as messages stems from eighteenth century Sweden. Dovring (55) (56) describes some of the crude quantitative comparisons that were made to determine whether a collection of hymns was the carrier of a religious sect's "dangerous thoughts" suspected by the clergy to undermine the Swedish state and orthodox church.

And yet, although these few incidents of analyzing message characteristics more or less systematically clearly presuppose some rudimentary understanding of the nature of communication processes in society, they were discovered only recently, did not enter the

¹Eugene Garfield, personal communication to the author.

content analytic literature and had little effect on current methodological developments. However indicative of the increasing awareness concerning messages, such unrelated incidents may be considered pre-historical to the study of communications as pursued today.

Outside the United States the first empirical investigation of newspaper content seems to have appeared in France during the Dreyfus affair in which the press was presumed to play a major role. A few years later, the study was repeated in Berlin to obtain comparative data (143:174-176). And although such interstimulation of investigations was originally quite evident, at this early time a cumulative growth of publications comparable to that of the American development did not occur. As early as 1903 a book by Löbl entitled Kultur und Presse (121) suggested an elaborate classification scheme for analyzing the "inner structure of content" according to the social functions newspapers perform. But the book, although influential in journalistic circles, did not give birth to the empirical investigations it held in its womb.

One of the most prominent European proponents of a systematic analysis of press contents was Max Weber who, at the first meeting of the German Sociological Society in 1910, laid down the design of a thorough sociological investigation. As a social scientist he explicitly rejected such problems as "what should be made public" as suitable for analysis. He rather wished to ascertain the historical changes of the convictions concerning such public issues, what "Weltanschauungen" underlie changes in those media, and what power structure produces

the specific newspaper publicity. His specific questions were essentially questions of content analysis: What are the information sources of the newspapers and how is the material presented? What habits do newspapers foster? How do they influence the "super individual cultural objects"? What kinds of mass beliefs and mass hopes are created and destroyed?

Suggesting that the investigation exploit the newspaper content itself, he said

"We will have to start measuring, plainly speaking, in a pedestrian way, with the scissors and the compass, how the contents of the newspapers has quantitatively shifted in the course of the last generation, . . . between feuilleton and editorial, between editorial and news, between what is presented as news and what is no longer offered . . . and from these quantitative results we have to move toward qualitative ones. We have to pursue the style of presentation of the paper, the way in which similar problems are treated inside and outside the papers, the apparent expression of emotions in the papers, . . ." (203:52).

In this way, Weber hoped to analyze the ideological basis, organization and power distribution in the press that may account for newspaper contents. He secured funds for the proposed research project but the scientific climate was unfavorable to such empirical approaches and the study was never carried out.

A third example of early European developments is Markov's statistical analysis of a sample of Pushkin's novel in verse Eugene Onegin from which he developed a theory of chains of symbols (126 c.f. 137:423). This work was published in 1913, was revived only in 1948

through Shannon's work on information theory (175) and produced no impact on content analysis until 1955 when Osgood undertook his contingency analysis (147).

Whether the total lack of references in the content analysis literature to such earlier European approaches with their comparatively much stronger theoretical bases indicates that their work was not considered content analysis or whether it indicates relatively little communication between the two continents, the fact remains that the early European work had little influence on the evolution of the method in North America.

In view of the voluminous American literature on content analysis now available and the multiplicity of viewpoints that can be imposed to structure it, the evolution of this mode of inquiry cannot be presented along a single dimension. Perhaps the most fruitful way of showing the changes that occurred during the life of content analysis is a differentiation of a few developmental phases during which particular disciplines dominated in their attempts to solve particular social problems to which content analysis was believed to be instrumental. These stages, to be distinguished below, may be called: quantitative newspaper analysis, mass communications research, propaganda analysis, interdisciplinary expansion, and computer text analysis.

Quantitative Newspaper Analysis

The earliest studies making use of what was then called "quantitative newspaper analysis" were almost exclusively made by journalists

and used to substantiate evaluative judgments concerning press performance. By and large such studies employed straight subject matter categories and compared the volume of print in each. Probably the first analysis, published in 1893, asked the rhetorical question "do newspapers now give the news?" (184). The author showed how religion, scientific and literary matters had dropped out of leading New York newspapers between 1881-1893 in favor of gossip, sports, and scandals. A similar study attempted to reveal the overwhelming space devoted to "demoralizing," "unwholesome" and "trivial" matters as opposed to "worthwhile" news items (128).

By simply measuring the column inches a newspaper devoted to particular subject matters journalists attempted to reveal "the truth about newspapers" (192), believed they had found a means of showing the profit motive as the cause of "cheap yellow journalism" with its emphasis on sensationalism (212), were convinced that they had established "the influence of newspaper presentations on the growth of crime and other antisocial activity" (62), or concluded that a "quarter-century survey of the press content shows demand for facts" (205). Such uses to which quantitative newspaper analysis was put during this phase reflects the transition of the press from a public service for the educated few to an economic enterprise seeking to attract masses of readers. The social consequences of such a transition were felt threatening.

Barcus, who tabulated the literature on content analysis in various ways, found that the concern with typical journalistic topics,

i. e., evaluations of press performance, media inventories and comparisons, took up 50 percent of all studies made during the first thirty years of this century.

Naturally, these early studies which were predominantly geared toward evaluations of press performance indicate the high emotional involvement of journalists with their own medium but are methodologically rarely satisfactory. If the conclusions were not formed before actual counts were undertaken, their simple subject matter categories tended to be implicitly biased toward intended evaluative judgments. Most of the results would hardly withstand critical examination. When reviewing these early quantitative studies one cannot help getting the impression that they were largely the product of the apparent power simple statistics or numerical expression could (and perhaps still can) bestow upon a primarily public argument.

This time period is also marked by the growth of journalism schools and their original concern with establishing the ideological bases of the journalistic profession and solving juridicial problems of the press. Much of quantitative newspaper analysis was influenced by the School of Journalism at Columbia University where investigations began to turn away from serving immediate objectives of press criticism. Already in 1912 the Columbia University Professor Tenney advocated a more global "scientific analysis of the press." He argued:

"why should not society study its own methods of producing its various varieties of thinking by establishing a ... careful system of bookkeeping? What is needed, ... is the continuous analysis of a large number of journals..."

the records in themselves would constitute a series of observations of the 'social weather' comparable in accuracy to the statistics of the United States Weather Bureau" (195: 896-898).

The practical difficulties were too great for such an idea to be realized, but various large scale descriptions of newspaper content were stimulated and these culminated in such studies as Willey's analysis of "The Country Newspaper" (213) published in 1926.

While a few journalism schools became mouthpieces for the kinds of studies mentioned above, the work which was done during the first three decades of this century remained largely that of single journalists of small prominence without theoretical foundation and without attempts at scientific generalizations. By the end of the 1920's, quantitative newspaper analysis as an approach to content analysis was essentially exhausted.

Mass Communications Research

The second phase of content analysis may be said to be due to at least three independent developments. There was first the introduction of new and more powerful media of communication such as film, and more importantly, radio. The technical development of such media, their rapidly growing popularity and their already apparent social consequences quickly escaped journalistic understanding and control.

Secondly, during the time period following the economic crisis - a time period of socio-psychological insecurity, political instability

and ideological struggles - the free political and economic exploitation of the public media of communication by big organizations was felt to be a serious threat to traditional individual and public values. Attempts to overcome the consequences of this crisis, culminating in the New Deal programs, assigned a major role to the new mass media.

Thirdly, the social sciences just started to be ready to extend their theoretical frameworks and empirical methods of inquiry to such multidisciplinary problems as the mass media of communication seemed to pose.

For example, sociology started to make extensive use of survey research and public opinion polling. The experiences gained in analyzing public opinion gave rise to the first serious consideration of methodological problems of content analysis by Woodward, entitled "Quantitative Newspaper Analysis as a Technique of Opinion Research" (215).

From writings about public opinion, interests in something like social "stereotypes" (122:95 ff) entered the analysis of communications in various ways. Questions such as, how Negroes were presented in the Philadelphia press (179); how the United States presented her wars in her history textbooks as compared to versions advanced by her former enemies (199); or how nationalism was expressed in American, British and other European children's books (127) now assumed importance.

One of the most important concepts that emerged in psychology during this time was that of "attitude." It suggested the association

of subject matter categories with such evaluative dimensions as "pro-con" or "favorable-unfavorable." In a situation of widely spread social and political struggles, the detection of hidden biases or partisanship toward one or another party of a controversy were felt to be important. Quantitative assessments of such biases led to various communication standards which - proposed by investigators - appealed to such rational ideals as "objectivity," "fairness," and "balance." Among such explicit standards Janis and Fadner's "Coefficient of Imbalance" (93) deserves mention. (The coefficient is a statistical index of the degree to which favorable and unfavorable references to an issue cancel each other out within some body of text).

Psychological experiments in rumor transmission led Allport and Fadner to study newspaper content from an entirely new point of view. Their "Five tentative laws of the psychology of newspapers" (7) attempted to account for the transformations that information undergoes as it travels through an institution and finally appears on the printed page.

Political science with its interest in political symbols added another feature to the analysis of public messages. McDiarmid, for example, analyzed thirty U. S. presidential inaugural addresses in terms of symbols of national identity, of historical reference, of reference to fundamental concepts of government, and of fact and expectations (131). Above all Lasswell, viewing communication problems within his psychoanalytical theory of politics introduced

many new perspectives to such studies. In an early attempt to classify symbol data (107) he suggested such categories as "self" and "others," forms of "indulgence" and "deprivation," etc. His symbol analysis led to a "world attention survey" (108) in which trends in the frequencies of national symbols were compared for several major national newspapers.

In the course of radio and press competition the Office of Radio Research was founded at Princeton University which paid much attention to the effects of communication. Lazarsfeld, Berelson, and Gaudet, to cite only one example, used the 1940 U. S. presidential election to relate mass media content to "how the voter makes up his mind" (114).

Several disciplines studied their own trends in scholarship as reflected in the contents of representative journals. This was probably first done in Russia regarding physics (166) but most thoroughly in the field of sociology (24) (25) (174) and recently also in journalism (193).

While many social sciences contributed to the scope of analysis during the late 30's, attention of content analysts was increasingly focused on studies of propaganda, identifying its principles, revealing manipulative intents and disclosing foreign propaganda sources in the United States. This interest goes back to Lasswell's pioneering analysis of goals in World War I propaganda and his attempt at evaluating the techniques employed by the opposing powers (106). Foster's study of "how America became belligerent" (66) reflects the then popular belief that the United States was drawn into the war against her will. Federal courts requested content analyses to disclose

propaganda agencies in this country and accepted their results as evidence (111). In a comparative study of British and German radio broadcasts to the United States during 1940 Bruner identified nine dimensions for describing political propaganda (36). Increased concern with propaganda stimulated the emergence of research centers with attempts at public enlightenment. Among them the Institute for Propaganda Research, did much to popularize so-called "tricks of the trade" or propaganda devices (88) on the assumption that people would resist propaganda if they were familiar with its techniques. Lee and Lee's study of Father Coughlin's speeches (116) may be cited as an example of the explanation toward which these devices lend itself. With the outbreak of World War II this institute ceased to exist.

In Barcus' tabulation of content analysis literature this second phase of content analysis showed dominant emphasis on social values and problems other than those directly associated with press performance in the narrower sense. Indeed 60 percent of the content analysis publications between 1930 and the outbreak of the Second World War are concerned with studies of race, social prejudice, value implications of motion pictures, standards of morality and propaganda; in short, with the expression of social values in the mass media.

Characteristic of this second phase of content analysis is furthermore that eminent social scientists entered the public debate. While accepting many of the social problems that had been identified by journalists and cultural critics, attempts were made to empirically

verify some of the propositions that were more or less believed in. However, many results were not encouraging. But, investigating mass communications systematically, more complex structures of message characteristics became recognizable and identifiable, structures that had some theoretical significance in the social sciences and could be studied empirically. Attitudes, stereotypes, styles, political symbols, values and propaganda devices simply escaped the crude measurements of newspaper content along subject matter categories so typical for the first developmental phase of this investigative tool.

When this technique of analysis was applied to various media other than the newspaper, such as books, radio programs, films, political speeches, conversation, objects of art, and cartoons; the original term "quantitative newspaper analysis" became "content analysis." The change of name did not result in a clearer definition of the technique.

Propaganda Analysis

The third phase of content analysis began with an ended shortly after the American involvement in the second world war. The mere characterization of the mass media of communication, radio in particular, as powerful agents of molding public opinion and mobilizing large populations toward political ends was not enough. But, such characterizations suggested their possible contribution to the war efforts in several ways: domestic propaganda and promotional activities had to be made more effective; psychological warfare directed toward enemy nations had to be planned; and systematic attempts of

extracting intelligence from foreign broadcast had to be organized. Such needs favored the establishment of large research organizations and in turn the development of new methods.

In 1941 a "research project on totalitarian communication" began its work at the New School for Social Research. "Supported by one of the large foundations, it was assigned to develop methods for the study of enemy propaganda and to train American social scientists for prospective government work in this field. The work of the project was to be mainly concerned with propaganda by radio, the importance of which was highlighted by the experience of the war in Europe (103:v).

One of the directors, Hans Speier, later resumed responsibilities at the Foreign Broadcast Intelligence Service of the Federal Communications Commission, a research operation with the principal task of monitoring, analyzing and reporting on broadcasts from other countries. This cooperation of notable social scientists offered "unprecedented opportunities to advance the methods of content analysis. Whether some newspaper is biased toward one side of a controversy or whether some speaker can be labeled a propagandist became rather irrelevant in this context except when such knowledge could be used to draw specific inferences to the antecedent conditions of communications or to give evidential support to predictions concerning planned political or military actions of interest to policy makers.

While content analysis in previous years had been essentially a descriptive technique, the most notable contribution of these war

years was a demonstration of the potential inductive use of this mode of inquiry. Indeed, George (71), who later evaluated the performance of this analysis operation, could report about remarkable successes and attempted some generalizations concerning the methods employed.

Another important contribution of this concern with propaganda is the recognition of the systemic nature of society within which the content of propaganda may play a certain role. By and large, previous content analyses had studied communications in relative isolation or in reference to only a few personality or social variables. Specific inferences from domestic propaganda, on the other hand, required consideration of more complex models of the situation from which communications were obtained. Such models had to consider the social structure of the governing elites, their modes of operation, perceptions of environmental changes and estimates regarding planned actions as well as their political support by, and ability to control the population.

While the former approaches did not fully develop methodologically, hence, emphasized qualitative methods of analysis and employed verbal logic to justify their inferences, a third influential group of researchers advanced the quantitative description of propaganda messages. This third approach was heavily influenced and guided by Lasswell and his earlier work, produced numerous memoranda under the Library of Congress's Experimental Division for the Study of Wartime Communications (see 96) and led to the volume edited by Lasswell entitled The Language of Politics (112). In the course of

this later approach and reflecting the nature of the material studied, "content analysis" became characterized as the "statistical semantics of political discourse" (96:230) and often simply referred to by the term "propaganda analysis."

Interdisciplinary Expansion

Following World War II, content analysis, having largely been constrained by war objectives, enlarged its scope of attention to problems far beyond those of mass media research. While a distinctive research task is very difficult to discern during the fourth phase of content analysis, its rapid spread into numerous disciplines hitherto almost unaware of the technique's potential use may be noted. Content analysis had matured to seek new boundaries.

It took the cooperation of historians, political scientists, sociologists and psychologists to analyze the volumes of raw documents that had been accumulated during the war years. Inferences made from domestic propaganda were systematically validated as formerly inaccessible information became available (71); new political phenomena could be linked to some forms of communication; and many research projects that had been delayed came up again and were pursued from new points of view.

For example, Lasswell expanded his idea of a "world attention survey" to the Revolution and Development of International Relations (RADIR) project designed to test the hypothesis that in the last 60 years a "world revolution" has been in steady progress, a revolution that is

manifest in extensive compositional changes of the vocabulary of the "ruling few" (113) (160). The project also shed light on the trends of Symbols of Internationalism (159) and Symbols of Democracy (161).

Similarly, White could now compare values expressed in political documents and speeches by Hitler and by Roosevelt to ascertain differences between war and peace propaganda that would shed light on the extent to which the Soviet Union may be engaged in the preparation of international hostilities (206). Jacob found frequencies of references to atrocities in German domestic propaganda to be correlated with intended political-military aggression (89). And Lewin analysed the social aims expressed in song books and manuals of the Hitler Youth and the Boy Scouts of America (119).

As an outgrowth of both experiences during the early phases of propaganda analysis and the traditional interest of literary criticism, sociologically inclined literary historians started applying content analysis to various forms of popular entertainment provided by the mass media. The method seemed suitable to explore and compare cultural pattern across time and space. Still during the war, Lowenthal (123) published his pioneering study of historical changes of biographies appearing in popular magazines. Adorno (3) suggested a psychoanalytic framework for analyzing the social relevance of television content. Kracauer (101) presented an extensive study of the German film and placed its content in historical and political

contexts, and Schneider and Dornbusch examined forty-six bestsellers published between 1875 and 1955 in order to identify trends in popular religious themes (170). Such approaches, plus the earlier interest in social stereotypes, can be considered a stimulus for such investigations as Berelson and Salter's "Majority and Minority Americans" in magazine fiction (31) and Gerbner's . . . "Social Role of the Confession Magazine" (73).

While studies in propaganda had taken up the majority of published literature during the war, Barcus' tabulation for 1950-1958 shows that the number of investigations concerned with social values, social problems and American cultural themes again ranked first within the content analysis literature. Although journalistic topics still occupied a large portion of the publications, the second highest rank was now taken by an area of application that hitherto had not contributed much to content analysis literature: psychological and psychoanalytical research.

"When one stops to think of it," writes Cartwright in 1953, "it is really surprising how much of the subject matter of social psychology is in the form of verbal behavior. The formation and transmission of group standards, values, attitudes, and skills are accomplished largely by means of verbal communication. Education in the schools, in the home, in business, in the neighborhood, and through the mass media is brought about by the transmission of information and by the exercise of controls which are largely mediated through written or spoken words. If one is concerned with problems of social organization, the situation is similar. Supervision, management, coordination, and the exertion of influence are principally matters of verbal interaction. Social and political conflicts, although often stemming from divergent economic interests and power, cannot be fully understood without studying the words

employed in the interaction of conflicting groups, and the process of mediation consists largely of talking things out. The work of the world, and its entertainment too, is in no small measure mediated by verbal and other symbolic behavior" (39:422-423).

Such sudden realization of the message characteristics of much psychologically relevant data led to the development of three interrelated areas of inquiry and development. The first is concerned with studying written material to discover motivational, neurotic, psychosocial, or other dimensions attributable to the author of a document. Auld and Murray (17) reviewed numerous projective techniques and tests for various clinical purposes, tests that require in essence a content analyses of verbal records. The Dollard and Mowrer "Discomfort-Relief Quotient" presumed to be an index of a psychological state may be mentioned as a representative example.

The second area of psychological use of content analysis refers to the analysis of qualitative data gathered in the course of research processes. Recorded responses to openended questions, records of conversations in controlled experiments, observational accounts of social processes can be utilized in scientific inquiries only insofar as reliable methods of characterizing their content are available. This need forced many psychologists to adopt content analysis for processing qualitatively recorded data. Bales' Interaction Process Analysis (19) is one example where content analysis merged with techniques of small group experiments and contributed to establish theoretical assertions concerning face-to-face communication. But also the use

of available verbal material as psychological data which was one of Allport's early concern (5) must be noted here. In an analysis of "Letters from Jenny" (6) he demonstrated the use of personal documents for ascertaining the personality structure of a writer.

A third psychological contribution to content analysis developed in conjunction with inquiries in the psychology of speaking. In the new field of psycholinguistics (146) relationships between speech characteristics and acceptance of symbolic material as well as of language acquisition, attracted the attention of a large group of psychologists. Under the leadership of Osgood numerous rigorous measuring instruments of verbal content (147) (152) were advanced and made available for application in other fields.

Quite independently from methods of analysis developed in the social sciences, literary scholars started to use statistical procedures to discern stylistic features of prose. The interest, particularly that of identifying the unknown author of a document on the basis of his vocabulary, goes back to Yule who attempted to show that it was not the alleged Gerson but á Kempis who had written De Imitatione Christi (217). More recently Mosteller and Wallace tackled a similar problem regarding the disputed authorship of the Federalist Papers (139) and Brinegar concerned himself with a statistical test of the authorship of the Quintus Curtias Snodgrass Letters (35).

While during the phase of mass communications research and propaganda analysis the focus of inquiries into messages was extended

to include such media as books, radio, films and to some extent television; during the interdisciplinary expansion stage this focus was furthermore broadened. Studies have been made of proverbs (100), folktales (130), inscriptions on Greek vases (11), private letters (153) (6), diplomatic documents (82) (84), rumors (49), results from openended interviews (157), pauses in psychodiagnostic sessions (40) (61), speech disturbances (124), photographs (201), paintings (155) and even dreams (80).

This widespread use of content analysis in hitherto untouched fields is also reflected in the composition of the participants at the first work conference on content analysis which the Committee on Linguistics and Psychology of the Social Science Research Council held in Winter, 1955. The researchers whose contributions were subsequently published in book form (162) came from such areas as political science, psychology, psychoanalysis, linguistics, anthropology, folklore, literature and history. When discussing new content analytic methods in their respective fields the participants found themselves surprised to discover numerous common empirical problems. In this interdisciplinary climate several suggestions for further improvement of the technique emerged.

Among the most notable contributions of this conference is probably George's clarification of the virtues and limitations of quantification in content analysis (70). Evidence for the success of so called qualitative methods rendered these hitherto often disqualified techniques as important alternatives. Osgood's methodological

suggestions, his contingency analysis in particular, designed to overcome some of the earlier limitations of frequency descriptions, has since then found numerous applications (147). And Mahl raised the problem of the instrumental use of language and derived methodological consequences of analysis (124).

The time period following the first working conference is still too short to allow for an adequate evaluation. Yet, a new branch seems to have emerged.

As a result of the Cold War various research organizations concerned with international relations found content analysis instrumental for their tasks. Since first-hand information about political-organizational changes in foreign nations is rarely directly accessible, an examination of political documents can provide indicants of otherwise hidden transitions. For example, Angell and Singer tried to ascertain and compare the values of Soviet and of American elites and their attitudes toward foreign policy from their articulations in the respective mass media (9). While this problem is still reminiscent of the type of propaganda analysis that had been done during World War II, North, Holsti and collaborators (84) (142) tried to measure the interaction of national tensions during international crises and thus added a new dimension to the content analysis of political documents. Singer (180) even went so far as to investigate the possibility of inspection for disarmament exclusively by means of analyzing mass media material in place of the then disputed international control stations.

While the spread of the technique into new fields and its subsequent assimilation with other modes of inquiry is still continuing, a process that was identified with the fourth phase of content analysis, a fifth phase is already emerging.

Computer Text Analysis

Probably the most important impact on the technology of content analysis during the current decade is to be expected from the use of electronic computers in the behavioral sciences (32). The quantity of symbolic material that needs to be processed in typical content analysis projects is often very large and easily exceeds available manpower and other human limitations. To overcome some of these barriers, computer analysis and transformation of data to which some meaning is attributed now appears almost everywhere and suggests most significant research problems.

One area of recent advancement of immediate relevance to content analysis is the use of mechanical devices to retrieve information stored in large libraries, to search for literature, to assemble bibliographies relevant to a given problem domain, to make abstracts, to index, etc. Theoretical frameworks and software suitable to this end are in the process of development (26).

Closely related to such efforts is the considerable progress that can be noted in translating languages automatically, particularly between Russian and English (144). Although much justified criticism referring to premature claims and much too optimistic expectations

has been heard (23), computer programs that actually do such translations within a limited discourse and theories that could lead to appropriate algorithms come more and more into prominence. Katz and Fodor (99) provided such a theoretical framework for semantic interpretations of sentences.

An example of more immediate and practical application of such technologies is the automatic manipulation of medical records for diagnostic ends. After applying proper codes on autopsy records in natural English, Smith and Melton (182) could show how a data bank of protocols of pathological processes can be utilized to aid autopsy diagnoses.

Quite different is an example by Allen (4) who is interested in the use of computers for legal purposes and who tried to determine the number of ways a section of the Treaty Banning Nuclear Weapons Tests in Atmosphere, in Outer Space and Underwater is structurally ambiguous and can lead to different interpretations. The existence of structural ambiguity, a serious problem in language translation, turns out to become of great value to the content analyst who wishes to ascertain the alternatives available to the partners committed to such an agreement.

Literary inquiries into style, mentioned above, have largely been facilitated by the use of computers. Mosteller and Wallace (139), for example, were aided by automatic data processors in their attempt to provide further evidence in the case of the disputed authorship of the Federalist Papers. Computer programs that discriminate subject content in scientific and technical prose (198) are in theory identical to

those that distinguish authors by their style of writing. Such and other formal similarities have led to a new mode of literary research called "computational stylistics" (172). It is needless to say that the volume of text that has to be handled statistically strongly links this mode of inquiry with the use of computers (117).

Examples of this kind could be extended at length. They suggest considerable advances in natural language processing for still very limited purposes. One computer program that claims to be a general one and has been developed to aid traditional types of content analysis (189) deserves to be mentioned, however. It is called "General Inquirer" and maps written text into sets of terms of interest to the analyst such that various statistical computations can be made. The program has been successfully applied to a wide range of problems such as establishing cultural differences manifest in folktales, predicting the inclination of the writer of a letter to commit suicide, finding differentiating issues in arguments for or against a proposal (190), and measuring international tension (84). While this program cannot handle the complexity many problems of analyzing natural language text may require, it is indicative of a trend that has barely begun, a trend that is believed to be dominant in the fifth phase of content analysis.

Summary

The historical sketch of the development of content analysis in its social-historical context may now be summarized as follows:

from the above it is clear that the accumulative concern with analyzing messages systematically dates from and has not been interrupted since the beginning of this century.

Originating as "quantitative newspaper analysis," the first phase of this concern was clearly dominated by journalistic attempts to evaluate press performance. Primitive quantitative measurements along subject matter categories were merely used in support of public argumentation involving journalistic values and concerns.

During the 1930's prominent social scientists replaced the analyzing journalist and cultural critic. New concepts and more refined descriptive techniques entered what was subsequently termed "content analysis," and its scope was extended to other mass media. But, the analytical tasks, prompted by the prevailing social concern with the new media of communication remained essentially the same. The content analytic results of mass communications research were relatively inconsequential.

During World War II, the third phase of the analytical concern with messages, content analysis became primarily a tool for analyzing propaganda either in the sense of detecting hidden agents of foreign countries or in the sense of drawing military intelligence from known propaganda sources. An inductive element was added to the hitherto entirely descriptive technique and the systemic character of propaganda was realized although its methodology did not develop fully.

The fourth phase has been characterized as a rapid spreading

of content analysis into numerous empirical domains, thereby losing its previous association with the mass media. Perhaps it is this dissociation from a specific subject matter and from particular disciplines which gave content analysis a chance of developing into an interdisciplinary method in its own right.

The still infantile fifth phase, it is believed, will be dominated by the emergence of new computer techniques designed to analyze large quantities of text for various scientific and practical tasks. More than before such techniques presuppose the development of sound theoretical-analytical groundwork.

CHAPTER TWO

CRITICAL ISSUES IN CONTENT ANALYSIS

Critical issues always have a historical dimension. Their coming into the focus of discourse is the result of a long-term intellectual preparation and is typically preceded by an unqualified acceptance of the subject matter of these issues.

As the previous chapter showed, content analysis was originally used mainly as a rhetorical device to support public judgements regarding press performance by supplying figures to the journalistic argument. Figures suggested objectivity regardless of the adequacy of the methods by means of which they were obtained and hence, regardless of how validly they represented whatever they claimed to represent. With the intrusion of the social sciences into content analysis, computational techniques became more sophisticated and conceptual categories more detailed. This transformation led to the emergence of a few critical issues: the explicit-impressionistic dilemma (110); the quantitative-qualitative dilemma (70) (20:21-23) and the manifest-latent dilemma (30:7-8) (20:19-21). Commitments towards either side of the controversy often had ideological overtones.

Although such issues can be viewed in a historical context they can also be discussed in the context of scientific methodology. This chapter proposes to do just this. It seems that the critical issues mentioned above as well as others that have not been covered

in the literature can be subsumed under three main headings: definitional issues, methodological issues and theoretical issues.

Definitional Issues

Definitions seem wholly arbitrary agreements and yet, in the context of technical discourses, their relative utility may be evaluated. For example, a good definition is expected to abbreviate and sharpen a specific discourse; it ought to improve the efficiency of communication. Another criterion of a good definition, one of interest here, is its organizing power, i. e. the degree to which it structures similarities among events and leads to unambiguous distinctions in the universe of possible phenomena. With respect to the latter criterion, we may suppose that methodological discourses attempt to define investigative techniques(a) in terms of their empirical domain or the domain of possible observations to which they are assumed applicable, (b) according to their specific purpose or the class of problems for which they are claimed to provide solutions, or, (c) on the basis of specialized procedures and evaluative criteria they contain. Following is an attempt to critically evaluate existing definitions of content analysis along the above mentioned lines.

Kaplan's "statistical semantics of political discourse" as a paraphrase for "content analysis" has already been mentioned. The same author continues to say that "...the technique...attempts to characterize the meanings of a given body of discourse in a systematic and quantitative fashion" (96:230). This, being an early (1943) attempt at clarification, already includes most of the concepts that were

relevant during the second developmental phase of content analysis. Berelson and Lazarsfeld, reviewing several similar definitions that had been advanced in the technical literature of that time, proposed a definition which is claimed to include all essential distinguishing characteristics:

Content analysis is a research technique for the objective, systematic, and quantitative description of the manifest content of communication (30:5-6).

Due to Berelson's subsequent book on content analysis (27) and his review in The Handbook of Social Psychology, this definition became by far the most widely accepted and most frequently cited definition of content analysis to date. It can very well be taken as representing the dominant conceptualization in the field. It seems that one of the reasons for the surprisingly widespread acceptance of this definition is its inherent indefiniteness concerning the empirical domain of the method. Note that the key term "content" appears in both, the definiens and the definiendum of the definition. How little such a definition delineates can easily be seen when replacing the critical term with, say X. The definition then reads: 'X-analysis is a research technique for the...description of...X of communication.' If the term "content" is not already well defined, which, as we shall discuss under theoretical issues is indeed not the case, room is provided for almost any intuitive interpretation of the term and hence almost any empirical domain is acceptable for content analysis. While this indefiniteness is clear without giving further examples, it is most probably not intended.

Slightly less indefinite concerning an empirical domain are two definitions that succeeded Berelson's. Both have neither gained popularity nor been frequently cited. From a psychological point of view, Schutz argued that almost all human behavior is symbolic in some sense and must therefore be said to have content. On the basis of such reasoning, he suggests the definition:

Content analysis is a research technique for the objective, systematic and quantitative description of human behavior, particularly linguistic (171:3).

Cartwright, elaborating on Berelson's definition from the same vantage point, came to a similar conclusion:

Communication should be thought of as any linguistic expression, and the restriction to 'manifest' content should be removed. With these modifications, we have an adequate designation of all the kinds of analysis of quantitative materials of interest to social psychologists. . . . we propose to use the terms "content analysis" and "coding" interchangeably to refer to the objective, systematic and quantitative description of any symbolic behavior (39:424).

Although these two formulations give the appearance of avoiding the circularity of Berelson's definition, they replace "manifest content of communication" by terms which are not very well defined either, and do not possess the necessary discriminative power. As far as the distinction between symbolic and non-symbolic behavior is concerned, agreement exists only at the extremes of such a dimension. To identify the empirical domain of content analysis with that of human behavior is equivalent to the suggestion that all research techniques in the social sciences should be subsumed under the label content analysis,

which amounts to making no differentiation among those techniques as far as content analysis is concerned.

The three definitions agree, however, that content analysis has to be "objective, systematic and quantitative." This triple requirement refers neither to the empirical domain of the technique nor to its purpose, but to evaluative standards imposed on its use. With "objective... description" Berelson wants to assure "reliability" of the analytic procedure. The analysis must be replicable, leading to identical results. With "systematic... description" he wants to exclude "biases" of the analyst by requiring that "all the relevant content is to be analyzed in terms of all the relevant categories" as well as "to insure (that the) data (be) relevant to a scientific problem or hypothesis" (27:17). The requirement of quantification is, according to Berelson, "the most distinctive feature of content analysis" (27:17) and refers to an enumeration of instances found in the material under analysis.

Many early writers concerned with the subject insist very strongly on the attribute "quantitative" as a definitional requirement of content analysis. For example Lasswell emphasized this point in a paper entitled "Why be Quantitative" (110). And Pool characterized "content analysis" briefly as "the statistical tabulation of the things that have been said" (161:3). Even most recently Stone makes quantification the central prerequisite for content analysis when defining:

"Content analysis" refers to any procedure for assessing the relative extent to which specified references, attitudes, or themes permeate a given message or document (188).

With "permeation," Stone wants to include both frequency and distribution of identifiable characteristics in texts, thus being quite specific concerning the quantitative descriptions that a content analysis is to provide.

On the other hand, quantification in content analysis has been an extremely controversial issue as McGranahan points out.

Quantitative techniques in content analysis can provide a defense against subjectivity and bias. They cannot, however, provide a substitute for serious thinking. Unfortunately, as in many other fields of social science, some authors seem tempted to quantify for the mere sake of appearing scientific, and produce elaborate statistics that are meaningless or, at best, trivial. Content analysis will be useful if it supports but not if it suppresses the inquiring intellect (133:559).

Smythe referred to the use of inadequately simple statistical techniques to describe mass communications as an "immaturity of science" (183). Kracauer (102) and George (70) challenged quantification as a definitional requirement of content analysis on similar grounds. Underlying this controversy seems to be the association of "quantitative" with "objective" as opposed to "qualitative" with "impressionistic" approaches, an association which Goode and Hatt try to eliminate by pointing to a more reasonable goal for scientific inquiries.

Modern research must reject as a false dichotomy the separation between "qualitative" and "quantitative" studies, or between "statistical" and the "nonstatistical" approach. The application of mathematics... does not ensure rigor of proof, any more than the use of "insight" guarantees the significance of the research.

The fundamental question to ask about all research techniques are those dealing with the precision, reliability, and relevance of the data and their analysis. . . . If the observations are crude, casting them in a statistical

form will not help the research. If other scientists cannot repeat them, mathematical manipulation is futile. If the data do not satisfy a rigorous logic of proof, the conclusions remain doubtful (77:313).

While quantification seems not to be an agreeable prerequisite for content analysis, virtually no objection has been raised against the two attributes "objective" and "systematic" in the aforementioned definitions. But these two definitional requirements refer to the most general presuppositions of any scientific method and could very well have been taken for granted without loss. When discarding the controversial requirement of quantification, Barcus comes perhaps closest to the points of agreement by asserting:

The term "content analysis" is used here to mean the scientific analysis of communications messages.

He then continues realizing that:

The method is broadly speaking the "scientific method," and while being catholic in nature, it requires that the analysis be rigorous and systematic (20:8).

At this point it seems that the definition of content analysis has lost almost any organizing power within methodological discourses. If no way can be shown to differentiate content analysis from other modes of scientific inquiry, then hardly any justification exists to call content analysis an investigative technique in its own right. But before we are to pass a final judgement let us examine definitions of content analysis with respect to explicitly stated purposes and procedures.

Kaplan, Berelson, Schutz, Cartwright and probably Stone are quite clear on the point that content analysis aims at some form of

description, and yet Berelson insists in addition that the data be relevant to a scientific problem or hypothesis. Cartwright too is ambiguous concerning the goal of content analysis. While explicitly defining the technique as a descriptive one, he goes on to say that "as a rule the content analyst is not interested in limiting his conclusion or findings strictly to the content actually analyzed. Almost invariably he undertakes his specific analysis in order to reveal something about a more general universe of data than just those symbolic materials (produced at a certain place and time) with which he deals" (39:449). If - so one is forced to argue - the job of a content analyst is not conceptualized here as something quite distinct from performing a content analysis, then at least the terms "description" and "interpretation" are seriously confused. This confusion also seems to be manifest in a recent unpublished definition of content analysis that makes no distinctions between the process of identifying characteristics within a text and that of making inferences. This definition has been proposed by Holsti and reads:

Content analysis is any technique for making inferences by systematically and objectively identifying specified characteristics within text (83:10).

So far the clearest description of a purpose in content analysis has been given by Osgood who wrote:

... if we define content analysis as a procedure whereby one makes inferences about sources and receivers from evidence in the messages they exchange, then the problem falls precisely in the field of special interest of the psycholinguist... This is because it is the psycholinguist who, by definition, is concerned with discovering and employing lawful relations between events in messages and processes transpiring in the individuals who produce and receive

them. . . . when the interest of the content analyst lies in making inferences about the source of a message, he must rely on encoding dependencies, that is, the dependencies of message events upon psychological processes in speakers and writers. When his interest lies in making inferences about the effects of a message upon its receivers, on the other hand, he relies upon decoding dependencies, that is, the dependencies of events in listeners and readers (their meanings, emotions, attitudes, and the like) upon the content and structure of messages. (147:35-36)

Such a proposed restriction of content analysis to the making of certain kinds of inferences of interest to the psychologist is quite powerful in differentiating between several investigative techniques. Controlled experiments, field observations or interviews are not usually directed toward the inferences referred to above. On the other hand, Osgood's strictly psycholinguistic orientation is most probably the reason why his definitional attempt has not been fully appreciated or further developed in the literature.

Since the purpose of the method is not unambiguously ascertainable from given definitions or not unanimously agreed upon in the literature, let us now turn to those definitions that attempt to characterize content analysis in terms of specific procedures.

In his Language and Communication, for example, Miller casts his very clear description of the content analytical procedure in definitional form:

In order to handle large blocks of verbal materials in a statistical way, it seems necessary to reduce the variety of alternatives that must be tabulated. This can be accomplished by putting a wide variety of word patterns into a single category. . . .when. . . the frequency of occurrence of word patterns in each category of a classification

schema is counted, the result is called a "content analysis" (136:95-96).

The second definition that delineates required analytical procedures has been proposed by Janis in his attempt to come to grips with some methodological problems of content analysis:

"Content analysis" may be defined as referring to any technique (a) for the classification of sign-vehicles, (b) which relies solely upon the judgements - which theoretically, may range from perceptual discriminations to sheer guesses - of an analyst or group of analysts as to which sign-vehicles fall into which category, (c) on the basis of explicitly formulated rules, (d) provided that the analyst's judgements are regarded as the reports of a scientific observer. The results of a content analysis state the frequency of occurrence of signs - or groups of signs - for each category in a classification scheme (91:429).

Both definitions depict the content analytic procedure quite adequately. Miller's formulation, although very specialized and geared to a consideration of analytical problems in the psychology of language, leads directly to the kind of permeation measures Stone suggested in his definition. Janis' formulation essentially agrees with the definition above but emphasizes the process of controlled human judgement that is implicit in the procedure as depicted by Miller and must precede any kind of enumeration. It is fairly obvious that the analytical procedure as described by both authors can hardly lend itself to the kind of interpretations Cartwright observed as being the rule in content analysis. Such interpretations are clearly outside the scope of a technique that categorizes sign-vehicles according to some explicit rules.

The two definitions seem to imply a distinction between content analysis and those analytical techniques that provide the basis for both

more definite and more sophisticated measurements. By suggesting distinctions such as (a) between procedures that lead to such standardized measures as of age, weight, or temperature, and those that solely depend on human judgements; or (b) between measuring scales possessing various types of order and simple (nominal scale) categorizations of qualities, content analysis appears as a method of systematically exploiting controlled human judgements in the absence of more refined measuring operations. Given the fact that science has always proceeded from qualitative differentiations to quantifications of such differences, content analytic procedures here appear formally identical with measuring operations but simply of a more primitive kind.

In summary then, we attempted to inquire primarily into the organizing power of proposed definitions of content analysis. With respect to the empirical domain of the technique, none of the definitions can be said to be explicit enough as to make adequate distinctions within the universe of possible data to which the technique is deemed applicable. With respect to the goals toward which the use of content analysis may be put, the definitions do little but give conflicting requirements. The definitions that attempt to delineate specific analytical procedures do indeed succeed in suggesting differentiations within the repertoire of investigative methods in the social sciences, but the question remains to be answered whether the dimension along which this differentiation is proposed is indeed intended by those making frequent references to the technique. Most of the definitions cited above are of little prominence.

The only one that has indeed gained wide popularity has almost no organizing power and must be judged inadequate with respect to this criterion.

We were almost exclusively concerned with the organizing power of definitions of content analysis and mentioned the efficiency of a good definition only in passing. But a good definition of an analytical technique can also be expected to have some heuristic value in that it directs attention to specific methodological problems. Some such problems, whether generated by the definitions or derived from analytical difficulties will be taken up in the following section.

Methodological Issues

This section is devoted to content analysis as investigative technique, that is to say, to some of its critical problems pertaining to methodology. Methodology examines principles and procedures of scientific inquiry with respect to their ability to provide certain knowledge but abstracts from the particular use to which such inquiries may be put. From a methodological point of view, the two chief criteria for evaluating investigative techniques are reliability and validity. There are other evaluative criteria such as their efficiency or the costs per unit of information gained which are important when making choices among possible research tools, but we will confine ourselves to considering reliability and validity only. Before the pertinency of these criteria to content analysis can be discussed some of the peculiarities of the technique have to be clarified.

As a point of departure, Janis (92:55) and Miller's (136:95-96) definition of content analysis, cited above may be taken as giving an adequate description of the analytical procedure to be considered. In short: a scientific observer applies explicitly formulated rules for categorizing sign-vehicles to a usually large body of data. The date or collection of sign-vehicles, to use Janis' term, can consist of almost anything: themes, characters, items (30:78), letters, phonemes, words (136), topics, propositions (76), headlines (75), music scores (cf. 30:17), cartoons (18), proverbs (100), films (95), etc. Similarly as we shall see no restriction seems to exist as to the category schemes that may be employed.

"Rules for categorizing" sign-vehicles are logically equivalent to operational definitions of categories that make explicit the criteria according to which a particular sign-vehicle is either included in or excluded from a particular category. It is generally required that definitions of categories be such that (a) a category scheme be exhaustive and (b) each of the categories within that scheme be mutually exclusive (34:10). Thus, the rules for categorization must be everywhere defined and single valued. In short, the rules effect a mapping in the mathematical sense of a set of sign-vehicles into a set of categories. Since these rules are required to be explicitly formulated, the scientifically trained observer is expected merely to ensure that they are implemented or followed consistently and reliably. We shall see the implication of such a method shortly.

Consider first the number of possible mappings that can be well defined over a given body of data or the number of explicit categorization rules that are formulable: If m is the number of discriminable sign-vehicles in the domain of such a mapping and n the number of categories in the category scheme chosen, then the number of possible mappings is n^m . Now imagine that only a single issue of the New York Times has to be content analyzed, say with words as sign-vehicles, m then already becomes a very large number. Note that in the number of possible rules for categorization m appears as the exponent of n . Thus, in the presence of this unimaginably large number n^m the content analyst is faced with an extremely difficult problem of selection, for he has to choose one out of n^m possible mappings!

By definition the product of any one of the n^m possible mappings applied on the text constitutes an objective and systematic description in the sense of Berelson and Lazarsfeld's requirement for content analysis. Waples, Berelson, and Bradshaw may have realized the large number of alternatives available to content analysts when writing: "There are as many ways of describing publications as there are reasons for wanting to know about them" (200:63) to which Berelson and Lazarsfeld add "...it opens the door to the indefinite expansion of categories" (30:101).

If no constraints on this large set of possible rules for categorization are discernable then any arbitrarily chosen one would do. Although there appear few guidelines as to appropriate choices among

those rules, the existence of relevant constraints is suggested in the following statement by Berelson and Lazarsfeld:

Content analysis stands or falls by its categories... Studies done on a hit-or-miss basis without specific problems for investigation and with vaguely or poorly articulated categories are almost certain to be of indifferent or low quality as research productions. Although competent performance of other parts of the analytic process is also necessary, the invention and definition of appropriate categories takes on critical importance. Since categories contain the substance of the investigation, a content analysis can be no better than its system of categories (30:88).

The authors continue:

... Since communication materials contain almost everything people say or do, the production of relevant categories is limited only by the analyst's imagination in stating a problem for investigation and designing categories to fit the problem (30:101).

Although much of the quotation merely asserts the importance of appropriate choices, key criteria for such choices seem to be derivable from a "problem of investigation." Osgood also emphasized this point when stating that "the nature, number and breadth of categories... depend upon the purposes of the investigation. If the analyst has a very specific purpose, he will select his content categories around this core" (147:62). But what is the formal nature of those problems of investigation that are presumed to affect decisions concerning particular category schemes? As it has been mentioned earlier, Berelson, Lazarsfeld and others require of a content analysis that the categories be chosen to test some hypotheses. Although this is not included as a definitional requirement they make the point quite clear:

The derivation of hypotheses for a content analysis study is of central importance, since the hypotheses determine the nature of the categories as well as the framework of actual results. The hypotheses derive out of the nature of the problem and they in turn are translated into categories for analysis. It can hardly be over-stressed that the prior construction of appropriate hypotheses is indispensable for a sound and fruitful analysis... if the problem was not clarified to the point where several worthwhile hypotheses can be formulated (in advance), then the projected content analysis should be abandoned. One should not analyze unless or until he has something concrete and specific to analyze for (underlined in the original) (30:92).

At this point we cannot stress strongly enough the methodological implications of making decision criteria concerning category schemes a derivative of the apriorily stated hypotheses to be tested: if a content analyst chooses his categorization rules only according to the set of hypotheses upon which the data to be categorized are supposed to bestow some significance, then the validity of the result is either entirely accidental or solely dependent on the analyst's prior intuition concerning that result. In either case the method is fallacious.

For proof of the above proposition let the number m of discriminable sign-vehicles in a body of text be very large compared with the number n of analytical categories. To keep the example simple let the categories be cells in a two-way contingency table. A hypothesis defined within the terms of the contingency table can be said to be accepted if the frequency distribution in that table differs significantly from the one for which the complementary null-hypothesis would account. Since frequencies are additive, the size of the sets into which the m different sign-vehicles are grouped are assertedly

arbitrary, the n^m possible mappings from the text into the table can produce almost any desired frequency distribution. The only limitation stems from the magnitudes of n and m . Hence, the mapping can almost always be chosen in such a way that any hypothesis with terms contained in the mapping's range, i. e. our contingency table, can be "supported." Thus, if decisions concerning rules for categorization are completely arbitrary or made without reference to criteria that are external to the analysis, then the degree to which a content analysis provides factual evidence for a set of hypotheses is absolutely indeterminate. The confidence that can be associated with some statement so "tested" is zero. The validity of such a statement cannot be better than chance unless the content analyst has some prior intuition as to which of the hypotheses is to be refuted or accepted and selects categorization rules correspondingly. Hence the analysis does not provide any evidence beyond the prior intuition of its designer and is in fact quite superfluous if not seriously misleading.

This fundamental fallacy which seems to be inherent in contemporary conceptualizations of this investigative technique must be considered the most critical single issue in methodological concerns with content analysis. It appears whenever content analysts are completely free to choose any category scheme they feel is applicable for whatever reasons.

In practice, however, the analysts cannot choose quite so freely among the possible rules for categorization. His choices are subject

to at least two kinds of constraints. The first type of constraint refers to the limitation of the content analyst's imagination - as Berelson and Lazarsfeld (30:101) mentioned in passing. This limitation need not concern us here, but it is obvious that the analyst cannot evaluate the astronomical number of possible mappings systematically. His imaginative capability delineates only a small manageable set of categorization schemes for examination. The second constraint refers to the limited instructability of the scientifically trained judge who is supposed to categorize the data under consideration.

Neither of these constraints have been discussed in the literature. On the face of it, it appears that they are disadvantageous to content analysis; but the case is quite the opposite. Since the method - if strictly followed as stated - leads to fallacious results, it seems that these constraints provide the only source through which some validity can enter the analysis. They may help to bring about results that are, if not acceptable, at least not completely arbitrary. Before we can examine the role of these constraints in full detail, some theoretical framework has to be adopted on the basis of which a definition of validity and reliability can be proposed and within which the methodological implications of such constraints become apparent.

As mentioned at the beginning of this section one important evaluative standard that any investigative technique ought to meet is "validity." Roughly stated, a measuring instrument is said to have validity if it measures what it proposes to measure; if its results,

which range from the numerical value of a variable to a complex statement, represent what they claim to represent. From an empirical point of view the validity of an investigative technique can be assessed by measuring the agreement between its results and those obtained from other already validated research procedures that are applied to the same phenomena. To be an acceptable investigative technique, content analysis must produce results that are valid in the above mentioned sense.

The validity of content analysis is in this respect extremely difficult to establish as it is not altogether clear what the product of the analysis is supposed to represent. As we have shown in the previous section, the definitions are quite ambiguous with respect to the empirical domain of content analysis. Hence, they do not offer satisfactory explications of the term "content" that would easily lend itself to validations. It is conceivable that this crucial indefiniteness concerning the empirical domain of the technique is the cause of the fact that almost none of the published content analyses attempt to validate their results by comparing them with evidence obtained by independent means.

In the absence of a simpler framework and without attempting to anticipate the topic of the final section of this chapter, let us accept Janis' sign-theoretical position (91) (92) and argue that the purpose of a content analysis is to represent the "signification response" by, say, members of an audience to a message composed of sign-vehicles.

Without suggesting any formal definition of this term let us assume that each member of the audience has acquired some "signification habits" - to stick to Janis' terms - or culturally conditioned competencies for distributing sign-vehicles into some notational scheme of possible signification responses. These signification habits may be thought of as being intuitive rules for conceptualizing. There is no need to suppose exhaustiveness of and mutually exclusiveness within the notational scheme and no reason to expect perfect agreement among the communicators or respective members of an audience. Assuming there are ways for assessing the signification responses to a given set of sign-vehicles, then content analysis can easily be validated by comparing the distribution of sign-vehicles in the category scheme of a content analysis with those in the respective notational scheme obtained from the individuals concerned. Thus, if the product of applying explicit categorization rules is identical with or at least sufficiently similar to an audience's signification responses to the same set of sign-vehicles then the content analysis can be rendered valid.

Signification responses may not be directly accessible in the case of which it becomes difficult to measure the amount of agreement between content analytic results and signification responses referred to. Under these conditions, Janis argues, a content analysis may be validated indirectly if some other variable that is dependent on the audience's signification response can be shown to correlate highly with the content analytic results. Such a situation may exist if

sign-vehicles cause some behavioral responses that are mediated through and moreover linearly dependent on the signification responses to that set of sign-vehicles.

Unfortunately it is not only the lack of adequate explications of "content" and the empirical restrictions on the observation of signification responses that make validation of content analysis so difficult. The analysis of historical documents, of domestic propaganda obtained from enemy nations or political speeches by otherwise inaccessible political leaders exemplify typical content analytic situations that exclude the possibility of obtaining validating instances. In such cases at least one other evaluative standard can be employed that is logically prior to validity and refers to the degree to which a research technique leads to replicable results.

This evaluative standard is necessary, for it is sometimes quite a difficult task, even for a scientific observer, to map such sign-vehicles as words, propositions, or sentences into exhaustive sets of mutually exclusive categories and to maintain consistency in such classification over a longer period of time. It is therefore of some interest to measure the degree to which the actual categorization performance of the scientifically trained judge deviates from the ideal of a mapping. This measure is called "reliability" and given an important place in methodological consideration of content analysis. For example, Kaplan and Goldsen write:

The results of content analysis, like those of other processes of measurement, must meet certain conditions of reliability before they can be accepted as data for hypotheses. By reliability of a measurement with respect to a given variable is meant the consistency of its results as that variable assumes different values. The variables usually considered are: the measuring event (e. g., the same person using the same value in successive measurements of the same object); the measuring instrument (e. g., different "forms" of an intelligence test); the person doing the measuring (e. g., different eyewitnesses on the same event).

The importance of reliability rests on the assurance it provides that the data obtained are independent of the measuring event, instrument or person. Reliable data, by definition, are data that remain constant throughout variations in the measuring process (98:83-84).

In content analysis reliability is measured either as inter-judge or as intra-judge agreement whereby each measure may be applied to evaluate any one component of the category scheme or focus on the categorization procedure as a whole. Whatever the focus of evaluation may be, reliability is logically prior to validity insofar as high validity presupposes high reliability but is not ensured by the latter. The measure of reliability sets only the upper boundary for the validity a content analysis can be expected to achieve. This fundamental relation between reliability and validity is not always realized in the literature when attempts are reported to evaluate a content analysis methodologically. Only a few studies care to measure the reliability of the analytical tool employed while most of them pay at best lip service to the problem of validation.

How does the limited instructability of judges affect both of these methodological standards in content analysis? Schutz (171) is probably

the first who realized a direct relationship between the reliability of a content analysis and the nature of the explicitly stated rules for categorizing sign-vehicles. These rules are given to a scientific observer in the form of instructions with the obligation to follow them. Searching for an adequate measure for reliability he argued that the mere act of giving instructions to a set of judges would almost ensure a level of agreement better than chance. Instructions are at least intended to specify and to determine the behavior of persons employed in the categorization process. If the reliability is low, Schutz argued, then the instructions have not been perfectly understood by the judges. If the reliability is high he infers that the instructions were successfully communicated to them or at least that the judges make consistent use of some rules that give the same results regardless of the individual idiosyncrasies of the persons involved.

The assumption of an initial chance agreement can most certainly not be maintained. Even a scientifically trained judge brings with him a host of intuitions concerning the categorization process. By virtue of the fact that he grew up in a certain culture, a certain social stratum and assumed certain roles when exposed to the mass media, for example, signification habits are inevitably acquired that ensure agreements better than chance. Signification habits are already present prior to accepting the role of the objective judge in a content analysis and to a large extent determine which rules for categorizing sign-vehicles can be acquired in a reasonable period of time

and which are followed with some degree of consistency.

Almost all of the few studies reporting on the reliability of the analysis describe how training sessions and extensive instruction programs had to be arranged in order to make the categorization rules sufficiently understood. O'Sullivan, for example, conducted a training seminar over a whole semester period to prepare judges for participating in a content analysis of writings in international relations (154). When categorization rules cannot consistently be followed by the judges, it is customary to arrange discussions among them that frequently lead to special interpretation and successive modification of the explicit rules until the categorization process reaches an acceptable level of reliability. For example, in "a study of the values of Soviet and American elites" Angell "found that... agreement among coders on whether or not a dimension was involved in a story or editorial - (was) most discouraging for a long time... a rule adopted on this subject helped a great deal. Discussion and analysis of the differences between coders on their practice runs also increased reliability. We believe our statistical tables represent 80% reliability..." (9:13).

Thus reliability is not solely the product of understanding explicitly formulated instructions--as Schutz seems to suggest - but may be said to be the outcome of an interaction between the rules for categorization, the judges' intuitive signification habits and the communication situation in which the judges are participants. On the one hand, the categorization rules rarely ever specify the process so

completely as to serve as an algorithm. They almost always require situation-dependent interpretations by the user. On the other hand, there seems to be ample evidence--and the two examples mentioned above are only suggestive in this direction - that during the judge's training period categorization rules are being imposed upon and partially override the stock of signification habits. Categorization processes in which a person is engaged when assuming the role of a judge in content analysis are typically quite alien to the intuitive conceptualizations that may go on when assuming roles in an audience. Whether and the extent to which explicit rules for categorization and intuitive signification habits override each other is crucial for the degree of validity that a content analysis can achieve in a given situation.

The situation in which a content analyst's choice of possible categorization rules is solely guided by his intent to test some hypothesis can now be reconsidered in the light the existing constraints on the judge's performance. It represents one extreme where explicit rules for categorization completely specify the procedure without being affected by any of the intuitive signification habits a person may have had prior to becoming a proficient judge. Such a situation exists particularly when computer analyses are attempted. A computer program can not delegate "intuition" to an information processing device. Such a situation is not very likely to arise when human judges are employed in the categorization process. For such an

extreme it has been shown that even when reliability is perfect, validity solely depends on the analyst's intuition concerning those categorization rules which he feels will produce results that are most likely valid to him.

The other extreme is found in the situation in which categorization rules either are not made explicit or are completely ignored by competent judges (i. e. judges who possess sufficiently developed signification habits to respond consistently to the sign-vehicles presented to them). Here object of validation and criterion against which validation is to be made become confused. According to the definition of validity in content analysis, the outcome such a situation would produce is valid to the extent that judges are representative of those communicators or audience members whose signification response their outcomes claim to represent. Such a situation comes closer to being a psychological experiment than a content analysis: The absence of explicit rules make the data obtained dependent on the personality of the individual who performs the categorization operation, and "lack of validity" becomes simply equivalent to the sampling error. While this situation avoids the troublesome fallaciousness of the other extreme, it is not a content analysis according to Janis's definition and, lacking explicitness and most probably replicability, does not satisfy the methodological requirements of an acceptable measuring technique. Actual content analyses tend to assume a position somewhere between the two methodologically defective extremes and create what might be called the content

analyst's dilemma: the more the content analyst pushes in the direction of non-directiveness concerning the judges signifying behavior the more his procedure becomes questionable as an investigative technique for assessing content. Since he is most often rewarded for exhibiting rigor, showing "objectivity," "systematicness," and "quantitativity" in his analysis, he is pushed into a methodologically fallacious situation which he cannot easily recognize as such.

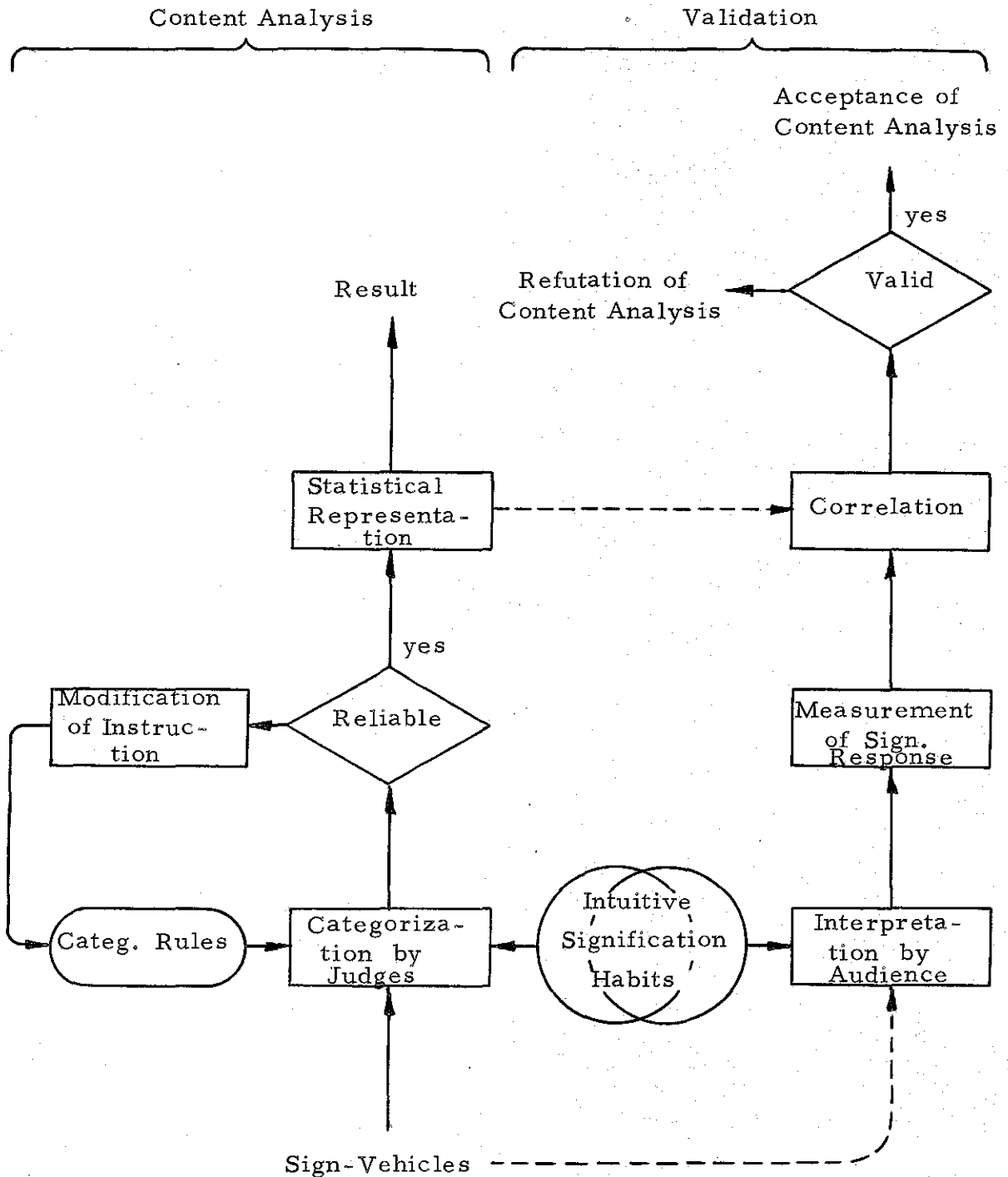
The crux of the matter is that validity in content analysis simply does not follow from those evaluative criteria in terms of which the analyst habitually justifies his pursuit. The conception of the content analytic procedure not only makes validation very difficult but also renders no provisions for keeping track of the actual sources of validity. For instance, content analysts are not expected to justify their choices of judges on the basis of the representativeness of their signification habits. Content analysts are not expected to - and indeed never do - assess the degree to which the explicitly formulated categorization rules approximate the signification habits of the audience or communicators to which the analysis generalizes. Even if a content analyst were able to eliminate such uncertainties he has no idea about the extent to which explicit categorization rules and intuitive signification habits mutually override each other during the categorization process.

The two actual sources of validity in content analysis seems to be (a) the existence of intuitive signification habits of judges as far as they are representative of those held by the respective audience and the

extent to which such habits are either not subject to explicit constraints or effectively override the categorization rules, and (b) the prior intuition that lead the designer of a content analysis to the selection of categorization rules that are equivalent to the signification habits of the respective audience and effectively override those of the judge's signification habits that are not representative of the ones held by the respective audience.

The surprising result of the methodological examination is this: while investigative techniques are generally designed in such a way as to ensure the validity of a scientific inquiry, content analysis can in no way guarantee valid results. If validity emerges in content analysis, then it does not stem from its explicitly stated procedure but from a hidden interaction process in which intuition plays a decisive part. This interaction process is neither under the control of a content analyst nor accessible to a methodological evaluation. Thus only luck and intuition ensures what is believed to be derived from explicit rigor and apparent objectivity.

The content analyst's dilemma becomes even clearer in a flow chart of the defective process (see Figure 2). Although the presentation is a simplified one, the critical feature appears in form of an iterative loop adapting the explicit categorization rules to the nature of the sign-vehicles and the stock of intuitive signification habits until the product of the categorization process passes the reliability test. When that product has reached the desired level of reliability the content analyst



Flow Diagram of the Defective Content Analysis Procedure

Figure 2

knows little more than that some rule has been applied consistently. Since he has no control over the nature of this rule as it emerges from the interaction between intuitive signification habits and explicit instructions, he can hardly be certain about the possible validity of the results. Assuming that the signification habits of judges and respective audiences are initially identical, it is almost certain that instructions only diminish the validity of a content analysis. Validation is at least theoretically conceivable but practically never done. In the diagram, communication between defective content analysis and validation procedure is denoted by dotted arrows.

Essentially two means seem to suggest an immediate resolution of the content analyst's dilemma. Both require some conceptual modifications of the analytic technique. The first would require the explicit rules for categorization ideally to be made identical or at least not of such a nature as to interfere with the judge's signification habits as far as they are representative of the respective audience. Then content analysis could most probably achieve explicitness, reliability and validity of the categorization process. This resolution presupposes the content analyst to acquire and possess a considerable amount of information about the signification habits to a given set of sign-vehicles and about the learning process for acquiring such habits before he can ever start formulating appropriate rules. In fact he must have a well established theory of signification which seems currently very far from being conceivable.

The other means of resolving the analyst's dilemma is standardization of the procedure. If a set of explicit categorization rules - as arbitrarily as they may have been chosen - are employed consistently, exhibiting high reliability in a large variety of situations, then differences in the results do represent differences in the data. What such differences mean is another problem altogether. They certainly cannot be so easily interpreted as representing some significant response as it has been customary in content analysis to date.

Little use has been made of either ways of resolving the methodological dilemma. Perhaps the attempt to make use of Osgood's measures of affective meaning (149) (152) as a basis for a computer content analysis program (84) may be mentioned as a timid experiment in the direction of the former means of resolving the dilemma. Lasswell's attempt to standardize categories for detecting foreign propaganda sources in domestic mass media (111) suffices as an example for the latter. But neither approaches have been widely accepted. Many content analysts, including Berelson argue "against the development of a single set of categories. "Proponents of this view," as Budd put it, "maintain that every content analysis is unique, presenting its own individual problems that require individual handling" (34:13). Pool believes that not enough research has been done to establish standardized measures in content analysis. "Such a measure is convenient when a considerable number of researchers are working on the same variable, and when someone succeeds in working out good categories

for that variable. It is doubtful that either of those criteria can be met in most areas of content analysis...until that time there is a good deal to be said for ad hoc categories..." (162:213-214).

How little various ad hoc category schemes, content analysis measures and indices yield comparable results and, hence, how little they validate each others results was the lesson of a study made by the Institute for Communications Research at the University of Illinois (191). The investigators took as many as 70 written passages of about 300 words each from such varied sources as The Bible, the Chicago Sun-Times and a manual for operating a Remington typewriter. Each of these passages were analyzed in 55 different ways. The 55 different analyses had been suggested in the content analysis literature and claimed to measure some effects a text may have on its reader, e. g. retention, interest, willingness to read more material of a similar nature. The analyses involved simple counts such as the number of first, second, and third person pronouns, various indices such as readability scores, the average number of meanings per word, and scaled judgements such as "interestingness of subject matter," "how well written." In total the study was a gigantic design, "a content analysis, to end all content analyses."

A factor analysis revealed 10 factors accounting for some 62% of the total variance. But most of the factors could not be interpreted in a meaningful way. To validate the factors, it was argued that they should at least be able to distinguish among texts of different sources.

Some positive results were present but they were only slight.

Then a set of texts scoring high, medium, and low on four factors believed to be meaningful were given to readers who were subsequently subjected to a series of tests known to measure interest, evaluation, comprehension and retention of the content. Correlation of the test results with each of the factors yielded no satisfactory result whereupon work on the content analysis variables was suspended.

This was the only extensive and sophisticated study designed to throw some light on the validity of the numerous content analytic schemes in a fairly limited domain. The rules for categorization varied from the highly explicit type quantitative measure to the kind using intuitive judgements on simple scales. Its results provide empirical evidence for the reality of the content analyst's methodological dilemma.

Theoretical Issues

Reviewing studies in content analysis one cannot but detect the feeling of those who are not absolutely satisfied with the quality of their products that more adequate results would quickly be forthcoming if there were more studies and better quantitative methods. Yet an increase in the number of such studies is not likely to bring about the expected improvements, although investigative technology undoubtedly plays a major role in determining the quality of content analysis.

Barcus' survey (20) of over 1700 content analyses displayed the great variety of subject matter to which researchers had devoted themselves but he could not point toward qualitative improvements. As "a content

analysis of content analysis" Barcus' method is subject to a well known logical constraint: no method can uncover its own explanatory power and limitations, much less go beyond it.

Dissatisfactions that are sometimes associated with content analysis do not always arise from methodological considerations. They can often be traced back precisely to the point when empirical research stepped in where hitherto socially responsible journalists and cultural critics had reigned supreme. To the latter there was never any doubt of what content is, what communications are about and that their mass distribution act as great social forces. But when specific inquiries into mass media content and their effects on election campaigns, audience evaluation of educational radio programs, etc., were made, these presumed facts could rarely be demonstrated. It is certainly conceivable that the social philosopher's judgments were severely biased or that such analyses, were objectionable on methodological grounds, but it is also possible that informed authorities on social, political and public matters make use of concepts of content that are incompatible with those underlying a particular content analytic technique. Under these conditions dissatisfaction may be due not to the methodological dilemma but rather to the inadequacy of the theoretical frameworks that are built into the investigative technique employed.

As we argued in the section on definitional issues, the empirical domain of content analysis is delineated only on intuitive

grounds. And yet each content analysis is explicitly or implicitly required to operationalize the term "content" in some way. This section is devoted to a critical examination of such built-in conceptions of content.

Content as a Permeating Characteristic

There can be no doubt that the volume of data upon which content analyses are most typically based calls for the use of procedures for rigorous simplification. In content analysis such simplification is most commonly achieved by enumerating the relevant units (sign-vehicles, words, sentences, paragraphs, cooccurrences, etc.) that are found in each category after a suitable categorization process has been applied on a given text. Enumerations of this kind lead to relative frequencies or other statistical indices of the distribution of category assignments within a category scheme. The most significant feature of such simplifications is that the relative position of the categorized units within the text is not maintained. Thus, the statistical measures so computed are always measures of permeation.

A logical prerequisite of categorization and enumeration is the discriminability of mutually exclusive units within the symbolic material to be analyzed. Even at this point sound theoretical frameworks are not available to justify a particular unitization in terms of the meanings conveyed by a given message.

According to Pool the problem of whether there exists a "basic unit of meaning of relevance to content analysis" had been considered at the first working conference on content analysis mentioned above.

The working definition that apparently emerged at this conference is an entirely statistical one. It identifies "a basic unit of meaning" with "relatively little freedom for variation within it, but much freedom at its boundaries. Habit strengths are strong, transitional probabilities high within it but low across its boundaries. Such a unit, if it exists, is a kind of building block" (162:203) that can provide the logical basis for categorization and enumeration.

The conference discussed this issue, could not find a satisfactory solution, and had to leave the matter of "basic units" vague. "It is one of the problems," writes Pool, "to which psycholinguistics may help to produce an answer. But as of now it is not clear how one identifies a basic unit of meaning" (162:203-204). Linguists, on the other hand, start out with the assumption that words, while isolable on statistical grounds are inherently relatively meaningless unless viewed in the context of the syntactic and semantic structure of a language. Such a structure, however, is precisely "counted away" when applying quantitative measures of permeation. It enters at best through the backdoor of an extra analytical interpretation.

While the problem of basic units of meaning that are sufficiently general for all content analyses has not been solved, the requirements on the nature of the units that are distinguished in content analyses seems to vary with the specific purpose of the investigation. For example, if the research tries to ascertain the amount of attention devoted to some country it might be adequate to enumerate the number

of words explicitly referring to that country. If more elaborately structured images of that country are the focus of analysis it seems necessary to define units of enumeration in terms of propositions that include respective references etc.

Whenever actual counts are presented of, say, words, political symbols, propositions, themes or even silences that have been identified within a speech or body of text, a critical attitude often leads to the question "so what?" When for example, the political symbol "freedom" appears in a country A with the highest relative frequency while the political symbol "dictatorship" takes the first rank among the political symbols mentioned in country B, what does this indicate? Are the people of country A more free than those of country B? The premise which seems to suggest a confirmatory answer to this question could very well be reversed on the assumption that people talk about what they don't have. The inferences that can be drawn from the degree to which known symbols permeate particular communications are most certainly not obvious.

Since Lasswell's World Attention Survey (108) content analysts have become more modest in their claims and take the relative frequency with which a symbol, theme, etc. appears as a measure for the amount of attention devoted to the phenomena signified by it. But analysts identifying relative frequency with relative attention cannot consider themselves on safe grounds either.

Symbols may, for instance, be purposively selected whereby attention is devoted to something instrumentally linked but not manifestly contingent with that symbol. For example, someone living under Stalinist domination who is primarily concerned with opposing this form of government would be a fool to use the symbol "dictatorship" or even "decentralization" too freely in public. He is more likely to argue in economic terms or express concern with the working conditions of the people or their living standard, thus making the link to his attention non-manifest. When early psychological theories of stimulus reinforcement were applied to political propaganda the sheer frequency of stimulation gained considerable significance. But as it now turns out, such theories cannot account for instrumental usages of communication, probably not even for content as distinguished from physical stimuli. They reduce communicators and audiences to rather primitive mechanisms of habituation.

To give another example that critically opposes the frequency attention identification: symbols when repeated frequently may lose their original meanings up to the point where they become habitual utterances devoid of cognitive or behavioral consequences. This is the essence of recent experimental work on "semantic satiation" (105). It suggests that high relative frequency of a symbol may under certain conditions be indicative of quite the opposite of high attention.

Neither is there any a priori reason for the units used in content analysis studies to be concerned with meanings in the linguistic

or psycholinguistic sense nor for permeation measures to be in accord with any particular sociological or political theory. But in order to have any practical or theoretical significance at all, such statistical permeation measures of message characteristics have to be indicative of some phenomena, whatever the basis of this indication may be. This hypothesized significance has yet to be substantiated in each individual situation.

One rare example of an attempt to give some significance to a content permeation measure appears in Holsti, Brody and North's study of the 1962 Cuban crisis (84). The researchers subjected all available documents issued by the major decision makers in the crisis to a computer content analysis. Empirical results in psycholinguistics had gone into this analytic device which could now be used to identify the intensity of affective meaning of each word appearing in the documents and compute an average score for each source of documents on a day-by-day basis. While the resulting scores are not strictly frequency characterizations their permeation measures are sufficiently similar to them. During this crisis situation the fluctuations of Holsti, Brody and North's permeation measures were found to significantly correlate with those of the Dow-Jones Average of Industrial Securities. Although this correlation is indicative of a relation between the two measures, since the meaning of the Dow-Jones Average is not perfectly understood the significance of the content permeation measure is still merely suggestive. In this case the analysts interpreted their measures as indices of international tension.

The content analysis described above moreover exemplifies the maximal indicative power that can be expected from a concept of content as a permeating characteristic. It is limited to uncovering only the most general tone or attitudinal coloring that prevails in the communication situation from which messages are sampled: international tension, affective orientation, public attention or something akin to the dominant social climate. Since more complex syntactic and semantic structures are discarded when the analysis focuses on such simple statistical measures of permeation, the organizational condition of the communications must largely remain hidden.

While also interested in such permeating message characteristics as "the German war-mood," George (71), who participated in an extensive analysis of enemy broadcasts during World War II, provided many irrefutable examples in which statistically insignificant occurrences, (the simple presence or absence of a reference in a political speech or newscast) yielded reliable bases of prediction. The propaganda analysis operation of the FCC which George evaluated after the war was of importance for policy makers in need of valid intelligence. Under these conditions it was of little importance how standards of reliability were assessed, which concept of content was utilized or whether the method qualified as a content analysis by definition. The experiences gained during this time period seem to indicate that under certain conditions non-statistical characterizations of messages can have more theoretical and practical significance than frequency type

characterizations of permeation.

The problem of the theoretical significance of permeation measures has unfortunately become an issue of qualitative versus quantitative analysis and remained as such at least since Kracauer's 1952 "Challenge of quantitative content analysis" (102) without getting to the basic argument. We touched on this apparent controversy under definitional issues. As it seems, the critical point is that the convenient method of measuring simple frequencies of occurrence becomes inadequate when message sources and/or receivers exhibit higher order dependencies, much more so when they follow a complex logic; and are even out of place when source and/or receiver possess some intelligence, e.g. produce novel instrumental communications according to particular objectives.

The problem of whether the products of a content analytic procedure ought to be statistical or non-statistical, quantitative or qualitative, becomes rather immaterial when viewed in isolation from the nature of the particular system from which messages are obtained for analysis. Thus, criteria for differentiating analytical units within given messages and analytical procedures including their evaluative criteria obtain their appropriateness only in reference to a suitable theoretical framework that is expected to predict some features of the system under analysis. Content as a statistically formulated permeating characteristic has not proven to have much theoretical significance except when interpersonal or social systems can be reduced to almost

structureless entities.

The history of quantification shows considerable success in its attempt to numerically represent what appeared hitherto "unanalyzable qualities" - the componental description of color qualities in the late 19th century or the recent success in quantifying such apparent intangibles as information and intelligence may suffice as examples. In order to have any theoretical significance it is quite conceivable that the analysis of message content within social systems of some complexity requires quantitative techniques that go far beyond simple statistical permeation measures. Such analyses may require, for example, quantizations and transformations of syntactic structures or computational procedures making use of elaborate models. Quantitative measures that are more sophisticated than simple frequencies may prove more appropriate for the analysis of complex messages even though such messages may appear to their receivers as non-analyzable qualitative varieties.

Content as Intersubjectively Verifiable

A second issue which leads to theoretical implication is the role of the "manifestness" of those message characteristics that content analysis can supposedly handle.

It will be recalled that Berelson made it a definitional requirement of content analysis that the content to be analyzed be manifest while Cartwright later rejected this requirement on the grounds that latent message characteristics can also be of interest to social

psychologists and should hence not be excluded. The controversy and the social psychologists' position becomes quite understandable when "manifest content" is identified - as it usually is - with a kind of dictionary interpretation while "latent content" then becomes more like a depth interpretation as it would be given by a psychoanalyst. But the "manifest latent" controversy can become too easily a quibbling over words without coming to the point. Berelson and Lazarsfeld, for example, conceive of this differentiation quite differently. They argue:

If one imagines a continuum along which various communications are placed depending upon the degree to which different members of the intended audience get the same understandings from them, one might place a simple news story on a train wreck at one end (since it is likely that every reader will get the same meanings from the content) and an obscure modern poem at the other (since it is likely that no two readers will get identical meanings from the content). Other kinds of content will fall at various points along this continuum. Thus analysis of manifest content is applicable to materials at the one end of the continuum where understanding is simple and direct and not at the other. Presumably, there is a point on the continuum beyond which the "latency" of the content (i. e., the diversity of its understanding) is too great for reliable analysis (30:7-8).

Here, "manifest content" becomes operationally identified with some message characteristic that produces "uniformity of comprehension and understanding" for a large majority of receivers. It is, in other words, intersubjectively verifiable. Intersubjective verifiability is also the underlying conception of content in Janis' sign-theoretical framework that was employed as an example for explicating reliability and validity in content analysis. In the light of the discussion in the section on methodological issues, we can see that in order to satisfy

any of the methodological standards, a content analysis that regards content as an intersubjectively verifiable message characteristic is absolutely limited to the investigation of manifest content in the sense of Berelson and Lazarsfeld's definition. This is true even if some content analysis proposes to investigate latent content in the sense that Cartwright presumably had in mind. Whenever an analysis makes use - as it commonly does - of content as an intersubjectively verifiable characteristic it must exclude highly divergent message interpretations on the ground that such divergent interpretations only reduce achievable levels of reliability and hence have a diminishing effect on the probable validity of the result.

If content analysis accepts a concept of content that is existentially linked with its intersubjective verifiability it is of course compelled to uncover only the most obvious content characteristics of communications. The limitation which the so conceived content imposes becomes apparent when one consults, for instance, Adorno's discussion of "various superimposed layers of different degrees of manifestness or hiddenness that are utilized... as a... means of 'handling' the audience" of television. His main hypothesis is that the "hidden message may be more important than the overt, since this hidden message will escape the controls of consciousness," (3:479-480) and will therefore not be subject to the same modes of interpretation. Adorno gives two examples of television plays which are overtly intended to be amusing and comical. Their "'hidden meaning' emerges simply by the way the story looks at human beings; thus the audience is invited to look at (and

identify with) the characters in the same way without being made aware that indoctrination is present" (3:480-481).

Analyzing verbal behavior, psychoanalysts in particular have found it useful to deal with "underlying motivations" or "deep-rooted assumptions" quite different from those explicitly expressed. This approach may take, say, two political speeches both overtly supporting the officially accepted ideology of the state, but, by utilizing fairly complicated metaphors, symbolisms, or allusions, may show that one makes indirect references to peaceful coexistence, economy, and eliminating previous obstinacy, while the other stresses a revolutionary philosophy and fight against revisionism. In certain critical political situations such a 'hidden content' may not only be intended, but moreover, may be used instrumentally in such a way that the content is not easily detectable by everybody who receives the message carrying it.

The argument is not solely meant to be in favor of including Adorno's "hidden content" in the empirical domain of content analysis. This would only replicate Cartwright's earlier cited definitional demand. The example is mainly meant to show what is implicitly excluded from the scope of analysis when the idea of content as an intersubjectively verifiable characteristic is accepted. The investigation of message characteristics that can not be recognized or of which a large majority of audience members is unconscious can hardly ever be validated for it would presuppose "uniformity of comprehension and understanding" by the audience which those message characteristics

will not yield by definition. The analysis of possible effects of communications must also be excluded on the same grounds, for the probability of obtaining valid results (valid again in the sense of high intersubjective agreement) from such analyses which are sometimes called "pragmatical" can, according to Janis, (91) be expected only to be very low.

The way the concept of an intersubjectively verifiable content is intimately interlocked with the methodology of content analysis has theoretical consequences of even more importance. Lasswell wrote that "although word counting is involved in the study of communication, not all quantitative procedures are necessarily 'content analysis.' The term can legitimately be applied only when 'counts' are undertaken with reference to a general theory of the communication process" (110:387). Not only has such "a general theory of the communication process" not emerged in content analytic pursuits, but the assumption of the intersubjective verifiability of content seems fundamentally alien to the basic ideas of communication. This assumption is not only opposed to tolerating possible differences in interpretative capability between scientifically trained judges and persons presumably handling the analyzed communications intuitively, but also fails to account for differentiations among the specific roles, intentions and positions those persons may occupy when constituting the communication network from which the messages were taken. This becomes explicit in a quotation from Berelson, who requires that

...the content be accepted as a "common meeting-ground" for the communicator, the audience, and the analysts.

That is, the content analysts assumes that the "meanings" which he ascribes to the content, by assigning it to certain categories, correspond to the "meanings" intended by the communicator and/or understood by the audience. In other words, the assumption is that there is a common universe of discourse among the relevant parties, so that the manifest content can be taken as a valid unit of study (27:19).

From the point of view of any conceivable theory of communication the avoidance of differentiations between the constituents of a communication network - whether such network is an interpersonal one or one in which mass communication processes take place - is crucial. Unsymmetric relations between social roles, conflicts (whether centered around unequal distribution of power, capabilities or opportunities), and differential access to information are but a few prerequisites of social communication processes. Differences in the interpretation of communications that may stem from such conditions can very well be indicative of the dynamics of the communication process itself. The concept of an intersubjectively verifiable content can hardly obtain an exclusive position in any communication theory.

For instance, a most primitive conception of a communication situation may postulate that messages flow only from someone informed to someone ignorant of the issue. Assuming this to be the case, a given message must consequently be interpreted differently depending on who is asked to reproduce its content. Interpretative differences of a given message may very well indicate the possible communication structures that a message may facilitate; they may very well provide the basis for

predicting the probable pattern of information flow within a social group or throughout a population.

Or, consider the phenomena of propaganda, the manifestation of social power in messages. Dahl, for example, considers political power as measurable in two respects: the first is the ability of an actor to produce a change in the probability distribution of a class of repetitive outcomes, the second is the frequency of association of an actor with outcomes that appear successful from the actor's presumed point of view (48). Political power lies in the essentially unsymmetric nature of a communication relation and appears by analyzing the interpretative differences and their peculiar interlinkages. Thus, the influencee might find himself increasingly involved in watching a popular television program while the growing popularity of the program helps the sponsor to sell his goods. For the one the program provides entertainment, for the other a convenient means to focus popular attention. To neglect such differences is to eliminate the possibility of inferring even the most rudimentary social relationships of communication situations from which such messages are taken.

And yet there seems to be no a priori reason for not allowing an analysis to account for those interpretational differences that provide reliable of possible dynamics of communication processes. Prerequisite for such analyses is, of course, the abandonment of the idea of content as something unique which is supposedly recognizably manifest in some physical stimuli for a large number of

individuals including the scientifically trained judge, or simply the rejection of the idea of an intersubjectively verifiable content.

In asking the question as to whose meaning is supposed to be categorized by a content analysis, Janis recognized that these messages may be different for different audiences or communicators whose signification responses are intended to be estimated. "The classification procedures of semantical content analysis... require the classification of sign-vehicles on the basis of the coordinated signification responses of some class of sign interpreters" (91:432). In this case the intersubjective verifiability is not abandoned but only limited to a specialized audience delineated in advance. Results that such an analysis can provide still cannot be expected to have significance in the light of a theory of communication.

But it is quite conceivable that a series of analyses of a given sample of communications could - assuming various information processing regularities that derive from the structure and constituencies of the communication situation - yield results that not only differ from each other but moreover make no attempt to represent something like signification responses of the persons involved. These analytical results, though not necessarily intersubjectively verifiable, may indeed provide the empirical basis for reconstructing the underlying communication network of the system under consideration as well as for inferring some of its inherent dynamics.

What we are arguing for is the liberation of content analysis from the idea of an intersubjectively verifiable content in order for its results to be relevant for a theory of communication. Since this content concept is so deeply built into the analytical technique its change would require considerable modifications of the procedure.

Content as Individually Realizable

A third quite serious theoretical issue is the dominantly psychological formulation of the content analytic process and hence the conception of content as only individually realizable.

By "psychological formulation of content analysis" we do not suggest that categories are held to be of psychological significance only. As Barcus' tabulation of the content analysis literature shows, categories of content refer more often to social matters such as prejudice, social stereotypes, majority and minority representation (31) or to political matters such as attitudes toward ideological complexes, pro and con fascism (111), political symbols (113) and values of elites (9). Berelson explains what the individual realizability of content encompasses:

In a sense, content analysis occurs whenever someone summarizes and/or interprets what he reads or hears . . . But in the more limited sense in which it is used here, content analysis denotes a . . . method . . . intended to provide precise and concise descriptions of what the communication says, . . . (160:iii).

As we have shown, Janis, too, presupposes a judge's ability to estimate the signification responses of a class of sign interpreters

to a given set of sign-vehicles. Whether content is here conceived of as the "what" that a communication "says," connoting a unique and manifest quality or whether it is viewed as an estimate of the signification responses that is intersubjectively verifiable with respect to members of a particular audience, it is always "someone" who summarizes, interprets or estimates an apparently otherwise intangible message characteristic. This is true whether this "someone" is a scientifically trained judge who becomes an essential part of the analytical procedure or whether it is a communicator and/or audience member who is regarded as providing validity criteria for the analysis, the meanings, significations, and contents are assumed to be housed solely in an individual human being. They are, so to speak, ethnocentral attributes.

As a consequence of this built-in conception of content as only individually realizable, one observer of content analysis, Schutz (171), whose definition was cited above, goes even so far as to declare that content analysis basically a psychological method of inquiry which is in this respect in agreement with Osgood's view. He correctly perceived that the content analytic procedure as currently followed is essentially analogous to the psychological technique of projective tests. Both, content analysis and such projective tests as the Rorschach and the Thematic Apperception Test, offer a person texts, visual displays and other material for a symbolic interpretation. The difference lies only in the interpretation of the results obtained in such situations.

While response variations in content analysis are assumed to be due to some characteristics in the material presented to the respondent, response variations in projective tests are assumed to be due to variations in the respondents personality. By controlling for reliability and forcing judges to follow explicit categorization rules, content analysis at least aims at setting possible personality differences of the respondents at invariance. Projective tests, on the other hand, try to standardize the relatively ambiguous material presented to the respondents and thus hope to gain certainty about the way mental mechanisms are expressed in the responses and the way in which elicited projections are to be interpreted reliably. While most of the tests are by now fairly well understood to "tap the durable essence of personality" (8), content analysis is in a triply difficult situation, for (a) the content categories are rarely ever standardized, (b) the universe of possible projections is virtually infinite and (c) there seems to be no adequate theoretical framework that could account for personality-independent projections elicited by the material presented.

In a self-critical moment, Lasswell and associates, whose work is almost entirely devoted to the content analysis of political symbols in the above mentioned fashion, admit that

...there is as yet no good theory of symbolic communication by which to predict how given values, attitudes, or ideologies will be expressed in manifest symbols. The extent theories tend to deal with values, attitudes, and ideologies as the ultimate units, not with the symbolic atoms of which they are composed. There is almost no theory of language which predicts the specific words one

will emit in the course of expressing the content of this thought. Theories in philosophy or in the sociology of knowledge sometimes enable us to predict ideas that will be expressed by persons with certain other ideas or social characteristics. But little thought has been given to predicting the specific words in which these ideas will be cloaked. The content analyst, therefore, does not know what to expect (113:49).

In a situation that lacks adequate theoretical frameworks, not to speak of established theories, the ease with which individually realized message characteristics are projected onto socio-political structures seems surprising, especially since judges are considered to be scientifically trained. But even if some certainty could be gained concerning this critical theoretical issue, when data are obtained from more complex social systems it is quite conceivable that the concept of content as an individually realizable message characteristic is entirely inadequate for providing information about viable structures of that system simply because the information processing capacity of an unaided human individual is fairly limited and even more restricted by particular points of view that are inevitably acquired.

Let us consider a very common example from the customary empirical domain of content analysis: products of modern mass culture in industrialized societies such as books, records of popular music, television shows, fads or fashions, popular celebrities. While these messages are distributed on a mass basis to very large audiences whose members enjoy them and respond to them more or less as individuals they are undoubtedly the outcome of highly

organized collaborations of man and machines, each participant of which fulfills specialized functions in, derives motivations and obtains rewards from those complex organizational frameworks.

It is, of course, always possible to apply a psychologically based content analysis procedure to industrially produced messages and come up with some subjectively satisfying description of their characteristics which may - in a case that is considered ideal in content analysis - even be congruous with the signification responses of those audience members toward which the communications were directed. However, the discovery of antecedent conditions of such communications which go beyond the habitual interpretations by single individuals must escape a concept of content as an individually realizable characteristic. Members of mass media audiences perceive only the front of a stage made up of authors, actors, simple interpersonal relations, social situations or features purposefully cultivated about them. Judges chosen from such audiences are more likely to achieve reliability along habituated lines.

The incapability of an approach to content analysis that is limited to the individual realizability of content refers specifically to the impact of more complex, super-individual, socio-technological structures of which the nature of the mass produced messages seems to be the outcome. The personification of modern governmental machineries or of international relations is a symptom of this incapability. Or, to stick to our example of mass media products, that under these conditions individual authors are still associated with them is but an

unconscious remainder of pre-industrialized culture and a useful sales argument skillfully manipulated by the cultural industry at large. As Adorno put it vividly: "To study television shows in terms of the psychology of the authors would almost be tantamount to studying Ford cars in terms of the psychoanalysis of the late Mr. Ford" (3:482).

Even Adorno, who in opposition to the intersubjective verifiability of content suggested consideration of "various levels of hidden messages" for analysis, is still limited to its individual realizability, although he regards content within a social psychological framework. This concept of content as individually realizable message characteristic allows for individual differences in interpretation but can treat neither communicator nor audience as an organization but as an agglomeration of individuals. The difference appears, for instance, in the multiplicity of aspects under which the successful communication industry tends to view its own products and the singleness with which such a product appears to an individual. This multiplicity of functionally interlinked 'contents' which reflect the complexity of a social communication network may, in fact, be purposefully reduced to a simple single interpretation on the part of an individual consumer.

Whenever sufficient evidence exists that participants in a communication situation are independent individuals or that its participants can be viewed as an agglomeration of people without too much loss - as it may be justifiable for the typical audience of modern mass media - the concept of an individually realizable content seems

perfectly adequate. But whenever messages mediate between social structures of some complexity, i. e. are the outcome of a non-random interaction process of which individuals are constituent participants, the analytical use of this concept of content must lead to faulty results. The fact that virtually no objections to content analysis have been raised along this line can be considered indicative of the content analyst's position in this situation. While practically and theoretically incapable of analyzing the content of a given message as it pertains to an interpretation on the part of the complex social organization of the mass media, he is severely bound by the nature of the popularizations, the images and points of view that the communication industry tries to create and maintain and can do nothing but conform in seeking validating support for his analysis in the happily individualized mass media audience.

A psychologically formulated content analysis that is based on the individual realizability of content could almost be paraphrased as an attempt to replicate or represent aspects of subjectively meaningful cognitive processes that are evoked by some stimuli whereby these aspects are regarded as symbolic manifestations of the psycho-social environment of the subject. The ease with which such individual realizations are customarily projected onto social structures, or its reverse, i. e., social events are studied through the cognitive processes of their participants, has had no suitably formulated theoretical basis but a long history and continual support by western

philosophies who have defined signs, symbols, language etc. in such a way that they uniquely segregate man from animals on the one hand and individual from society on the other. A concept of content that is super-individually realizable is virtually nonexistent.

When communications between social organizations are intended to be the subject of something like a content analysis the relevant messages must be expected to exhibit an extremely complicated "grammar" and "semantics" and tend to contain much more information than a single human being may be able to process. Thus the analysis of the products of such social organizations as the mass media industry, political parties or whole cultures as messages, and in terms of the dynamics of the underlying communication networks, must be assumed to be very involved. Analyses of this magnitude necessitate adequate theoretical frameworks within which scientific teams can cooperate effectively and elaborate investigative tools can develop.

Very little has been done to enlarge the scope of content analysis beyond the boundary that the individual realizability of content imposes. Perhaps Hall's insightful interpretation of culture as a gigantic communication process should be noted as an example. Unfortunately, his attempt to develop a "vocabulary of culture" of which messages transcending the lifetime of individual human beings are thought to be composed (81) has not found empirical applications.

We have focused on three theoretical-conceptual issues that seemed most critical in implicitly delineating the scope of content

analysis. As far as one can speak of a concept of "content" in psychological tests involving symbolic responses it is most certainly conceived of as an individually realizable quality of the material presented. When one attempts to suppress the effects of personality variables on such symbolic interpretations and then proceeds to extrapolate from these interpretations to the possible signification responses of communicators and/or audience members of a communication situation, "content" then becomes moreover an intersubjectively verifiable characteristic. Indirect validation makes necessary, and the volume of material typically analyzed favors the view of "content" as a permeating characteristic of communications. Although these critical theoretical issues are completely independent of the methodological dilemma in content analysis they are closely related to the way trained judges and their non-formalized content concept are explicitly and exclusively used as crucial constituents of the analytic process. After elaborating on the practical consequences of these theoretical issues it is now appropriate to focus briefly on some of the potential breakthroughs.

One of the legacies of propaganda analysis in World War II are some sound objections to content analysis and the rudimentary form of a theoretical framework for a new approach. Although the permeation of moods, tensions and anxieties in domestic propaganda were also of interest to the policy makers of that time, they placed more value upon predictions of military actions and inferences concerning expectations of the governing elite. While the analysis was used in

this context rather pragmatically and explicit descriptions of the theoretical assumptions and propositions were not attempted until after the war, (71) it became quite obvious that an analysis that was based on a concept of content as elaborated above was not very likely to bring about the desired results. Account had to be taken of the social structure of the governing elite, their decision-making situation, and in particular the position of the propagandist within that elite and in relation to the population to be mobilized. The conventional content became merely a vehicle through which specific insights could be gained, and not the object of description. This inductive element which is quite alien to content analysis as an investigative technique is already manifest in the interest of the propaganda analyst as stated by George:

In propaganda analysis, typically, the investigator is interested in inferring one or more of the following antecedent conditions of the propagandist's communication: his propaganda goals and techniques; the estimates, expectations, and policy intentions of the leadership group for whom the propagandist is speaking which have influenced the adoption of a particular propaganda strategy; the situational factors or changes which have influenced the leadership's estimates, expectations, and policy intentions and/or the propagandist's choice of communication goals and techniques (70:18).

According to George the propaganda analyst proceeds through a series of inferential steps from the most obvious linguistic features of a message to those of interest to the analyst. While the traditional content analyst takes into consideration only what the communication manifestly "says," the propaganda analyst assumes such surface appearances to be subsumed under a propaganda strategy which is to

be inferred as a first step in order to get at elite intentions, expectations etc. George argues that this "indirect method requires logic-of-the-situation reasoning and the use of generalizations other than the one-to-one type of correlation between a content indication and an aspect of the elite's political behavior or situational milieu" (71:43).

Making inferences from texts as to their antecedent conditions or possible effects became also the concern which seemed to unite the efforts of many participants at the working conference on content analysis mentioned above. Here Osgood remarked that there seems to be a "general natural law" relating the nature of a message with the nature of its producer and it appeared that the analysis of messages is very much concerned with some such law. Elaborations on some such law. Mahl's "Exploring Emotional States by Content Analysis" showed, for example, how speech disturbances such as superfluous repetitions, hesitations, stuttering, and sentence corrections may be used clinically as indicators of an individual's state of anxiety (124). Note that such speech disturbances are traditionally not considered subject to semantic analysis and have certainly little to do with signification habits or meaning in the common sense of the word. Saporta and Sebeok made a similar point in their paper on "Linguistics and Content Analysis:" "presumably, deviations from the structural norms in the formal characteristics of messages would then be correlated with differences in the intentions, behavioral states, in short, with some non-linguistic conditions in the producer of those messages" (169:131).

While Mahl based the validation of his analysis on some kind of intersubjective verifiability, namely, on a high correlation between the judgements of experienced psycho-diagnosticians with the measures obtained, Osgood sought validating evidence for his inferences in psychological experiments. He could show "that contingencies among events in messages are indicative of the association structure in the source and predictive of the association structure that may result in the receiver" (147:73). The "association structure" that can be inferred from contingencies in messages can be regarded as a theoretical construct that has its roots in classical associationism in psychology and has been used to explain a variety of behavioral phenomena. While Osgood's contingency analysis provides a tool for the description of a particular message characteristic that is quite different from simple frequency characterizations, the meaningfulness of its results is rendered only under the assumption of a particularly psychological theory of human cognition. Thus, contingency analysis as an analytical tool remains entirely descriptive. As a technique for counting some identifiable co-occurrences in messages it does not offer a method for making inferences from messages.

When analyzing a written text a psychological point of view suggests itself immediately, for the text having been produced by an individual author can most obviously be expected to reflect non-linguistic features of that author. Even the analysis of Nazi propaganda had to consider the personality and propaganda habits of Goebbels

as a first step. Less specifically psychological in orientation is a statement by Gerbner, who took up the main argument advanced in propaganda analysis and at the conference. He wanted to "see in content the basis for inference about specific functional relations between the communicating agent or agency and other events or systems, and about actual or potential consequences" (74:87), and not as a kind of objective summary of what the message says to someone. For him, "a 'communication' is... a specialized, formally coded or representative social event which makes possible inferences about states, relationships, processes not directly observed. The 'process' of communication is the transmission of such events and sharing of certain inferences. The 'content' of communication is the sum total of warranted inferences that can be made about relationships involved in the communication event" (74:86). The above statement was part of an attempt to introduce a conceptual framework for content analysis in mass communications research. But the paper containing this statement did not go so far as to outline how such a view can be implemented on a practical basis. According to Gerbner² this formulation has not found any reflection in empirical research, which is rather unfortunate.

A recent review of "Trends in content analysis" by Stephenson led to the conclusion that in the focus on methodological problems of computing data, "Osgood's contingency analysis, for example, merely

²George Gerbner, personal communication to the author, February 1966.

sidetracks genuine communication problems, providing complications of facts which have no relevancy to such problems. A return to earlier formulations, and to real problems would provide the necessary theoretical basis for sound theoretical use of content analysis" (186:155). But Stephenson also neither offers any convincing argument for a re-orientation of the goals of content analysis, nor specifies the critical issues of such computational techniques from a theoretical point of view.

Since the conference on trends in content analysis no significant theoretical contributions to content analysis have been published. Numerous applications in sociology, psychology, communications research and linguistics rarely indicate a departure from those traditional research ideas which have already been suggested by Berelson and Lazarsfeld (30) Berelson (27) (28) and recently been reviewed by Pool (162). Perhaps a handbook by North and others is worth mentioning. It discusses some of the more sophisticated procedures for analyzing historical documents in reference to situations of international conflict (142). But, this work as well as Holsti's yet unpublished review of content analysis (83) and Stone's report on his work with the General Inquirer computer programs (188) (189) (190) do not provide new theoretical insights either, and Stephenson's unexplained dissatisfaction applies as well.

Summary

This is essentially the current state of content analysis. Its critical issues show more unsolved problems than resolutions. Already the definitions that have been advanced in the cause of its development and that ought to have distinguish this mode of inquiry from others are by and large insufficient. Neither do they unambiguously delineate the empirical domain to which the method is presumably applicable, nor do they clearly assert toward what use such analyses may be put. The few attempts to specify analytical procedures that are typical of this mode of inquiry are either too narrow or have been shown to easily lead to methodological inadequacies that may render content analysis a method full of fallacies and hence, unacceptable on intellectual grounds.

The more carefully the habitual use of this investigative technique is examined, the weaker does its theoretical foundations appear. It seems that the intentions of the content analysts and their claims often run far ahead of their understanding of the constraints that are built into particular methodologies. Part of the difficulties, it seems, stem from unnecessary commitments regarding explicit procedures of enumeration and computation that have been useful in other domains of empirical inquiry but are apparently alien to the study of the content of messages. If data are subjected to an analysis because of their known or assumed "semanticity" or "referentiality," their "symbolic nature" or by virtue of the fact

that they are "about" something else, or have "content," then it must be argued that specific methodological requirements have to be met which may be irrelevant where such assumptions are inconsequential.

Rather than systematically working to eliminate methodological defects and to enhance the power of theoretical frameworks, whether consciously or not, content analysis seems to have frequently made use of its techniques for reason other than that of gaining verifiable information from available data. The peculiar historical origins of this undertaking may account for this use.

The current state of content analysis seems all the more unsatisfactory considering the fact that the method today constitutes probably the most fundamental tool in communications research and in the social sciences as far as they are concerned with the exchange of messages of any kind.

CHAPTER THREE

TEN WORKING EXAMPLES

As has been shown in the previous chapter, the current conception of content analysis as an investigative method is unsatisfactory in numerous respects. This makes it difficult to conceive that a redefinition of this widely used term will bring about the desired adequacy. The strong associations between these previously elaborated insufficiencies and the term "content analysis" alone justify the introduction of another, broader, and intuitively more satisfactory name for our subject matter: message analysis.

What is meant by "message" will be clarified later. For the moment it suffices to assume the intuitive notion of a "message" as "a communication about something not identical with the materiality of that which is transmitted." A letter could, for example, be considered a message on the ground that it tells a reader something about something other than the paper and ink of which it consists. But the notion of message becomes more interesting if it is extended beyond its conventional interpretation to include, for example, the products of popular mass media if they indicate to an analyst some antecedent condition of their industrial production or omission, or allow him to predict the possible socio-cultural consequences of their existence. On the other extreme this notion should be broad enough to encompass non-verbal behavior of which the individual may not be aware.

Graphology would be an example of this extreme (214).

In the light of the previous criticism it does not seem feasible to start-out by defining what message analysis IS or how it OUGHT to be understood, but rather to ask what problems are solved with it and what methods are employed when data are considered as messages in the above-mentioned sense. Therefore we begin to describe various incidents in which directly observable phenomena were treated as a message about something else. In order to emphasize the generality of our concern the ten examples which are chosen below refer to a wide range of areas, some of which appear to deal with problems of message analysis only on second inspection.

Working example I, for instance, describes the decipherment of a language, a classical problem of archaeology. A historically interesting case of what is called "quantitative semantics" is reported as working example II. Cryptography provides the working example III. From literary research working example IV could be taken. Working example V is an example of war propaganda analysis. The use of propaganda analysis for intelligence purposes is exemplified in VI. The authors of working examples V, VII and VIII are committed to communications research, each from a different point of view, but all dealing with mass media products of one kind or another. Working examples IX and X are included to show the role computers may play in message analysis with X as a specific application to psychodiagnosis.

The working examples are assumed to provide a sufficiently broad support for the generalizations concerning the goals of such an inquiry, the analysis of the underlying methodological pattern and a statement of the specific empirical problems associated with message analysis which are attempted in succeeding chapters.

Working example I

One of the traditional subjects of archaeology is the inquiry into hitherto unreadable records pertaining to ancient cultures. "The greatest single task of decipherment ever performed" is, according to Pratt (164:19), the decipherment of the old Persian script. Although this accomplishment belongs to the history of science, it may provide a good illustration for a certain type of message analysis although a replication of such an incident is improbable.

During the 17th century, when many European travelers discovered origins of civilizations in the Near East, several inscriptions were copied from the rocks of old Persian ruins and published as mysteries along with the travel adventures. Neither the purpose of these inscriptions, nor the language in which they were written was known.

According to Doblhofer (52:81-113), our main source for this example, the first contribution to an understanding of these cuneiform characters was evidence provided in support of the hypothesis that the inscriptions were written horizontally and not vertically as was assumed at that time. Years later Carsten Niebuhr, mathematician,

engineer and archaeologist, discovered that the inscriptions belonged to three different writing systems. He concentrated on the first, distinguished 42 different characters but could not make sense out of the extensive frequency tables he compiled.

After he died the orientalist and librarian Oluf Gerhard Tychsen continued. He correctly assumed that the role of one of the characters which appeared with a frequency unusual for natural languages is that of a word-distinction-marker. His knowledge of philology led him to conclude that the three writing systems discovered earlier belonged to three different languages, the first based on an alphabetical, the second on a syllabic and the third on a word script none of which was known. But two important mistakes led him into a blind alley. The one was that he tried to assign phonetic values to the characters in the hope of finding a language close enough to give meaning to the words. He obtained only gibberish. The second was a misdating of the Persian inscriptions.

Friedrich Christian Karl Heinrich Munter paralleled the discoveries of Tychsen but, being in addition familiar with the medieval Persian usage of titles, he reasoned that if the seven characters which had already been noted to be repetitious in the inscriptions, refer to "King" and "King of Kings," then the preceding word should be a personal name. This was all he could achieve during his lifetime.

Then came George Friedrich Grotefend, no orientalist, but a thorough philologist and historian with broad interests and a

predilection for mathematical puzzles. He knew enough of medieval mythology and was sufficiently equipped to place the many hypotheses which had been accumulating in a proper historical context. Herodot, with whom he was thoroughly familiar provided him with lists of names from which he had to select. The fact that these three writing systems had also been found together on clay plates indicated a period in which three languages had to have been used simultaneously. This period had to coincide with the names of three successive kings if Munter's hypotheses were correct. The Greek names of kings satisfying such a condition could then be identified but old Persian was an unknown language. Happily, their translation into medieval Persian corresponded to the number of characters at the appropriate places. So Grotefend gained the total of 13 letters and several other word interpretations consistent with the mythology handed down through history, and with what became independently known about those places where the inscriptions were found.

The comparative philologist Ramus Christian Rask could correctly determine the genitive plural of "king" after other inscriptions became available. Then Engene Burnouf published a new cuneiform alphabet and suggested that several of Grotefend's interpretations were wrong. The indologist, sanscritist and historian Christian Larsson, being equipped with thorough knowledge of the documents pertaining to the historical period and area in which the script presumably originated, could suggest certain

very probable interpretations of the situation in which the texts were written. His work resulted in a new alphabet which already contained 23 phonetically correct determined letters. Later several missing signs were independently interpreted by E. E. F. Beer, E. V. St. Jacquet and others. The final and probably most inclusive contribution to the decipherment of the old Persian script is due to Henry Creswicke Rawlinson, who as British representative in this area discovered numerous monuments with similar inscriptions and could--in cooperation with the ongoing research in Europe--complete the task in the middle of the 19th century. The script could then be transcribed and the documents translated into modern languages capable of denoting what the inscriptions presumably referred to.

The working example represents, of course, an extreme case of message analysis. The obstacles which had to be removed to achieve a correct reading of the records were so great that it occupied the lifetime of four generations of distinguished scientists. Therefore the case illustrates most clearly some of the steps required for such an analysis and the kind of knowledge brought to bear on such a problem.

Working example II

18th century Sweden provides an example where a religious controversy was decided by applying certain rudimentary quantitative techniques to written text. The incident is documented by Dovring (55) (56) and involved a collection of 90 hymns, entitled "Songs of Zion."

The songs of unknown authorship passed the state censor and were published several times during a period when the powerful state church felt undermined by various religious movements. Disobedient behavior was observed, and suspiciously enough those people using the songs dared to choose their preachers according to their preferences, leaving empty the churches to which they were assigned. The popular ministers soon became associated with a religious sect, the Moravian Brethren, and the orthodox clergy accused the songs of being "contagious," carrying "dangerous ideas" which "may have disastrous consequences for the whole Swedish state."

The controversy soon crystallized around the question of whether the apparently quite popular songs were in fact the carriers of those disintegrating thoughts or not. The accusation seemed, however, quite pointless. The frequency distribution of significant symbols in the songs showed close resemblance to the one in the official hymnal of the established church and no obvious difference between these two song books seemed to justify the prediction of "disastrous effects."

However, the clergy and intellectuals involved in this controversy were not only well read but also had continual access to foreign newspapers. A study of the German literature written in opposition to the Moravian movement revealed that the sect used a "special language" in the dissemination of their "dangerously diffuse doctrine." Their ideas were dressed in the ordinary language of each country's native tongue but new meanings were given to well known words,

themes and symbols. Because of the familiarity of the words and phrases used by the Moravians, the public was not aware of being exposed to a new way of thinking. According to Dovring, the learned clergyman "Kumblaeus felt that this use of language made it possible for the Moravians to conceal dangerous, false doctrines, and to create 'a state within the state'" (55:392).

Kumblaeus then devised a kind of key-symbol-in-context method in order to recover the apparently concealed information. This method not only significantly distinguished the songs from the official hymns, but, moreover, clearly brought to light some of those features of the "special language" which had been described in the literature to be indicative of the Moravian Brethren's propaganda technique. Supplemented by other "tests" and further "interrogations" the analysis led to the irrefutable conclusion that the songs indeed represented a link between the religious dissenters' behavior and the activities of the Moravian movement.

The example refers probably to the first well documented incident in the history of message analysis in which non-conventional indicators of written text (i. e. not based on conventional or dictionary meanings of words) were used to draw inferences as to possible communication links. Although the analytical tools employed were not highly developed, Dovring claims that a reconsideration of the investigation with modern scientific methods of quantitative semantics confirms the "correctness of many of the accusations made by the orthodox clergy" (55:394).

Working example III

The history of the concealment of information goes back to the Greeks who supposedly first made this art purposefully subservient to the needs of diplomacy and the army. But cryptography, as the science of secret communication is called today, reached its highest significance when the organization of big armies started to rely on wireless telegraphy, a medium of communication which could easily be overheard by an opponent. But simultaneously with the advance of secret codes arose the skill to break them. Many war situations therefore depended on whether the cryptographer of one side could outwit the one on the other, by analyzing those messages the content of which were intentionally concealed from him.

Pratt (164:183-187) vividly describes how Union cryptographers during the American Civil War scored their most spectacular success. In fall of 1864 the Union operations in the southwest were not prospering. General Canby commanded there for the Federals and his problem was what Kirby Smith's Rebels meant to do. The rebels were lighter and moved faster than Canby could; unless he figured out their intentions in advance he would have to guard every point at once, an undertaking for which sufficient troops were not available.

Just at this time three documents were transmitted to Union headquarters in New Orleans. One was a telegram partly cipher, partly clear, that had been taken from a tapped Confederate wire:

September 30

To Genl. E. K. Smith:

What are you doing to execute the instructions sent you to HCDLLVW XMWQIG KM GOEI DMWI JN VAS DGUGUHD MITD. If success will be more certain you can substitute EJTFKMPG OPGEEVT KQFARLF TAG HEEPZU BBWYPHDN OMOMNQGG. By which you may effect O TPQGEXYK above that part HJ OPG KWMCT patrolled by the ZMGRIK GGIUL CW EWBNDLXL.

Jeffn. Davis

The second was a telegram which had been intercepted two years before, looking somewhat similar to the first.

Vicksburg, Dec. 26, 1862

Gen. J. E. Johnston, Jackson:

I prefer OAAVVR, it has reference to XHVKJ QCHFF IBPZE LREQP ZWNYK to prevent PNUZE YXSWS TPJW at this point. ROEEL PSGHV ELVTZ FIUTL ILASL TLHIF NOIGT SMMLF GCCAJ D.

J. C. Pemberton

With the third document came a note saying that it probably is the original clear of the second. It had been found among the captured Confederate papers at the fall of Vicksburg and corresponded in date, phraseology, and number of letters:

I prefer Canton. It has reference to fortifications at Yazoo City to prevent passage of river at that point. Force landed about three thousand, above mouth of river.

The cryptographic department at New Orleans was sufficiently familiar with the Vigenère tableau, a device by means of which the clear of a message could be transformed into a cipher according to a

variable key. It was discovered that the Pemberton message of 1862 was written by means of that device. With the ciphered message and its clear, the key "MANCHESTER BLUFF" could be worked out, for the process of extracting the key is in the Vigenère tableau just the reverse of enciphering the message. But this was not the key for the message to Smith.

Like the Pemberton message, the telegram included passages in clear; the irregular grouping of the letters seemed, moreover, to indicate word divisions. In particular the last sentence of the message had a peculiar suggestive structure to the cryptographer:

BY WHICH YOU MAY EFFECT * ***** ABOVE
 THAT PART ** *** ***** PATROLLED BY THE
 ***** ***** ** *****.

The only patrols in that part of the world and of the war were the naval gunboat patrols on the river. He tried "of the river" between "part" and "patrolled" to extract the key and got "TE VICTORY C," a perfectly sensible fraction which could not possibly have been the result of a fortuitous process.

However, the key was still incomplete, especially its beginning was missing. The longer word at the end of the message seemed to offer several possibilities, but the one-letter word followed by another eight letters could only be an "a" and for the eight-letter word the cryptographer could think only of "crossing." Again he tried to extract the key and obtained "ORY COMPLE." The two fractions appeared successive in the message, hence, giving "COMPLETE

VICTORY" as the key to the decipherment.

Beyond any doubt the message could now be read. It ordered Kirby Smith ". . . to forward troops to the east side of the Mississippi . . ." and contained precisely that information which Canby needed to plan his campaign.

In comparison with I and II this working example is probably most restricted. Perhaps just because of it, it provides an illustration for a message analysis in which the structure of the message is fairly simple and well understood in advance but the sheer quantity of combinatorial possibilities goes and is typically intended to go far beyond the possibility of achieving an interpretation by trial.

Working example IV

Literary historians find themselves frequently engaged in the identification of authors of unsigned documents. Controversies as to whom Shakespeare's plays can be attributed, whether or not St. Paul wrote the epistle to the Ephesians, and in which sequence Plato wrote his works, are still partly unresolved.

Probably the first sophisticated quantitative approach to such problems was presented by Yule in his book The Statistical Study of Literature (217). The unidentified document which provided the challenge for this investigation was a small but well-known volume entitled De Imitatione Christi et Contemptu Omnium Vanitatum Mundi henceforth called Imitatio. The authorship was and still

seems to be vigorously disputed. Among the candidates to which the book was ascribed are St. Bernard, St. Bonaventure, Pope Innocent III, Gerard Groote, and most prominently Thomas à Kempis (1379-1471) of the diocese of Cologne, and Jean Charlier De Gerson (1363-1429) of Paris University.

Yule argued that "words are to the writer what paints are to the painter, the materials at his disposal for the purpose of creation" . . . and in order to answer any question concerning the authorship of a piece of literature "every element of that highly complex quality of the author's style may and should be taken into account, but amongst those elements his vocabulary -- the aggregate of words he uses -- takes an important position. It is a definite characteristic," (217:1). Consequently vocabulary samples were taken from the theological work of Gerson, from miscellaneous works of a Kempis and from the unidentified Imitatio itself.

While working on these texts, Yule perceived an analogy between his data showing numbers of words used once, twice, thrice, etc., and data showing number of persons of a finite population being involved in 0, 1, 2, 3 . . . accidents during a given period of exposure. The theory of accident distribution had received a great deal of attention during that time and led him to develop several statistical indices by means of which various features of the vocabulary distribution within written texts could be comparatively stated.

Supplemented by numerous data concerning variations of these indices within the different works of one author, concerning variations among different authors writing in the same subject area and data about sampling effects, the three documents in question could be compared. The vocabulary indices of the Imitatio exhibited a considerably higher degree of resemblance with the ones of the admitted works of à Kempis than with those of the theological works of Gerson. From this indirect evidence Yule concluded with a high degree of confidence that Thomas à Kempis was the author of the Imitatio and not the alleged Charlier De Gerson.

This example is of interest in several ways. While the previous working examples dealt in some sense with conventional meanings either directly (I), indirectly (II), or as a check for the plausibility of the inference (III), Yule did not rely on such meanings in predicting the deceased originator of a document. His work can also be considered as the first attempt to use statistical methods not just in support of an otherwise independent inferential argument, but as an inferential method. We will refer to this method later.

Working example V

In late 1939 U.S. legislation required the registration of foreign agents with the State Department. The measure was intended to disclose the identity of persons employed for the dissemination of "antidemocratic propaganda." In conjunction with the enforcement

of such legislation, Federal courts accepted the results of quantitative methods of content analysis as evidence.

Among the most prominent cases one "involved a corporation engaged chiefly in the dissemination of books, periodicals and other publications. Although a subsidiary of a foreign government (the USSR), 'Bookniga' had failed to register. . . . Transocean G. m. b. H., a news agency, was likewise indicted for failure to register, since it was a 'corporation organized and existing under and by virtue of the laws of Germany'" (111:177). The government asked Lasswell to provide judicial evidence for answering the question of whether the information disseminated is linked to a foreign government and can hence be considered to be propaganda.

Lasswell and associates (111:173-232) developed a set of eight tests with implicit standards for accepting hypotheses concerning links between foreign governments and information disseminated in the United States:

The avowal test: a simple but not very reliable test making use of explicit declarations with one side of a controversy. For instance Lasswell et al. compared the relative frequencies with which publications described themselves as authorities in what they had to say about the USSR in order to ascertain a possible link to this country.

The parallel test: a test designed to compare statements and themes which appeared in the publications in question with

those of a known foreign propaganda channel. In the Transocean case Lasswell found for each incongruent statement, 23 statements congruent with Nazi themes.

The consistency test: a test to compare the consistency or inconsistency of attitudes expressed with the declared propaganda aims of a party to a controversy. The analysis of public pronouncements by Nazi party and governmental officials led to a set of propaganda aims on the basis of which the affinity of various publications to Nazi objectives could be exhibited.

The presentation test, a test determining the balance of favorable and unfavorable treatment given to a controversial issue. For example, in Moscow News, distributed by Bookniga, the number of favorable references to the USSR outnumbered the unfavorable ones by more than 600 to 1 while the favorable references to other countries were outnumbered by unfavorable ones in the proportion 5 to 1.

The source test: a test designed to establish the balance of sources relied on regarding a controversial issue. Lasswell found that Moscow News relied exclusively on acknowledged governmental and party sources in Russia.

The concealed source test: a test involving detailed text comparisons in order to discover the origins of the information disseminated.

The distinctiveness test making use of vocabularies peculiar to the propaganda source. Distinctive vocabularies such as party slogans, Fachsprachen can be indicative of dominant ideological

orientations. Lasswell compiled a list of key political terms from Russian newspapers: bourgeois, class, class struggle, collectivism, collective and state farms, commissariat, comrade, soviets (councils), diversionism, exploitation, . . . such terms appear quite alien when translated into fluent English text and can be utilized to indicate the origin of the text in question.

The distortion test: "Objective reporting" does not necessarily present all details of a controversy but only those an agency considers essential. The nature of the omissions and additions, obtained by comparison, are therefore of considerable interest. For example Transocean and the New York Times were compared on some sample days. A contingency table revealed that 58% of the additions by Transocean favored foreign propaganda aims while only 3% contradicted them. Of the themes omitted by the suspected agency, 48% were contradictory to foreign propaganda aims and 16% in favor of them. In reference to other newspapers in this country the suspected agency carried a comparatively larger portion of pro foreign distortions (as implicitly defined in the method employed).

The objective of this example of quantitative content analysis is closely related to the one of the Swedish state church (II). It represents however, one of the first attempts to systematically extract information from the mass media and makes use of more advanced methodology.

Working example VI

During World War II all major powers monitored the mass communications media of other nations, opponents, allies or neutrals. Mass communication in general and broadcasting in particular were largely responsible for organizing socio-political actions on a grand scale, and offered useful intelligence as to the internal states of a nation at war, her morale, intentions, expectations, capabilities, etc.

One type of intelligence of particular interest to the policy makers is the prediction of a governing elite's planned major initiatives and actions. Such interests bestow relevance to "questions concerning the timing of the action, its precise nature and magnitude, its exact location, the objectives assigned to the action, the elite's expectations concerning its success, and the extent and nature of any opposition to that particular initiative within the elite group." (71:133)

"In one of the outstanding cases of propaganda analysis on record, British content analysts were able to infer that Nazi propaganda talk about forthcoming use of a secret, unconventional air-bombardment weapon was no bluff. This inference was made in November, 1943, eight months before the inception of the V-1 'buzz-bomb' attacks.

"Promises that Germany would have a reprisal weapon, which began to appear in German propaganda as early as June, 1943, were obviously intended to bolster domestic morale, which had been badly shaken by increasingly heavy Allied raids to which Germany seemed to have no answer. If the propaganda objective of such promises was obvious enough, the questions remained whether such talk was mere propaganda or whether a new reprisal weapon was actually being

prepared for use on a militarily important scale in the near future. The British analyst answered these questions affirmatively with considerable confidence. His inference rested upon the fundamental assumption, confirmed on many past occasions, that 'German propaganda never deliberately misled the German people in matters involving an increase of German power.'

"The British propaganda analyst also inferred that the prolonged delay in the appearance of the new reprisal weapon -- after it had been repeatedly and authoritatively promised to the German people -- must have been due to delays in its timetable not anticipated when the propaganda commitment was made. This inference was supported by the observation that it was Goebbels' practice not to make an important propaganda commitment of this character too far ahead of the date when he expected it to be realized. Thereby, he avoided aggravating domestic morale, which would be quickly affected by resentment over false propaganda promises. The propaganda analyst even estimated the maximum period of time -- about three months -- that Goebbels would allow himself for propaganda anticipation of the event. Hence, when the promised reprisal weapon was delayed appreciably beyond the time period, the analyst concluded -- correctly -- that the scheduled employment of the new weapon must have been unexpectedly delayed. He even identified the approximate dates on which something had happened to cause the delays.

"The British analyst noted that references to air reprisal by means of new weapons suddenly dropped out of German propaganda for ten days beginning August 19, and later for seven days beginning September 11. . . . He found that the 'gaps' did not coincide with 'other events' and, significantly, that the propaganda commitments on reprisal and new weapons was watered down when such propaganda was resumed after each 'gap.' The necessary explanation, then, was that something had happened just before each of the 'gaps' that was connected with the preparation and scheduling of the new reprisal weapons. (An implicit assumption was that shifts toward increased ambiguity in propaganda time commitments regarding date of reprisal -- a shift that had in fact occurred after each 'gap' -- reflected an official Nazi estimate of a further delay in D-day for the new weapon.)

"... He then was told of the British air raid of August 17 on the secret weapon station at Peenemunde and the Allied air-raids of September 7-8 on installations in the Boulogne-Calais area which were suspected of being launching platforms for a new type of German weapon. . . . (thus), his inferences provided additional confirmation of the significance of the targets (not fully certain at the time) and of the effectiveness of the raids in disrupting Nazi reprisal preparations" (69:341-342).

After the war, George (71) attempted to rationally reconstruct some of the procedures the propaganda analysts had followed. These attempts were facilitated by the fact that many propaganda analytic reports listed the evidence, reasoning, and more or less explicit models of the situation on the basis of which the inferences were drawn. Moreover, historical documents, now available, permitted verifications of the inferences made and, hence, an indirect evaluation of the methods employed.

We will refer to some such methods later in detail but at present another illustration of propaganda analysis will make some additional points.

Working example VII

Speculations regarding the power structure and policy differentiation within the ruling elite of a foreign nation have always been of interest to students of politics. For various political reasons information regarding the structure of such an elite is likely to be withheld, a fact that makes the confirmation of political hypotheses extremely difficult.

Stalin's seventieth birthday, December 21, 1949, provided a rare opportunity for an analysis of policy orientation and degrees of influence of various members of the Politburo. On this occasion the speeches by members of the Politburo and other officials were published in Pravda and Bolshevik. Such speeches, it was hoped, would shed some light on the then frequently debated problem of succession.

Leites, Bernaut, and Garthoff who undertook the task of analyzing these speeches wrote "while the statements mentioned appear at first glance to express the same adulation of Stalin, they do contain nuances in style and emphasis" (118:317). Being well aware that these statements were made publicly, i. e. not only or at least not exclusively addressed to Stalin, but prominently directed to the masses of readers, the style and emphasis was assumed to be a reflection of the speaker's political position.

The characteristics relevant for an indication of such positions, Leites et al. argued, lie in the modes of expressing nearness. For this, the Soviet use of language provides two distinct approaches. One set of "symbols of nearness and intimacy (father, solicitude, etc.) appear most frequently in the popular image of Stalin and (is) stressed for that audience which is far removed from him." The other set of symbols derives from the prevailing "deprecation of such nearness in political relationships. The ideal party member does not stress any gratification he may derive from intimacy for political ends. . . . Those closer to Stalin politically are permitted to speak of him in terms of

lesser personal intimacy ('leader of the party,' etc.), " are privileged to refrain from the crudest form of adulation. The relative emphasis on the Bolshevik image or on the popular image of Stalin therefore "not only reflects the Bolshevik evaluation of the party as distinguished from, and superior to, the masses at large, but also indicates the relative distance of the speakers from Stalin" (118:338-339).

Leites et al. counted the number of references made by each speaker to the Bolshevik image and to the popular image of Stalin as well as to images that are ambiguous with respect to the former and presented their results tabularly. The table suggested the existence of three major fractions within the Politburo. The fraction consisting of Molotov, Malenkov, and Beria (in this order) having the highest number of references to Stalin's Bolshevik image and hence being probably closest to Stalin.

For convenience of presentation we used the tabulated results by Leites et al. and computed the relative political distance D between Stalin and each member of the Politburo on the basis of their assumptions as follows:

$$D = \frac{N(\text{popular}) + 1/2N(\text{ambiguous})}{N(\text{popular}) + N(\text{ambiguous}) + N(\text{Bolshevik})} \quad 0 \leq D \leq 1$$

whereby N represents the frequency of respective references to Stalin's images. Accordingly the following rank order was obtained (the fractions result from contrasts in the relative political distance within the Politburo).

Molotov	D = 0.095
Beria	.143
Malenkov	.175
Shvernik	.533
Mikoyan	.714
Voroshilov	.750
Andreyev	.809
Kanganovich	.909
Kosygin	.917
Bulganin	.950
Khrushchev	.958

The power struggle immediately succeeding Stalin's death clearly confirmed the inferences made. What had not been known at that time but becomes clear now is that the group closest to Stalin obtained its power from the party organization while the group distant to Stalin derived its power from the more popular organs of the USSR government.

Working example VIII

As was suggested in Chapter One, much of "content analysis" is most directly associated with mass media research and in particular with quantitative inquiries into the popular content of those media. One of the classical studies is Berelson and Salter's "majority and minority Americans" (31).

The analysts randomly selected short stories published in popular magazines between 1937 and 1943. The attributes of persons appearing in such stories were mapped into several category sets of which the three most important ones were: a) explicit or implicit

membership in ethnic groups (white Americans, Anglo-Saxons and Europeans, Negroes, Jews, or others); b) social roles occupied in the story; c) their manner of presentation (favorable or unfavorable).

A compositional comparison of the short-story population with the population in the U.S. showed a striking discrepancy. 90.8% of the persons in short stories were "Americans" as compared to 60.2% in the U.S. population. In addition, most heroes were drawn from this group. The minorities tended to provide the villains. The "Americans" occupied positions with higher socio-economic status, were more law-abiding, and acted less on the basis of materialistic motives than members of the minorities. The more a person resembled the stereotype of the white American, the better, the more decent, honest, superior, and the wealthier he was presented as being.

The interpretation of this frequency characterization goes in two directions, the condition affecting the publication of such stories and the effects they have on the reading public.

The antecedent conditions inferred are those of the institutional set up: the compactness and shortness of the stories favor the use of established cliches. Familiar stereotypes immediately provide symbols of identification for a majority of the reading public, hence, optimize sales. Changing a once established successful formula may decrease expected returns and is, thus, not economically feasible.

Although the stories are offered and accepted as entertainment, the "constant deprivation" of the various minorities "over a long period of time serves to activate predispositions of a hostile or an indifferent audience. Readers with latent tendencies to assign the usual stereotypic descriptions to groups whom they do not know, or toward whom they are unsympathetic, or with whom they do not come in personal contact, can find support for their convenient tags, labels and aggressions in such magazine fiction. As this is all the more striking as a result of the implicit comparison with 'the Americans' the condition and behavior of fictional characters can readily be used to "prove" that the Negroes are lazy or ignorant, the Jews sly, the Irish superstitious, the Italians criminal, and so on" (31:190).

The reported research project is generally considered one of the corner stones for the use of content analysis in the study of popular culture. Together with working examples V and VI it shows how vast amounts of mass circulated material can be analyzed quite suggestively, but it is moreover an example in which the interesting part of the interpretation follows more or less as addenda -- inferences as to the antecedent conditions and effects do not follow from the method of content analysis. They are intelligent speculations for which the data could not provide conclusive evidence.

Working example IX

As some of the previous examples suggest, message analysis can easily lead to and require quite time consuming operations. When

the volume of data to be analyzed becomes in addition very large, the task often becomes hopelessly unmanageable. And yet many of the interesting problems in the behavioral sciences require the processing of large quantities of written text. A public opinion interviewer, for example, recording the free answers to his questions, is faced with the difficult problem of evaluation. Or, studies in small group research typically tape the verbal interactions that occur in a human group, transcribe them and try to make sense out of them according to some theoretical framework. Historians and political scientists have recently become interested in collecting exchanged diplomatic documents to study the acceleration and deceleration of hostility in situations of international crises (84) (142). Similarly anthropologists, when attempting to analyze the structure of proverbs or folktales (100) have to consider large collections of written records and messages.

The common difficulties associated with such problems of analyzing written texts have led to several attempts to use electronic computers that are capable of handling large quantities of data. Among the outstanding solutions are two programs, the "General Inquirer" developed by Stone (188), and Stone, Bales, Namenwirth, and Ogilvie (189), and the "Concept Learner" (86) developed by Hunt, which have jointly been used for automatic theme analysis (190). The range of practical applications of these programs is rapidly growing. We take only one illustrative example to show the procedure and potentialities of the method.

A well-known study by Osgood (148) attempting to test hypotheses regarding the writer's state of anxiety and the style of his product compared genuine suicide notes which had been collected in California with notes obtained from private letters received from friends and relatives of members of a panel. Each suicide note was then paired with a "pseudocide" note the writer of which corresponded in sex. Graduate students with no prior experiences with suicide notes were instructed to independently assign them to these two categories. They did no better than chance.

Stone and Hunt (190) attempting to test the performance of their computer system for content analysis, obtained simulated suicide notes by instructing subjects to write such notes as realistically as possible. Genuine and simulated suicide notes were then paired according to sex, age, and socioeconomic level and given to sophomores for the same task of distinguishing them on an intuitive basis. As a whole the students did better than chance with the mean being 66% correct, posing the question: could the General Inquirer do better?

The General Inquirer is a computer program for answering certain questions concerning stored texts. It accepts IBM cards on which the original sentences only slightly edited together with marks for the syntactic position of the words are punched. In accordance with a specialized dictionary each word is then associated with a set of tags presumed to be of theoretical significance for the problem under investigation. Tags and syntactic positions are then stored on

a magnetic tape and provide the data base for retrieval questions.

The task of predicting whether the writer of the note intended to commit suicide or not became in this context one of effectively discriminating between real and simulated notes. To this end the actual source of each of the first fifteen pairs of notes was known to the researchers. These notes were compared by means of the General Inquirer. After asking sets of questions and obtaining the proportion each of them could correctly distinguish, three factors were found to discriminate:

1. References to concrete things, persons, and places (higher for real notes)
2. Use of the actual word "love" in the text (higher for real notes)
3. Total number of references to processes of thought and decision (higher for simulated notes)

The discriminate function derived on the basis of the scores on these factors was then applied to the remaining eighteen pairs of notes with the members of the research team not knowing their identity. After the prediction was made the actual source of the notes was revealed to the team. It turned out that seventeen of eighteen pairs of notes had been identified correctly. This result is quite remarkable when compared with the near chance identification by human judges.

The major difficulty discovered in working with the General Inquirer was that the human user of the program tended to be too constrained to find enough questions which distinguish a large enough percentage of the text. At this point Hunt's "Concept Learner"

developed to discover discriminate functions automatically was suggested. In conjunction with the General Inquirer it could discover distinguishing "themes" in both sets of documents. The Concept Learner looks at all the sentences in each document to see if there are one or more tags common to all sentences in one document that are not found in any sentences of the other document. If such a single all or none question does not discriminate all sentences in one document from all the sentences in another, a heuristic procedure is employed which develops a discriminating tree of tags and syntactic markers until the two sets of documents are completely distinguished. The tree structure so developed is equivalent to a sequence of decision rules determining the class membership of a document.

So far both programs have been applied to several problems of automatic theme analysis. The Concept Learner is then used to develop distinguishing rules for texts differentiated according to some criteria outside the documents, e. g. the psychological state of the writer, and acquires information about that criteria. The General Inquirer can then apply these rules to make predictions referring to such criteria.

The practical utility of such analyses by computer is obvious. The example is included, however, for its theoretical significance. Not that these two programs are meant to be satisfactory at this stage of development, but, in describing message analysis to a computer nothing can be left implicit for a process of intuition to which

most of human symbolic behavior rightly refers. In some sense the ultimate task of understanding such analytic processes is an executable computer program working toward the specified goal of message analysis.

Working example X

One of the processes which have only recently been described as communication processes is psychotherapy (168). The psychodiagnostic interviews preceding intended therapeutic treatments can profitably be viewed as dialogues between a patient and a diagnostician in which an attempt is made to assess the nature of the patient's psychic disturbances from his linguistic and non-linguistic behavior.

This task has rightly been claimed to be extremely difficult. When a patient attempts to express himself during psychodiagnostic interviews, he tends to communicate several things simultaneously. For instance, what it is that he is talking about, what he thinks in general about it, what he is feeling at the moment, what he intends the diagnostician to think, what he wants to avoid revealing to the diagnostician about himself, etc. The task is rendered even more difficult by the experience that the dictionary meanings of the patient's assertions are frequently misleading. The denial of a symptom may, for example, alert an astute analyst to the possible presence of that very symptom. Or uncontrolled assertions rendered during such interviews would, on the other hand, yield entirely inadequate interpretations if treated as instrumental.

The fact that the expressions a patient gives during psychodiagnostic interviews is very rich and must be interpreted with enormous subtlety, has often led to a wholesale rejection of more explicitly stated methods of diagnosis. Yet the protocols of such interviews can become quite voluminous and unmanageable and require a simplified representation of its relevant characteristics.

Among the numerous indices which have been proposed (17), and normatively defined over the body of recorded data is Dollard and Mowrer's discomfort-relief quotient (54). This quotient purports to be a measure of tension by taking into account the number of words revealing some form of discomfort and those indicative of relief or reward. Although such measures have indicated quite suggestive differences of recorded texts, little is known about what they actually measure.

Recently Mahl argued that predictors of a patient's emotional state should make use of speech characteristics which are not under the control of the speaker. He systematically explored the correlation between such emotional variables as the level of anxiety and various types of speech disturbances (124). His results supported the belief that a certain speech disturbance measure will be a useful nonlexical indicator of current anxiety in the speaker (125). But more work has to be done in this direction.

Another way of facilitating psychodiagnostic processes has been suggested by Cassotta, Feldstein, and Jaffe. These researchers

describe a device for automatic extraction and quantification of vocal behavior in interviews (40) which is already in existence, and propose a new, more complex device of which the former will be a component part (61). This device is intended to be programmed to evaluate a patient's speech pattern and print out some diagnostic statements.

The device is conceptualized as performing several pattern-matching operations. The researchers suggest that "normative patterns of speech from other persons comparable in intelligence, education and socioeconomic background might be put into the machine memory. The computer might then be asked to compare the speech patterns of our patient with this criterion. Extrapolation from current theory suggests that schizophrenics use abstract words more frequently than non-schizophrenics. Another conjecture is that schizophrenics more frequently use words connoting social distance, such as third person pronouns, in preference to first and second person pronouns, which imply greater closeness. . . . It might be hypothesized that schizophrenics show greater variation in their range of associative patterns than do non-schizophrenics. If shown to exist, such greater variation may account for the perception of schizophrenic speech as difficult to understand" (61:246).

Work with the already existing device for automatic extraction and quantification of vocal behavior led to the discovery of even simpler kinds of indicative speech patterns. "In all cases in which pairs of a group of nonlexical attributes were significantly intercorrelated for

normal persons, they were not intercorrelated for diagnosed schizophrenics. Assuming the findings were confirmed with sufficient power for use with individuals, we could, with suitable programs, ask the computer to store frequencies of the extralinguistic measures as they were extracted from speech and intercorrelate successive pairs of the measures across the interview. To automate the complete process the computer could then be asked to decide . . . which of the correlations were significant. Concomitant use of both the lexical and the nonlexical analyses should enable us to say something about at least one kind of psychopathology" (61:249).

This working example is overtly similar to IX, but geared to another end. Although the researchers noted that much work has to be done before the envisaged computer programs can reliably be employed for diagnostic purposes, the work on the computer has already clarified several issues concerning the procedures that an effective psychodiagnosis will require. Making explicit what the solution of psychodiagnostic problems involves and testing such procedures by employing computers for executing them systematically not only helps psychotherapists in their work but also provides much information about the possible modes of reasoning, or analytic procedures a message analyst may have to follow in pursuing diagnostic ends whether he is concerned with single individuals or complex societies.

CHAPTER FOUR

THE GOAL OF MESSAGE ANALYSIS

This chapter aims at an adequate formulation of the purpose of message analysis. The emphasis is not placed on the process of message analysis as such but on the nature of the ends toward which the method can be considered a means. In this context the notion of adequacy is meant to refer a) to the decidability as to the structure of the situation in which message analysis is appropriate, b) to the conditions under which a message analysis can be considered as approaching or having reached a suitable goal, and perhaps c) to the simplicity or elegance of such a formulation. The ten working examples will be used to support our formulation and it is suggested that the resulting formulation, which will be formalized in Chapter Five, holds far beyond these examples, showing message analysis to be a very general mode of inquiry.

The Message Analytic Situation

Let us begin by describing the message analytic situation as a system. This requires the identification of a set of variables and the formulation of some constraints accounting for the nature of interaction between these variables. As a first approximation let us make an obvious distinction between two sets of variables of the message analytic situation, the one being labeled "message analyst,"

the other, the environment under the analysts' consideration, will be called the "object system."

Although some working examples appear to place individual persons in the role of analysts, to restrict the notion of message analysis to the ability of single human beings would severely limit its scope. As a matter of fact, the role of message analyst is more frequently assumed by scientific cooperatives of persons and facilities than by individuals. In 18th century Sweden, working example II, it was the intellectual elite whose members challenged each other until acceptable responses were found. Propaganda analysis during the Second World War (VI) was accomplished by organizations specifically designed to cope with the large volume of foreign broadcasts in a meaningful way. The decipherment of the old Persian language (I) took several generations of members of a scientific community. And the attempts to ascertain psychopathologies from speech reported in X is even conceptualized as involving no specifically human ability, if the work succeeds.

As far as this chapter is concerned the message analyst will be treated as a whole, as a black box, so to speak, the internal structure of which must be considered to be extremely important in determining the outcome of analysis but which can be left undifferentiated when external criteria of adequacy are discussed.

The object system in message analytic situations can take the form of an individual as in working examples IX and X, specific

his psychology; the form of social behavior of the politburo members under Stalin (VII); the form of a national system of socio-political mobilization and coordination of war efforts (VI) or the form of the social use of language (I). The materiality of any actual system may suffice as an object system in message analysis.

The message analyst and the object systems are coupled in a typical way. The most distinctive characteristic of the message analytic situation is that the object system is only partly observable by the message analyst. This becomes abundantly clear from the working examples.

For example, the object system of the propaganda analyst in (VI) was an enemy nation deliberately concealing strategically significant information. Traditionally, war situations favor the use of security measures to hinder the spread of such information beyond the national boundaries. The broadcasts which propaganda analysts monitored represent only a very small section of the spectrum of possible observations.

The incomplete observability is even more vividly demonstrated by the psychodiagnostic situations described in (X) in which the diagnostician finds himself incapable of observing the emotional states of his patient directly. Even the concept of "emotional state" seems to be a hypothetical construct effectively characterizing some fundamentally inaccessible states of the patient's brain. The speech of a human being represents only a very small subset of those variables

along which the behavior of a human being may adequately be describable.

The object system which interested the Swedish orthodox clergy in working example (II) was the complicated international network of religious influence. Indicative of the existence of such a network was the increasing religious dissent in Sweden and the "Songs of Zion" both of which were subjected to extensive analysis.

The incomplete observability of a message analyst's object system becomes the real condition under which the old Persian language in example (I) had to be deciphered. The empire in which the three languages were written and in terms of which some culturally important messages were carved in stone, had disappeared long ago. Its main body of cultural things, its social communication structure was not observable. Only a few records indicated its probable existence in history.

Not a defining characteristic of message analysis, but of considerable consequence is the fact that the interaction between the observable and unobservable parts of the object system is typically very rich. This fact is, no doubt, the reason why the attempts to develop analytical methods for such situations has originated in communications research and not in other disciplines which characteristically start with complete observability. Communications research is by subject matter orientation concerned with some such interaction between messages and their producer or

between messages and their possible effects.

Consider working examples II, V, VI, and VIII as more obvious cases in point. They are all concerned with object systems the component parts of which are not only richly interacting but also conventionally conceived of as containing communication. The message analysts of these four examples considered their object system as social communication networks that link partially observable components.

Less obvious is the kind of interaction that underlies the object systems described in working examples IV, IX, and X. They deal with the communication that exists between some person's personality or internal states and his verbal behavior. Working example VII not only deals with the interaction between such internal states and a person's verbal expressions but, moreover, with the socio-political communication network that links a mass audience with an aspect of the structure of a ruling elite of which the internal states of participating persons are component parts.

A second distinctive feature of the message analytic situation is that communication between the object system and the message analyst is a one-way process.

The communication with object systems which have existed at some point in the past, for example, is absolutely bound to be one-way. The analysis of messages from extinct cultures such as the Persian empire of working example I, or from historical figures

such as the possible writers of the Imitatio in working example IV does not have any effect on the sender of such messages. Communication is directed from the object system to the analyst and not vice versa.

Analysis of enemy propaganda for intelligence purposes (VI) or of the power structure within a foreign elite (VII) would be greatly facilitated if an opportunity existed to request additional information, or to ask for information confirmatory to the inferences made. But the analyst is restricted to the role of a receiver. Although the product of a message analysis may indeed be assumed to have significant policy implications, the message analytic procedures are a priori to possibly intended acts upon the object system and do not account for such a feedback. The propaganda analysis in working example VI and the cryptographic analysis in working example III readily exemplify such situations.

Even the psychodiagnostic use of message analysis, described in X, exhibits the typical one-way flow of information. Although the protocol which serves as an input to the message analytic process is indeed one of an interview, i. e. of a two-way interaction between diagnostician and patient, the message analysis in no way affects the course of the psychodiagnostic interview until it is completed. The communication clearly originates at the object system and is transmitted via a transcription of the exchanged sounds in a computer understandable language.

In this sense the message analytic situation is distinguished from the classical experimental situation in which the experimenter manipulates at least some variables assumed to affect his observation in a significant way.

Corollary to the typical unidirectionality of communication between object system and message analyst is the essentially non-cooperative relation between both.

The use of ciphers as a means of deliberately concealing information for unauthorized receivers is only one case in point. Another indication of such a relation is an attempt to provide message analysts with misleading information about the nature or states of the object system. This is often the goal of war propaganda, overtly directed toward home consumption but calculated to have a desirable effect on the opposing country. George analyzed several such incidents (71:138) and Lasswell's "distortion test" reported in (V) was designed to uncover publications employing such techniques.

The non-cooperative character of the message analyst/object system relation does not necessarily stem from conflict or competitive situations. The psychodiagnostician knows of situations in which the patient is simply unable to freely express what the analyst is interested in. Similarly, in communicating short stories as entertainment to large audiences (VIII), the mass media made it very difficult indeed for Berelson to analyze the biases underlying such stories. Whether this is a deliberate attempt to hide information of interest to the

communication researcher, or an unawareness of the service the mass media could provide to the analyst of popular culture remains to be decided; it is certainly non-cooperative.

Non-cooperation may simply stem from the fact that the object system just doesn't know of, or has no conception of, the existence and/or intentions of the message analyst. Although some of the messages written in stone were clearly addressed to future generations, no conceivable characteristics of the message analyst could have been anticipated by their writer. The same is of course true in the authorship problem of example IV and all other analyses of messages from history.

The essentially non-cooperative relation between object-system and message analyst also distinguishes message analysis from such techniques of inquiry as psychological tests, surveys and controlled or free interviews. In all these cases data obtained from such techniques must be considered as being potentially biased by the fact that their gathering is stimulated, if not by specific questions, then at least by the presence of an interviewer who engages in a form of cooperative relationship with the object system. When data so obtained are interpreted, the effect of such a cooperative relation has to be accounted for quite carefully. In message analysis the object system is typically unaware of the fact that it is a subject of analysis, unaware as to which of its parts is under observation and unaware of the consequences of the analysis. Hence, message analysis is an

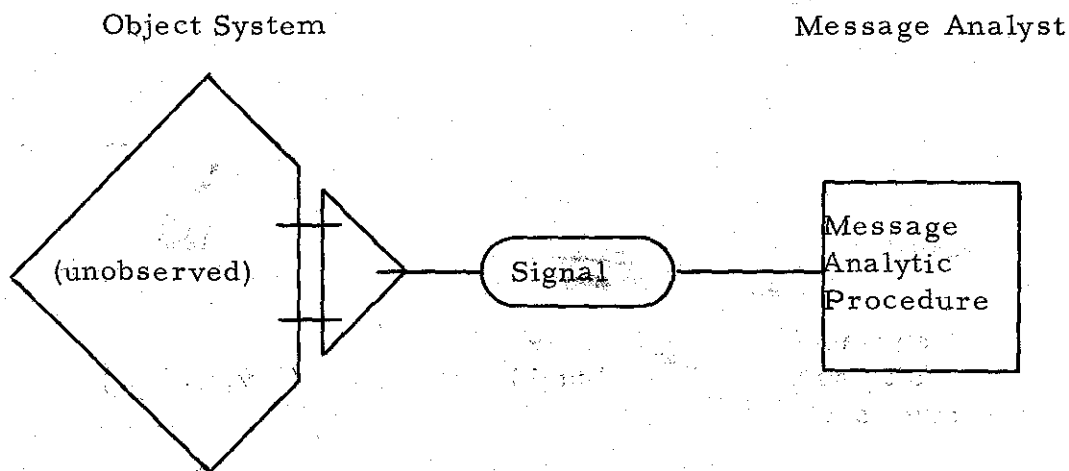
unobtrusive technique, quite in the sense of Webb et al. (202).

At this point let the weak notion of "observation" be replaced by a notion referring more precisely to what is transmitted between object system and message analyst: a "signal." To quote Zinkin: "By 'signal' we understand a certain sequence distinguishable by its elements, or a simultaneous totality of various physical states. A signal may be changed in the course of time and be differentiated in space. It may be preserved (by photography, magnetic recording, etc.) or it may pass quickly from one state to another. A signal may be measured according to definite parameters with the aid of physical instruments" (218:144). Whether signals are produced by means of a stylus on clay or by brush and ink on rice paper, whether they are printed from movable type slugs on modern paper or recorded by hand on data sheets, the movement of an electronic picture tube and the punched holes on an IBM card, they are not conceived of as having meaning in any conventional sense.

A signal is accepted by a message analyst solely on the basis of the distinguishability of its inherent properties, the physical nature of its elements and the structure discoverable between them. In this technical sense signals constitute the domain to which Shannon and Weaver's information function (175) applies. Shannon and Weaver both explicitly avoid any semantic notion when defining the amount of information quantitatively.

A preliminary diagrammatic presentation of the message analytic situation is attempted in Figure 3. Herein arrows denote "communication in the indicated direction"; boxes represent "processes"; and the oval, "that which is transmitted."

Message Analytic Situation (preliminary)



Primary Components of Message Analytic Situations

Figure 3

In order to avoid confusion, the role of the external observer, in which the reader will find himself, might be clarified as well. To begin, the external observer is faced with an observational task quite similar to that of the message analyst. The message analyst obtains signals from a typically small portion of some object system. The rest of that system is inaccessible to him. The message analytic

situation in which such unidirectional communication occurs is the object system of the external observer. Hence, the external observer is the component part of a system that is superordinate to the message analytic situation: a meta system.

Although message analyst and external observer are in fact subject to similar kinds of observational constraints, if the external observer wants to make assertions about the observational constraints which a message analytic situation imposes on the message analyst, then he is forced to assume a less constrained vision; he is forced to make the assumption that he has more complete or even perfect information about the message analytic situation in general and the object system of that situation in particular; he must assume that he has that information which the analyst lacks. As unrealistic as the assumption of nearly constraintless observation may appear in some cases, it is useful for the presentation of the argument and avoids certain contradictions provided that the two systems, the message analytic situation and the meta system, are kept separate in the discussion. Since many concepts concerning message analysis derive from the typical observational constraints which the message analyst has to face, we will continue to assume to have access to parts of the object system that are concealed from the message analyst such that the message analytic situations can be made an interesting subject of study.

The Predictive Nature of Content

Having characterized the message analytic situation as a one-way communication process between a partly accessible object system and a message analyst to whom some signal is transmitted, nothing has been said so far about the purposive outcome of the analysis. Characterizations of purpose require consideration of some behavioral delineations and for the discovery of the primary focus of message analysis, in particular, two approaches suggest themselves immediately.

The first approach would require finding some teleological commitments agreed upon by writers in the field. This approach refers to the most popular anticipatory conception of a goal. Chapters One and Two, in which this road was taken, pointed out the relative fruitlessness of such an attempt. A commitment to being quantitative and systematic may uniquely distinguish content analysis from entirely intuitive interpretations of symbolic materials but is too broad to be considered the goal of this specific investigative technique. Almost all scientific inquiries would be included under such a formulation.

Considering the fact that the whole complexity of social existence is transmitted by means of interpersonally exchanged informal messages, a confinement to materials to which social conventions attribute meanings or symbol characteristics in one sense or another without stating the requirements imposed upon the outcome of the analysis is inadequate on similar grounds.

The almost complete lack of explicitly expressed purpose in the content analysis literature may reflect the well-known fact that techniques, employed originally as a tool in full awareness of the goal for the attainment of which they may have been designed, can become a value in themselves. The goal then simply drops out of the awareness or the concern of writers in the field. Be it as it may, the search for anticipatory-type formulations in the literature of content analysis has failed to provide clues for the formulation of what message analysis is supposed to accomplish.

The second approach to the assessment of the goal of a system requires observation of its behavior whether a goal is explicitly stated in advance and consciously pursued or is implicit in the technique adopted by a component part of that system. The concept of goal suggested here corresponds to that of an equilibrium toward which a system moves over time, a state which it tends to maintain or toward which it returns if disturbed. Subjectively such a state may be expressed in terms of the satisfaction with the result obtained by a message analytic technique, in terms of the plausibility of the interpretation advanced, or in terms of the expressed practical usefulness of the outcome. Objectively such a goal-attaining process may manifest itself by the observation that the output of a message analytic process becomes less and less altered, causing fewer and fewer objections on the part of the analyst or some user, and finally reaches a definite state

at which the analysis, having solved the problem of investigation in its own terms, comes to a stop. Such a state will be called a goal.

Several working examples may be considered from this point of view. For instance, working example I described how four generations of scientists worked on the problem of deciphering a language. The emergence of such mysterious patterns on rocks, assumed to be man-made, posed nothing but the problem. The discovery of the word-distinction-sign, considered as a milestone in the analysis, was far removed from a solution. Nevertheless, more scientists became stimulated by this discovery and contributed to the search. Numerous speculations and hypotheses were proposed and successively eliminated, among them being all premature attempts to assign phonetic values to the distinguishable elements, i. e., the signals composing the text. The extensive frequency tables which were compiled for letters, words and simple relations between them contributed very little to the decipherment until a few short repetitive sequences of figures were found to represent some property outside the texture of the script, something that could have been a cultural standard of the old Persian empire and independently transmitted to medieval Persia: the habits of using official titles. Then one piece after another from the known history of the region became associated with textual elements. The message analysis clearly stopped, reached its goal so to speak when all signals could be related or explained in terms of some events consistent with the history of the old Persian

empire as far as it was known; when this interpretation could even be extended to other excavated documents of a similar kind; and when the proposed reading of the text caused no serious objections from the learned community.

This goal of deciphering a language, it seems, can be described as a state in which the analyst is capable of making assertions about that part of the object system which he can not observe, the part which is considered to encompass the antecedent conditions of the signals transmitted. Conversely, the inability to draw such inferences seems to be accompanied by a subjective state of dissatisfaction indicative of the lack of goal attainment. The dissatisfaction which has until recently been asserted concerning the knowledge of the Etruscan script and Minoan Linear B, a dissatisfaction which is still heard when some of the 25, 000 year old north-west Indian scripts such as those of Harappa and Mahenjodaro (52:286) are discussed, are cases in point. Grammars of such writing systems can be relatively easily formulated on the basis of the material found, and this was almost all that was known about the Etruscan language until very recently some names could be identified in the written texts.

While the inferences toward which the decipherment of a language tend are more those of a traditional semantic interpretation, the inferences that are of interest to the psychoanalysts in working example X, are clearly not of the conventional linguistic type. As Mahl suggested, inferences as to internal emotional states of a

patient are most profitably based on speech patterns not under conscious control by the speaker. Similarly the analyst of propaganda described in working example V suggested a set of tests which do not produce anything similar to what is customarily referred to as "meaning." The "manifest meanings" in Berelson's conception of content analysis are even completely ignored in Yule's inference about the authorship of a document on the basis of its style. Rightly claiming that the complex expressions of industrialized culture in the modern mass media are not sufficiently understood, or, that we have not learned how to look at television, many cultural critics such as McLuhan (134) (135) point in the same direction, demanding inferences from the surface appearance of complex social systems to their internal operations, from signals to their source.

Whether the analysts whose work was described in the working examples call their task the decipherment of a language (I), or their method quantitative semantics (II), cryptography (III), literary research (IV), propaganda analysis (VI), content analysis (V, VII, VIII, IX), text analysis (IX), psychodiagnosis (X), in all cases the goal seems to be related to the making of inferences from signals to some unobserved components of an object system from which those signals were obtained. It is therefore tempting to equate "content" with what a message analyst inductively infers from a given signal. Although we indeed wish to associate this term with the output of a message analytic procedure, such a simple equation needs further

elaboration for two reasons.

First, the term "inference," which according to Webster refers to any outcome of a normal thought process, to a process of arriving at a conclusion or of accepting an opinion on the basis of available evidence, etc. (204:1158) is much too weak to serve as a defining characteristic of message analysis. Persons may infer all sorts of things from received signals which may or may not have been intended by its sender, which may or may not be appropriate in the existing situation. Especially a methodological analysis of signals as messages cannot rely on some thought process qua thought process. Extensional criteria for the adequacy of an inference have to be applied from outside the inferential procedures; this specifically requires us to consider the outcome of the inference, not whether some inferences have been made. Hence, the process of inference must be considered a means and not an end of message analysis.

Second, the incomplete observability makes a direct link between observed and unobserved components of an object system impossible. The message analyst cannot point to what is not observable to him. Although this argument is straightforward, the working examples can provide additional illustrations: the psychodiagnostician in (X) attempting, as we used to say, to infer some internal state from a person's speech behavior is not ever likely to observe such a state. Psychopathologies such as "schizophrenia" or emotional states such as "anxiety" are hypothetical constructs operationally

defined in some technical discourse and in conjunction with practical behavioral problems. Similarly the goal of deciphering the old Persian language (I) was not one of denoting the cultural objects and object constructs to which it may once have referred but that of a translation into a modern language in terms of which the historical context of this script's origin was adequately representable.

The point which needs to be made is that because the object system is only partly observable and the message analyst is absolutely bound by this limited access not under his control, his products need to be mapped into a notational system capable of representing all of the possible states of the object system as a whole or at least as much of it as the analyst is interested in.

One example of a representational system is the state space of a system within which each point represents one of the object system's possible states. In effect Mahl adopted such a representational system when conceptually manipulating states of anxiety. Similarly a behavioral space, each point of which represents one of the possible behaviors of a dynamic system, can be considered a representational system. Another possible realization would be a formal language limited to and capable of representing just the features of the object system under consideration. In the weakest case, a natural language such as English may be supplemented by a set of well-defined scientific terms and some general theoretical assumptions concerning the object system constituting what is

commonly called a special discourse. The representational system in working examples I and VIII demonstrates this case. In the domain of social and psychological systems the current presystematic message analysis most frequently uses the latter. Whether a message analyst makes assertions about anticipated military actions by an enemy country, predicts the possible social consequences of mass media products, detects interpersonal relationships within a ruling elite or diagnoses the pathology of a patient, he finds himself confined to a representational system assumed to be adequate for representing the object system of his concern.

According to our terminological distinction between observed and unobserved components of an object system, the "signal" must -- in accordance with its definition advanced above -- be understood as a direct representation of the observed parts of an object system in the representational system, while the term "content" can designate only a notational element in the representational system as far as it refers to the unobserved part of the same object system.

With the establishment or recognition of the necessity for a representational system as a third constituent part of the message analytic situation, a system that is intermediary between object system and message analyst but perfectly accessible to the latter, the opportunity is gained to locate more concisely the domain and range of the message analytic procedure: they are contained in the representational system. The operations that account for the intuitive

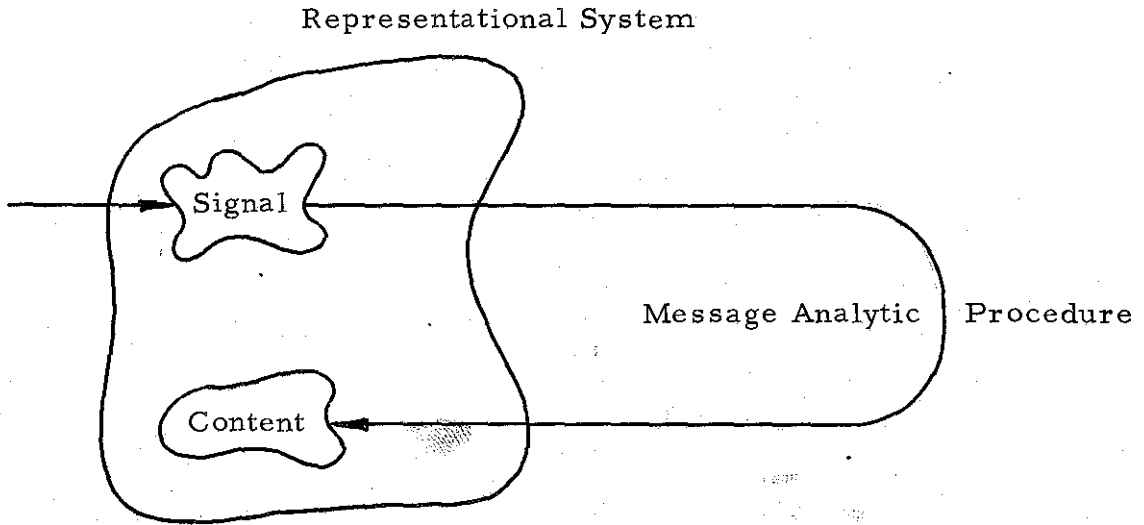
notion of inference have to be conceived as defined in terms of the notations of a representational system that is capable of representing not only observed states of an object system (signals) but also its unobserved states (contents) that are of particular concern to message analysts.

The pre-evidential character of the outcome of a message analysis, the message content representing not facts as a signal does, but conceivable facts, makes our notion of content predictive by definition. These predictions need not refer to future steps in time. They appear simply as results of operations within the representational system and outside the signals obtained. Specific choices among the notations referring to yet unobserved parts of a system, operations that lead from a set of actual observations to a set of possible observations or the ascertaining of the implications of given evidence for the solution of a problem must be considered as the making of predictions although not necessarily in the specific sense referred to here.

Figure 4 informally depicts the message analytic procedure as an operation defined over the notations of a representational system. Note that domain and range of this procedure, the message-signal and the message content must by definition of message be disjointed in the representational system. Note further that the Figure presents the situation only from the point of view of the message analyst.

It should again be emphasized that such a notion of content makes the material nature of the object system, i. e. whether it is

a social, biological, or artificial system, appear entirely irrelevant as well as the question of whether meanings are conventionally associated with the signals so analysed. A reiteration of our ten working examples in the terms advanced so far may make this point clear.



Representational System (representing an object system) containing Domain and Range of a Message Analytic Procedure

Figure 4

Working example I

Object system	:	The social use of language in the old Persian empire
Signal	:	Figures carved in stone
Content	:	(Historical) events in old Persia

Working example II

Object system	:	International network of religious influence
Signal	:	Text in a song book
Content	:	Communication between a foreign religious sect and religious dissenters in Sweden

Working example III

Object system : Secrecy systems in military communication
 Signal : A cipher
 Content : A clear referring to military actions

Working example IV

Object system : Covariation of literary styles and identities of writers
 Signal : The text from an unsigned book
 Content : The author

Working example V

Object system : International news network
 Signal : The output of suspected organizations
 Content : Links to foreign countries

Working example VI

Object system : National system of social-political mobilization
 Signal : Radio broadcasts
 Content : Preparations of major actions

Working example VII

Object system : Public behavior of a governing elite
 Signal : Text of speeches
 Content : Social distances between members of an elite

Working example VIII

Object system : Public media (organization and mass audience)
 Signal : Fictional short stories
 Content : Socio-economic conditions of production, social psychological effects

Working example IX

Object system : Relations between style and emotional state of the writer
 Signal : Written notes
 Content : The writer's readiness to commit suicide

Working example X

Object system : Human psychological behavior including speech
 Signal : Recorded speech
 Content : A psychopathology or emotional state

Concerned with the meaning of assertions of natural language, Rapoport came to remarkably similar interpretations of "content." The attempt to sharpen the concept of meaning from the point of view of operational philosophy led him to the straight forward postulate that an assertion becomes empirically meaningful only if it implies some predictions. He therefore defined "predictive content" as "the totality of predictions implied by an assertion" (167:37). Thus, the assertion made by the British propaganda analyst in VI:

It is beyond reasonable doubt that Germany possesses an offensive weapon which her leaders believe: a) is of a type unknown to the Allies, b) cannot be countered within a short period. . . . (will) come into use not before the middle of January 1944, and not later than the middle of April"

can be viewed as implying a rather specific set of predictions of the form: "If someone were to conduct a search in Germany he would find a new weapon. If he were to ask her leaders, he would find them believing such and such about it. If nothing were to interfere before the time specified, direct experiences would prove me correct."

Similarly, the inferences described in working example VIII could be viewed as implying such predictions as: "If a study of the attitudes toward American minorities as a consequence of exposure to magazine fiction were conducted, such and such would be the result."

Even more striking is the interpretation of the outcome of computer speech analysis in (X) as predictive content. "Schizophrenia" indeed does not refer to any single observable phenomenon and may not even refer to a patient's internal state in as complicated a manner as it

may be defined. If it is a therapeutic term then it is very likely to imply that a certain set of treatments, applied to the patient so labeled, will yield a certain result. Many psychopathologies are explicitly defined in terms of anticipated consequences of a treatment.

With this interpretation by Rapoport, our concept of content is quite in agreement. It also requires an unobserved environment toward which the predictions apply and in the context of which they are potentially disconfirmable. It would not be in agreement, however, with the notion of "meaning" expressed in a question like: "What is the meaning (or content) of the set X of movies?" Our message analyst to which such a question may be posed would have to simply refuse an answer on the ground that no object system is specified and hence no message analytic situation exists, implying that any prediction would be fortuitous. Consider only the fact that the number of possible content analyses in Berelson's (27) and Miller's (136:95-96) sense that can be applied with the highest degree of reliability is an exponential function of the number of distinctions that can be made in the signal and consider the number of elements that can be distinguished within a single movie! If such a question were to be asked, however, in reference to some specified audience, the film-maker, the industry that produces and distributes them, the culture in which they survive, etc., i. e. if an object system were to be delineated of which the set of movies in question could be considered an observed part, then the question

becomes one of message analysis in our sense. In this case the intuitive notion of "meaning" may become equivalent with our predictive notion of content and is, so far as the conditions of a message analytic situation are satisfied, disconfirmable in principle.

External Criteria of Adequacy

The notion of the predictive nature of content is not purely nominal. It has an important conotative implication: it opposes the idea of an objective truth inherent in a message. It requires (a) that the content inferred must at least be potentially disconfirmable and suggests (b) that the truth may be assessed in degrees rather than as an "either or" proposition.

In either case some external evidence must be available after a message analysis has been attempted such that the adequacy of the content selected on the basis of the signals received can be evaluated. This external evidence that represents the unbound part of the object system in the representational system may be called the validating signal. By comparing the inferred content with the validating signal the validity of a message analysis procedure may be established, and the appropriateness of the choices regarding the content assessed.

It could therefore be argued that the goal of message analysis is a maximization of valid content, that as many inferences as possible should be drawn from given signals, and that the knowledge

about the unobserved part of an object system should be pushed to its upper limit.

Such a goal however, seems to be an altogether unreasonable one. Reconsider only the fact that the systems a message analyst tends to deal with range from single human individuals (IV, X) to whole nations in the situation of a war (VI), systems that contain a vast quantity of unobserved components and an extremely complex internal organization. To demand from a message analyst a perfect determination of the states of such complex systems on the basis of extremely limited observations would be unrealistic for two reasons.

First, Ashby has shown that adaptive behavior is variety limiting (13:58-70) i. e. that any adaptive system, any system that behaves toward some goal or possesses some intelligence, tends to suppress the variety in the signals it produces. Many -- although not all -- object systems of message analytic concern must intuitively be considered "intelligent," "adaptive" or "goal-oriented." As a corollary to Shannon's eleventh theorem (175:39), the complexity of a source that can be inferred on the basis of the signal it produces is absolutely bound by the variety the signal exhibits. These propositions lead to the conclusion that to the extent an object system possesses adaptive characteristics the message content inferred can only predict a limited segment of the unobserved part of the object system.

The second reason is a more practical one and refers to the message analyst's capacity to process information. His capacity to

process signal information is limited by the nature of his normal mental and computational facilities. That message analysis tends to require a relatively high attention to such information processes is indicated not only by the frequently heard complaint that (even the relatively simple) content analysis is too time-consuming, but also by the recent attempt to computerize certain routine procedures of such processes. Consider the threatening complexity the message analyst has to face who attempts to analyze the messages circulating within a social system; the analyst must rigorously limit his task to a manageable size. The information processing facilities he has at his disposal bind him to accept only those investigative problems which can be solved within a reasonable period of time.

In practice the message analyst accepts such a restriction by adopting specific interests, a narrow point of view, or by devoting himself to certain limited practical or theoretical problems. As the history of content analysis vividly indicates such interests are typically derived from the prevailing cultural climate. Around 1900, for example, mass media content analysis was very much concerned with ideas associated with the "decline of culture"; in the twenties, with the "effects of propaganda, ideological warfare and commercialism on the individual"; now peace research and political science draws novel inferences from the same type of material.

The working examples show more specifically that message analysts tend -- consciously or unconsciously -- to focus only on a

fairly limited part of an object system. The psychodiagnostician in working example X, for example, directed his attention only on certain psychopathologies or therapeutically relevant emotional states. Among the numerous contents that could have been inferred from recorded speech but were excluded by the analyst's point of view are those referring to ethnolinguistic characteristics, those of socio-economic characteristics, intelligence, education, etc. The analyst in working example V explicitly directed his research toward the detection of sources of foreign propaganda in the United States. He thus excluded all those contents that provided neither positive nor negative evidence about an agency's transmission of foreign propaganda. For example, those contents that refer to antecedent conditions or possible effects of the messages, as they are of concern in VIII, were declared irrelevant to the problem. Similar and most obvious is the restriction imposed upon the analyst of war propaganda described in VI. The analyst was only rewarded for and consequently only interested in those inferences that were assumed to have some significance for the wartime policy-makers. Other irrelevant inferences were just not made or simply not communicated.

The point that needs to be made is that the message analyst facing relatively complex and possibly adaptive systems typically can not obtain perfect knowledge about the whole system from the observation of a very limited part of it. Rather, he is forced to select contents referring to a limited "problem domain" within the representational system, a domain which derives from a specific interest, value,

or problem adopted by or imposed upon a message analyst.

The goal of message analysis could now be limited to maximizing the valid content within a problem domain that is delineated in advance. But this goal is still too simplistic for it does not consider the fact that a message analyst may make several kinds of errors when attempting to appropriately select among the possible contents on the basis of signals received. Some notion of the "degree of accuracy" of a prediction or some notion of the "degree of completeness" of a prediction has to be considered in formulating the goal.

When making specific content inferences the message analyst always seems to be susceptible to two basic errors which have different effects on the appropriateness of the content selected. The most conspicuous error appears when the content inadequately represents an unobserved part of an object system, i. e. when the content "says things that are not so." This "error of commission" which corresponds to the degree of accuracy of a prediction referred to earlier is largely independent from another error, the "error of omission" which appears when the content ranges only over a section, not over the whole problem domain, i. e. when the content fails to represent what it is expected to represent. This error corresponds to what has previously been mentioned as the degree of completeness of a prediction.

While it is fairly obvious that a goal-oriented message analyst has to suppress both errors as far as possible and it is, hence, easy to agree on the desirability and undesirability of the extreme values of the assumed continuum, it seems difficult to evaluate the desirability and undesirability of the intermediate values of that continuum

on which both errors have differential effects.

The difficulty is increased by the fact that the message analytic situation does not permit a message analyst to directly recognize or assess an error of commission he commits in selecting a content while he may control his error of omission provided that his problem domain is adequately specified. An arbitrary extension of the inferred content that ranges only over a section of the problem domain may indeed eliminate the error of omission but only at the expense of increasing the error of commission, that error to which he has no immediate access. The message analyst is therefore burdened with a difficult task of optimization.

The differential weights which the two errors carry depend entirely on the situation in which the message analyst finds himself, and depends on how the conduct of the message analyst is tied to the quality of his product, regardless of whether the rewards are imposed on the message analytic situation by an external observer or by some other source.

Working example VI depicted, for instance, a situation in which the inferences of a war-propaganda analyst were utilized for strategic decisions of possibly crucial political importance. In such a case one should expect that the accuracy of the content is of greatest significance; hence, the error of omission may have to carry less weight than the error of commission.

Similarly the extreme caution with which psychodiagnosticians approach the problem of predicting psychopathologies from the speech of a patient indicates the great weight which the accepted responsibility for the mental health of a human being bestows upon errors of commission. Although the reported results were quite convincing indeed, the researchers warned against immature generalizations and concluded that more work is required before an adequate computer diagnosis could supplement the work of a psychotherapist. A wrong diagnosis would not only affect the life of a patient, but its publicity would seriously harm the analyst's future conduct as a professional.

On the other hand, if the determination of the authorship of the unsigned Imitatio, described in working example IV, turned out to be false, the consequences for the literary researcher or for those who use his results could be estimated as less serious. That is not to say that such a task is merely an irrelevant intellectual exercise, but that the error of commission, the direct assessment of which is apparently very difficult anyway, carries less weight than the error of omission.

The imaginative inferences in the addenda to the content analysis of mass media fiction, reported in (VIII), similarly seem to de-emphasize the error of commission in favor of a speculative extension toward the problem domain, circumscribed by the topic "racial prejudice." Validation would indeed be very difficult, and so far as is known nobody has attempted, to gather validating evidence regarding the inferences Berelson and Salter made. The study is, however,

well known, frequently cited and reprinted for its stimulating interpretation indicating an emphasis on reducing the error of omission rather than that of commission.

The last two examples represent in a sense extremes in which either the complete lack of independent evidence hinders an assessment of the inferred content's error of commission (VI), or the way the inferences are stated makes an assessment of that error extremely difficult if not impossible (VIII). Even if this error is not known in most of the cases which the working examples represent, the claim that the inferences made do indeed represent some unobserved part of the respective object system, is maintained with different degrees of certainty. In other words, even in situations of extreme lack of direct evidence in support of the representativeness of the content, the goal of message analysis again seems to focus on a valid representation of some unobserved component of a partly observable system.

In full awareness of the empirical difficulties of evaluating the errors of omission and commission, let us assume that the content selected by a message analyst is evaluated by the external observer by means of comparison with what may be called a "validating signal." Such a signal is assumed to constitute precisely that observation which the message analyst is lacking, represents, for instance, the unobserved part of the object system within the problem domain, and is of course accessible only to the external observer or

after message analysis has been completed. The extent to which content and validating signal correspond, the extent to which the selected content adequately represents what it claims to represent, i. e. the extent to which the content is valid could then easily be assessed. Assuming a quantitative measure function for content, the amount of valid content contained in the output of a message analysis could then be measured. Errors of commission and omission then appear respectively in the quantitative differences between validating signal, content and valid content, and constitute quantities that need to be eliminated as a message analysis progresses toward the goal.

Given the risks involved in making wrong and/or incomplete predictions, i. e. given the differential weights accrued to the content errors of commission and omission, or more specifically the monetary rewards and punishments associated with each of them, the message analyst's goal becomes finally that of selecting contents in a problem domain in such a way that the rewards are maximised. If these differential rewards are set up favorably, the quantity of valid content may become an optimum.

As we have shown, optimization of valid content is not always a goal, at least not in content analysis. Often speculative inferences are rewarded highly without controlling for errors of commission. On the other hand, in the more rigorous sciences, errors of commissions are punished highly in comparison with errors of omission,

in the case of which the results of message analysis so evaluated exhibit a different picture.

Message analysis, as an attempt to appropriately select contents in the predictive sense as a consequence of signals received, as an attempt to make valid content inferences from signals, as the scientific treatment of data as messages with specific contents; is then involved in a complicated optimization process. This process attempts to induce as much as possible from given observations to determine unobserved states of an object system's affairs within the dimensions of a specified problem domain and attempts to avoid errors that are related to the validity of the content inferred and to the rewards imposed on this activity.

Summary of Definitions

In concluding this chapter the definitions of the technical terms may be listed below. The informal diagram of the message analytic situation in Figure 5 gives an overview regarding most of the terms.

The message analytical situation is composed of essentially three subsystems: the object system, the message analyst, and the representational system.

The object system consists typically of many interacting component parts and is only partially observable by the analyst.

The representational system is a specialized (formalized or disciplined) language or notational scheme, perfectly accessible to

the message analyst and capable of representing all conceivable states of the object system or at least those within the problem domain.

A problem domain delineates within the representational system those component parts or dimensions of an object system that are of special interest to the analyst.

A signal is transmitted from the object system and accepted by the analyst just on the basis of its distinguishability from other signals or the distinguishability of its elements. The signal represents states of the observed part of an object system in the representational system.

A content refers to states of the unobserved component parts of an object system and is a member of the set of possible representations that the representational system offers for selection before a signal is received. Specific choices make content always predictive.

A message is a signal that has some consequences regarding the selection of contents in a given message analytic situation.

The message analyst is a material interpretation of some message analytic procedure, the domain and range of which are disjointly defined in the terms of the representational system. More operationally, the message analyst makes appropriate choices among contents as a consequence of signal received, accepting a specific problem domain and certain rewards (i. e., the different weights the content errors may carry) as his parameters. Within these parameters, the goal of a message analytic procedure is to minimize errors and to maximize the rewards such that valid content may become an optimum.

A validating signal is a signal that represents states of the unobserved part of an object system. Revealed a posteriori to a message analysis, it may be used to determine the appropriateness of the selections made, to validate the message analytic procedure or to determine the quantity of valid content.

Message analysis, then becomes (a) any method for appropriately selecting (inferring) contents (in the predictive sense) as a consequence of (from) signals received. The term may also be defined as (b) a systematic attempt to make specific and potentially valid content inferences, or as (c) a scientific manipulation of given data as messages about unobserved components of a system.

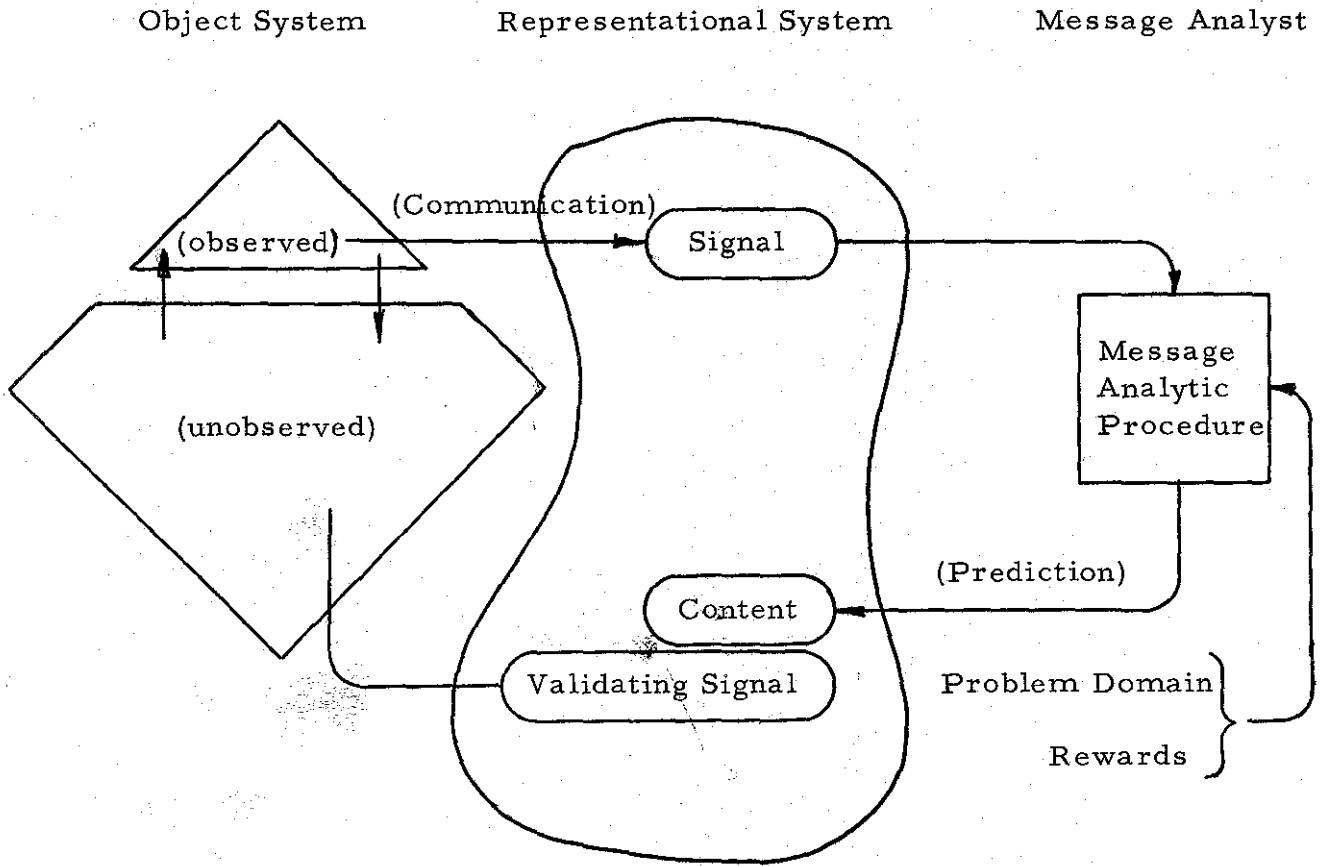


Diagram of the Message Analytic Situation (informal)

Figure 5

CHAPTER FIVE

FOUNDATIONS OF AN INFORMATION CALCULUS
FOR MESSAGE ANALYSIS

The following chapter is an attempt to treat previously discussed subjects more rigorously. To this end a calculus has to be developed in terms of which informational aspects of message analysis can be treated more adequately. As far as the information calculus will be formulated in this chapter, it will be primarily geared to state the goal of message analysis abstractly. For this purpose the explication of only one type of information, the quantity of information carried by a signal, seems to be necessary. Other kinds of information will be taken up in Chapter Seven after some of the distinct empirical problems of message analysis have been discussed. It will be seen that other quantities of information to be defined later, are based on and expressed in terms of the fundamental ideas presented in this chapter. Furthermore, it is assumed that the calculus will be useful not only in message analysis but that it will also provide the basis for a non-statistical information theory for a range of situations in which observations are utilized for purposes of prediction, situations more complex than the one of our immediate interest.

Preliminaries

The notations which will be used in the following are mainly set theoretical ones based on Ashby's "Set Theory of Mechanism and

Homeostasis" (15), an approach to formalization which draws heavily on Bourbaki's "Théorie des Ensembles; Fascicule de Résultats" (33). In cases where we deviate from this approach suitable definitions are given.

To start with the nature of the representational system, let us assume a relatively simple object system which, however, has very many interacting components. Let each component be represented by the set of states it can take. The set of states could be stages of international conflict, levels of deterrence, measures of tension, positions of the moon, authors of documents, indices of stylistic features, letters of an alphabet, the presence or absence of a symptom, scores of an aptitude test, measures of symbol entropy, expressed political ideas, historical events, steps in time, . . . anything that might interest a message analyst at some time and for some purpose. The "set of states a component may take" is meant to include such things as "values on a variable," "positions along a dimension," "indices on a scale," "measures" of some attribute, implying no metric, however. Each component of the object system needs neither to be represented by the same set of states, nor need their states be differentiated along one dimension only.

Let the set Z represent the component parts of the object system. Z 's elements A, B, C, D, \dots, I represent each component by the set of states it can take. The representational system into which such an object system can be mapped then becomes the

product of the elements in Z . This product set or state space of the object system as it is often referred to, may be written:

$$A \times B \times C \times D \times E \times \dots \times Z = \Theta^Z \quad /1/$$

where:

$$\{A, B, C, D, E, \dots, Z\} = Z \quad /2/$$

Note: our notation for the product set Θ^Z should not be confused with a similar notation that Bourbaki uses to denote the set of all mappings. The typical element of our many-dimensional space is a many-tuple which in accordance with /1/ may be written in two equivalent ways:

$$\langle a, b, c, d, e, \dots, z \rangle = (s)^Z \quad /3/$$

where:

$$a \in A, b \in B, c \in C \dots \quad \text{and } (s)^Z \in \Theta^Z \quad /4/$$

If the object system is such that it can take only one state at a time, then its behavior becomes a trajectory within the state space. We could consider another representational system, capable of representing all possible behaviors of the object system, in the case of which a behavioral space would have to be taken to represent all possible trajectories an object system may occupy in the same way as it occupies a state. We could consider representational systems which are quite different from our many-product set, but we want to focus

only on the simplest object system that is complex enough to serve as a basis for explicating the terms of our concern and leave representational systems capable of representing more complex object systems for a later extension. Such a restriction does not however, in any way affect the generality of the argument. It serves only for the clarity of the presentation.

The previous chapter led to the conclusion that the message analytic situation must be characterized by the incomplete observability of an object system and by the message analyst's attempt to infer or predict some unobserved event on the basis of those observed. In the framework of the representational system defined above, incomplete observability can be identified with having access not to all members of the set Z but only to a proper subset, say, E thereof. Thus, an incompletely observed state of the object system; the typical signal of which is to be subjected to message analysis becomes equivalent to a fraction of a many-tuple ranging only over some of the state space's dimensions. Such a signal can be regarded as an element of a subspace of the object system's state space.

In the notations of our representational system such a signal, i. e., incomplete observation can be written as follows:

$$(s)^E \in \Theta^E \quad \text{whereby} \quad E \subset Z \quad /5/$$

Specific signals within a space may be individualized by subscripts, for example, to express that $(s)_i^E \neq (s)_j^E$. If the set of components,

variables or dimensions, or more adequately, the sets of states those components may occupy in conjunction need not be referred to explicitly, then the superscripts denoting such sets may be omitted. For example, some signal may be denoted by the symbol (s) or $(s)_i$ and some space simply by Θ .

Given the signal $(s)^E$ the message analyst knows the actual state of the object system to be in the subset $(s)^E \times \Theta^{Z-E}$ of Θ^Z . Given in addition his problem domain denoted by the subset D of Z , the message analyst is informed that the content to be inferred from that signal will have to be found among the members of the subspace Θ^{D-E} . Such conclusions are fairly obvious and indeed implicit in the structure of our representational system conceptualized as a product set. The operation accounting for these implications is essential for the information calculus to be developed. It is related to the "operation of projection" which, applied on a state space or any subset of it, simply picks out a subspace. Customarily defined as a mapping (15:14), the operation of projection is:

$$\text{pr}_G : \quad \Theta^Z \longrightarrow \Theta^G \quad /6/$$

When operating on a single element, it produces an element having fewer components:

$$\text{pr}_G (s)^Z = (s)^G \quad /7/$$

The idea of reducing the dimensionality of a state space is of

course, inversely related to the idea of considering a set of an object system's components which is larger than the set of those actually observed. In fact the subset containing the actual state of the object system which is implicitly known when a signal is received can be obtained by applying the inverse of pr_G on the signal. According to the definition of the operation of projection its inverse produces the following set:

$$\text{pr}_G^{-1} (s)^G = (s)^G \times \{(s)^{Z-G}\} = (s)^G \times \Theta^{Z-G} \quad /8/$$

For the intended development of our information calculus for message analytic situations, a more general notion of projection is needed which will be termed "cojection" for it involves two joint operations based on projections. The term has been suggested by Robinson.³ We start with a definition of two projections wherein E and F are two arbitrary subsets of Z and the * distinguishes them from those having the total state space Θ^Z as domain:

$$*\text{pr}_E : \Theta^{E \cup F} \longrightarrow \Theta^E \quad /9/$$

and

$$*\text{pr}_F : \Theta^{E \cup F} \longrightarrow \Theta^F \quad /10/$$

³T. Thatcher Robinson, personal communication.

With /9/ and /10/ the operation of "cojection onto F" can now be defined as follows:

$$\text{co}^F = *pr_F *pr_E^{-1} : \Theta^E \longrightarrow \Theta^F \quad /11/$$

Whereby the domain of the projection is always to be understood as indicated by the dimensions of the operand. The cojection of a specific signal $(s)^E$ onto F is:

$$\begin{aligned} \text{co}^F (s)^E &= *pr_F *pr_E^{-1} (s)^E = *pr_F((s)^E \times \Theta^{F-E}) \\ &= (s)^{E \cap F} \times \Theta^{F-E} \end{aligned} \quad /12/$$

Note that the operation of cojection is a mapping only under the condition that its range is either identical with or fully contained in its domain.

Otherwise it is not single valued.

One of the peculiarities of cojection which will be of importance later on is the cojection of a null-tuple, i. e., a signal none of the values of which are known or specified. Such a cojection produces the whole space within the set of dimensions specified by the superscript:

$$\text{co}^F (s)^\emptyset = (s)^{\emptyset \cap F} \times \Theta^{F-\emptyset} = \Theta^F \quad /13/$$

The effect of cojections may be more vividly demonstrated by an example with actual values. Let the state space be:

$$\Theta^Z = \prod_{e \in Z} \Theta_e \quad \text{and} \quad \Theta_e = \{ a, b \}$$

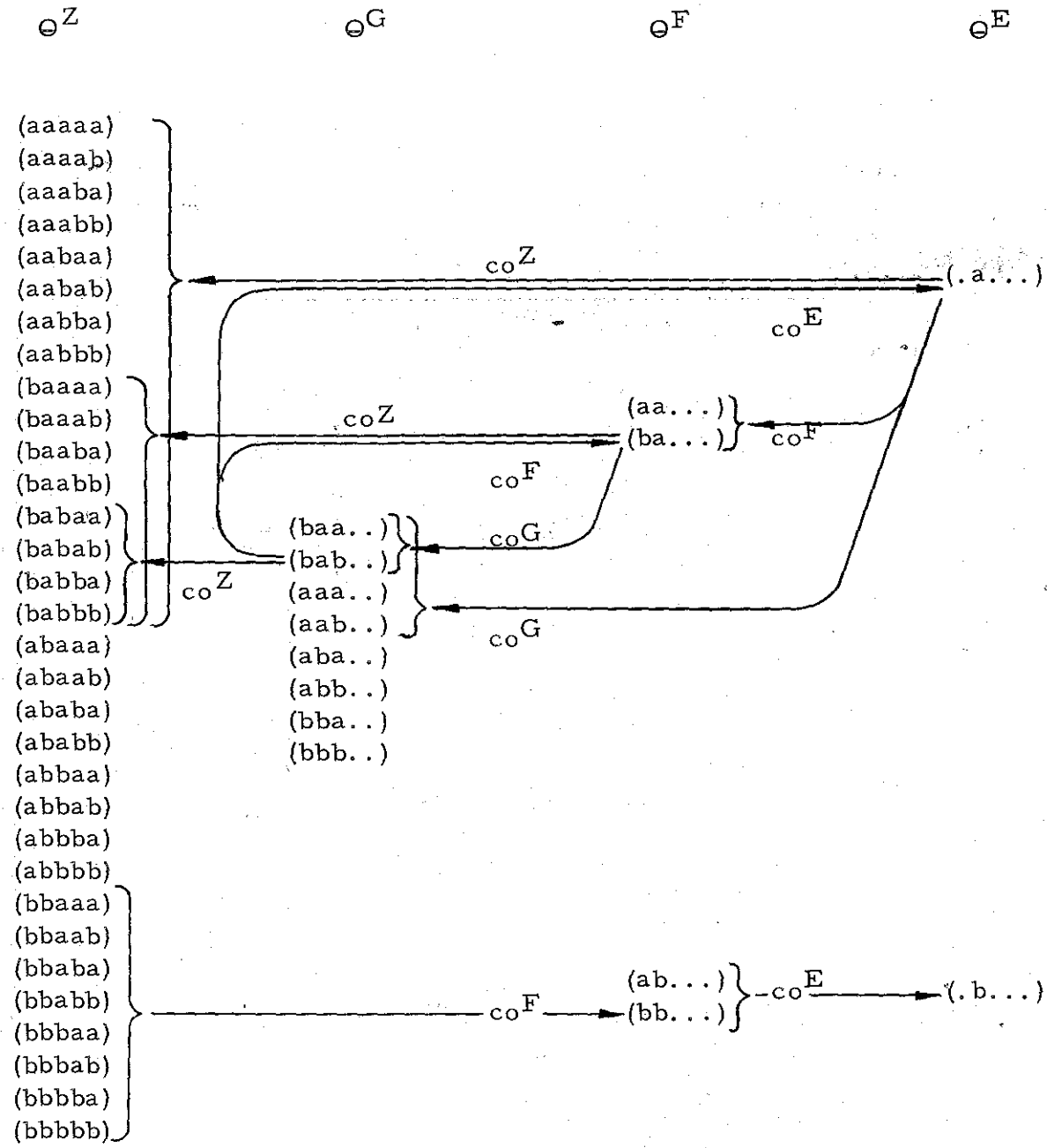
Let five signals be given as: $(s)_1^E = \langle .a\dots \rangle$, $(s)_2^E = \langle .b\dots \rangle$,
 $(s)_3^F = \langle ba\dots \rangle$, $(s)_4^F = \langle bb\dots \rangle$, $(s)_5^G = \langle bab\dots \rangle$, whereby E, F,
 and G are all subsets of Z and the dots represent components of a
 quintuple along dimensions in Z not specified by the respective signal.
 Some of the cojections are depicted diagrammatically in Figure 6.

In order to discuss the operation of cojection more fruitfully
 another operation has to be introduced which maps set theoretical
 notions into the natural number system. The operation referred to
 provides a basis for translating expressions of the algebra of sets into
 those of cardinal arithmetic. Cardinal arithmetic is required for ex-
 pressing quantities within the representational system numerically.
 Let A be any set and a be a cardinal number representing the number
 of elements in A, the operation denoted by the symbol # may be
 interpreted as an enumerator of the elements contained in its operand
 and be written:

$$a = \#A \quad /14/$$

With the operation #, some of the fundamental operations of
 the algebra of sets such as union and product can be equated with such
 ordinary operations as addition and multiplication. Let, for example,
 A and B be disjoint sets, then:

$$\# A \cup B = \#A + \#B \quad /15/$$



- (s)₁^E = (. a . . .)
- (s)₂^E = (. b . . .)
- (s)₃^F = (ba . . .)
- (s)₄^F = (bb . . .)
- (s)₅^G = (bab . .)

Operands and Transforms of some Cojections

Figure 6

For any set A and B:

$$\#A \times B = \#A \cdot \#B \quad /16/$$

Consequently:

$$\#\Theta^{A \cup B} = \#\Theta^A \times \#\Theta^{B-A} = \#\Theta^A \cdot \#\Theta^{B-A} \quad /17/$$

Moreover, # leads to various inequalities and equivalences, for example:

$$A \subset B \quad \text{implies} \quad \#A < \#B \quad /18/$$

$$A \equiv B \quad \text{implies} \quad \#A = \#B \quad /19/$$

If each component Θ has the same number of elements:

$$A \subset B \quad \text{implies} \quad \#\Theta^A < \#\Theta^B \quad /20/$$

The possible signals that can be obtained from an object system and that can be distinguished in the respective state space is not just the set of elements in Θ^Z , but the set of all many-tuples (s), ranging over all possible subspaces of the state space.

With $\mathbb{P}Z$ denoting the set of all subsets of Z

The number of signals distinguishable in Θ^Z is:

$$\# \left\{ (s)^{E \in \mathbb{P}Z} \right\} = (1 + \#A) (1 + \#B) (1 + \#C) \dots (1 + \#Z)$$

because any $(s)^E$ can be construed as taking any one value within the set E of sets of states or as being not accessible. That this number is much larger than the number $\#\Theta^Z$ of elements in the total state

space is easily seen by converting the above expression into the following form:

$$= 1 + \#A + \#B + \dots + \#Z + \#A \times B + \#A \times C + \dots + \#O^Z$$

i. e., it is the sum of all nul-tuples, all simples, all couples, all triples,, all elements in the state space.

The previous chapter showed message analysis to be a problem of making appropriate selections within some domain delineated by terms of the representational system and referring to unobserved components of the object system. The goal of "optimizing valid content within a problem domain" presupposes a quantification of the appropriateness of a selection. Since the number of decisions that are to be made by an analyst can most reasonably be assumed to be strictly finite and enumerable, it is suggestive to apply some of the well known information measures on the effective number of alternatives presented to him. As appealing as such a suggestion may seem, the task is rendered difficult however, if confined to the concept of information as advanced by Shannon (175) and Wiener (209). The four main reasons are as follows:

Firstly, it seems to be impossible to assign priori relative frequencies to the alternatives within the behavioral space of an object system. A representational system represents not only actual but also possible signals that may be preconceived by a receiver or message analyst on purely logical grounds. It contains not only the observed but also, and most importantly for the message analytic situation,

preconceived and yet unobserved states of the object system's components that may be subject to prediction. The representational system is imposed by an analyst on the object system. Hence a statistical treatment of both observed and unobserved states would indeed be vacuous.

Secondly, a simple counting of the number of characters in a signal or an assessment of the frequency with which such a signal or its characters has been obtained in the past does little to account for the referentiality of such a signal to an object system's components represented in the representational system. Such notions as "the amount of knowledge about the object system conveyed by a message" cannot be expressed by merely measuring some characteristics of the signal itself which carries that knowledge. In traditional stochastic information theory notions such as "the validity of the inferred content" have no place because the former cannot handle semantical aspects of signals. These notions typically require the viewing of a signal in the larger context of an *a priori* representational system.

Thirdly, a treatment of the alternatives available to the message analyst for selection as "equiprobable", the assumption of which has proven helpful in other situations of complete uncertainty, would seriously violate the systemic character of the state space. Or, stated differently, the "logic" implicit in a representational system accounting for some other than statistical dependencies would be neglected if all possible signals within such a system were treated as equally likely. This is not to say that probabilistic notions are completely irrelevant

for our interests but that some other form of dependency needs to be considered which a statistical notion of information does not incorporate at this point of its development.

Fourthly, Shannon's mathematical theory of communication assumes processes of information transmission to be ergodic, i. e., the transition probabilities are fixed and frequency distributions are equiprobable. On the other hand, one of the most significant characteristics of message analytic situations and perhaps of all interaction through messages is that the reception and manipulation of signals successively and irreversibly reduces the uncertainty about an object system. The information process in which the message analyst is engaged is essentially a non-ergodic process that terminates when as much uncertainty as possible is removed from the problem domain. Thus, several assumptions of stochastic type information theories as proposed by Shannon and Wiener are fundamentally different from those that have to be considered regarding message analytic situations.

Consider an abstract example of a message analytic situation. Suppose we were given some signal and asked to make some predictions as to the actual state of the object system, i. e., we are asked to appropriately select some content out of the alternatives remaining in the state space after a signal has been received. For purposes of illustration let us refer to the signals the various conjectures of which have already been diagrammed in Figure 6. For the sake of simplicity let the problem domain be the respective subspace whose values remain

undetermined after one of the signals are given.

Comparing signals $(s)_1$ and $(s)_5$, for instance, it is quite obvious that given $(s)_5$ much more is known about the object system than if only $(s)_1$ were to be received. The "more knowledge" that seems to be associated with $(s)_5$ appears also to be connected with some notion of "higher confidence" in adequately selecting among the possible contents of that message. Moving from $(s)_1$ via $(s)_3$ to $(s)_5$ we would even say that the "probability" of correctly guessing the possible contents of the message increases with the increasing knowledge about the object system directly conveyed by the respective signal. Without violating our intuition we could furthermore assert that $(s)_5$ is in some sense "richer" than $(s)_1$, makes prediction "easier" than $(s)_1$, or carries "more information" than $(s)_1$. In the same sense $(s)_1$ and $(s)_2$ could be said to carry the same amount of information although they are different signals. The same can be said for $(s)_3$ and $(s)_4$. Note that such notions have little to do with those explicated in Shannon and Wiener's statistical information theory. The notion of probability, for example, is not based on any frequency of selections. It is a probability a priori to any frequency and uniquely dependent on the nature of the representational system chosen. Needless to say, no statistical extrapolation of the signals can account for such intuitive notions of probability and consequently it cannot account for the notion of information of our immediate interest either.

Conversely, given $(s)_5$ the knowledge conveyed by it includes what $(s)_3$ and $(s)_1$ could convey and this is true regardless of how frequently either of the signals have been observed. The fact is that $(s)_3$ is a projection of $(s)_5$, and $(s)_1$ can similarly be obtained from both $(s)_3$ and $(s)_5$ by simply omitting some of the signal's components. Both $(s)_3$ and $(s)_1$ can be inferred from $(s)_5$ with absolute certainty and can be said to be redundant with respect to $(s)_5$. Under these conditions our intuition leads us to assert that $(s)_1$ contains no information relative to $(s)_3$ and $(s)_5$ just as $(s)_3$ contains no information relative to $(s)_5$. It should again be noted that the concept of information which is used here informally refers neither to Shannon's entropy (175) nor to McGill's uncertainty (132) nor to a measure of rarity or surprise value as the statistical information measures have often been interpreted.

The crux of the matter is that the example and its interpretation just mentioned, does not deal with a frequency interpretation of probability but with a logical interpretation of probability, a distinction which has been made clear in Carnap's work (37). Similarly, the notion of "information" as used here derives from the logical interpretation of probability and is probably the one Cherry envisaged when saying "...when we solve a set of simultaneous equations we do not really obtain new information; the various steps and the final solution represent transformations (or 'codings') of the information which was contained implicitly in the original equation" (42:389). The idea that there may be many concepts of information, a statistical one, a

semantical one, etc., all of which can be said to be specific interpretations of a general information calculus has been presented by Bar-Hillel (22).

The diagram seems in a sense to "explain" some of the intuitions we asserted regarding the amount of information carried by an incomplete observation. We suggested that signal $(s)_3$, being in some sense "richer" than the signal $(s)_1$, carries more information. Now the diagram depicts the immediately striking fact that the number of elements remaining in Θ^Z after $(s)_3$ has become known is indeed much smaller than after only $(s)_1$ has been obtained --not to speak of the further reduction of the variety of elements among which the state of the object system will have to be found after $(s)_5$ has been cojected onto Z . On the other hand, going from $(s)_5$ to $(s)_3$ or to $(s)_1$; and from $(s)_3$ to $(s)_1$, the variety remains unaffected neither increasing nor decreasing. This fact may account for the intuition that a signal which is only a fraction of a another carries no information and is perfectly redundant with respect to the latter.

The diagram is such that all cojections which do not increase the variety found in their operands are depicted by left-to-right arrows. It happens that these cojections are projections as defined in /8/. On the other hand, cojections depicted in the diagram by right-to-left arrows are not mappings. They are the inverses of projections and may be called extensions which never decrease the variety found in their operands. Compare by means of the diagram the number

$\#co^E(s)_5^G = 1$ obtained by a projection with the number $\#co^G(s)_1^E = 4$ obtained by an extension.

How these cojections are termed appears to be secondary. But, that the intuitive notion of information in the sense of the specificity of a signal is intrinsically related to the varieties obtained after cojections have been applied on subspace of a state space and elements thereof, seems at least suggestive of the following:

A Derivation of the Signal Information Function

The introduction of this chapter developed the basic tools for our information calculus. It enables us to formulate the requirements which a measure function for "amount of information carried by a signal," or briefly, "amount of signal information," should satisfy. These requirements will, at first, be discussed informally.

The most general requirements on this measure function is that it should be a continuous function of the signal's specificity or the degree to which a signal represents the object system within a representational system.

The measure function should yield quantitative statements representing some signal characteristic in reference to a representational system which are amenable to some algebraic operations. More specifically, measures of signals that specify different parts of an object system and that are in this respect independent of each other, should be additive.

Suppose a set of signals are received in the form of punched cards. It seems close to our intuitive conception as to a proper measure of information that two punched cards have, as Shannon suggests, twice the capacity to store information as a single such card. Analogously, if an object system is composed of many identical components, a signal representing the state of two such components should contain twice as much information as a signal representing the state of only one.

If the set of received signals, for example, punched cards, written text, numerical record etc., are only replicas of each other, then the information function should not be affected by the number of identical signals received. On intuitive grounds the first of these signals contains all information that is obtainable from the set, the remainder can be considered redundant and therefore should not contribute to the measure. Note that this notion of redundancy is quite different from the concept of redundancy in Shannon's statistical information theory where it is a measure of a constraint.

If a receiver or message analyst defines his focus of attention, area of interest or problem domain to be a particular set of an object system's components, some signal should be measured as carrying information only to the extent that it has specificity within the set of dimensions that denote the priorily defined focus of attention. And yet, the function should still remain a measure of the amount of information the signal carries and not vary with the amount of ignorance

prior to the reception of that signal. This requirement becomes important for differentiating relevant from irrelevant information and should permit us to consider arbitrarily chosen parts of an object system without affecting the quantities measured with one exception: the size of the arbitrarily chosen part of an object system should determine the upper limit of the amount of information a signal may carry within the delineated focus of attention. This requirement is also quite natural. If a signal provides all information of interest, there is nothing to be added to the quantity of information possessed by receiving more signals of whatever kind. This requirement particularly makes the difference between our measure of information and a statistical measure of information quite an obvious one.

Under the assumption that the particular sequence in which a variety of signals of an object system's components are received is merely a problem of observation and hence does not provide information about that system, the measure function should not be affected by the order in which these signals appear.

Two or more received signals may represent components of the object system as being in mutually exclusive states. In such cases the measure function should take an indefinitely large value. On intuitive grounds contradictions of this kind in no way reduce the uncertainty regarding an object system. When such contradictions appear, they indicate that the representational system chosen is not powerful enough or that it is incapable of adequately representing the object

system from which the signals were obtained. In some sense such signals can be conceived as carrying more information than the representational system can handle. Hence, the measure function is then expected to assume the value of infinity. For example, the same place cannot have two different colors at the same time. At least within the common representational system, colors are mutually exclusive. An observation of incompatible states would lead to the collapse of the representational system. In a more powerful representational system which includes, for example, observer differences, such incompatibilities may become resolved and observations to this effect may then become manageable and contain finite quantities of information.

After this informal discussion of the properties that we expect a measure function of amount of signal information to possess, we will state these requirements more formally. Just for the derivation of the function (i. e., just in this section of the chapter), the particular subspace which is of interest to the analyst or receiver will be denoted by the set G of dimensions that constitute a subspace of the state space Θ^Z representing an object system and the two sample signals $(s)^E$ and $(s)^F$ will be considered with sets E and F both contained in Z , delineating the components represented by each signal.

Axiom 1: the value of the measure function f is not to exceed a certain maximum that is determined by the size of the subspace

denoted by the set G of dimensions of interest to the receiver or message analyst, i. e.,

G being fixed or known,

$$f(G, (s)^E) \leq f(G)$$

whereby equality is obtained when $G \subseteq E$.

Axiom 2: The value of the function is to remain invariant for all arbitrarily chosen dimensions of subspaces that are merely extensions of the subspace of which the received signal is an element, i. e.,

$(s)^E$ being fixed or known,

$$f(G, (s)^E) = \text{invariant for any } G, \quad E \subseteq G.$$

Axiom 3: If fractions of a signal are taken independently, then the value of the measure function is to remain invariant to any order or arrangement in which these signals are considered, i. e.,

for any E, F and G ,

$$f(G, (s)^{E \cup F}) = f(G, (s)^E \text{ and } (s)^F) = f(G, (s)^F \text{ and } (s)^E)$$

the non-committal "and" denoting an operation to be defined according to the axiom.

Axiom 4: If the members of a set of signals represent no common components within the dimensions of interest to the analyst, then the value of the measure over all signals is to be the algebraic

sum of the measures obtained from each individual signal, i. e.,

$$\text{whenever } (G \cap E) \cap (G \cap F) = \emptyset,$$

$$f(G, (s)^E \text{ and } (s)^F) = f(G, (s)^E) + f(G, (s)^F).$$

Axiom 5: The measure is to be a continuous function over the number of elements that its arguments delineate within a representational system, i. e.,

$$f(G, (s)^{E \cup F}) \text{ is continuous.}$$

Theorem: The only function satisfying the five axiomatic requirements is:

$$f(G, (s)^E \text{ and } (s)^F) = c \log \frac{\#_{co} G_{\Theta}}{\#_{co} G_{(s)^E} \cap \#_{co} G_{(s)^F}}$$

where c may be any constant.

Proof: From /12/ and /16/ follows:

$$\#_{co} G_{(s)^E} = \#(s)^{G \cap E}, \quad \#_{\Theta}^{G-E} = \#_{\Theta}^{G-E}$$

and

$$\#_{co} G_{\Theta} = \#_{\Theta}^G = \#_{\Theta}^{G \cap E} \cdot \#_{\Theta}^{G-E}.$$

Suppose now $G=E$, then according to both axioms 1 and 2:

$$f(G, (s)^E) = f(G) = F(E).$$

By axiom 1 the value of the measure is not to be affected by any signal's specificity outside the space denoted by G . In the cardinal arithmetic expressions above, it is easily seen that under the condition $G=E$ the number of elements in the signal's cojection onto G is always one and remains unaltered for any $(s)^E$, $G \subseteq E$. The operation cojection onto G ensures that $\#\Theta^{E-G}$ is eliminated.

By axiom 2 the value of the measure is to be invariant for any G , $E \subseteq G$ in which case the measure is solely to be a function of the specificity of the signal. Suppose a few dimensions, constituting a space having, say, m elements, were added to G . The new space denoted by G' then has m times as many elements and so has the cojection of $(s)^E$ onto G' m times as many elements. Axiom 3 requires now that the number of elements in $\Theta^{G'-E}$ in the expression above to have no effect on the measure function. These quantities vary exponentially with the number of dimensions in the arbitrarily chosen space denoted by G . The only way of effectively compensating these joint variations is by dividing the quantities in question. Hence, the only function that satisfies axioms 1 and 2 jointly is:

$$f(G, (s)^E) = g \frac{\#\text{co}_G \Theta}{\#\text{co}_G (s)^E}$$

where g is a function that needs to be determined by other axioms.

Thus when $G \subseteq E$,

$$f(G, (s)^E) = g \frac{\#\text{co}_G \Theta}{\#\text{co}_G (s)^E} = g \frac{\#\Theta^G}{\#(s)^E} = g \#\Theta^G$$

thereby satisfying the requirement of axiom 1. When $E \subseteq G$,

$$f(G, (s)^E) = g \frac{\#_{coG} \Theta}{\#_{coG(s)^E}} = g \frac{\#_{\Theta^E} \cdot \#_{\Theta^{G-E}}}{\#_{(s)^E} \cdot \#_{\Theta^{G-E}}} = g \cdot \#_{\Theta^E}$$

whereby the requirement of axiom 2 is met.

By axiom 3, which can be taken up quite independently of the other axioms,

$$(s)^{E \cup F} = (s)^E \text{ and } (s)^F = (s)^F \text{ and } (s)^E.$$

Since signals in this expression may pertain to several different spaces, "and" must include a standardizing operation for which cojection has been defined and an operation that is associative and commutative. Applying $co^{E \cup F}$ on the signals in the above expression yields:

$$co^{E \cup F} (s)^E = (s)^E \times \Theta^{F-E}$$

$$co^{E \cup F} (s)^F = (s)^F \times \Theta^{E-F}$$

whereby

$$(s)^{E \cup F} \in co^{E \cup F} (s)^E \subseteq \Theta^{E \cup F}$$

$$(s)^{E \cup F} \in co^{E \cup F} (s)^F \subseteq \Theta^{E \cup F}.$$

Therefore, the only operation that satisfies the requirement set forth in axiom 3 is the intersection of these cojections. Thus "and" can only be defined:

$$(s)^E \text{ and } (s)^F = (s)^{E \cup F} = co^{E \cup F} (s)^E \cap co^{E \cup F} (s)^F$$

which, inserted in the function obtained from axioms 1 and 2, yields:

$$\begin{aligned} f(G, (s)^E \text{ and } (s)^F) &= g \frac{\#_{co} G_{\Theta}}{\#_{co} G_{(s)^E} \cap \#_{co} G_{(s)^F}} \\ &= g \frac{\#_{\Theta} G \cap (E \cup F) \quad \#_{\Theta} G - (E \cup F)}{\#_{(s)} G \cap (E \cup F) \quad \#_{\Theta} G - (E \cup F)} = g \#_{\Theta} G \cap (E \cup F) \end{aligned}$$

Axiom 4 requires the measure for a set of individual signals to be additive whenever these signals represent no common component within G . In conjunction with axioms 1, 2, and 3, axiom 4 requires the function to have the following property:

$$g \frac{\#_{co} G_{\Theta}}{\#_{co} G_{(s)^E} \cap \#_{co} G_{(s)^F}} = g \frac{\#_{co} G_{\Theta}}{\#_{co} G_{(s)^E}} + g \frac{\#_{co} G_{\Theta}}{\#_{co} G_{(s)^F}}$$

Simplified as it has been done above, axiom 1 through 4 requires

$$g \#_{\Theta} G \cap (E \cup F) = g \#_{\Theta} G \cap E + g \#_{\Theta} G \cap F$$

Under the stated assumption that $(G \cap E) \cap (G \cap F) = \emptyset$, it is always so that

$$\#_{\Theta} G \cap (E \cup F) = \#_{\Theta} G \cap E + \#_{\Theta} G \cap F$$

The requirement axiom 4 imposes on the function then becomes more clearly expressed as:

$$g \#_{\Theta} G \cap E + \#_{\Theta} G \cap F = g \#_{\Theta} G \cap E + g \#_{\Theta} G \cap F$$

It is well known that the only function that has this property and confirms to axiom 5 by being continuous is:

$$g(x) = c \log x.$$

Hence, the measure function for amount of signal information that satisfies the requirements put forth by the five axioms can only be:

$$f(G, (s)^E \text{ and } (s)^F) = c \log \frac{\#co^G \Theta}{\#co^G(s)^E \cap co^G(s)^F}$$

Q. E. D.

There is no reason to assume the constant c to have any value other than $+1$. The basis of the logarithm is arbitrary. But, for accordance with other information theories we can assume it to be 2 whenever practical computations are made. Hence, the values of the function are expressed in "bits." Moreover, we wish to express the function for any set $\{ \dots, (s)_i, \dots \}$ of signals and therefore define the amount of information carried by a set of signals as:

$$SI^G(\dots, (s)_i, \dots) = \log \frac{\#co^G \Theta}{\# \bigcap_i co^G(s)_i} \quad /21/$$

It is easily shown that the informally stated requirement concerning contradictory signals is implied by the five axioms. Consider two signals $(s)_i^E$ and $(s)_j^F$ that are mutually exclusive within G , i. e.,

$$(s)_i^E \cap F \cap G \neq (s)_j^E \cap F \cap G$$

implying

$$(s)_i^{E \cap F \cap G} \times (s)_i^{(E-F) \cap G} \times \Theta^{G-E} \cap (s)_j^{E \cap F \cap G} \times (s)_j^{(F-E) \cap G} \\ \times \Theta^{G-F} = \emptyset$$

which is in fact equivalent to

$$\text{co}^G(s)_i^E \cap \text{co}^G(s)_j^F = \emptyset$$

in which case

$$\text{SI}^G((s)_i^E, (s)_j^F) = \log \frac{\#\text{co}^G \Theta}{\#\emptyset} = +\infty$$

Q. E. D.

Our measure function for amount of signal information exhibits a superficial resemblance to " $-\log_2 p_i$," the amount of statistical information that is associated with a single signal out of a set of signals that are characterized by their occurrence with certain frequencies. The expression derives from Shannon's work (175) although it has been formally introduced only by others, for example, Fano (59). Consequently, p_i is the frequency interpretation of probability and ought not to be confused with our expression right of the logarithm. Our measure function is more similar to Carnap and Bar-Hillel's amount of semantical information conveyed by a statement: " $\text{inf}(i) = -\log_2 m(i)$ " (21) (38), whereby m is a measure function defined over the range of statements that do not imply the statement i .

Although formally similar to the measure of statistical information and to the measure of semantical information in that they involve the logarithm of some proportion, our measure is concerned with the specificity of a signal within an arbitrarily chosen domain of interest to the receiver and with respect to an object system from which the signal presumably originated. Insofar as signals are being measured in their capacity to represent components of an object system, one might conceive of our measure as being a measure of the amount a given signal represents. It should be noted that the specificity of a signal still has little to do with the content we are ultimately interested in.

In our definition, the expression to the right of the logarithm is a proportion of the number of alternatives within a space denoted by G and the number of alternatives that remain in that space after a signal has become known. In other words, the information measure is based on the proportion of the varieties in a designated space a priori and a posteriori to cojections of a set of signals onto the dimension of that space. This fact leads us to a rather convenient interpretation of our quantity of information as the difference between a priori and a posteriori knowledge within a given boundary. More formally, let

$$U^G = \log \# \text{co}^G \ominus \quad /22/$$

and

$$U^G(\dots, (s)_i, \dots) = \log \# \bigcap_i \text{co}^G (s)_i \quad /23/$$

then our function for amount of signal information becomes:

$$SI^G(\dots, (s)_i, \dots) = U^G - U^G(\dots, (s)_i, \dots) \quad /24/$$

With this intuitively meaningful equation of information with the difference between two different states of knowledge, the function becomes a recognizable explication of the kind of information concept which is made use of when asserting that an experiment yields information about some object tested; that a photograph contains information about something depicted; when claiming that television presents more information in subject area X than in subject area Y, or when judging a person as being informed or not informed. It is the kind of information that is necessary for the making of decisions concerning a delineated aspect of someone's environment and is therefore sought and paid for by purposive organizations. It can be conceptualized as successively and irreversibly eliminating the uncertainty within a given domain of interest to the receiver of the signals. By permitting an arbitrary delineation of a particular focus of attention to which the assessed quantities refer, the measure function accounts for differential evaluations that a receiver may impose on the specificity of a signal thus differentiating between relevant and irrelevant information according to a receiver-specified interest or purpose.

Some distinctive values of the signal information measure

$SI^G(\dots, (s)_i, \dots) = 0$ implies that $U^G = U^G(\dots, (s)_i, \dots)$ and indicates that the signals carry no information with respect to that part

of the object system represented in the set G of dimensions. If the amount of signal information in Z (Z encompassing the whole state space) is zero, the signals must be considered empty or not received. According to /13/, $U^Z((s)^{\emptyset})$ then assumes its maximum value.

$SI^G(\dots, (s)_i, \dots) = U^G$ implies $U^G(\dots, (s)_i, \dots) = 0$ and indicates that the set of signals perfectly specify the state of the object system represented by Θ^G . The set of signals can then be said to have carried precisely the amount of information required to remove all uncertainty in Θ^G .

$SI^G(\dots, (s)_i, \dots) = \infty$ indicates an indeterminacy in the subspace denoted by G due to contradictions that the representational system cannot resolve. For example consider the diagram in Figure 6. The cojections of $(s)_2$ and any one of $(s)_1$, $(s)_3$, or $(s)_5$ never have any common element as long as E is included in the respective subspace G . Hence, their intersection is always the empty set. The measure then indicates the presence of two or more signals that are mutually exclusive within the assumed representational system.

Dependencies Between Signals Affecting the Measure

When two signals contain the same information, one of them may be said to be redundant with respect to the other. A set of signals may or may not contain redundancy depending on whether and the extent to which the specificity of one signal is already implied by some other signal. The quantity of redundancy of a set of signals can be

defined as follows:

$$RI^G(\dots, (s)_i, \dots) = \sum_1 SI^G((s)_i) - SI^G(\dots, (s)_i, \dots) \quad /25/$$

or expressed in relative terms, taking values between zero and one:

$$ri^G(\dots, (s)_i, \dots) = 1 - \frac{SI^G(\dots, (s)_i, \dots)}{\sum_1 SI^G((s)_i)} \quad /26/$$

If two signals are identical, $(s)_i \equiv (s)_j$, their cojection onto G produces identical sets. Therefore:

$$SI^G((s)_i, (s)_j) = SI^G((s)_i) = SI^G((s)_j) = RI^G((s)_i, (s)_j)$$

whereby the relative redundance becomes $ri^G((s)_i, (s)_j) = 0.5$.

If two signals are independent in G , i. e. $(G \cap E) \cap (G \cap F) = \emptyset$, then according to axiom 4:

$$SI^G((s)^E, (s)^F) = SI^G((s)^E) + SI^G((s)^F)$$

and relative as well as absolute redundancy assume the value zero.

If two signals are such that $(s)^E$ is a fraction of, derivable from, or already specified by the signal $(s)^F$ in G , i. e., $G \cap E \subset G \cap F$, and $(s)^{G \cap E} = co^{G \cap E}(s)^E = co^{G \cap E}(s)^F$, then:

$$co^G(s)^F = (s)^{G \cap F} \times \emptyset^{G-F} \subseteq (s)^{G \cap E} \times \emptyset^{G-E} = co^G(s)^E$$

from which it follows that

$$\# \emptyset^{G-F} \leq \# \emptyset^{G-E}$$

whereby

$$SI^G((s)^E, (s)^F) = SI^G((s)^F) \geq SI^G((s)^E).$$

Consequently only $(s)^E$ contributes to the redundancy of the set of signals:

$$RI^G((s)^E, (s)^F) = SI^G((s)^E).$$

With the exception of the case where two signals are mutually exclusive in G , i. e., $co^G(s)^E \cap co^G(s)^F = \emptyset$, the amounts of joint and individual signal information are related in the following way:

$$SI^G((s)^E, (s)^F) \leq SI^G((s)^E) + SI^G((s)^F).$$

Measures of the amount of signal information conditional on some given signal can be defined in analogy to Shannon's conditional entropy. Suppose the amount of information conveyed by the signal $(s)_i$ is to be assessed, the signal $(s)_j$ being given or known, we define:

$$\begin{aligned} SI^G((s)_i/(s)_j) &= SI^G((s)_i, (s)_j) - SI^G((s)_j) \\ &= U^G((s)_i) - U^G((s)_i, (s)_j) \\ &= \log \frac{\#co^G(s)_j}{\#co^G(s)_i \cdot co^G(s)_j}. \end{aligned} \quad /27/$$

The relation between the amounts of conditional information and of redundancy follows from /25/ and /27/:

$$SI^G((s)_i/(s)_j) = SI^G((s)_i) - RI^G((s)_i, (s)_j). \quad /28/$$

If two signals are free of contradictions in G or the contradictions are intentionally to be ignored, then the amount of conditional information can be expressed in a more convenient way. Starting again with the definition /27/:

$$\begin{aligned}
 SI^G_{((s)E/(s)F)} &= \log \frac{\#co^G(s)^F}{\#co^G(s)^E \cap co^G(s)^F} \\
 &= \log \frac{\#(s)^{G \cap F} \times \Theta^{G-F}}{\#(s)^{G \cap E} \times \Theta^{G-E} \cap (s)^{G \cap F} \times \Theta^{G-F}} \\
 &= \log \frac{\#\Theta^{G-F}}{\#(s)^{(G-F) \cap E} \times \Theta^{(G-F)-E}} \\
 &= \log \frac{\#co^{G-F}\Theta}{\#co^{G-F}(s)^E} \\
 &= U^{G-F} - U^{G-F}_{((s)E)} = SI^{G-F}_{((s)E)} \quad /29/
 \end{aligned}$$

provided that $co^G(s)^E \cap co^G(s)^F \neq \emptyset$.

Among the many specialized information measures that can be defined in terms of our calculus is a measure of the amount of valid information. This measure is needed to state the goal of message analysis formally. Suppose a message analyst takes a guess as to the state of a set G of an object system's components and this guess is only partly correct. We wish to have a measure of how much of this guess was valid. This entails the comparison of the guess with some validating evidence and requires the definition of a special operation " σ " that picks out those dimensions E' of the guess $(g)^E$ that are

in agreement with the validation signal $(v)^F$. Let the operation \mathcal{U} induce a mapping:

$$\mathcal{U}: E \longrightarrow E' = \{ e \mid e \in E \text{ and } \text{co}^e(g)^E = \text{co}^e(v)^F \} \quad /30/$$

and be written:

$$\mathcal{U}(\text{co}(g)^E, (v)^F) = \text{co}(g)^{E'}$$

The names of information functions that include the operation \mathcal{U} will be prefixed by a capital V. Consequently the amount of valid signal information is then defined as:

$$\text{VSI}^G(\dots, (g)_i, \dots // (v)^F) = \log \frac{\# \text{co}^G \Theta}{\# \mathcal{U}(\bigcap_i \text{co}^G(g)_i, (v)^F)} \quad /31/$$

Since by definition /30/ of the operation \mathcal{U} , $E' \subseteq E$, it follows from /31/ that:

$$\text{VSI}^G(\dots, (g)_i, \dots // (v)^F) \leq \text{SI}^G(\dots, (g)_i, \dots) \quad /32/$$

The Goal of Message Analysis

After having developed the foundation of an information calculus assumed to be adequate for message analysis and after an attempt has been made to show some typical properties of the suggested measure function, we are now equipped to formulate the goal of message analysis more concisely and in more elegant terms. For the sake of simplicity,

the symbols referring to the state space of an object system will be used throughout, keeping in mind that the formulations are meant to be generalizable to other representational systems as well.

As it was developed in the last chapter, the diagram in Figure 7 depicts now formally the message analytic situation as a system having an object system, a representational system and a message analyst as its components. Although the message analyst has only limited access to the object system of his attention, it should always be understood that the external observer, from whose point of view the message analytic situation is depicted, assumes that access of which the message analyst is lacking. This assumption, it will soon be recognized, is a prerequisite to formulating the goal of message analysis unambiguously.

Let the object system be represented within the set Z of dimensions constituting the state space Θ^Z ; and the signal (s) , specifying some subset of variables in Z , be received. The first condition which the message analytic situation must satisfy can be formulated as follows:

The object system is incompletely observable if

$$0 < SI^Z((s)) \leq U^Z \quad /*/$$

suggesting that a problem of message analysis may exist. The concept of a message always requires some inferences beyond the factual observations which are meaningless in isolation. Message analysis therefore becomes empirically relevant only if the amount of information

Object System

Representational System

Message Analyst

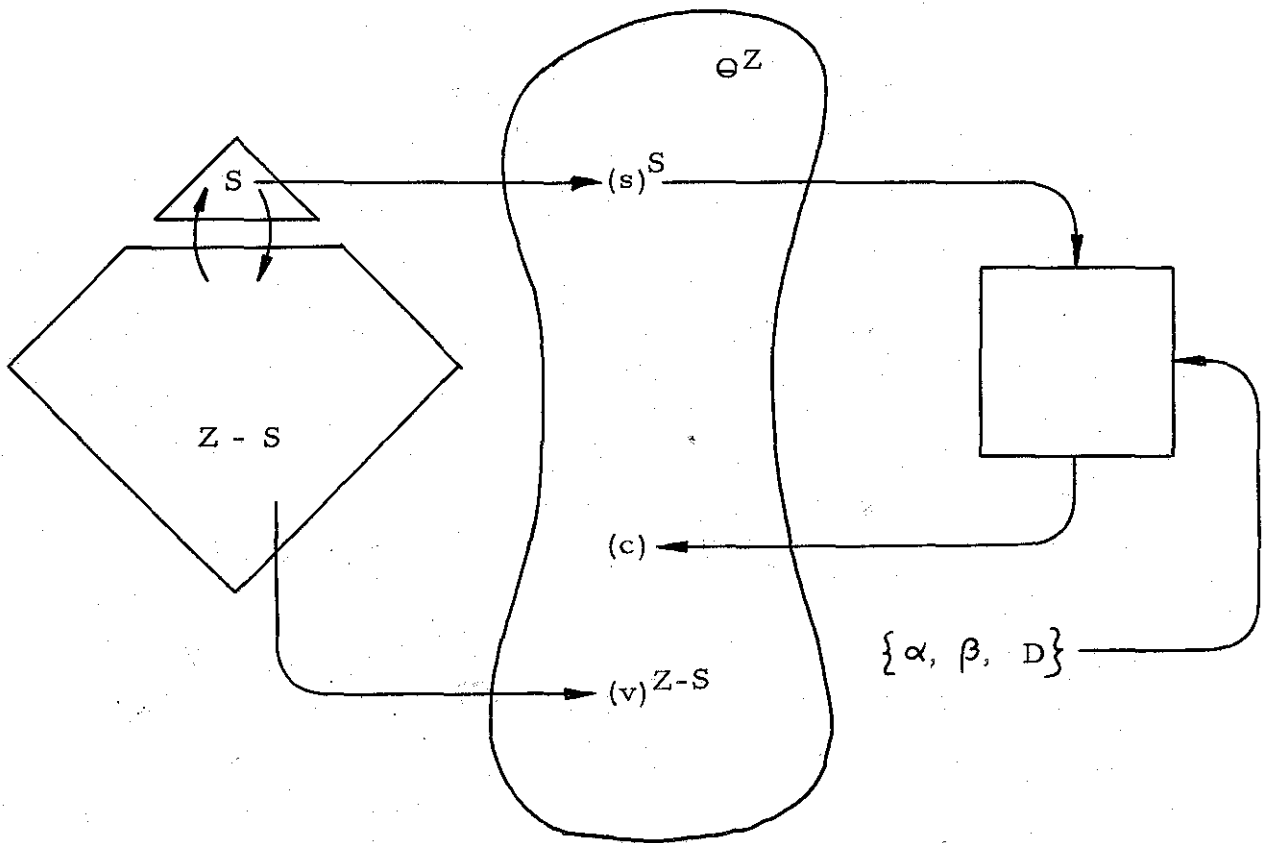


Diagram of the Message Analytic Situation (Formal)

Figure 7

conveyed by the signal is markedly larger than zero. This amount of information should not, however, be too large for two reasons. Firstly, if it equals the maximum uncertainty concerning the object system's state as a whole, the system is perfectly specified and no need for inferences arises. Secondly, if it exceeds the maximum uncertainty, the signal contains contradictions and cannot be utilized for inferential purposes within the representational system chosen.

Our conception of a message requires some predictive efforts, some inferences on the part of the message receiver and, hence, the appropriate selection of some content, denoted by (c), over the variables in Z but not included in those of the signal which is presumed to carry that content. In other words, signal (s) and content (c) of a message are not to be redundant. Therefore the second condition which the message analytic situation is required to satisfy is:

Some signal is treated as a message if:

$$0 < SI^Z((c)/(s)) \leq U^Z((s)) . \quad /**/$$

If and only if condition /**/ is satisfied the content inferred from a given signal can be considered predictive. If only condition /*/ is satisfied and the amount of information carried by the content conditional to the signal is zero, then the content is merely descriptive of what has been observed directly or is already specified by receiving the signal. In such a case no references are made to unobserved parts of the object system, and in fact the signal being known, the content is

perfectly redundant. Under condition $/**/$, the amount of conditional information may indeed approach the maximum amount of uncertainty regarding the unobserved part of the object system, claiming perfect knowledge in spite of incomplete observability.

Unfortunately, both conditions, $/*/$ for the incomplete observability of an object system and $/**/$ for something being treated as a message, can only serve as a prerequisite, not as a basis for formulating the goal of message analysis. This becomes immediately evident by the following two reasons. Firstly, as it has been argued in the previous chapter, a simple maximization of content cannot be a reasonable goal of message analysis. The reduction of most of the remaining uncertainty concerning the object system after a signal has been sent and received may not only be an impossible task, but also irrelevant to the interest and specific problems which motivate an analyst to employ such a mode of inquiry. We therefore settled on a more limited task. A problematic area of interest to the analyst may define a specific problem domain D of Z within which appropriate selections of predictive content are significant to the conduct of the analyst. The diagram in Figure 7 depicts D to be externally imposed on the message analyst, but it could as well be viewed as the correlate of an intrinsic goal of the message receiving system. Under this objection condition $/**/$ could be modified by replacing Z by the set D of the problem domain's dimension within which information is declared relevant.

Secondly, any arbitrary selection among the contents not specified by the signal in D would already satisfy the modified condition $/**/$ regardless of whether the prediction is valid or not. Therefore the amount of information conveyed by the inferred content conditional on the signal would in no way measure the effort on the part of a message analyst to "correctly" infer the content of a message or to "adequately" predict some inaccessible state of the object system's components unless the information is valid. Consequently, a statement of the goal of message analysis cannot solely be based on simple quantities of information that the analysis is to yield; but to a significant degree, on the quantity of valid information that is associated with the inferred product of treating some signal as a message. If appropriate selections are required to satisfy a certain goal, then a criterion of appropriateness must be given. Note that the first objection to accepting condition $/**/$ argues for an intensionally defined value of information gained from messages, while the second argues for an extensionally defined value of information provided by a message. A statement of the goal of message analysis will have to include both.

These two arguments suggest looking for a reasonable goal within the following inequality in which the validating signal $(v)^{Z-S}$ serves as external evidence against which the inferred content is validated. The inequality derives from /27/ and /32/ and reads:

$$0 \leq \underbrace{\text{VSI}^D((c)/(v)/(s))}_{\text{Error of Commission}} \leq \underbrace{\text{SI}^D((c)/(s))}_{\text{Error of Omission}} \leq \text{U}^D((s)) \quad /33/$$

A message analyst must not, of course, be considered "ideal." He is susceptible to various kinds of errors two of which appear in the inequality above. Firstly, the predictive content may refer only to a portion of the problem domain not specified by the signal. This error may be called "error of omission." By analogy to the conventions of statistical inference Simon (178) called such an error Type I error. It appears here as the difference between the amount of information the content conveyed and the uncertainty in D , both conditional on the signal received. Secondly, given the signal, there is the "error of commission" which can be defined as the difference between the amount of information the inferred content conveys and the amount of validated information of that content in D . This error would, by analogy to the above suggestion, be called Type II error.

The message analyst has to minimize or to avoid both of these errors according to the extent each affects his future conduct. In some situations it may be more important to infer as much relevant information as possible even though it includes invalid information, in some other situation emphasis may be placed on the validity of the inference. Let α therefore be a non-negative constant of merit associated with the worth of each unit of valid information, and β a

non-negative constant of penalty representing the punishment for errors of commission. α and β may be conceived of as monetary values. Let the total value of the product of a message analysis be defined as the quantity:

$$\alpha VSI^D((c)/(v)/(s)) - \beta(SI^D((c)/(s)) - VSI^D((c)/(v)/(s))) \quad /34/$$

Then the goal of message analysis can be characterized as an optimization process applied on the product's value whereby the amount of predictive information in D tends toward its maximum and invalid predictions toward their minimum depending on the value associated with each of them. Hence, according to the conclusion of the previous chapter and the above considerations:

A message analyst must be considered goal-oriented, i.e. behaving toward the goal of message analysis if, considering his initial state of having received a signal satisfying /*/, the inferred content satisfying /**/:

$$0 < (\alpha + \beta)VSI^D((c)/(v)/(s)) - \beta SI^D((c)/(s)) \longrightarrow \text{Optimum} \quad /***/$$

(read the arrow as "becomes") whereby it is implied that:

$$0 < VSI^D((c)/(v)/(s)) \longrightarrow U^D((s)) \quad /****/$$

reaching an ultimate state at which neither error is present:

$$VSI^D((c)/(v)/(s)) = SI^D((c)/(s)) = U^D((s)) \quad /*****/$$

Condition /***/ may be considered to be a statement of motivation which directs the process of inquiries into message content in the way stated in /****/ toward some end stated in /*****/. This process /*****/ is manifest in the successive attempts at deciphering the old Persian language which indeed reached the ultimate state /*****/ at which the hitherto unreadable script was perfectly understood and subsequent content inferences yielded valid results. The motivation stated in /***/ is most clearly recognizable in the situation of the war-propaganda analyst in VI of which George (71) could report an increase in accuracy of content inferences over time, demonstrating the process described by /*****/. One could argue that the constants α and β determining the nature of rewards were relatively high in the propaganda analyst's situation as compared with their values in the situation of the mass media critic in VIII. The strong emphasis on pragmatic validation in the case of the former and in the case of the latter, on intuitively determined face validity only exemplifies two different consequences of the two variables of the reward as defined in /34/. At any rate the process of increasing certainty /*****/ is also observable in the illustrated attempts of psychologists to analyse human speech (X) and written texts (IX) with the purpose of making inferences as to the psychological states of the speakers. And it is finally the hope of reaching a state /*****/, or at least of coming closer to it (/*****/), that motivates many content analysts in their search for an understanding of the intricacies of modern industrialized culture

by analyzing and making inferences from the products of popular mass media (V) (VII) (VIII).

The ultimate state /*****/ of message analysis seldom seems to be reached and can only be considered an ideal. One must rest satisfied when the conditions of reward /***/ are defined in such a way that the process /*****/ of inquiries into message content tends toward this ideal /*****/.

An Application to Working Example III

One of the fundamental postulates in cybernetics which has been formulated by Ashby is that:

any system that achieves appropriate selection to a degree better than chance does so as a consequence of information received (14).

The postulate is abstractly analogous, though not identical with Shannon's (175:37) theorem ten which concerns the quantity of statistical information that must be supplied to restore a noisy signal. The postulate has been shown to hold for all systems known so far, and states that under very general conditions the amount of appropriate selection is bounded by the quantity of information utilized.

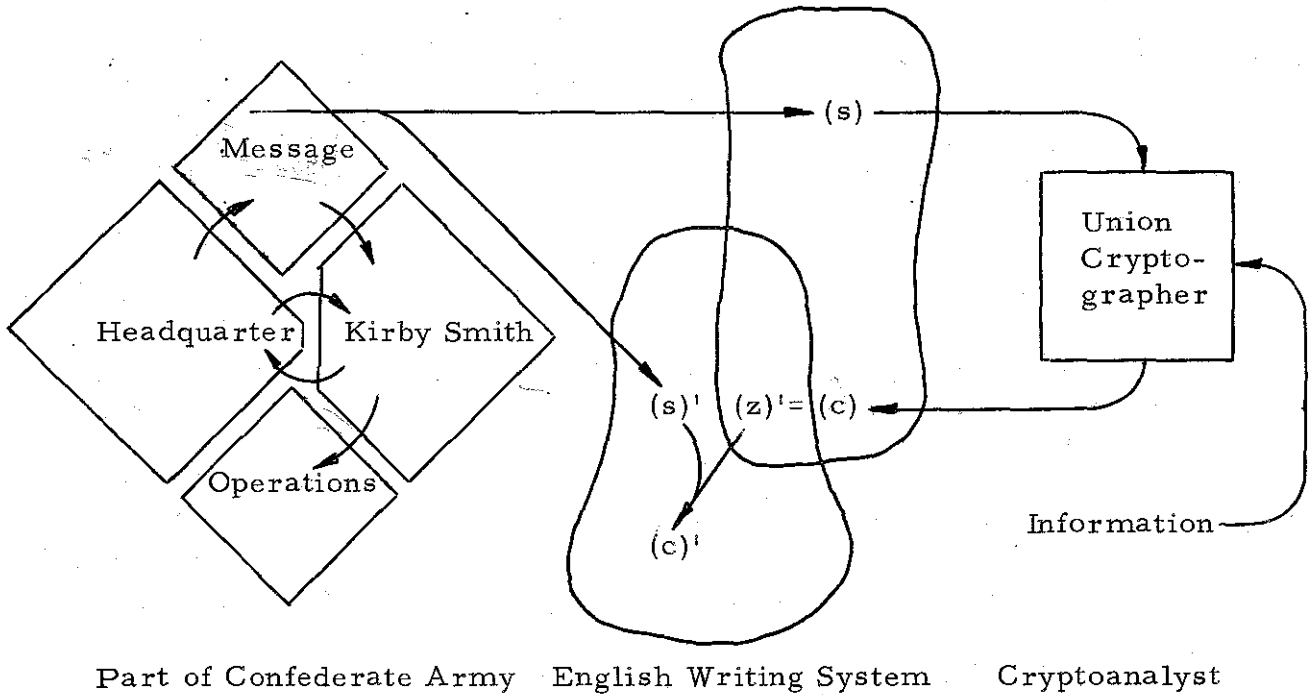
By defining the quantity of information as a measure of the amount of uncertainty reduced as a consequence of signals received (messages interpreted, content selected, etc.), our measure function for information is an explication of the information concept referred to in the postulate. In the light of this interpretation, condition /****/

requires a message analyst to bring some quantity of information to bear on a delineated problem domain, while condition /*****/ in accordance with axiom 1 states the upper limit of the amount of information required to obtain certainty in that domain. The fact that information has to be supplied by any analyst attempting to treat some received signal as a message is one of the most fundamental and consequential features of message analysis and will pose many empirical problems of processing available information, discussed later.

In order to demonstrate the information processes a message analysis may require and to exemplify the quantities of information which pieces of knowledge carry in reference to a message analytic problem, let us consider working example III. Working example III describes a message analysis which exhibits a structure that is most obviously susceptible to quantitative operations.

Figure 8 depicts the message analytic situation described in III. General Canby's object system is the Confederate Army; his specific problem domain, Kirby Smith's intended operations. The English writing system is one of the representational systems in terms of which the object system can be represented adequately as far as the needs of Canby are concerned. The telegram, presumably referring to the problem domain in question is, however, to a significant degree formulated in terms of another representational system presumably representing English terms. Hence, the cryptographer is faced with the problem of supplying that information which permits

Cipher System



(s) = Ciphred part of the message

(c) = (z)' = Deciphred part of the message (=content in cryptographer's terms)

(s)' = Clear part of the message

(c)' = Clear of the message (=content for the native English speaker)

(s) → (c) = Decipherment

(s)', (z)' → (c)' = Intuitive semantic interpretation

Diagram of the Situation in Working Example III

Figure 8

him to appropriately select among the possible letter sequences which a) could be represented by the signals, the ciphered version of the English text, and b) are consistent with the semantic and syntactic rules of the English language.

The initial state of the message analysis is characterizable by an extremely unmanageable amount of uncertainty resulting from the fact that each of the 127 letters of the ciphered parts of the telegram can take any one of the 26 letters of the English alphabet. The initial and maximum uncertainty is the uncertainty within a state space of 127 dimensions each of which can take 26 values. If an unambiguous reading of the message is to be achieved, it is precisely this maximum uncertainty which has to be effectively eliminated by supplying a certain amount of knowledge to the interpretation. The amount of information required is:

$$SI^M_{((c)/(s))_{\max}} = U^M = \log_2 \# \Theta^M = \log_2 26^{127} = 596 \text{ bits}$$

Note that the cryptographer's problem domain denoted by M is different from Canby's problem domain which represents Kirby Smith's possible operations. The set M of dimensions constitute a state space of possible letters that can be considered as replacements of those in the ciphered part of the telegram. Since this required amount of information referred to by far exceeds the capacity of any terrestrial organism or technical device to systematically try and test all combinatorial possibilities, the cryptographer's emphasis has indeed to

be placed on an "effective" elimination of the uncertainty.

The first relevant piece of information obtained by the cryptographer came from analyzing the two accompanying documents. The Confederate Army, it was figured out, made use of the Vigenere tableau. This device involves the application of a transformation from a clear and a key to the cipher of a message. The key has only a few, between 10 and 20 letters which are used repetitively to encode and decode messages of an arbitrary length. The Pemberton message was enciphered by means of a 15-letter key. Knowing the nature of the transformation it was not necessary to look for all combinations of 127 letters in the state space denoted by M , but only for those of the key with which the message could possibly be deciphered. Hence, the knowledge "ciphered by means of a Vigenere tableau" introduces a constraint of the number of combinations within the state space relative to the clear and thus reduces the dimensionality of the initial state space by a known transformation which we will call μ . Let the new state space be: $\Theta^V = \mu \Theta^M$, the estimated amount of information conveyed by μ is:

$$U^M - U^V = U^M - \log_2 26^{15+5} = 596 - 70 \pm 23 =$$

$$526 \pm 23 \text{ bits}$$

Although this is an enormous amount of information, the remaining uncertainty between 47 and 93 bits is, however, still much too large for any trial and error process. Consider only the number of possible

10 to 20-letter words or phrases which the English language could provide as a key!

The second piece of information the cryptographer could bring to bear on the message stemmed from both his familiarity with the English language and the knowledge of that part of the object system to which the message presumably referred. Knowing that "the only patrols in this area are the gunboats on the Mississippi" and discovering "a sequence of letters that can easily be replaced by 'of the river, '" which will be denoted here by $(k)_2$, " produced with the help of the Vigenere transformation the fraction of the key: "TE VICTORY C."

Note that the message analyst did not have any other validity check than his sense of plausibility in judging the key fraction so extracted. His argument that this fraction could not have occurred by chance suggests a view of his sense of plausibility in terms of the statistical redundancy (in Shannon's sense) of the English language, but we are not concerned with this sort of judgement at this point.

μ and $(k)_2$ are quite different in effect. The former affects the dimensionality of the state space without specifying some value on its dimensions, the latter specifies 10 letters in that reduced space denoted by V . The amount of information carried just by $(k)_2$ is therefore:

$$SI^V_{((k)_2)} = U^V - U^V_{((k)_2)} = \log_2 26^{10} = 47 \text{ bits}$$

and the amount of information so far obtained by utilizing μ and $(k)_2$ is:

$$U^M - U^V + SI^V((k)_2) = 573 \pm 23 \text{ bits.}$$

After having utilized $(k)_2$, the analyst discovered the third piece of information in the nine letters "a crossing" fitting a certain suggestive letter sequence in the ciphered part of the message. This suggestion was again due to his familiarity with the English language and his fragmentary knowledge of the nature of the object system. Applying the transformations for extracting the key this time on "a crossing" yielded "ORY COMPLETE" which was cojectable onto the space of the remaining unspecified letters of the key. Let us call this third piece of information " $(k)_3$." $(k)_2$ and $(k)_3$ exhibit a certain amount of redundancy (in the sense of our information calculus) which confirmed the cryptographer's judgement concerning whether the extracted key was complete. The amount of redundancy of $(k)_2$ and $(k)_3$ is:

$$\begin{aligned} RI^V((k)_2, (k)_3) &= SI^V((k)_2) + SI^V((k)_3) - SI^V((k)_2, (k)_3) \\ &= 47 + \log_2 26^9 - \log_2 26^{15} = 19 \text{ bits} \end{aligned}$$

and the amount of signal information conveyed by $(k)_3$ conditional on $(k)_2$ is:

$$\begin{aligned} SI^V((k)_3/(k)_2) &= SI^V((k)_3) - RI^V((k)_2, (k)_3) \\ &= \log_2 26^9 - 19 = 23 \text{ bits.} \end{aligned}$$

The complete decipherment of the message could now be accomplished by repeatedly applying the transformation prescribed by the Vigenere tableau on both the chipher and the key. No additional information was needed to execute these transformations. The requisite information for this decipherment was provided by what we called μ , $(k)_2$, and $(k)_3$. The resulting clear was unambiguous, made sense in terms of the English language and was accepted beyond any doubt. At this point the condition /*****/ was satisfied although no validating evidence other than the cryptographer's intuition could be provided. The quantities of information conveyed by the three successively utilized pieces of knowledge add up to the total amount of uncertainty of the initial state as it is to be expected:

$$U^M - U^V = 526 (\pm 23)$$

$$SI^V((k)_2) = 47$$

$$SI^V((k)_3/(k)_2) = \underline{23}$$

$$U^M = 596 \text{ bits}$$

whereby the estimate for the amount of information provided by knowing that the message was enciphered by the Vigenere tableau (the latitude of ± 23 bits) became certainty.

The behavior of Kirby Smith's Rebels could now be anticipated as far as Canby's planning was concerned. However, the assessment

of the degree to which this prediction was accurate and the mode of validating the inferences made, is beyond the scope of this discussion.

While this example demonstrates the way the information calculus can be applied to assess quantities of effective signal information that are conveyed by certain pieces of knowledge, Chapter Seven will attempt to define several expressions for quantities of different types of information that have so far been cast in terms of signal information only.

CHAPTER SIX

EMPIRICAL PROBLEMS OF MESSAGE ANALYSIS

When discussing the message analytic situation, the message analyst has to be treated as a "black box" because a specification of the goal of message analysis has to avoid references to the analyst's internal structure, his procedures and subroutines, if objective external criteria for evaluating the total performance of a message analysis are to be established. The task of this chapter is to break this black box into its essential components, to show the requisite information processes and to outline a macro structure of an analytic procedure that would satisfy the goal of message analysis as stated in previous chapters.

We want to reserve the term "message analysis" for a methodologically conclusive inquiry into incompletely observable systems i. e. a methodologically verifiable treatment of data as message. The possible confusion between message analysis and other overtly similar activities which this additional requirement is supposed to eliminate necessitates some introductory remarks before the procedural details of message analysis and their specific empirical problems are discussed.

The Methodological Commitment

Message analytic situations as defined in previous chapters are indeed very common in everyday life. Signals such as lines on

a television screen, black ink figures on paper, punched tapes, radio waves, and even car shapes, cloud formations, odors, etc. provide intelligent beings a basis for speculating about aspects of their environment to which they have no direct access.

People, social organizations, nations or content analysts may satisfy the goal requirements of message analysis without in any formal way allowing their behavior to become a subject of methodological examination. The domain of such behavior is generally termed and investigated as "symbolic behavior" and is a behavior that is abundantly exhibited by many higher organisms and social systems of varying size. There is no reason to assume that symbolic behavior presupposes a formal analysis of sensory data as messages. The great efficiency with which symbolic interaction takes place between social organisms of any kind even suggests that awareness of the inferential processes involved cannot serve as a prerequisite for handling symbols effectively. For this reason, most of the analytical conceptions of symbolic behavior can afford to avoid references to the fundamental fact that information must be supplied in order to treat signals or data as messages.

An intelligent mass media critic, (for example Berelson in his study reported in VIII), when attempting to infer some social conditions from the frequency counts he obtains from content analyzing popular fictions, is most certainly quite aware of his reasoning. His interpretations may have evolved in actively participating as a member of society at large, in the course of his career as a scientist, etc. But making use

of a method is quite different from explicitly stating the method employed such that it can be subjected to methodological evaluation. It is this distinction that differentiates symbolic responses from message analysis.

In a rudimentary way working example II can serve as an illustration of the evolution of a methodologically more satisfactory inquiry into messages from a hitherto entirely intuitive judgment: the process originated when the Swedish scholars refused to accept the public accusations made by the orthodox clergy. Although the link between the religious dissenters, the Moravian sect and the "Songs of Zion" seemed to be appealing, the evidence for such inferences were judged insufficient. It will be recalled that the first explicit method which emerged was a comparison of the counts of key-symbols found in both documents, the suspected songs and the authorized book of hymns. The method first produced results supporting the intuition. It had to be discarded, however, when other disputants proved the difference to be due to what is today called an error of sampling. In response to such challenges another method emerged that took into consideration the contexts in which certain key symbols appeared. The analytical technique yielded differences between the two documents more reliably but could not provide the full evidence necessary to support or reject the accusations made. So the scholarly dispute went on until explicit methods of analysis emerged which under the given circumstances appeared to be irrefutably conclusive and withstood all tests of intellectual adequacy.

In this example it was not the results of the analyses that were

challenged but the methods by means of which those results were obtained. Since direct evidence for the possible link between the sect, the song book, and the undesired effects was virtually unobtainable, the only concrete object of the dispute was the inferential method itself. The prerequisite of such disputes which are in essence methodological, is that the analytical technique employed is explicitly described and hence potentially replicable.

Herein lies the fundamental distinction between a systematic message analysis and other forms of symbolic behavior. The former requires an explicit and complete map of the inferential procedure followed, the decision criteria employed and assumptions made during the analysis while the latter requires nothing of this sort. In the absence of direct observational evidence the credibility of the products of message analysis depends solely on a methodological examination of the conclusiveness of the antecedent analytic process while the credibility of symbolic behavior has intuitive and social roots.

An analytical procedure that is satisfactory on methodological grounds is of course one that has been examined before being applied on a particular set of signals, i. e. it is at least to some extent planned in advance. Such a requirement has often been attacked on the basis that science ought to give primacy to observations and therefore collect as much data as possible before designing computational procedures for representing them.

One objection to the above argument is that the universe simply contains too much (irrelevant) information to be considered

by an analyst with limited capacity to process it. As we shall see later, one of the problems of message analysis is to suppress irrelevant signal information. If a message analyst is concerned with any problem at all, then this problem bestows differential relevance upon the possible data he can consider. Especially since message analysis typically deals with latently structured and relatively voluminous material, a recognition in advance of what is relevant is usually a significant part of solving the whole problem. To plan message analytic procedures in advance is therefore not only a matter of economy but possibly a matter of arriving at a solution at all.

Another objection stems directly from the content analytic dilemma elaborated in Chapter Two. If the analyst is completely free in choosing the analytical procedure after data have been collected, it is quite likely that he will be trapped in a methodologically fallacious situation which will produce only pseudo evidence.

In scientific inquiries, it has often been suggestive to proceed from an uncontrolled scanning of the "symbolic environment," perhaps guided at first by a scientist's disciplined intuition, to what is called a "fishing expedition" and from there via exploratory studies and tests of investigative techniques to analytical methods of some definiteness. While the state of the art of message analysis may not always be such that explicitly stated procedures permeate the whole analysis, the iteration converging toward the methodological ideal of examining and planning investigative techniques prior to their actual use should be

recognized as a typically scientific one.

To approach such an ideal becomes an absolute necessity when information processing devices for the analysis of messages are intended to be used. Here nothing can be left to intuition. Working examples IX and X show what is required when computers are to be utilized for message analytic purposes. Some of the technical problems involved are discussed in Borko (32), Hunt (86) (87), Garvin (68), Feigenbaum (60), North (142), Janda (90), and Stone (188) (189) (190). The researchers attempting to solve such empirical problems agree that the task is often meticulous and yet, as a result of this self-imposed methodological rigor, they are able to report quite unexpected results obtained with a minimum of clerical labor. Many scientists share Wrigley's belief that:

the electronic computer will prove to be the most versatile and influential scientific instrument so far invented and that it will play a larger role in the scientific histories of the future than even such obvious challenges as the microscope and the telescope (216:163),

but of equal importance is the extreme explicitness that computers require in scientific research. As Holsti remarks "...computers impose rigor and discipline on the formulation of research. The investigator using computers for content analysis is forced to make every step of his research explicit . . . it is not wholly facetious to suggest that all content analysis research should be designed as if it were to be done by computer" (83:124). The use of electronic computers lends itself to the kind of explicitness that was missing in much pre-behavioral theorizing and is a prerequisite for systematic methodological evaluation.

Of course the procedural details of message analysis cannot be specified without reference to a particular message analytic situation. Some such situations may require the obtaining of permeation measures as one of the analytical steps; some other situation may suggest that the presence or absence of a particular characteristic is more relevant to the problem at hand; and in a third situation, the appropriate inferences may be triggered by the appearance of certain abstract properties that emitted signal sequences exhibit. There is ample reason to assume that no universal algorithm can be formulated that will yield the desired inferences in any situation, for any object system and with respect to any problem domain given.

Given the general goal of handling available information in such a way that uncertainty in an unobserved problem domain is to be effectively minimized, we can hope to show some of the subgoals that have to be reached when inquiries into messages are to be successful in the above sense. This is another way of saying that it is assumed that any message analytic procedure can be broken down into a few essential components or subroutines, each geared to a different end and posing different empirical problems to the analyst, and that their essential components can be abstracted from the specific nature of the message analytic situation.

It is furthermore assumed that if enough information about the regularities of the object system is available and the formal properties of such essential components are sufficiently understood, these

sub-procedures may then be suitably assembled such that the message analytic goal can be accomplished. The essential components suggested in the following can be formulated only in general terms and differentiated heuristically. This means that other approaches to message analysis may prefer to make other distinctions and use different labels. But it is believed that some such procedures are the prerequisite for any message analysis that is satisfactory on methodological grounds.

The following components of message analysis in the wider sense will be distinguished in this chapter:

1) Recording denotes a process of transcribing raw data into primary notations that are amenable to subsequent explicit analysis.

2) Filtering signifies a systematic reduction of data by eliminating irrelevant information or noise from available data, past or present, by applying appropriate operations on their structure. The output of this component is a transformed version of the data or a representation suitable for further processing.

3) Constraint analysis attempts to discover relevant constraints existing in an object system and to formulate regularities that can be considered to account for them. This component accepts data representations as input and produces regularities that can be utilized for inferential purposes.

4) Design of message analysis in the narrower sense involves an evaluation of the paths provided by known regularities according to whether and how the uncertainty in a delineated problem domain can be

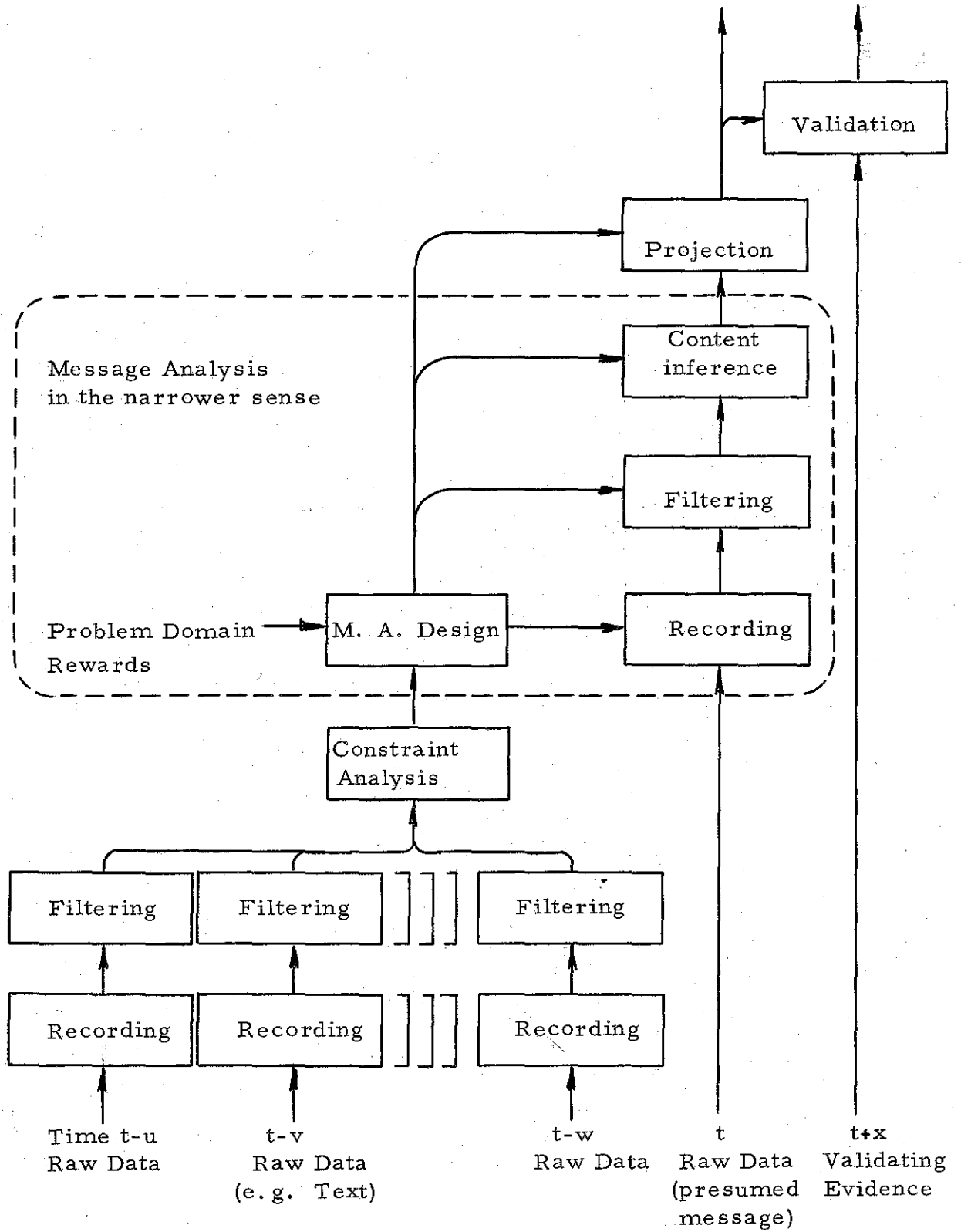
reduced effectively. The output of this component contains specific instructions to be used in recording, filtering and content inference.

5) Content inference may be regarded as the heart of message analysis and refers to a process by which problem-relevant constraints are applied on filtered data or texts. The output of content inference is a representation of the message content by definition.

6) Projection refers to a transformation of the abstractly represented content onto the dimensions of the problem domain whenever content inferences do not already yield results in those dimensions. Projections may take the form of applications of analytic results according to other objectives.

7) Content validation evaluates the output of content inferences against independently received validating evidence representing some aspects of the object system.

In a simplified form Figure 9 gives an informal outline of the empirical concern with messages which we will term message analysis in the wider sense. One of the research tasks that can be discerned among others in empirical inquiries into messages, is the analysis of relevant constraints an object system may exhibit or the establishment of regularities concerning the messages it produces. Such a task must be considered preparatory to the systematic treatment of data as messages. Message analysis in the narrower sense is in accordance with the goal as defined in Chapters Four and Five. It involves recording, filtering, and content inference. The specific arrangement and nature



Components of 'Message Analysis in the Wider Sense' (informal)

Figure 9

of these components are determined on the basis of available information from a constraint analysis. Projection and validation are, on the other hand, a posteriori to message analysis in the narrower sense and may be regarded optional as far as the goal of the message analyst is concerned.

The diagram is a simplified one in so far as actual message analyses tend to be much more complex than depicted. There may be interactions and iterative loops between the components and not just a one way flow of information. There may be chains of filters and inference procedures and not just one of each. Lack of validity may have to induce procedural modifications and not just be indicative of some defect as the diagram seems to suggest. In short, reaching the goal of a particular message analysis may presuppose more complex networks of numerous such sub-procedures. The simplified presentation merely depicts the minimal differentiations among essential components and is primarily meant as an outline for the following discussion of the empirical problems of message analysis.

The remaining sections of this chapter are devoted to constraint analysis, filtering, recording, content inference and validation. The order in which they are discussed is not chronological. The other procedures are not discussed here. After this attempt at clarification the following chapter will take up the same subject in the light of the information calculus introduced in the previous chapter.

Constraint Analysis

This section concerns the empirical problem of analyzing message-relevant constraints in the following steps: consideration will first be given to the relation between requisite information and the existence of constraints. Then indices of constraints are discussed showing the idea of constraints to be a quite general one. This leads to the problem of formulating the regularities that can be assumed to account for the discovered constraint, a problem that is quite different from just indicating the presence of it. The section will subsequently be concluded by presenting two examples of constraint analyses as an illustration of the kind of empirical prerequisites of message analysis in the narrower sense.

Requisite Information and Constraint

The working examples make it abundantly clear that the goal of message analysis can only be achieved if a certain quantity of information is available that can be brought to bear on given data. At the end of Chapter Five an attempt was made to illustrate the information calculus by expressing the amount of requisite information quantitatively, completely neglecting, however, the nature of such information. This is perfectly legitimate but insufficient. Shannon and Weaver (175) do not either offer an explication for "information" when defining a measure function for the average amount of statistical information. But message analysis deals with several kinds of information: the information that the data provide, the information that is required to make

specific inferences, the information that is finally obtained as message content, and the information that is necessary to validate content inferences. Here we have to consider the nature of the information that becomes operationalized in filtering and in content inference which in turn permits us to make appropriate selection of contents within a problem domain.

To show exactly what must be known when specific content inferences from given data are attempted let us again examine some of the working examples. A simple case is the identification of the author of an unsigned document described in working example IV. Although a long list of persons were originally considered as potential authors of the Imitatio, evidence other than those described in The Statistical Study of Literature reduced this list to two persons. Hence one bit of information was required to decide the authorship in this case.

Yule discovered and verified for many documents with known authors that certain statistical indices defined over the vocabulary of a document varied only slightly within the works of one author but considerably between the works of different authors. He found, for example, nouns to be most distinctive and was therefore able to characterize each author by the set of nouns he employed in his writing. This one-to-one relation between writer and his statistically represented vocabulary was precisely the knowledge needed to decide on the authorship of the Imitatio. Note that this relation could be established only after the document's characteristics were suitably recorded, filtered and

represented and that this relation was a prerequisite for making the intended content inference.

Working example IX showed how the General Inquirer was used to infer the suicide intentions of a person from his personal letters. The example again demonstrates that the inference could not proceed in vacuo. It was preceded by what we may call a "learning period" during which 15 known pairs of letters (one real and one simulated) were subjected to an analysis that was in effect a constraint analysis. It will be recalled that three vocabulary variables were found to discriminate the relative frequency of 1) references to concrete things, persons, and places, 2) the use of the actual word "love" and 3) the number of references to processes of thought and decision identifiable in the text. By subtracting the score on the third measure from the sum of the scores on the first two measures a discriminate function was developed which when applied on 15 other pairs of unknown origin correctly distinguished 13 of them. The kind of information that was acquired during the learning period and subsequently made available for making inferences was the discriminate function mentioned above.

Evaluating the propaganda analysis efforts during World War II, George (71) studied numerous incidents of which only one could be reported as working example VI. Inquiries into the propaganda analyst's reasoning on record revealed relatively detailed "models of the situation" on the basis of which inferences were made from the monitored message. He found in particular that the analyst discovered and made

use of numerous recurrent regularities in the opponent's propaganda behavior. These regularities sometimes took the form of typical indicators of which lists were compiled; and sometimes, the form of generalizations about the major propagandist within the political setting of the governing elite. Knowledge of these recurrent regularities were in fact a prerequisite for making the inferences intended. The successively increasing accuracy of the inferences made are indicative of the accumulation of relevant information.

While inferences in content analysis mainly rest on a speculative base, Yule's relation between the identity of an author and a statistical representation of his vocabulary had been investigated thoroughly; the above mentioned discriminate function over the General Inquirer measures had been subjected to an empirical test; the knowledge of appropriate regularities of propaganda behavior had been successively acquired and verbally expressed by the analyst on the job.

For example in V, the basic assumption which is implicit in the interpretation of the series of tests designed to disclose foreign propaganda in the United States refers to the nature of the communication channels between foreign governments and publication agencies suspected to be arms of those governments. If a foreign government has control over the communication channel between the events within its nation and a publication agency operating in the United States then - so it could be argued - certain essential message characteristics should be expected to remain relatively invariant throughout the transmission

process. The analysis consequently focuses on such characteristics which would very likely be altered if transmitted through a communication channel not under the control of this government. The decision concerning the existence of a communication link between a suspected agency and a foreign government presupposes such an assumption which takes the place of the requisite information in our sense.

Whether this requisite information is established by empirical means or assumed on the basis of sufficient intuitive experiences, it always affects some specific property of the object system. In order to show this property more clearly let us take working example VII for a change. Leites' knowledge about the Soviet mode of expressing adulation and about the conditions under which political and private intimacy are expected to be suppressed in public, led him to deduce a rather simple relation between the number of references to Stalin's Bolshevik image and the number of references to Stalin's popular image on the one hand, and the socio-political distance of the speaker to Stalin on the other. Suppose the frequency of references to either of Stalin's images varied independently of the actual distance of the speaker to Stalin, then their mention could in no way be indicative of this distance. In other words, if no dependency between the respective variables could be expected to be persistent, nothing could be inferred from one to the other. Persons politically closer to Stalin were not permitted, however, to express personal intimacy to him in public while those more distant felt compelled to use crude forms of adulation.

The behavior of the persons comprising the object system in question was confined with certain normative or otherwise accepted limits. In other words: the object system possessed a constraint.

Whenever a system cannot utilize its full combinational possibilities and is compelled to behave within a subset of it; or, whenever a system possesses some internal structure, some invariant relation, some persistent regularity, we say that a constraint is present. The kind of information that a message analysis presupposes is existentially linked to the existence of such a constraint.

In working example IV Yule discovered, formulated and applied a relation symbolically accounting for that constraint which is present in an author's use of his vocabulary. In V, Lasswell assumed with sufficient confidence the existence of a constraint concerning communication links within a socio-political organization. In VI the propaganda analyst utilized the constraints that persisted in the particular social situation within which the propaganda analyst operated. In attempts to analyze some data as messages it is always a constraint of the object system that the requisite information represents.

Fisher is probably the first who identified the presence of a statistical constraint within obtained data with an amount of information that they convey. Concerned with evaluating research designs he took the inverse of the sampling variance to "measure the quantity of information supplied by the experiment of the particular value to which the variance refers" (63:196). Thus, if the frequencies are

equally distributed over the values of a variable, the standard deviation is infinity and Fisher's measure of information assumes the value zero. As the experiment yields narrower statistical distributions Fisher's quantity of information assumes some larger value indicating that some constraint is present.

Fisher's measure is of course mainly of historical value. But the idea of identifying the discovered severity of a constraint with an amount of information is most certainly not an obvious one. It has been utilized in the mathematical theory of communication and will provide the basis of our information calculus to be further developed in Chapter Seven.

Discovering Constraints

It can be taken as evident that message analysis presupposes the object system to possess some relevant constraint, or, to formulate it more pointedly, that message analysts must have available some adequate representation of whatever accounts for the constraints present in the object system, a representation that we could identify with the requisite information. Consequently, one task of message analysis in the wider sense is to discover constraints that are relevant in a particular situation. In order to accomplish this, evaluative criteria must be at hand that permit the making of decisions as to whether or not a constraint is being observed.

As we suggested, no confusion should be made between information and a measure of the amount of information. Similarly, a

constraint should not be confused with a measure of its severity, intensity or strength. It is only the latter which provides criteria for decisions concerning whether it is feasible in a particular situation to attempt the formulation of the regularity that accounts for the constraint observed.

Since the existence of a constraint seems to be a quite general prerequisite for knowing anything at all about the structure or identity of a system, the search for constraints and consequently their quantitative evaluation is most common in all empirical sciences. Most of the statistical procedures that are used particularly for testing hypotheses can be considered measures of the severity of a constraint. Such measures quantitatively relate a measure of the maximum range of freedom within a system, or at least reference points of it, and a measure of the actually observed freedom and can be considered specialized interpretations of the following general form:

severity of constraint = f(observed freedom, maximum range of freedom)

If, for example, frequencies are assigned to the i th category of a contingency table, a Chi-Square Test "may be used," as it is commonly expressed, "to test whether a significant difference exists between an observed number of objects or responses falling in each category and an expected number based on the null-hypothesis" (177:43).

In the most familiar formulation

$$\chi^2 = \sum_i \frac{(O_i - E_i)^2}{E_i}$$

The differences between observed frequencies O_i and frequencies E_i estimated on the basis of the absence of any constraint show the test to be a particular case of the above form. The value of χ^2 becomes larger as the measured constraint becomes more severe.

Pearson's familiar product-moment correlation coefficient also conforms to the same basic idea assuming, however, linear dependencies between variables, say X and Y . The somewhat lengthy formula boils down to a proportion of the actually observed covariance (X, Y) and the maximally possible covariance computed as the geometric mean of the two variances of X and Y . The coefficient takes the value one when the constraint is perfect and zero when no constraint is present in the data.

In Shannon's mathematical communication theory (175) the existence of a constraint is indicated in the form of the measure of redundancy. The name is an unfortunate result of the early engineering orientation of this calculus during which constraints appeared as a kind of waste of channel capacity. At any rate, the severity of a constraint becomes identified as the difference between the quantity of information that a channel can maximally transmit and the quantity actually communicated.

Statistical constraints are not the only important ones in message analysis and the point has frequently been made that non-statistical signal characteristics may in certain situations provide more adequate bases for inferences. Consequently measures of the severity of a constraint cannot be confined to statistical measures. Recently

Ashby(16) suggested a straight-forward measure of this property that is not statistical. He traced his idea back to Wiener (208) who, already in 1914, identified a relation, previously regarded as somewhat metaphysical, with the set R of those n -tuples in a product set Θ that satisfied the relation. As arbitrary as a relation may be, Wiener's suggestion makes it at once definite and a subject of formal operations. According to Ashby "the 'constraint' introduced by a relation R^* is most naturally identified with the set $\Theta - R$. When $\Theta - R$ the constraint is zero; as R shrinks, so does the constraint become more intense" (16:9) (original symbols replaced). We will take up this argument in the following chapter, but the idea of a constraint and a measure of its severity now seems to be an entirely general one and not bound by some particular material feature of the object system from which signals are emitted.

Although these and many more indices all boil down to measuring some property of constraints which we labeled "severity" for convenience, they cannot always be assumed to be indicative of that inferential quality of a constraint which the message analyst is ultimately interested in. For example, Fisher's measure represents the severity of a constraint within one variable only. If specific inferences are intended to be drawn from a given text, relevant constraints must exist and must be represented between at least two variables one of which represents some text characteristic, the other referring to the problem domain.

For example, the successive attempts at interpreting the old Persian language in I was for quite some time a test of various hypotheses concerning the most productive syntax of the figures carved in stone. As long as constraints within these figures were discovered little could be inferred from it. Inferences started emerging when a few syntactically characterized figures and certain social uses of language could be assumed to be invariably related, i. e. when constraints could be discovered that go beyond the data from which specific inferences were intended or, to phrase it in more conventional terms, when constraints between documentary and extra documentary data appeared. As we suggested in Chapter Four, the constraint that finally led to inferences from these carved figures to historical events of the old Persian Empire was one that held between the old Persian writing system and a modern language in terms of which the history of that empire was represented.

Thus it is always a constraint between at least two sets of independently observable variables that needs to be discovered and decided on by means of some suitable measure of the severity of the constraint. Multiple correlation coefficients, measures of multivariate information transmission, Ashby's conception of a constraint defined in a many-product set, etc., provide such indices for the inferential quality of constraints which message analysis in the narrower sense utilizes.

Formulating Regularities

When appropriate measures indicate the existence of a sought constraint, the problem still remains to formally represent what introduces the constraint in a system: relations, dependencies, or regularities. The measures discussed above only indicate the strength of a constraint or its potential usefulness for a particular problem of inference but they do not discover the precise nature of a constraint. Ultimately, what is needed for making specific content inferences is not a measure of a constraint's severity, but a formal representation of the regularity, lawfulness, relation, etc. that accounts for such a constraint.

In this sense the works reported in working example X cannot be considered as complete message analyses as far as their current development is concerned. Although the efforts are assertedly geared toward inferring a person's emotional state or pathology from his speech, Mahl has not gone very much further than to show the correlation between level of anxiety and certain speech disturbance measures; while Feldstein, Jaffe, and Carroll are still struggling with the attempt to find variables of recorded speech that correlate with various psychopathologies. And yet if there are sufficient reasons to assume linear dependencies between these psychological variables and measures of speech characteristics then correlations provide a limit for the possibility of formulating relations that the intended inferences presuppose.

When actually formulated, the relations that are finally used in message analysis sometimes take rather simple forms. For example the one-to-one relation between the statistical measures over the vocabulary of a set of documents with the identity of their authors in IV is so simple that it too easily escapes notice. But the formulation must nevertheless be definite in order to allow the making of the intended content inferences.

In working example VII the relation, although it was not obtained from the empirical analysis of a constraint but deduced from some generally known regularity, has been given the form

$$D = \frac{N(\text{popular}) + 1/2 N(\text{ambiguous})}{N(\text{popular}) + H(\text{ambiguous}) + H(\text{Bolshevik})} \quad 0 \leq D \leq 1$$

This formulation of a regularity is a well defined function that accepts frequencies of references made to Stalin's Bolshevik image; frequencies of references to the popular image of Stalin; frequencies of references to an image that is ambiguous with respect to the two; and also produces distances D of the writer of the document to Stalin. It might be argued that this function assumes the existence of too severe a constraint and that its single-valuedness may not be justified, but the formulation even allowing for some variance, would be considered as being well defined.

In IX the regularity formulated to infer suicidal intentions of a letter's author was formally quite similar to the one above. Here too a few elementary algebraic operations were applied on three frequency-like scores that came out of a General Inquirer analysis of the texts.

Again the question might be raised as to whether this formulation accounts for all the variance that writers in this situation may exhibit although the empirical test indicated that it comes very close to it.

Of quite a different nature was the constraint with which the cryptanalyst in III had to struggle. He knew in advance that the Vignere Tableau in conjunction with the key "COMPLETE VICTORY" which he had to discover, define a mathematical transformation of letters of the ciphered message into those of the clear.

Most of the few explicitly formulated regularities that have emerged out of content analysis and are potentially relevant in message analytic situations are represented in natural language terms. For example Lasswell argues that

"... an increase in discussion of CENSORSHIP or TYRANNY will lead to an increase in reference both to FREEDOM and to LIBERTY" (113:56).

On another occasion, he found that changes in the frequencies of political symbols reflect major policy changes (108). Pool also states the result of his analysis in words:

Those nations which have at any given moment dominated the world scene have generally said little that was adverse in 'prestige papers' about the other powers. The insecure or unsatisfied powers, on the other hand, have generally had editorials full of hostile judgements of foreign states (159:62).

North put forth numerous propositions concerning international crises among which the following appear:

The higher the tension, the greater the redundancies of communication, the heavier the overload of channels,

and the less the ability of decision-makers to assimilate the incoming messages (142:165).

The higher the tension, the stronger the tendency of agents in the field to report - consciously or unconsciously - that information which they perceive as desired or expected by decision-makers at the center (142:170).

Such verbal formulations often even suggest certain hidden generalities. Compare, for instance, North's proposition concerning international crises:

The higher the tension, the stronger the tendency to rely on habitual images and stereotypes (142:174).

with Osgood's hypothesis concerning human speech behavior:

The greater the motivational level under which language encoding occurs, the greater will be the stereotypy of choices (148:298).

But, there are serious limitations attached to the use of informal verbalizations as a mode of representing message-relevant regularities.

Firstly, if the formulation refers to some regularity concerning the social use of language - which is indeed often the case - and is represented in the very same medium, then object-language and meta-language may become easily confused and lead to well-known paradoxes and limitations. A representational system must always be "more powerful" than the object to be represented otherwise a constraint may remain unrecognized.

Secondly, although such propositions, theoretical statements or simply "knowledge" may indeed be supported by empirical evidence, the way they have been established is often irrecoverably lost. This

is the result of an intuitive use of natural language favoring the tendency of statements to become independent of the events they purport to express. Hence, it is difficult if not often fallacious to derive filtering procedures from verbally represented constraints.

Thirdly, as many authors have shown, it is almost impossible to handle more than two or three simultaneous relations in verbal logic (178). Therefore, more complex constraints of object systems can hardly be represented in the verbal mode of scientific discourse. The verbal propositions listed above may represent only inadequately simple structures of object systems simply because natural language is most capable of dealing with them.

Fourthly, it is very difficult to transform such verbal statements into rules of inference because verbal reasoning is not only replete with logical gaps and with ceteris paribus assumptions, but also with considerable operational ambiguity. Thus, while a statement concerning an existing constraint might be intuitively convincing, it is often difficult to use this statement as an inferential operator on statistically represented texts.

Unlike many empirical efforts in the social sciences which are directed toward and generally end with testing verbally stated hypotheses, in message analysis the methodologically similar task of discovering relevant existing constraints and formulating regularities that account for them is only an intermediary step. As such, the representation of a regularity need not enter verbal discourses but it must

be inferentially applicable on future data, signals or their derived representations. In the light of the above listed difficulties with the use of verbal formulations for inferential purposes of the kind required in message analysis, it is therefore quite suggestive to simply omit the attempt of idealizing a discovered constraint in the direction of a natural language proposition in favor of representing respective regularities directly for use in content inference and filtering. Although the vividness of the interpretation of relevant regularities in intuitively more meaningful natural language terms may be lost this way, the validity of the outcome of message analysis might gain considerably.

Two Further Constraint Analyses

Examples of constraint analyses that are geared to represent regularities in a form adequate for future content inferences have already been given. Many of them take the form of psychological experiments of which working example X and perhaps Osgood's work can be considered representative. Some formulations that have been used effectively such as Leites' work in VII are, as has already been mentioned, logically derived from some more general regularity known to the analyst. The two examples to be reported in the following, exhibit formal structures that are relatively uncommon in message analyses reported so far. In addition, the first one is interesting because in it an automatic discovery procedure was used that is suggestive for future developments. The second one is included and developed because

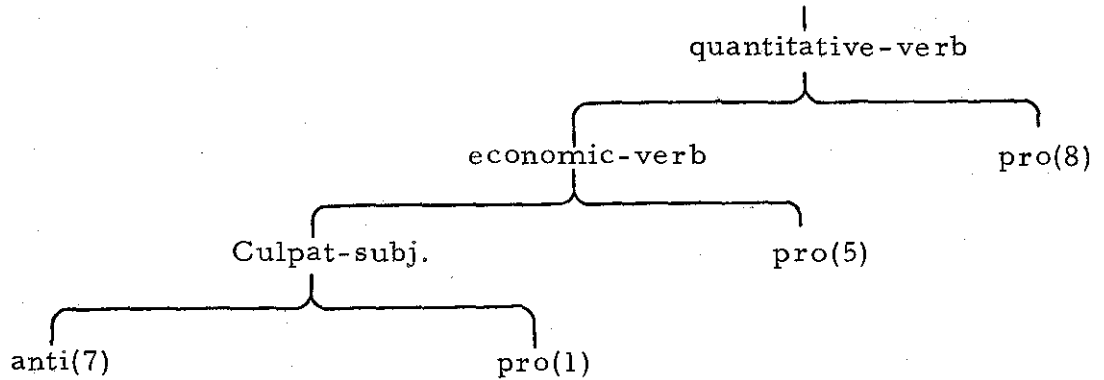
it deals with some non-statistical constraint of some complexity which had not been adequately tackled before.

The first example is an outgrowth of the work reported in IX. The attempt to find constraints that distinguished real from simulated suicide notes culminated in the joint use of two computer programs: (a) the General Inquirer simply mapping words and short phrases that appear in texts into sets of tags and answering retrieval questions concerning the distribution of specific tags, and (b) the Concept Learner asking enough retrieval questions and deciding whether they are relevant for differentiating the texts according to some attribute outside those texts. The Concept Learner thus operates on very many variables and stores the rather complicated constraint it discovers in the form of a decision tree.

An illustrative example is provided by the comparative analysis of arguments for and against two legislative proposals in California from which sentences containing such obvious differentiating phrases as "vote no" were omitted. After the General Inquirer had tagged the texts its retrieval part was coupled with the Concept Learner. Without going into the procedural details -- one of the most simple constraints that the Concept Learner discovered within 21 sentences was accounted for by an ordered set of distinguishing characteristics depicted in Figure 10.

The verbal interpretation of such a regularity would be that those opposed to the proposal are apparently preoccupied with its

economic costs, represented by the two distinguishing text characteristics "quantitative-verb" and "economic-verb," while those in favour emphasize non-economic aspects of the issue.



Discriminate Function "discovered" by the Concept Learner

Figure 10

The constraints that the Concept Learner discovered without any human aid exhibit two important properties: first, the program is capable of considering many valued relations quite dissimilar to the type of relations that are usually encountered when such indicants as product-moment correlation coefficients are used as in the case of working example X. In fact the above depicted tree includes a quaternary relation.

Second, the represented relation takes a form that can be directly converted into an ordered set of decisions. Thus, if the relation that the Concept Learner finds successfully discriminates between complex data or texts (here sentences containing specific references) according

to a set of attributes (here the pair "pro" and "con") outside those data, the decision structure into which the above tree can be converted at once can be used to infer such attributes from other data or texts that are obtained under similar conditions. In this example the operation of formulating a relevant regularity that can be considered to account for the discovered constraint becomes in a sense an operation complementary to content inference.

Although the joint use of these two computer programs as presented by Stone and Hunt (190) is capable of discovering constraints, formulating relevant regularities and making what are in fact content inferences, the drawback that needs to be mentioned is that the inferences amount to a simple decision between two attributes. Thus the quantity of information these computer programs find and utilize is exactly one bit. While this is a rather severe limitation it may not be an absolute one.

The material for the second example is taken from Goodenough's influential "componential semantic analysis" (78) illustrating an anthropological approach to "empirical semantics" by the study of Truk kinship terms. The work not only provides evidence for a quite complex constraint that may have to be utilized for making content inferences but moreover demonstrates some of the differences in the task of content analysis and message analysis.

It is quite obvious that cultures impose constraints on the situational use of their kinship terminology, thus encouraging the formulation

of regularities that can be considered to account for such constraints. To represent these regularities Goodenough made use of a hypothetical construct that is identical with Janis' conception of content (91) and has in reference to Morris' theory of signs (138) been phrased the structure of signification. It involves identifying basic dimensions of meaning or semantic components along or according to which the observed and recorded differentiations within the kinship terminology can be represented. It is assumed that this hypothetical construct accounts for a native speaker's signification habits.

Goodenough's representational system consisted of the well established linguistic notations plus notations he had to develop for representing the "contextual elements" of utterances, i. e. the kinship relations denoted by a speaker. The notations had to make as many differentiations as conveniently possible. In its terms an English informant would use the expression "my cousin" to denote what is transcribed here by FaBrSo (father's brother's son), FaSiSo, FaBrDa, FaSiDa, FaFaSiSo, FaMoMoBrSoDa, etc. With the addition of Sp (spouse) this notational scheme can represent a very large number of familiar kinship relations, certainly more than can be expected to be culturally significant.

The anthropologist's preliminary task is to gather all expressions whose denotata make it appear that there may be some common element in their significata. Goodenough found that whenever a person was denoted by one of 14 single utterances, called lexemes, it was

also 'tefej' to the speaker, here called "ego." Hence, 'tefej' was taken to define the universe of lexemes and denotata considered. After this first analytical step, each lexeme can be viewed as imposing a partition of the recorded denotata in the universe. For example, the kinship relations denoted by 'neji' were found to be the following:

So
 Da
 ChCh
 BrCh
 SiCh
 MoBrCh
 MoMoBrCh
 FaBrChCh
 MoSiChCh
 FaSiSoChCh
 FaSiDaSoChCh
 FaFaBrSoChChCh
 Etc.

The structure of signification now becomes manifest in the distribution of lexemes in the universe of possible denotata. On inspection this distribution revealed to Goodenough among other things that the Truk's concept of generation does not coincide with the usual genealogical schema. For instance,

the denotata of "neji" include persons in lower generations than ego's, excepting persons in ego's father's matrilineal groups and children of men in these matrilineal groups. They also include the children of any men in ego's matrilineal kin groups together with their children, and the children of any children of men of ego's father's matrilineal group (78:205).

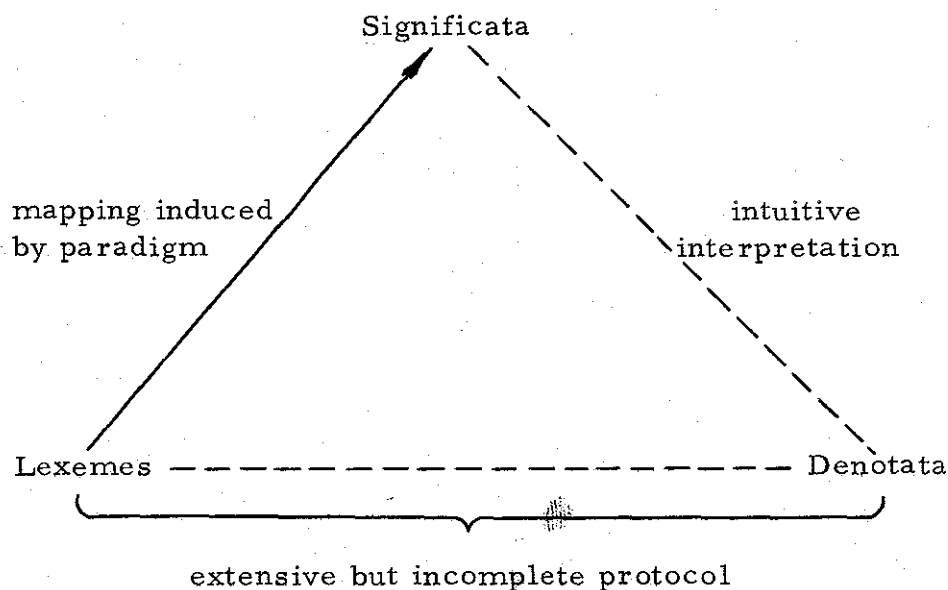
E.g. Ch, BrCh, SpSiChCh are included as well as FaBrCh, and MoFaFaSiCh although the latter range over generations higher than ego's while the former do not.

Such observations render sufficient support to the analyst's conviction that the native differentiates among the denotata within the universe according to some consistent principle which he hopes to formulate in terms of a few semantic dimensions or components of signification. The denotata of 'neji,' for example, were characterized by the two component values 1) being 'tefej' to ego and 2) being of junior generation in the Trukese sense of "generation height." The denotata of the kinship terms could be similarly characterized according to generation height as well as according to such dimensions as sex of relative, sex relative to ego's sex, symmetrical or asymmetrical relation. Goodenough's task was to construct a system of signification for Truk kinship terminology which he presented in the form of two simple paradigms. In it each lexeme is assigned a location that represents its relevant components of signification.

The anthropologist's paradigm is a mapping of a set of lexemes into a hypothetical construct that is claimed to be a representation of a native's system of signification. Goodenough is quite aware of the hypothetical nature of this system of signification when showing that more than one such system can be constructed.

The difference between Goodenough and a message analyst appears in the mode of validation to which the analytic results are amenable. While the mapping of lexemes into the hypothetical signification is well defined in Goodenough's paradigms, the relations between these significata and their observable denotata is not explicated

at all and requires an intuitive interpretation which is far from obvious. Thus if the anthropologist receives some kinship term he can find its signification according to his paradigms but has no way other than his intuition in order to infer what kinship relation is being denoted by the speaker. Face validity is the only justification of this hypothetical construct. In analogy to Ogden and Richards' symbol/interpreter/referent triad (145) Goodenough's result may be depicted in Figure 11,



Triadic Interpretation of Goodenough's Results

Figure 11

What a message analyst would need to make inferences more explicit is either (a) a formal statement of the relation between significata and denotata in case of which the lexeme's references could be inferred from its hypothesized signification, or (b) an explication of the regularity that accounts for the constraints observed and recorded in the notational

terms of the protocol and is stated as a relation between denotata and lexemes. If the latter is given, inferences from a denotatum to the lexeme appropriate in that situation can be made as well as inferences from a lexeme to the set of denotata that constitute its reference. If the former relation were given, inferences from denotata to lexemes cannot be made effectively because the relation from significata to lexemes is not single valued as far as Goodenough's conception is concerned. The relations that are needed to fully account for a native speaker's competence in the situational use of his kinship terminology can be depicted as arrows (a) from significata to denotata and (b) between denotata and lexemes in both ways.

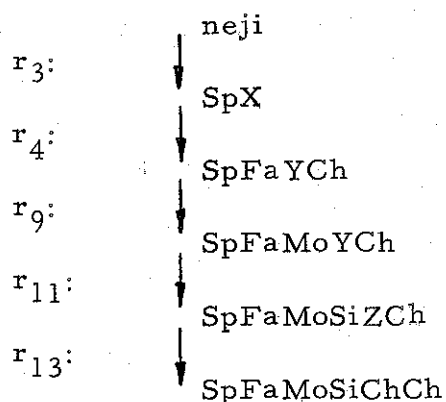
In the above situation the message analyst's task is rendered difficult by the fact that the sets of denotata tend to be very large and in many cases even non-denumerably large (note the obligatory "etc." after each list of a lexeme's denotata). As it would be unreasonable to assume that the native speaker has acquired his familiarity with kinship terminology by something like "pair-learning" it is hardly possible to expect adequate results from a contingency analysis of the kinship protocol. Rather, it may be assumed that such non-denumerably large sets are recursively enumerable by a few formulas, a set of which is associated with each lexeme in question. If this is the case we cannot search for components of signification that seem intuitively satisfactory but for recursive formulas that account for a native's recorded competence in using kinship terminology.

In search for suitable grammars of natural languages Chomsky (43) (44) suggested and investigated several generative processes of which a simple type, a "phrase structure grammar," seems adequate for representing the regularities of our concern. The rules governing this generative process can be applied in reverse and accept just those strings of symbols that can be generated by them.

In terms of the above mentioned generative process, our formulae which are in effect reversible rules of inference become sets of rewrite or substitution rules that generate all appropriate denotata (in notational form) for each kinship term. In this set of rewrite rules, lexemes provide the natural initial symbols, capital letters are used for the non-terminal symbols, and Goodenough's notation for kinship relations are the atomic terminal symbols. A typical rewrite rule " $r_6: X \rightarrow BrZ$," for example, is to be read as "X may be replaced by BrZ." Another rule may replace Z and so forth until the string of symbols contains the description of a denotation. Taking again 'neji' as an example, the rewrite rules depicted below recursively enumerate its denotata as far as is evident from Goodenough's report. (For the sake of simplicity the terminal symbols So and Da are collapsed into Ch).

r ₁ :	neji	→	Z	r ₈ :	Y	→	FaY
r ₂ :	neji	→	X	r ₉ :	Y	→	MoY
r ₃ :	neji	→	SpX	r ₁₀ :	Y	→	BrZ
r ₄ :	X	→	FaYCh	r ₁₁ :	Y	→	SiZ
r ₅ :	X	→	MoY	r ₁₂ :	Z	→	ChZ
r ₆ :	X	→	BrZ	r ₁₃ :	Z	→	Ch
r ₇ :	X	←	SiZ				

On the basis of the rules formulated above, one of the possible inferences from 'neji' can be generated as follows:



It should be noted that the formula for each individual kinship term cannot be viewed in isolation from the rest as it has been done here for purposes of demonstration. It must be assumed that the sets of their rules overlap somewhat. However, r₁₂ and r₁₃ as terminal rules leading to Ch, ... Ch, ... ChCh, etc. and r₄ and r₅ which ensure that decendants of the children of ego's father's group are included but not those of ego's mother's group, are not likely to be found in any other formula. Therefore, these rules represent in a different way those

aspects of the signification into which anthropologists such as Goodenough may want to inquire without attempts at making inferences.

It can well be imagined that some definable constraints exist that limit the set of denotata of 'tefeji' in terms of the maximum "kin-distance" between ego and relative. Such a constraint has not been mentioned by Goodenough who primarily focused on components of signification. Such a constraint would require a limitation as to the number of times a recursive rewrite rule can apply.

In this discussion no claim is meant to be made concerning the simplest symbolism for the formulas. Goodenough's notation was used just for convenience of presentation. In addition this elaboration is not meant to be a contribution to the study of kinship terminology. Goodenough's data was merely used as a convenient vehicle to illustrate the formulation of a regularity that is much more complex than is thought. Constraint analyses may have to locate constraints which are much more powerful than those discovered by correlational methods or by the Concept Learner's method, i. e. constraints which are appropriate for systems that possess a significant degree of organization. We cannot go further into the discussion of various possible structures of constraints that may be relevant to some content inferential tasks.

In summary then, constraint analysis operates on suitably represented data, filtered texts, or measures of relevant characteristics that are found in data with the goal of obtaining formulations of

regularities that account for observed constraints and can be utilized for making inferences to a given problem domain. Technical prerequisites for the discovery of constraints are measures of a constraint's severity and inferential power which serve as evaluative criteria of a given data, text, or signal for inferences intended. Though formally similar, hypothesis testing aims at the recruitment of evidence to test a given statement while constraint analysis aims at the recruitment of a formalization accounting for a discovered constraint that is suitable for specific content inferences from given data.

Filtering

The primary purpose of this constituent part of message analysis becomes at once apparent when one considers the sheer volume of data that has to be processed in most of the cases. (For exceptions see working examples I and III). In conjunction with the analysis reported in working example V, for instance, Lasswell writes:

The Bookniga and Transocean cases involved great quantities of printed and unprinted matter. Four periodicals, 76 books in the English language and 132 books in the Russian language were examined in connection with the Bookniga prosecution. Particularly detailed analysis were made of the periodicals. Four kinds of material were relevant to the Transocean proceedings: "Cables" to Germany from America; "Transmissions" to South America from America; English news service to Americans; and German news service to Americans... (111:177).

If one is willing to consider the number of propositions, not to speak of words, that had to be read, recorded, categorized, measured and subjected to some kind of computation, the problem of drastically

and rigorously reducing the complexity in the data to a manageable form becomes a major problem in most message analyses.

Rigorous reduction and simplification of data while an obvious prerequisite of many such analyses cannot be the sole criterion for the procedure in question. In fact one of the criticisms that had been made in chapter one is that content analysis often simplifies the data too much. When relying on simple frequency characterizations, structures of which the textual units are constituents are counted away and those within the units are treated as whole entities. If structural characteristics of text that are significant for further analysis simply disappear during computation, the analysis defeats its purpose.

What the filtering process should accomplish is not simplification per se but a purposeful reduction of the available complexity. The specific purpose of this complexity-reducing transformation cannot, on the other hand, be established without reference to the message analytic situation as a whole and the component structure of the analytic procedure in particular.

Referring again to the diagrammatic presentation of the message analytic procedures in the introduction to this chapter, filtering appears in two slightly different positions. In one case it takes an intermediate position between recording and content inference, in the other between recording and constraint analysis.

When filtering mediates between recording and content inference the purpose of filtering is well established: given a specific

problem domain and available regularities accounting for previously discovered constraints in the object system, filtering has to produce just those representations of data that will lead via content inferences to appropriate selections within the problem domain. By replicating those transformations that lead to the observation of constraints, irrelevant information in the text or noise is suppressed.

"Noise" in this formulation is not to be understood in the very specific sense of statistical random variation. The noise that filtering is to suppress is delineated by the purpose of message analysis and is of two kinds.

Firstly, a text can be represented along dimensions irrelevant to any known regularity of the object system, i. e. dimensions, variables, components, etc. that do not or have not been found to relate to any other dimension, variable or component of the object system. Such dimensions of the text's representation do not contribute to any conceivable inference and cannot be considered carriers of content. Statistical noise is a special case of this irrelevant information that filtering is to eliminate.

Secondly, among those dimensions of the text's representation that pertain to available regularities not all will lead to selections of content within the problem domain. They may lead to inferences other than those delineated by the message analytic situation. Hence, this source of irrelevant information does not result from the regularities available but from a projection of the problem domain through those

given regularities onto the data representations needed. Thus, while the first kind of noise is rooted in the explicated "past experiences" of the analyst, the second type stems from the particular problem under consideration.

When filtering mediates between the recording process and constraint analysis the specific nature of the complexity-reducing transformation is not known in advance. While filtering here too has to eliminate what does not lead to the discovery of constraints of potential use in content inference, the relevance of representational dimensions which filtering produces can only be established after the accomplished constraint analysis. Thus, when constraints are sought any conceivable filter may be used until the relevant constraint is found, but when specific content inferences are intended only those filters can be utilized that are known to produce desired text representations, that are standardized on the available regularities and delineated problem domain.

Often complexity-reducing transformations are used and even defined as indicants. Janis and Fadner's "coefficient of imbalance" (93) reduces a whole text to just one variable whereby it is not at all clear what this coefficient exactly indicates. The one-to-one relation that is claimed to hold between an indicant and some other variable is so simple that the implicit inference is often overlooked. For analytical purposes we have to clearly differentiate between some computational formula i. e., representing the filtering procedure; the various

states of "imbalance" i. e., the contents inferred; and the empirical generalizations that are needed to go beyond the characterization of a given text, i. e., the established regularities.

To give a brief illustration of the role of filtering consider Mahl's "exploring emotional states by content analysis" (124) reported in working example X. He argued that our cultural standards stress concealments of a speaker's emotional states and that language training and communication habits tend to focus awareness more on lexical characteristics of speech than on its non-lexical features (existing constraint). To obtain information about an individual's emotional states (problem domain) it is advisable to seek out those attributes of his speech that are most free from linguistic and social control (characteristics that a filter needs to maintain) and discard those speech characteristics under conscious control of the speaker (dimensions carrying noise with respect to problem domain). Mahl furthermore showed the high correlation between certain types of speech disturbances and the individual's state of anxiety (relevant constraint) and suggested a set of speech disturbance measures (standardized filter) as an inferential basis for individual anxiety. Here the existing constraint and the delineated problem domain justified the computational reduction of the complexity of speech.

Our conception of a filter must not be confused with a frequency selective network as it is traditionally conceived of in communication engineering. This conception appears narrow indeed when viewed

against the background of Wiener's theory of smoothing and prediction of time series (210) and Shannon's theory of statistical information (175). And even this recent development appears too specialized for our filter problem. Message analysis is not yet so well formalized. What Wiener and Shannon have shown, however, is that in order to reduce a certain amount of statistical noise in a signal, a certain amount of statistical information is required that is equivalent to the amount of noise to be removed from that signal. In Wiener's theory, dealing specifically with filter problems of continuous and stationary signals with additive noise, the designer of a filter must know the auto-correlation function and cross-correlation function of the input and the desired output. If he knows less he cannot design the filter and if he knows more he cannot make use of the additional information.

Very similar conditions exist for the designer of the filter in a message analytic procedure. The problem domain must be delineated and some formulated regularities accounting for observed constraints must be available to him. Only then is he able to evaluate the possible inferential paths that would lead him to appropriate selections within the problem domain and only then can he specify the transformation that was antecedent to the formulation of the relevant regularities and which can now be applied on the given data. The choice of the filter is thus absolutely determined by the available constraints and the specified problem domain. If the filter designer has knowledge of the problem domain only, he cannot adequately select a filter and is trapped

by the content analyst's dilemma. If he knows only the regularities of the object system, no problem of message analysis exists thereby making inferences vacuous.

Filtering procedures vary greatly in complexity. Simple selections among the elements of the data qualify as filter as well as such means of reduction as sampling procedures, categorizations, enumerations, elementary algebraic operations and even such sophisticated computational techniques as factor analysis. All accept the notations of one representational system and transform them into those of another more convenient form whereby the structure of data that are relevant for content inferences are carried over and those that are irrelevant are eliminated. In other words filtering is a mapping of one representational space into another which separates relevant from irrelevant information; it is a homomorphism maintaining significant structures that appear in the data or text to be analyzed. Much methodology in the behavioral sciences goes into the design of filters in our sense and the study of their properties. Kaplan uses the term "derived measurements" to refer to computational techniques that are applied on "fundamental measurements" which presuppose no other measurements (97:188). Derived measurements and filtering procedures are by and large synonymous.

For the most elementary example of the filtering process consider two measurable text variables in a traditional content analysis: the total amount T of printed space in a newspaper and the amount S

devoted to a particular issue. Suppose the analyst knows that S varies proportionately with T and T is for some reason irrelevant to the analysis while a third variable affecting S linearly carries the desired information. Here some function like S/T could provide an adequate filter eliminating the effect of T on S and represent the relevant variable in an adequate form, say in percentage. The example illustrates in the most simple form that (a) filter processes are irreversible, (b) the justification of a particular filter requires some knowledge about the relations between the observed variables or presupposes at least assumptions about them, and (c) filters operate only on characteristics measurable on the data itself, i. e. represent only syntactic not semantic features.

That filtering is irreversible does not need a detailed demonstration. The reversal of a many-one transformation is not single valued and always leaves some indefiniteness. After a set of categories is lumped into a single class nothing can be said about the original class membership of its elements. Percentages do not represent anything about the magnitudes on the basis of which it was computed. Any summation irrecoverably loses information in this sense, etc.

That filtering presupposes some knowledge about the relations that hold between the observed variables is less obvious. The previous example makes evident that if S were not dependent on T , the filter would not produce any significant representation of the text.

But suppose we wish to sample from the available text. The implicit assumption that would justify such an attempt is that the text is either composed of statistically independent elements or that the dependencies that may be observed between those elements are irrelevant for the analysis. If this assumption cannot be maintained, any sample taken from the text would be biased, misleading or at worst represent only noise. While a categorization process irrecoverably eliminates a certain amount of specificity in the data, the enumeration of occurrences allocates equal weights to each categorized unit regardless of their position within a text. If, for example, something like "attention" is to be inferred from a text and this variable is expressed by the size of headlines and the relative position of the feature text within a newspaper page, then an ordinary frequency count of specified references would not contain much relevant information for it discards contributory variables observable in the text. Gerbner's "news value index" (76: II-D-4) tries to maintain some such relations by considering frequencies of references to a topic in both headlines and feature text. Osgood's "contingency analysis" (147), for example, discards the individual frequencies with which differentiated units appear in a text in favour of co-occurrences. Osgood's interest in assessing a writer's association structure clearly justifies such an omission but if it were shown that individual frequencies are related to the association structure of a source then the analysis would have to be said to eliminate too much relevant information.

Filtering procedures - whether merely categorizing text characteristics or computing numerical values for representing features of a text - generally have very little to do with analyzing the "meaning" of a message or its "content" in the conventional sense of these words. This has been consistently overlooked by traditional content analysts who claim to analyze the content of communications by mapping a complex text into some measure of permeation. On intuitive grounds the original text may be quite meaningful to a competent user of the respective language, but the transformed version of this text need not be. If the product of a filtering process is meaningful to someone - in whatever sense - it is so either through some familiar semantic clue that happened to be maintained during the transformation process or due to some interpretations of these results that are based on information other than that contained in the transformed version of the data itself.

For example, Osgood in his contingency analysis of Goebbels Diary reported of a negative contingency between ENGLAND and GERMAN SUPERIORITY as a race, significant at the 5 percent level (147:71). While the two categories into which various instances were grouped are labeled in an intuitively comprehensible manner, the meaning of the negative contingency between them can only stem from information other than that provided by the analysis. The content analyst may, for example, rely on an intuitive reading of the original text or know from other sources about the ideological conflict

that existed for the Nazis when differentiations between allies and enemies did not correspond with their racial conception of the war aims.

How little filtering has to do with a semantic interpretation or an analysis of "content" will become even more evident from the following pilot study: To determine the applicability of factor analysis and "to understand and interpret the inter-acting forces that were identified by theoreticians" of international relations, O'Sullivan Jr. (154) designed a content analysis in which Richard Snyder's Deterrence, Weapon Systems and Decision Making was chosen as source material. The document was based on some 150 recent writings dealing with arms control concepts, particularly those dealing with stability and deterrence and was therefore assumed to be representative of the field. Forty variables and six degrees of relatedness were defined that led to generic assertions of the form "A affects B" in terms of which the text could be represented. Among the variables were "credibility of threat," "likelihood of accident," "first strike premium," "decentralization of decision process," "stability of deterrence." The degrees of relatedness ranged from "in certain situations induces" to "is directly related to."

A factor analysis, "the principal purpose of (which) is to reduce a matrix of correlations to the smallest possible number of dimensions in the interest of parsimonious description of the interrelationships between the variables," (156:377) yielded six factors. They were named by the investigator: stability, decision making conditions, rationality of decision, credibility, exploitativeness. For one of the factors no

satisfactory name could be found.

The kind of reasoning that goes into interpretations of the factors discovered by factor analysis is symptomatic for results obtained by means of a statistical procedure that is far removed from being commonsensical and reveals the non-semantic character of the filtering process. Suggesting "exploitativeness" as a characteristic quality of his factor no. VI, O'Sullivan Jr. argues:

This factor has moderate negative loadings in constraints on the decision process, likelihood of containment of limited war and ability to engage retaliatory systems. There are marginal negative loadings in the pace of arms race and aggressors' uncertainty over defenders' specific tactics or weakness in weapons and marginal positive loadings in diversification and versatiling of weapon systems. This appears to be a power-grab situation, or a factor relating to the degree to which the situation is subject to exploitation by one of the parties (154:8).

The argument illustrates what Peak observed elsewhere namely that "considerations other than the procedures of factor analysis must enter into the interpretation of the meaning of the factors discovered" (156:278). While this statistical tool is certainly explicit and determinate, it is hardly conceivable that another investigator could interpret the semantically highly ambiguous results of the above analysis in the same way. Although the five factors named by the researcher seem indeed to be intuitively important in the process of international decision making, so are very many others. In addition, it should be mentioned that the nature of correlation on which factor analysis is based eliminates all the dynamic properties of the international system that may have been described by writers in the field, and the reliance on

binary generic assertions does away with all higher order relations that may have been felt to be of theoretical significance. The above example presents factor analysis as a means to reduce the dimensionality of the text in such a way that the new dimensions account for much of its variance. But the statistical procedure neither processes nor analyzes "content," nor does it help "to understand and interpret the inter-acting forces that were identified by theoreticians..." as it was stated at the onset of the investigation.

At this point someone may wish to argue that all statistics can qualify as a filtering of data. This is correct, but the reverse is certainly not the case. Someone interested in analyzing a particular formal theory as a message about an object system is not very likely to get very far by applying some statistic on the symbols appearing in propositions that are deduced from that theory. Such an attempt would most probably produce nothing but noise. If one were to succeed in devising a suitable filter that would uncover the formal structure of that theory from propositions deduced from it, the filter will not say anything about the empirical content that theory may have.

Summarizing this section, we can say that filtering is a homomorphic mapping, a many-one transformation reducing the variety in the data by eliminating variables in its domain that are irrelevant with respect to (a) the available regularities (or constraints to be discovered) and (b) the problem domain of a message analytic situation. Filtering has little to do with processing content although it may have to operate

on structures of data that are meaningful to someone. The sole justification for using a particular filtering process stems from its having exhibited a constraint of the object system that is to be utilized for a particular content inference.

Recording

When data are given to a message analyst they may appear in a form which is not amenable to the kind of analytical processes he can handle explicitly. Particularly written text, visual images, musical creations, etc. which possess an unmanageably large variety of structures and forms and may appear meaningful to the analyst on entirely intuitive grounds - cannot be subjected to scientific analyses unless some notational scheme is available in terms of which the data can be transcribed. The process by means of which given data, signals or texts are translated into the primary notations of a message analysis may be called recording.

Although the sensory organs of an observer already impose some kind of notations or at least a structure on the received data, their "records" are rarely directly communicable to other observers and therefore lack inter-analyst verifiability. And if such records were indeed communicable they may not be in such a form that they can be subjected to the analysis intended. Recording produces a representation of the given raw data in an analyzable form. In Kaplan's terms recording provides "fundamental measurements" (97:188), that

presuppose no other measurements.

In content analysis the procedure by means of which a text in an observational space is recorded in terms of the categories of a representational system is often called "coding." The use of this term for the categorization process by content analysts seems to be quite misleading in view of the existence of an extensive body of literature on coding (including: encoding, decoding, recording and transmission) dealing with the subject in an explicit and well defined way, but in an entirely different sense. To take only a relatively simple but perfectly adequate definition of a code consider Chomsky and Miller's formulation made in the context of formal analysis of natural language, which necessitates the use of the concatenation " \frown " of symbols to strings. They define a code C as a 1:1 mapping Θ of strings in V into strings in A such that if v_i, v_j are strings in V then $\Theta(v_i \frown v_j) = \Theta(v_i) \frown \Theta(v_j)$. Θ is an isomorphism between strings in A ; strings in A provide the spelling for strings in V " (45:277). A typical example of a code is the mapping of letters of the English alphabet into the strings of dots and dashes of the morse alphabet and reverse. Working example III dealt with finding the key to a code in order to decode a cipher. Being a 1:1 mapping, codes are reversible and have little to do with processes of coding as understood in content analysis; nobody would require Berelson (working example VIII) to reverse his coding instructions that supposedly yielded a tabular representation of fictional characters to obtain the short stories in which they occurred.

Only if the original could be reproduced from its coded version could he be said to have employed a code in the technical sense.

It is not coding in the technical sense but rather some simplified description of the data which is the aim of recording. In this sense recording resembles much of content analysis itself in as far as it has been explicitly stated by Janis (92:55) and Miller (136:95). This characterization, cited earlier, required content analysis to be a mapping of a large variety of symbolic data into sets of fewer categories involving human judges. Here symbolic data include anything that is presumed to have some meaning e. g., sign vehicles, words, visual forms, texts. Sets of categories are used synonymously with dimensions, variables, an attribute space, in short a notational scheme for representing the raw data, signal or text. While one feels inclined to identify content analysis with the process of recording, this identification would easily be misleading for (a) the term is unfavorably loaded with the methodological dilemma that is inherent in the analytical pursuits signified by it, and (b) content analysts typically feel that they are not limited by the explicitly stated recording procedures and often claim much more than the analytical technique can accomplish.

While it seems obvious that the notations in terms of which raw data are recorded have to provide for adequate representation of those data, determining this adequacy of representation is by no means a simple matter as we shall see later. But regardless of its representational properties the explicit analysis of data as messages imposes on

a primary notational scheme a formal requirement: the notations have to be well defined and neither lead to contradictions in the subsequent analytical process nor allow syntactic ambiguities to arise. Strictly speaking, the notational scheme has to be a formalized language that the explicit message analytical procedure can accept as input.

Abstracted from a particular problem there seems to be no other requirement on the notation of a representational system. Consequently the representational systems actually used can take many different forms. The most elementary structure of a representational system is found in a set of independent categories, a slightly more complex one in the conjunction of a fixed number of such categories constituting what is often called an attribute space. Because of their emphasis on relative frequencies that can be obtained most easily on the basis of such a scheme, attribute spaces of this kind have been preferred by traditional content analysts. The generally accepted requirement that the categories be mutually exclusive shows the attempt at formalization which ensures that subsequent analysis does not produce spurious results. We can easily omit examples for this type of representational scheme.

O'Sullivan Jr.'s (154) analysis of writings in international relations, already referred to, employed a representational system that included in addition to notations for forty categories, notations for six degrees of relatedness. If C_i , C_j are categories and r

a certain degree of relatedness, O'Sullivan could record observations of the type " $C_i r C_j$."

In Osgood, Saporta, and Nunally's evaluative assertion analysis (151) the relation between concepts is provided by verbal connectors, c , the numerical value of which can range from -3 (strongly dissociative) to +3 (strongly associative). Differentiations among concepts are made between "common meaning terms," cm , and "attitude objects," AO_i . The emotive valence of common meaning terms ranges from -3 (strongly unfavorable) to +3 (strongly favorable), and is assumed to be generally accepted among the speakers of a language, while the evaluation of attitude objects has the same range but is assumed to be situation dependent. The notations of the analysis represent assertions in the following formats: " $AO_i c AO_j$ " and " $AO_i c cm$."

North et al. discusses a set of notations that have been developed for a computer analysis. A manual editing phase that is preparatory to programed data processing introduces these notations into the text. Although defined semantically, these notations subscript fractions of a text that are treated in the subsequent analysis as syntactic differentiations. These notations are defined as follows:

- /1 the perceiver and incorporated modifiers
- /2 the perceiver other than author of the document and incorporated modifiers.
- /3 the perceived and incorporated modifiers
- /4 the action and incorporated modifiers
- /5 the object acted upon (other than actor-target) and incorporated modifiers
- /6 the auxiliary verb modifier
- /7 the target and incorporated modifiers (142:137).

The following is an example of an edited sentence from a study of the Cuban crisis: "Kennedy /1 Premier /2 Khrushchev /2 announced that, 'the Soviet Union /3 may /16 withdraw /4 the offensive /5 missiles /5 from Cuba /7'" (142:138).

A slightly more complex system of notations has been used by Piault (157) to analyze answers to open ended questions concerning relations between foreigners and natives in Ghana. The structure of the notational system appears in the following general outline:

- a) Objective data of the interviewee such as age, religion, marital status, number of dependents, occupation.
- b) Identification of the source of judgments made. The sentence "foreign interviewee says that natives say that foreigners are dirty" would be recorded as " $X \rightarrow Y \rightarrow X$ " with X denoting foreigner and Y native.
- c) Type of predicate. The assertion "foreigners are avaricious" could be recorded as "avarice (X)" and "natives help foreigners" becomes "help (Y/X)" in the formal notation.
- d) Twenty eight categories of syntactic relations between X and Y each of which may be assigned separate indices: (F) factor or cause, (P) product or consequence or (N) neuter or non-causal relation.
- e) A list of 675 concepts divided into 28 classes to represent semantic characteristics of the text once the individuals, source, predicate type have been recorded. These notations were designed for a computer analysis of the data.

To conclude our examples of representational systems we may cite the formal notations Goodenough (78) used to record the denotata of kinship terms which constitute a mathematical group providing a non-denumerably large set of categories. We referred to this notational scheme in the previous section of this chapter.

With the rare exception of one to one identifications, recording reduces the variety in the raw data: it has filtering properties. That recording into the notational schemes described above omits much of the specificity that is present in the raw text is quite obvious. But let us turn to one more example. Contingency analysis, for instance, provides both a computational apparatus with which we are not concerned in this section and a notational scheme for recording the raw text. During the recording process evaluative attributes, qualifiers, predicates, etc. are discarded and even the nature of relations expressed between concepts for which categories are provided are not differentiated by the formal notations. The notations of contingency analysis are capable of representing only co-occurrences of specified concept categories in the raw text. Osgood exemplified this method by an analysis of Goebbels' diary. The reported findings give an impression of the nature of the recorded data. He describes his findings:

References to GERMAN GENERALS were significantly contingent upon references to INTERNAL FRICTIONS (in the inner circle about Hitler) at the 1 percent level; references to GERMAN PUBLIC were associated with those to BAD MORALE at the 5 percent level, as were contingencies between RUSSIA and EASTERN FRONT; negative contingencies significant at the 5 percent level,

were obtained between RUSSIA and BAD MORALE, between references to ENGLAND and references to GERMAN SUPERIORITY as a race, and between references to the GERMAN PUBLIC and references to RUSSIA (147:69).

While the imaginative reader familiar with the political situation which Goebbels' diary depicts will undoubtedly be able to explain some of these contingencies, he will also realize how much information has been removed from the original text when recording in order to apply a contingency analysis. Osgood's primary interest in assessing the writer's association structure clearly justifies this drastic reduction of the complexity in the original text but other interests may not permit the same procedure.

The variety reduction induced by recording procedures suggests problems of evaluation that are similar to those of filtering. If recording is used in the course of attempts at finding constraints and formulating regularities little a priori criteria can be formulated. If recording is used to enter a message analysis in the narrower sense i. e., geared to make specific content inferences, (a) recording instructions must be standardized in precisely the same way as filtering. That is, the result of their application must lead to regularities intended to be used for content inferences. In the case of contingency analysis this standardization was based on psychological experimentation in the course of which association structure as a hypothetical construct was defined operationally. (b) The elimination of variables due to recording raw data can only be justified in terms of known regularities and a given

problem domain. Osgood's declared interest in inferring the association structure of the source defined many intricacies of the text, except co-occurrences, as irrelevant to the problem. So did Piault's problem impose a simple structure and a particular unitization of the raw data that would otherwise not appear acceptable.

One is almost inclined to identify recording as a filtering process. Although these processes do indeed have several characteristics in common, they differ in two related respects. One source of differentiation lies in the non-formalized nature of the raw data to which recording but not filtering applies, and the way representativeness can be assured. The second difference appears in the kind of operations that go into recording but not into filtering, and the kind of empirical problems that are associated with it. We will consider both differentiating features separately.

First, while filtering (whether accomplished by a set of standardized analytical operations or by a computer program) can be described as a well defined and explicit transformation of one representational system into a more simple second one, the domain of recording procedures is typically not so formalizable. Film, painting, visual displays, much of music and to some extent speech has largely resisted formalization so far. Alphabetical transcripts of human verbalizations lose many non-formalized expressions in the original. Even though the textures of such signals may be copied and reproducibly stored on a one-to-one basis by photographic means or sound recording

devices. Respective equipment for recording such data in a way amenable to message analysis is rarely available. If the raw data were already given in formalized notations and a mapping could be defined from those data into the notations needed, then the problem would be reduced to that of filtering and would not concern us here.

Not only is it logically impossible to explicate the translation of non-formalized raw data into formal notations but also very little is known about how the observational space of a human judge gets represented in the notational terms an analysis requires. What is known, however, is that often this translation can be accomplished quite accurately.

In the absence of the kind of definiteness filtering exhibits, the only evaluative criteria concerning the representativeness of the records obtained is a measure of reliability defined as the consistency with which judges record raw data or the degree to which a recording process approximates the ideal of a mapping. The measure is completely abstracted from the nature of the representation of raw data in formal notation and concerns only its degree of definitiveness. This critical property of reliability has already been elaborated in Chapter

Measuring reliability presupposes at least some formal distinction between elements in the raw data. Otherwise observations concerning whether something is consistently represented by a certain notational term cannot be made. Thus, if any attempt is made to assess the accuracy of the formal representation of data or the

consistency of the recording process as a whole, raw data must be at least unitizable or, in other words, partially formalizable.

These problems do not occur in filtering. The motivation for making use of recording procedures almost always derives from the non-formalized raw data that constitute the domain of a message analysis.

Second, even if raw data were given in formalized notation, it may not always be possible - for whatever reasons - to explicitly define the operations for translating raw data into the notations needed. In such cases we will also speak of recording. The operations that can go into a recording procedure may range widely. The most elementary recording process seems to approximate a one-to-one identification of directly observable characteristics in the raw data. It is most probably these physical-syntactic characteristics of raw data to which Gerbner refers when stating that the non-randomness or structuredness of a signal, its "built in quality," is to be recognized in order to assess meaning (72:180). In its most simple form identification could make use of an extensionally defined catalog of terms. For example, in the case of colors, each color in the catalog would have to be matched with the ones appearing in the raw data where measures of resemblance determine the appropriateness of a particular notational term.

However, judges in content analysis or observers of social situations are rarely ever limited to identification in the above sense. Moreover, they are frequently expected to estimate the meanings a text may have for a particular audience and categorize them according

to intentionally defined notations. It is this kind of identification that takes place within the semantics of a non-formalized natural language, some terms of which provide the formal notation of the analysis. This later characterization would be a "semantical content analysis" according to Janis while the former would be a "sign-vehicle analysis" (92:57).

Recording may not be limited simply to a semantic interpretation of the text. For example Shneidman requested his judges to record the missing premises that must be supplied to a political argument in order to make the assertions logically conclusive (176). Here notations do not represent semantical interpretations of a text but certain inferences accounted for by a well defined hypothetical construct cast in formal logic terms. The underlying operations of such a recording process are quite complex and require considerable training on the part of the judge.

It is probably safe to suggest that the further the operation of recording is removed from simple identification, the lower the reliability that can be achieved. Although such a proposition has not been subjected to an experimental test so far, its intuitive acceptance seems to provide the motivation for many researchers to push the explicit analysis as far "down" as possible such that fewer intermediate operations are necessary to obtain formal notations whereby recording becomes ideally equivalent to an identification. This ideal is achieved, for example, in Stone's General Inquirer computer program (188) which simply requires the text to be punched on machine

readable cards or, in Cassotta, Feldstein and Jaffe's Automatic Vocal Transaction Analyser (40) operating directly on tape recorded psychodiagnostic interviews.

On the other hand, as the recording process increasingly resembles that of identification or even becomes eliminated as a significant analytical component of message analysis, it is to be expected that processes of filtering and content inference demand a large amount of requisite information which would otherwise be supplied by intuitive interpretations made by the judge during the recording process and become increasingly complex and costly. Hence, a particular message analytic situation may define an optimal mixture of the unaccounted complexity that goes into the recording process and increasingly reduces reliability, and the accounted complexity that goes into filtering and content inference and increasingly incurs costs.

Thus, while filtering treats recorded data - whatever they may represent - syntactically, it does not go outside those data, and hence has little to do with processing "meaning," "content," or "semantic features" of the original text; the informal use of the capabilities of human individuals for formally representing only partially formalized raw data allows semantic interpretations and certain informal processes to enter the recording process. Therefore, information may be supplied during recording which would not be able to find its way into the filtering procedure.

As far as the typical empirical problems are concerned, recording resembles most closely the process of content analysis. As mentioned above we avoided the term for its ambiguous connotations and methodological insufficiencies elaborated in Chapter Two.

Content Inferences

Inference commonly refers to a process of reasoning by means of which propositions are derived from other known propositions. Traditional logic contrasts essentially two kinds of inference: deduction and induction. Deductive inference proceeds from a general proposition to particular instances implied by it. The classical Aristotelian syllogism illustrates this mode of reasoning. Inductive inference on the other hand leads from less general to more general propositions or in Aristotle's terms from individuals to universals. For this reason induction and deduction have often been said to be "inverse operations."

Content inference does not fit either characterization. For instance, deduction presupposes complete availability of information. As the working examples have amply demonstrated message analytic situations are existentially linked to the partial observability of an object system. Consequently the message analyst's efforts are typically constrained by the lack of complete information. On the other hand, the working examples show no sign of attempts at generalization. The inferences that are made in message analytic situations are always directed toward a rather specific problem domain, are pointed rather than universal.

Many logicians maintain that this contrast between inductive and deductive inference is not the most fruitful one. The distinction should rather be one according to whether the inference is logically conclusive or not. Induction clearly goes beyond its premises in the sense that the conclusions do not completely follow from the antecedents, while deduction certainly remains within its premises. And yet, in the light of the recent advances in inductive scientific methodology these distinctions are not altogether happy ones either.

The prominent method of inductive or predictive sciences as they are often called, is statistical inference or inductive statistics. Briefly, the method provides a rationale for deriving statistical generalizations concerning a population or universe - as it is interchangeably termed - on the basis of empirical knowledge obtained from a sample drawn from that universe. The argument is a strictly probabilistic one. The certainty with which evidence obtained from an analyzed sample can be considered to confirm or disconfirm sets of hypotheses concerning a universe is a function of two probabilities: (a) the probability that a sample of a given size represents a certain universe, and (b) the probability of obtaining the differences observed within or the scores measured on the sample by chance. Thus, the apparent logical inconclusiveness of the basically inductive argument is replaced by a probability calculus providing a measure of certainty assigned to a generalization which accounts for incomplete observations. This measure is founded on the fundamental assumption that

the universe is composed of statistically independent individuals and that the degree to which sample statistics represent the parameters of a universe is solely a function of the relative sample size and the nature of the sample statistics.

Overtly, the situation in which inductive statistics is applicable seems similar to that of the message analytic situation for both methods pertain to incompletely observable objects, i. e. object systems, populations or universes, and both attempt to go beyond their direct access, i. e. beyond the data, signals, texts or observations. The methods must however be kept strictly separate since the assumption upon which inductive statistics rests is incompatible with those required for content inference.

Inductive statistics rests - as we have said - on the assumption of statistical independence of the individuals in a particular sample and those in the population toward which the generalization proceeds. Message analysis is based on the recognition of possible dependencies between the individuals in a sample (data, signal) and those in a universe (unobserved components of the object system) to which content inferences lead. If the data obtained can be shown to be independent of the unobserved components of the object system, attempts to treat this data as a message would be in vain. If the sample turns out to be dependent on the rest of the population, inductive statistics leads to fallacious generalizations. Since inductive statistics presupposes the assumption of statistical independence of the sampled components

of an object system or universe, it must discard any communication between sample and universe, it can in no way account for the communication structure that an object system may possess unless this communication structure is decomposable into independent components and is adequately represented in the sample.

This differentiation is not meant to suggest that inductive statistics has no place at all in message analysis. For example, if sampling from a given text is theoretically possible and practically feasible, inductive statistics may become an unavoidable method for reducing noise during filtering. Or, generalizations of statistical regularities formulated on the basis of samples requires inductive statistics for evaluating the generalizability of such formulations for content inferences. But the calculus for justifying statistical inferences from a sample to its universe requires assumptions entirely different from those of content inferences proceeding from signals to contents. Since many content analysts habitually apply tests of significance (developed according to the assumptions of inductive statistics) on data known to be the outcome of complex communication structures, one can hardly give enough warning against improper usages of such methods by emphasizing the incompatibilities of their basic assumptions.

With the aid of known regularities of the object system, content inference proceeds from given data or signals to those unobserved components of an object system that are represented in the specific

and often rather limited problem domain. Traditional logic would say that it proceeds from particulars to particulars, leaving universals completely out of its consideration. A logical scheme that seems to come closest to content inference has been described by Johnson (94), as leading from instances to instances, and has been given the technical term "eduction."

Johnson demonstrates this mode of reasoning by using a rather simple example:

Mars is a solar planet
 the earth is a solar planet
 the earth is inhabited
 mars is inhabited

and argues:

Here the only point of agreement between mars and the earth is that they are both solar planets, and from this very slender relation of agreement we infer with the lowest degree of probability that mars is inhabited, because we know the earth to be so. The probability of this conclusion is strengthened, the greater the number of characters in which mars is found to agree with the earth; e. g. its being near the sun, and having atmosphere and vapour. It would be still further strengthened, if other solar planets besides the earth were known to be near the sun, to have atmosphere and vapour, and to be inhabited. The more complete process of eduction thus exemplified may be represented in the following scheme:

- (1) s is-characterized-by p_1 and p_2 and... p_m ,
 - (2) p_1 and p_2 and... p_m characterize s_1 and s_2 and... s_n ,
 - (3) s_1 and s_2 and... s_n are-characterized-by p,
- ∴ s is-characterized-by p.

Thus, in eduction there are three summary premises, containing (a) the summary term " p_1 and p_2 and ... p_m " which is adjectival; and (b) the summary term " s_1 and s_2 and ... s_n " which is substantival; besides the substantival terms "s" and the adjectival term "p" which occur in the conclusion (94:45-46).

It is quite clear from this formulation that Johnson deals here with an object system "s" and that the data p_i in terms of which it is represented are incomplete. From given knowledge about other object systems which are in many ways similar, possible properties of "s" that are not accessible are then "deduced." His premise (1) represents what the incomplete observation of "s" yields while his premises (2) and (3) represent the knowledge already possessed about objects " s_1 and s_2 and... s_n ." The knowledge that is brought to bear in the situation can be formulated by putting the premises (2) and (3) together in the following way: " s_1 and s_2 and... s_n " are characterized by both " p_1 and p_2 and... p_m " and " p ." Although Johnson did not think in terms of constraints and therefore does not make it very clear exactly which of the possibilities are excluded by assuming " p_1 and p_2 and... p_m " and " p " to hold, the conjunction induces a constraint in our sense.

Johnson's motivation for using the two summary terms in the eduction scheme most probably derives from the stated intent to develop a rationale for accepting eductive inferences. According to his argument the number of objects in " s_1 and s_2 and... s_n " provides him the basis for weighing previously obtained knowledge, i. e. the basis for assessing the certainty with which an established regularity can be assumed to hold for an object system, regardless of its inferential use, while the number of properties " p_1 and p_2 and... p_m " in which both "s" and " s_1 and s_2 and... s_n " agree provides him the basis for weighing the eductive conclusiveness of a specific inference, regardless

of the nature of the object system. In an appendix Johnson goes on to suggest corresponding probability measures with which we are not concerned here.

Statistical and eductive inference both show that it is obviously possible to eliminate the seeming arbitrariness of inductive conclusions by accepting certain assumptions concerning the nature of the object system. Inductive statistics assumes statistical independence of an object system's elements. Johnson's eduction assumes some sort of stable contingencies between the properties of objects: the more objects are known to agree in a certain set of properties, and the more the incompletely assessed properties of another object agree with the former the more likely is the latter object to possess properties of the former not assessed with regard to the latter. On the basis of any of those assumptions definite calculi for specialized forms of induction may be formulated.

Since content inferences by definition go beyond immediately observed evidence, they are specialized forms of inductive inferences and require certain justifying assumptions. Based on constraints discovered in the past, content inference derives its justification on the assumption of the permanence of these constraints in an object system. Osgood (147) talked about a general law relating the nature of the source with the nature of the messages produced; Yule (217) assumed the relative invariance of a writer's use of his vocabulary, and Leites et al. (118) justified their inferences by pointing to the history of the

Soviet use of political symbolism. If regularities formulated in the past will not account for future constraints any content inference that is justified in terms of such regularities is bound to produce invalid results. Since there can never be absolute certainty of the invariance of a constraint, the assumptions that need to be made to justify content inferences can only be heuristic ones.

The argument that seems to prevail is that the longer the time period during which constraints have in the past been found to be invariant, the less likely they will be expected to change in the future. This heuristic assumption is of course analogous to the one contained in the usual argument that the amount of evidence provided in support of a theory is proportional to the degree to which this theory can be accepted. Although Hume's scepticism fully applies to this situation, to make such heuristic assumptions about the nature of the constraints that are utilized in content inferences is probably the only way that information acquired in the past can be transformed into predictions; that certainty about unobserved parts of an object system can be gained; and that content inference can be justified. This assumption ought to be regarded as a policy in the Peircean sense which has to be discarded as soon as it does not produce valid predictions.

Content inference can take many different forms depending on the nature of the constraints discovered in an object system and ultimately on the type of regularity that has been formulated to account for these constraints. It cannot easily be forced into a simple

syllogism, i. e. into a traditional scheme of logical inference particularly since the content inference need not be single valued which means that the content inferred may not reduce the uncertainty perfectly. Essential to content inference is a representation of the data obtained from suitable recording or filtering procedures, an adequately formulated regularity from which rules of content inference are derived, rules matching data representations with the arguments in the rules of content inference that determine which of the rules are applicable in a given situation, and ultimately the content within the dimension of the problem domain. A diagrammatic presentation of the typical elements of content inference may be presented in Figure 12:

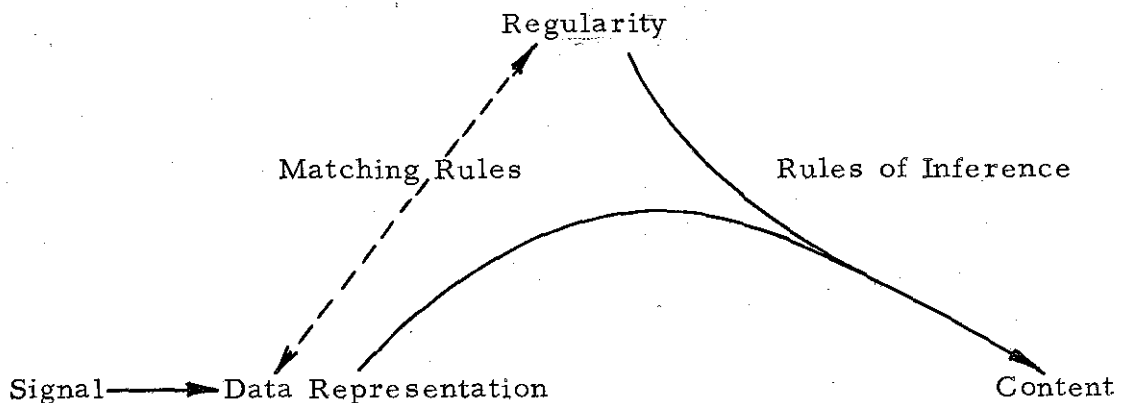


Diagram of the Process of Content Inference

Figure 12

The examples that can be given to illustrate content inferences exhibit structures that are far less complex than those of filtering. This fact is quite understandable in view of the long history of using

derived measurements, i. e. filtering in our sense, in the physical and behavioral sciences and the only recent interest in communication and the analysis of messages in particular. The formal characteristic of content inference has already been implicitly referred to when discussing the empirical problems of formulating relevant regularities. Here we will give only a few more detailed examples that demonstrate the points more clearly.

A more explicit example of content inference, although involving only a binary choice of possible contents, is one of Yules final arguments in working example IV. To recapitulate: in one of his analyses, he eliminated from the texts in question all grammatical structures, frequencies, rank orders, etc. and represented the documents solely by the set N_i of nouns that appeared in the i th work. The problem domain was just one variable, the set $\{Gerson, \grave{a} Kempis\}$ of possible authors. A constraint analysis yielded the set $\{ \langle N_g, Gerson \rangle, \langle N_k, \grave{a} Kempis \rangle \}$ of couples representing the author by his name and his writing vocabulary by N_i . The Imitatio was subjected to the same filtering procedure and became represented by the set N_s of nouns. The rule of matching involved an "association quotient," $-1 \leq Q_{ij} \leq +1$ defined as follows:

$$Q_{ij} = \frac{\#((N_i \cup N_j) - (N_i \cap N_j)) \cdot \#(N_i \cap N_j) - \#(N_i - N_j) \cdot \#(N_j - N_i)}{\#((N_i \cup N_j) - (N_i \cap N_j)) \cdot \#(N_i \cap N_j) + \#(N_i - N_j) \cdot \#(N_j - N_i)}$$

The rule of inference that was derived from the above regularity simply determines the selection of that author the vocabulary of whom resembles most closely that of the unidentified document; i. e. has the highest association quotient. Yule's content inference is diagrammed in Figure 13:

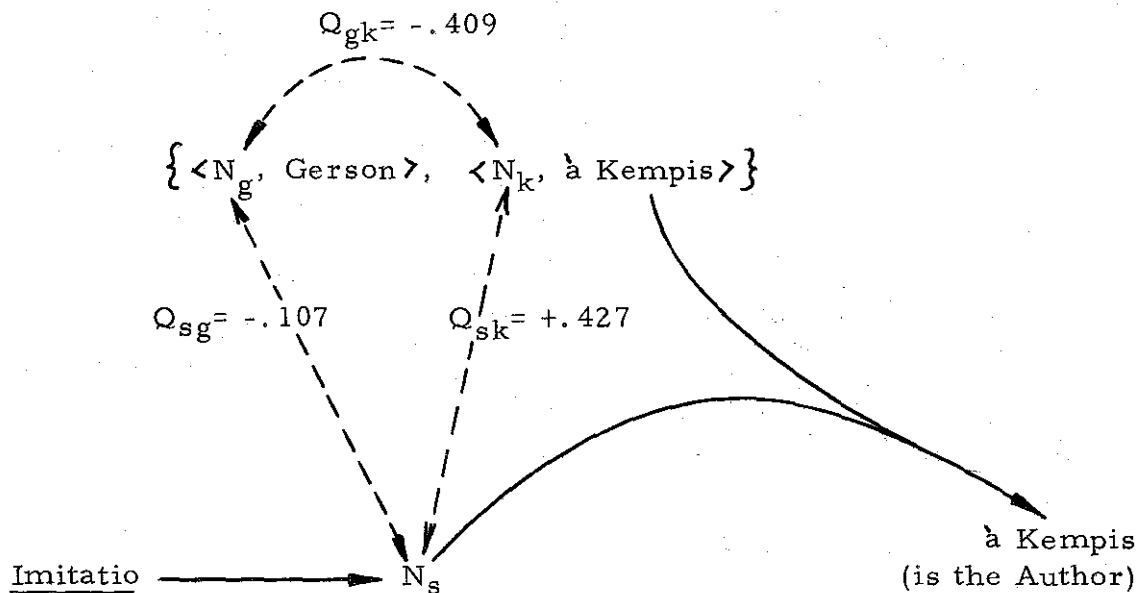


Diagram of Yule's Content Inference

Figure 13

Lasswell's attempt to provide evidence to the courts about propaganda links between U.S. publications and foreign governments, described in working example V, could be formalized similarly to Yule's inference. As we suggested in the section on constraint analysis, the regularity that must have been assumed by Lasswell can be stated as "whenever communication between two parties exists, some transmitted signal or message characteristics are typically invariant."

Assuming certain types of characteristics that are maintained when a foreign government has control over the channel between its nation and a U.S. publication, an inferential rule can be derived as follows: "if measures of certain specified signal characteristics show a suspected publication to exhibit above chance resemblances with information sources of a foreign government in question, then the suspected publication can be inferred to possess a link to that government." It should be mentioned that "chance resemblances" obtain a special non-statistical meaning in this context and is measurable in comparison with a publication which is known not to be under control of that foreign government.

The content inferences that are built into evaluative assertion analysis (151), already referred to on several occasions, are of a different kind. Here inferences are made as to a writer's affective evaluation of a particular attitude object AO_1 from the associative or dissociative bands to other attitude objects AO_2 and common meaning terms cm the affective evaluation of which is already known. The rules of inference are presented in the form of a calculus that derives from Osgood's congruity principle (150). Briefly, the congruity principle states that initially affective-neutral AO_1 's obtain their favorable evaluations as they are associatively linked to favorable AO_2 's and cm 's and dissociatively linked to unfavorably evaluated AO_2 's and cm 's. The rule for inferring the evaluative direction of a particular AO_1 makes use of the algebraic convention that assigns a positive value to the product of two numbers with equal signs and a negative

value to the product of two numbers with unequal signs. Thus, an associative band between AO_1 and AO_2 or cm to which a plus is assigned gives, multiplied by the positive valence of an AO_2 or cm , a positive valence for AO_2 and multiplied by the negative valence of an AO_2 or cm , a negative valence for AO_2 .

Dissociative bands are handled analogously. The intensity of an affective evaluation of an AO_1 is similarly inferred by weighing the intensity of AO_2 's and cm 's with the strength of association or dissociation respectively. Thus, Osgood's congruity principle which absorbed considerable experimental work in psycholinguistics provided definite and formalized rules of content inference from the common meaning terms appearing in a text to a particular attitude object according to the net bands that link them.

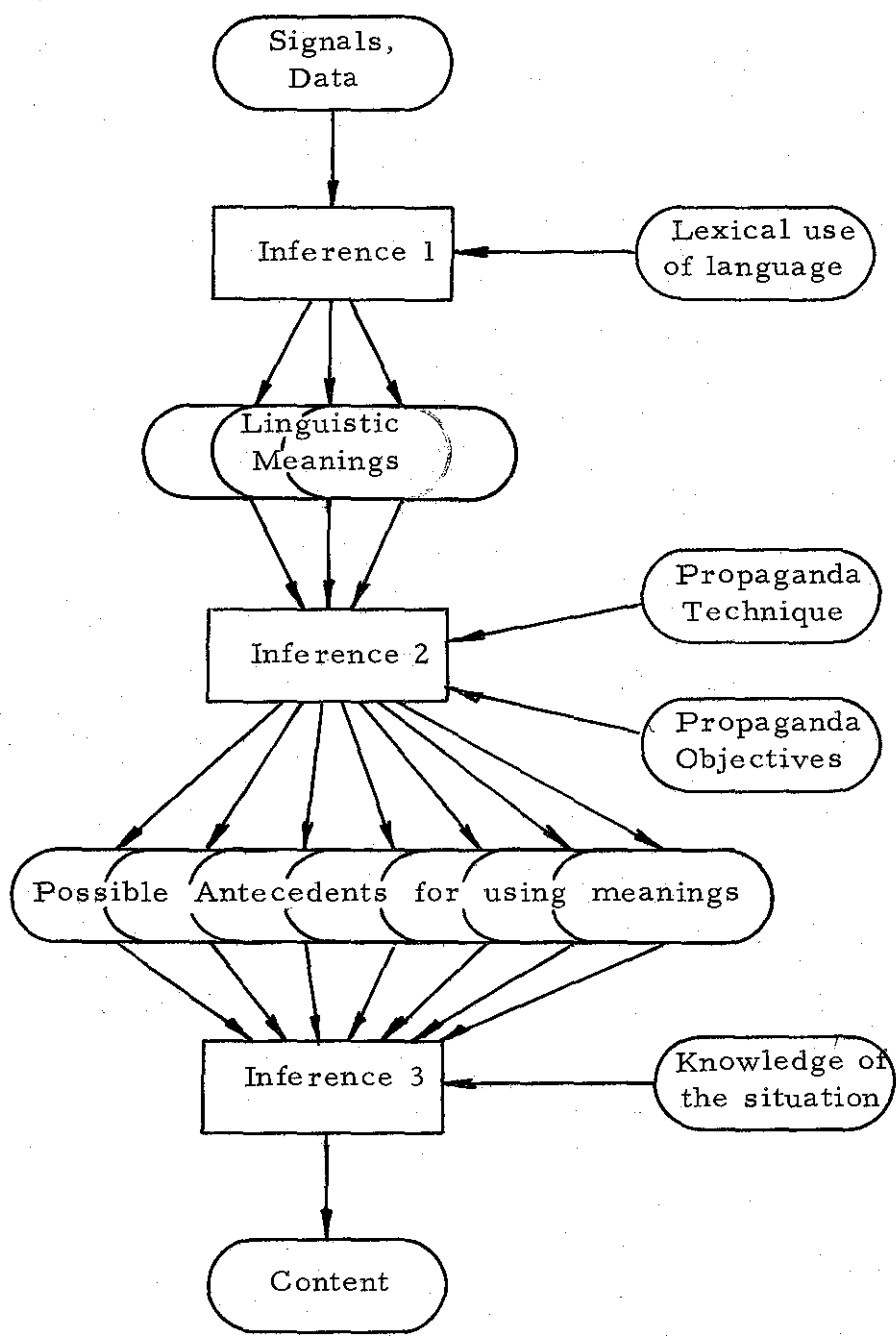
A less formalized but nevertheless important example of content inference has been described in working example VI. The British propaganda analyst had discovered a sudden gap in retaliation propaganda which was followed by a watering down of propaganda commitments on reprisal. His mode of reasoning was based on the following observed regularity: "references to reprisal usually occurred either in propaganda diatribes against Allied air raids or in conjunction with propaganda efforts to solve the poor morale of the German public" (71:148). Put into the terms of a rule of content inference: "if no other more important event overshadows the references to reprisal weapons, their absence allows us to infer an absence of Allied air raids on

Germany and/or an improvement in German morale, and/or interferences with the preparation of the weapon referred to." The analyst knew that no other important event superseded the reprisal talk, that air raids did not cease in intensity, and that the situation was such that German morale had no reason to be improved. Only when these possibilities were successively ruled out, was it possible to infer quite specifically that something had happened to the preparation and scheduling of the retaliation weapon, a fact that could be later confirmed.

George called the methods of drawing inferences from such propaganda messages as the one presented here "indirect" ones for they use the conventional meanings of the propaganda only as a vehicle to get at a speaker's purpose or propaganda goal and finally to the events in the problem domain. Diagrammatically the inferential steps and known regularities of the previous example can be depicted in Figure 14.

By this multiple-step inference which involves consideration of the lexical use of language, the propaganda objectives and techniques, as well as information of situational changes, the propaganda analyst systematically eliminates the possible denotations and antecedents a given propaganda message may have under situations other than the one given. These multiple-step inferences seem to be necessary when object systems possess some intelligence, i. e. disseminate messages according to some objective.

The example illustrates moreover how many inferential possibilities are simply omitted or how results easily become misleading



Example of Inferential Steps for Inferring Content by George's "Indirect Method"

Figure 14

when simple frequency counts of manifest references are made in such situations. Traditional content analysts would be able to only scratch the surface, if not possibly themselves be subject to manipulation by this highly instrumental use of communication.

Mahl had a good point in arguing that if human individuals use their speech instrumentally, and psychological states of interest to the psychodiagnostician are very likely to be suppressed consciously, the speech characteristics not under the direct conscious control of the speaker are more likely to carry the desired information. He thus got around the problem of treating communications instrumentally by relying on direct indicators of an unconscious kind. Yule's authorship identification in IV, Lasswell's detection of propaganda channels in V, Leites' analysis of political distances of members of the politburo to Stalin in VII, etc., all disregard the possible instrumentality of messages. They make use of some content inferential procedures presupposing the assumption of the object system as a basically purposeless one. George seems to present the only large scale effort to make content inferences from partly observable object systems that are considered as having some teleological properties.

Psychological theories of meaning too are of little help in suggesting more definite rules of content inference for the analysis of data derived from a source which is purposive. This is most obviously true for Skinner's conception of meaning as a conditioned constraint on the stimulus response pattern a person can exhibit (181). But Osgood's

theory of meaning which represents the significata of words in a metric "semantic space" having psychologically relevant dimensions (152) does not come closer to the instrumental use of meaning either.

Only very recently algorithms have been studied that describe intelligent behavior although still of a rudimentary type. Most prominent among those approaches is Newell, Shaw, and Simon's Logic Theory Machine. The machine "was devised to learn how it is possible to solve difficult problems such as proving mathematical theorems, discovering scientific laws from data, playing chess, or understanding the meaning of English prose" (141:109). The authors demonstrated that it can be programmed to prove theorems in elementary symbolic logic. In this case, the machine was given the five axioms used in the Principia Mathematica, three rules of inference, and the theorem to be proven. The machine generated sequences of logical expressions, evaluated each step heuristically according to whether the subgoal or goal was approached. It terminated when a sequence of transformations linked axioms with the expression to be proven.

With a little imagination, the procedures that lead to proving a theorem seem to be overtly similar to the reasoning a propaganda analyst employs in coming to a conclusion concerning the existence of reprisal weapons talked about by an opposing power. And yet, a few very important differences should be noted. Firstly, symbolic logic is a formalized system of mathematics. Although the propaganda analyst's reasoning can surely be described as logical in his

own terms, the "logic" of propaganda, of political mobilization or of the manipulation of war-moods - if one can speak of "a logic" at all - is certainly not formalized at this point. Secondly, the "constraints" in the system of symbolic logic are imposed by very few axioms and rules of inference. The constraints a propaganda analyst has to rely on are numerous and typically incomplete. This leaves the analyst uncertain about the adequacy of his representational system and thus leads easily to inconsistencies, indeterminacies, etc. Thirdly, the system of symbolic logic is deductive and not inductive in the sense that axioms and rules of inference provide all information about the permissible states of the system. On the other hand, content inference is inductive. The formulated regularities are assumed to account for the constraints of the object system and in the light of the heuristic assumption of the temporary invariance of those constraints messages obtain specific interpretations. Although the Logic Theory Machine does not provide a mechanism for the type of inferences needed in message analysis, it illustrates a few of the procedural requirements for simulating some kind of intelligent behavior.

A machine program which "understands natural language" at least in the domain of simple kinship relations has been described by Lindsay (120). The motivation for developing such a program stems from various sources. Information retrieval as currently applied to numerous library problems usually processes items of information without considering their meaning in any of the possible senses.

High-speed computers have been employed to scan very long lists for key words, count their frequencies etc. and although abstracts, bibliographies, subject matter identifications have been made in this way, they are anything but those produced by a human being "understanding" the meaning of the text. Machine translation has mainly been approached by devising syntactic rules and extensive dictionaries for converting sentences of one language into the other. Native speakers then have to refine such translations by supplying information which may indeed account for what he "understands" the text to mean. Simply adding to each stored word its idiosyncratic usages or how it is to be understood in each of its possible contexts multiplies the memory space required of a machine and becomes quickly unrealizable.

Lindsay identified the problem of understanding as one of finding ways of storing and using large amounts of detailed knowledge while keeping the amount of memory capacity required within realizable limits. By calling such ways of storing information an "inferential memory" the relevance of his work for content inference is even more suggestive.

The filter of the machine which "understands..." is a syntactic analysis or more specifically, a sentence-parsing program making use of Chomsky's phrase structure grammar (44). The sentences it accepts are those included in Ogden's Basic English, a system of grammar and a vocabulary of about 1700 words. The program constructs a phrase structure diagram for each sentence

with the component words as terminal elements and stores them with their syntactic description. In this way the enormous number of relations that are expressed in the text are reduced to a manageable size and only those of interest are maintained.

Lindsay's subsequent semantic-analysis program does not completely distinguish between constraint analysis and content inference for reasons which will become clear immediately. The first step is to take all nouns appearing in the text and search for all subject-object combinations whose main verb is some form of "to be." Words in such combinations are then marked "equivalent" and their modifiers grouped together.

Next a search is made for the eight words which Basic English provides to discuss kinship relations: "father," "mother," "brother," "sister," "brother-in-law," "sister-in-law," and "married." If any of these relations occurs in the sentence, their modifiers are examined to discover proper names appearing as possessive adjectives or objects of a proposition, as for example "Jane's brother" or "the father of John." The sentences are thus reduced to a set of word triplets containing two proper nouns and a relation word which connects them.

Now family trees are constructed. The computer memory is organized as a list structure in which items in one list can be associated with items in another list. Each list is reserved for one family unit leaving places for the names of "husband," "wife," "offspring," "husbands' parents," "wife's parents." Suppose the triplet "Jane married John" appeared in the sentence, the two names are then

written in the respective places of husband and wife of say, family unit 1. The triplet "Jane's father Bill" would then be stored in the following way: Bill is written in the place of husband in, say, family unit 2 and the Jane's family unit 1 gets the entry "family unit 2" in the place of wife's parents. In this way lists representing family units are used to represent more and more complicated kinship relations as texts are read into the memory.

Lindsay also describes how the order of presentation of the input data has a crucial effect upon the efficiency of memory allocation, even when dealing with simple kinship relations. For example, if the machine is first told that X has offspring A, B, C, and D it must construct an elaborate organization to handle this information, places such as for the spouse of X being left blank. If the machine is then informed that Y has offspring E, F, G, and H, it must construct another such structure, unrelated to the first. Finally it may learn that A and H are brothers. This permits (neglecting multiple marriages) a collapsing of the two structures into a single organization representing the implied information much more compactly. Such collapsing of several list structures into a simple scheme could - permitting an analogy to subjective experience - very well account for the so-called "aha-experience."

The contribution of such inferential memories to message analysis is quite obvious although its real significance may not appear when exemplified only by storing kinship relations. But, the inference of X being Y's spouse from knowing the regularities of kinship and "reading" that A and H are brothers is at least as simple as the

propagandist's reasoning concerning inferences as to the planned use of reprisal weapons.

Suppose the explicit structure of the memory, i. e. the overall regularity of the object system, is adequate for representing relevant implications implicitly, a message analyst may wish to build up an inferential memory during the history of his dealing with an object system as the propaganda analyst did concerning Goebbels' propaganda habits, the behavior of a decision making-elite and of large masses of people under stress. Given a further piece of information, a signal, (either linking several structures in an hitherto unprecedented way or simply replicating an event while perhaps other structures have been modified,) a problem-solving program of the type Newell, Shaw and Simon used for their Logic Theory Machine could now be employed to search for the implications a signal has for the problem domain or to trace a path through the memory. If enough inferential information is available an automatic message analysis can be accomplished that is at least in the domain of intelligent object systems and infinitely more promising than traditional content analyses.

Lindsay realizes of course the extreme simplicity of kinship relations which were chosen only to demonstrate the technical possibility of constructing memories for storing definite implications implicitly since the required memory capacity increases too rapidly when storage is explicit. But the demonstration quite clearly supports his main point that machines exhibiting some human-like intelligence in

handling natural language presuppose some memory with inferential capabilities because otherwise meaning and understanding - whatever they may be - cannot be adequately processed.

Concluding this section we wish to contrast inference with filtering in message analysis in the narrower sense. Since both procedures are derived from discovered constraints or from formulated regularities they are apt to be easily confused. Filtering has been characterized as a mapping, as a mathematical function, or as a computational procedure reducing the complexity of data and representing it in the terms in which relevant regularities are formulated. Content inference on the other hand neither needs to be nor usually is a mapping, i. e., it is not required to be everywhere defined and single valued. Filtering reflects the way regularities of an object system are formulated. More specifically, it is either identical with or a projection of the mapping that leads to the discovery of a relevant constraint. A regularity could also be said to be a partial model of the object system. The rules of content inference that derive from an adequately formulated regularity then become equivalent to the operating rules in the object system's model. Hence, content inference can always be regarded as interpreting a given message by applying relevant operating rules of the object system on suitably represented data yielding specific contents within a problem domain. Filtering remains within the data to be analyzed. Content inference goes beyond their formal representation requiring the assumption that the object system's constraint, on the basis of

which rules of content inference were formulated, remain invariant.

As we have emphasized in Chapter Four the content so inferred subsumes the traditional concept of meaning, whether it be connotative or denotative. It may take the form of causes or effects, of antecedent conditions of data or its consequences, of logical implications, or of imputed goals. The working examples identified content in our sense with deciphered messages, predicted political actions, inferred social distances or communication structures - in any case with events other than those manifest in the physical characteristics of a given signal, data, text or representations thereof. A classification of types of inferences can lead to a set of distinct models of content inference. The task of formalizing such models goes beyond the scope of this work and must be postponed for a later paper.

Validation

There really can be no justification for any message analysis unless there are sufficient reasons to believe that its outcome has some factuality; unless some evidence can be provided to substantiate its results; unless the content ultimately inferred has an acceptable degree of validity. The goal of "optimizing valid content within a problem domain" has been suggested as a definitional requirement of message analysis. Optimizing valid content is meant to be synonymous with minimizing the uncertainty within a problem domain where the source of this uncertainty may stem from incomplete knowledge within that domain or from the lack of confidence concerning

whether the content inferences made will stand empirical tests. Validation in message analysis then is the process by means of which the procedures of message analysis in the narrower sense are jointly evaluated with respect to their ability to yield reliable information about an object system's unobserved components which are of declared interest to the analyst.

Validation has obtained its highest degree of formalization in the statistics of psychological testing. This methodology attributes validity to a measuring instrument when referring to the degree to which this instrument measures what it purports to measure. Thus an intelligence test may be said to be valid to the extent the scores obtained are indicative of the subject's intelligence. The example is not as simple as it sounds for intelligence is not directly observable. Thus, the validity of a measuring instrument is usually assessed by comparing its scores with those obtained from another measuring instrument independently of the former, the validity of which is already established. A suitable example is the General Inquirer measure, presumed to be indicative of international tension, which have been shown to correlate with the Dow-Jones average of Industrial Securities (84). The extent to which these two measures correlate expresses the degree to which the validity established for whatever the Dow-Jones Average is indicative of can be transferred to the General Inquirer measure. It is evident that the validity of a measuring instrument can never be higher than the validity of those

instruments by means of which it is validated.

In traditional content analysis, validation is an extremely difficult problem. Not only is the meaning of "meaning" hardly understood, as we have seen in Chapter Two, the term "content" is not always explicated either. Thus, it is not altogether clear against which criteria results of content analysis are supposed to be validated.

We cited Janis' suggestion that "semantical content analysis" be identified with a classification of the "signifying responses" to given "sign-vehicles." While this does not provide an immediate basis for validation, Janis suggests the measurement of a related characteristic called "productivity" which would lead to some kind of indirect validation of content analytic results.

A content-analysis procedure is productive insofar as the results it yields are found to be correlated with other variables. Whenever there is a substantial correlation between two variables, one variable may be regarded as an indicator of the other, because it is possible to predict, within known limits of error, the value of the second variable from the first. We may say, then, that a technique is productive to the extent that the results it provides serve as indicators of other variables. Thus, a content-analysis technique would be highly productive if its results served as indicators of such variables as, (a) intentions of the communicator to produce favorable attitudes toward a foreign country, (b) periods of severe frustration for the political organization within which the communicators are affiliated, (c) 'unconscious' guilt feelings on the part of the speaker, (d) changes in attitudes toward democratic practices on the part of an audience, and (e) feelings of insecurity about the future on the part of the audience, etc. (92:65-66).

Janis goes on to say that although the validity of semantical content analysis cannot be established directly, it may be inferred

from the measurable productivity on the assumption that "relationships among various observable aspects of the communicative process are mediated by signification responses. Different signification responses tend to have different behavioral causes and effects; similar signification responses tend to have similar causes and effects" (92:70). The conclusion drawn from such considerations is that "every content analysis study, therefore, is required to provide some evidence of validity. This means that, for the present, research projects which intend to provide purely descriptive information about content - without testing any relationships exhibited by the content data should be avoided" (92:78). This advice, however, has been rarely taken.

It is not difficult to see that correlations between hypothetical signification responses and other variables which according to Janis are necessary to infer the validity of a content analysis, are indicative of a constraint similar to the one we presupposed for content inferences. The correlational measure of productivity purporting to establish relations between these variables is nothing but a measure of the severity of a linear constraint. In fact Janis supports our view partially, via the discussion of the empirical problem of validating the analytical procedure that the only methodologically acceptable way to analyze data as messages is one that includes content inferences of some sort, although he does not formally state such requirement.

In the light of Janis' discussion of the validity problem in

content analysis we should like to make an additional remark. We can regard such content analysis results as being only arbitrary hypothetical constructs. Since descriptions of the conventional meanings of symbolic data, their semantic representation, etc., cannot be validated directly, they cannot in themselves lead to predictions, have no theoretical or practical consequences. Such hypothetical constructs for significata are arbitrary in the sense that almost always several ways of description can be found as Goodenough has amply demonstrated with his semantic analysis of kinship terminology (78). The arbitrariness of these constructs becomes restricted, however, if taken in conjunction with specific inferences that are claimed to be validly drawn from them. In this sense the results of message analysis represent aspects of the unobserved components of an object system and are subject to direct validation while the results of content analysis remain hypothetical and are indirectly validatable only in conjunction with an additional hypothetical construct that relates signification to other measurable aspects of the object system.

Numerous schemes for differentiating types of validation have been suggested by various authors. Janis mentioned "direct" and "indirect" validation. The American Psychological Association concerned with the clinical use of tests identifies and defines "content validity," "predictive validity," "concurrent validity," and "construct validity" (197). Content validity is solely based on the informed judgement of the investigator, predictive and concurrent validity are

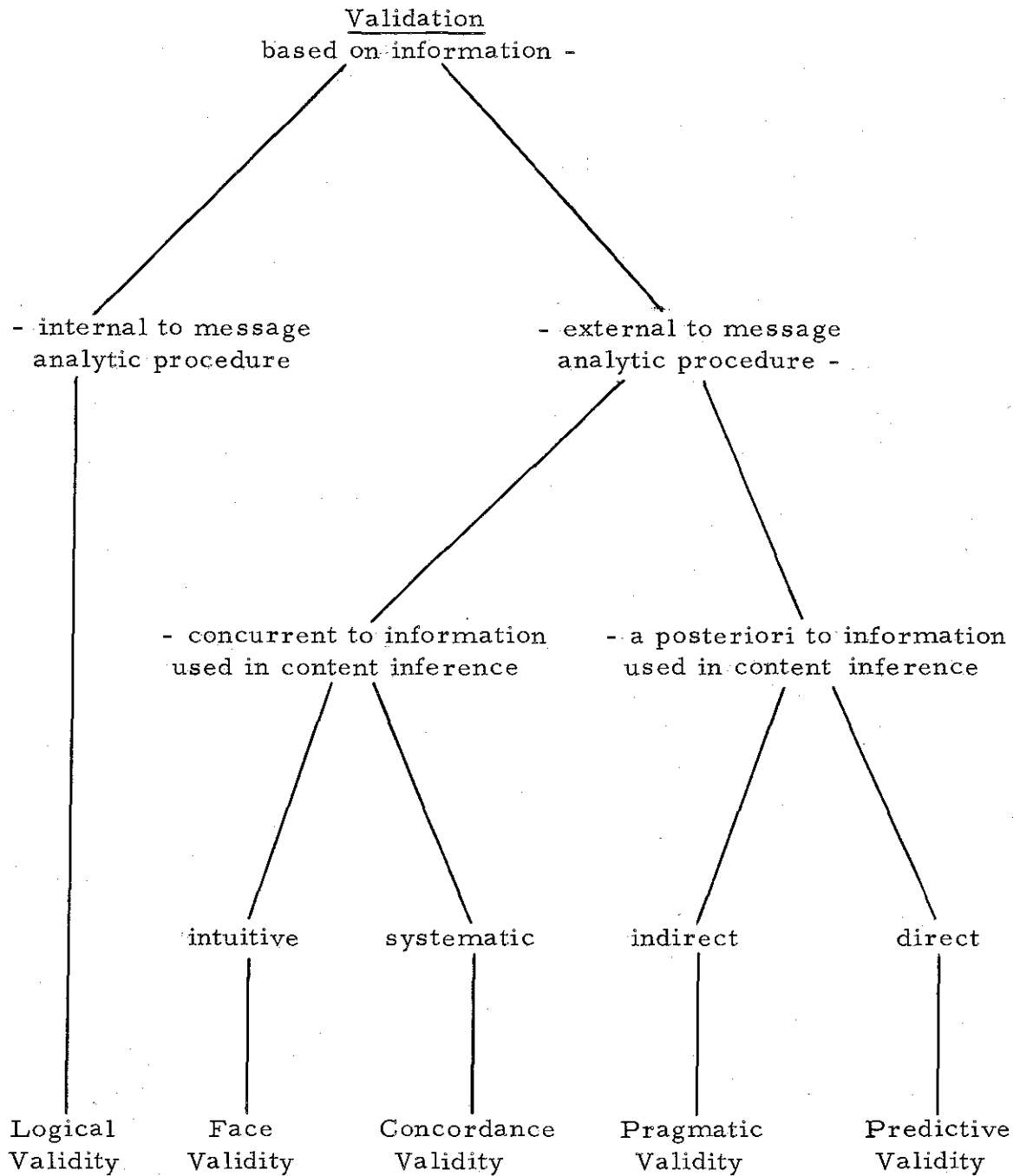
both established by some correlation either between simultaneously occurring variables or between variables distinguished along a time scale, and construct validity bestows validity not only upon the outcome of the test but also upon the theory underlying the construction of the test. Selltitz, Jahoda, Deutsch and Cook (1973:154-166) felt that there were only two basic types of validity, "pragmatic validity" as an answer to such question as "does this measuring instrument work?" and "construct validity" characterized as above. They also mention "face validity" as a self-evident measure.

In message analysis problems of validation are not always identical with those of psychological testing. For one thing, the stimulus conditions that are typically standardized in test situations are rarely accessible in message analysis; or, psychological tests can often be regarded as a more economical shortcut to the assessment of personality characteristics such as through aptitude tests for particular jobs in order to ensure efficient labor. In message analysis, the components of the object system that its results claim to represent are often impossible to observe. This necessitates modes of validation which are quite different from those used in psychological tests. Thirdly, psychological tests make use of relatively generalizable psychological constraints such as manifestations of intelligence, aspiration levels, psychopathologies, etc., while message analysis is more often based on relatively situation specific regularities that are often hardly generalizable in the same way the empirical domain

of psychological testing seems to permit. Finally, message analysis is often bound to operate in situations that are less controlled than those of psychological testing but nevertheless requires methodological examination and evaluation.

In spite of the obvious differences validation in message analysis can take any of the above mentioned forms. Whether only the product of a content inference is validated against some external criterion (pragmatic validity in Selltitz et al's sense) or whether external criteria are chosen to validate the theory underlying the analytic procedure (construct validity) in all cases some evidence other than the one utilized for processing the data has to be made available. We therefore wish to leave the question open as to whether the message analyst gathers additional data to confirm his inferences or whether he employs such information to validate the theoretical constructs that went into the design of the analysis. Hence, we suggest a differentiation of modes of validation according to the nature of information utilized for such ends. Without insisting too strongly on the terminal names for types of validation, the diagram in Figure 15 intends to depict the suggested distinctions and to outline the subsequent discussion.

The left-to-right order in which the five types of validation are presented in the above diagram suggests an order of increasing certainty that could be claimed on the basis of the kind of information utilized. Although the certainty each type of validation can render is also limited by the amount of validating evidence available, logical



Types of Validation

Figure 15

validation tends to provide the least certainty concerning the content inferred, predictive validation the most. The message analyst of course is not free to choose at will among the types of validation. His choice is dependent on the kind of information that the message analytic situation makes available to him.

Logical Validity

If no information is made available other than the one already utilized in the message analytical process, the justification of the content inferred rests solely on the logical conclusiveness of the method employed and on the certainty associated with the assumption that the relevant constraint still holds for the object system under consideration. True, this situation seems most uncertain but it must be considered the most frequent situation in which a message analyst finds himself. Indeed, if he optimizes the content in the specified problem domain, he should be expected to have utilized all available resources leaving nothing for additional validation. Yet, the redundancy of available information and the stability of the constraint observed during the history of dealing with the respective object system, as well as the conclusiveness of the procedures, certainly does give weight to the content inferred.

For example, historians have traditionally dealt with inferences from documents to events although no extensive methodology has emerged from this pursuit. Only recently Dibble (51) devoted a paper to the explication of some general syllogisms that historians

tend to use implicitly to evaluate the reliability of a document whether it be a testimony, a product of social bookkeeping, or considered as correlates or direct indicators of events. Such attempts toward a methodology for content inferences in history are not very highly developed. By referring to the correct use of such syllogisms historians attempt to provide logical validity to the results obtained.

Another case in point has been described in working example V where Lasswell tried to substantiate the suspicion that certain publishing agencies were controlled by a foreign government. The validity of his inferences rested solely on his definition of propaganda; the assumptions that went into the identification of "links to a foreign government" and specified characteristics in texts; and the reliability with which the statistical analysis was executed. Reporting on such matters justifies the result in the light of the conclusiveness of the investigative technique. It provides a logical validation.

Similar justifications seem to have been required from the war propaganda analyst in working example VI. George reported that in writing their weekly reports the FCC analysts included their mode of reasoning in support of the inferences made. Reporting these explicit reasonings was most probably intended to give weight to the results of the analysis by exhibiting their logical conclusiveness. No information external to the message analytic procedure was provided. Only its internal structure could be exhibited to those making use of the inferences. (This apparent requirement incidentally

enabled George to reconstruct many of the models of the situation propaganda analysts made explicit use of).

Face Validity

Most content analyses, while required to be explicit concerning the procedures employed, do not attempt to provide explicit external information to validate their results. Such results are accepted or rejected according to whether they seem plausible or not to the analyst. Variousy referred to as plausibility or content validity, this mode of validation involves - as we have mentioned - the intuitive judgement of an informed investigator. This is the most critical type of validation since the plausibility of an analytic result is not communicable; it can only be intuitively evident to the one who assesses the validity of the result and is based on implicit competencies.

The most general example of this mode of validation is the use of relative frequencies of references appearing in newspapers, for example, to measure public attention to the respective referents. This identification has been accepted for over 50 years without recruiting empirical evidence in its favor. Although it is not difficult to find sufficiently many examples where identifications of this kind seem invalid, the plausibility of such measures seems so strong to content analysts that they have never seriously been questioned.

Another example for face validity is Gerbner's definition of his "news value index" (76:II-D-4) the values of which are presumed to measure the "newsworthiness" of a topic to a mass media

institution. Gerbner accepts this measure on the basis that it seems to be intuitively plausible without providing further evidence. Similarly Berelson's equation of the disproportionate representation of U. S. minorities in fictional stories with "constant deprivation" is - as plausible as it may appear to him - simply accepted "on the face of it" without further justification. A somewhat mixed example is provided by the General Inquirer measures obtained from documents pertaining to international issues and plausibly interpreted by Holsti, Brody and North (84) as measuring international tension. The example states an attempt at predictive validation although the idea of such a measure does not seem to have been conditioned by such an attempt at validation.

That face validity cannot be communicated and rests solely on the intuition of the individual judging the results of a message analysis has already been mentioned. Another critical characteristic of face validity and concordance validity as well, lies in the fact that it involves some knowledge of the probable content prior to the date the analytical results are assessed. Thus, results may be rejected if they do not seem plausible or do not confirm the prior knowledge held by the investigator. Such a validation can easily lead to setting up a procedure in support of already established beliefs about incompletely observable systems, often without the investigator becoming aware about the circularity of the validating process involved. The history of science is full of examples where face validity failed to accept analytical results that turned out to be acceptable at a later time.

Concordance Validity

Concordance and face validity have in common the characteristic that information utilized to validate the results of a message analysis is available to the analyst concurrently with the information used to accomplish the intended content inferences. While face validity refers to an informed judgement of the investigator, we wish to reserve the term "concordance validity" for a systematic and explicit attempt to validate inferences on the basis of their coherence, consistency or at least lack of contradiction with other information about the partly observed object system. A more thorough analysis of the process involved may render both modes of validation the same with the exception that the former is characterized by intuitive judgements, while the latter by more explicit formal rigor. Hence, the evidence of concordance validity is communicable while that of face validity is not. Although the borderline between these two types may not always be easily drawn, the two extremes should be distinguished.

All analyses of messages from object systems having existed at some point in the past history are absolutely bound to be evaluated at best on the basis of concordance validity. Consider Yule's statistical analysis of literature describe in working example I. There is no hope of obtaining direct evidence from the object system studied; the authors of the documents cannot be interviewed. Inferences as to the authorship of the unsigned document can only be justified on the basis that they are not contradictory to the information that had been accumulated

about the authors, their works, and some generalizations concerning the statistical properties of their writing styles.

The use of the concordance criterion as a basis for validating message analyses can be illustrated by almost any content inference made from historical documents. Working example I, the decipherment of the hitherto unreadable old Persian script, may suffice. In the cause of this analysis none of the numerous hypotheses that had emerged concerning the semantic interpretation of the cuneiform characters, their grammar, or their phonetic values were rendered acceptable until some consistency with known historical events of the old Persian Empire could be demonstrated. It was only after a century of trying and testing that some of the inferences suggested by scholars emerged as not only being in conformity with known historical facts but moreover explained several events in a coherent way. This refers particularly to the medieval Persian use of titles which provided the key for the names of consecutive kings whose periods of reign were consistent with the use of the three distinct writing systems, etc. So content inferences from documents were systematically validated by testing their concordance with the transmitted history of the culture until all contradictions were eliminated.

Concordance validity as a mode of evaluating content inferences does not of course lead to absolute certainty about inferences. Householder (85) has investigated some of the peculiarities of the "semantic mapping" as he calls it. He could easily demonstrate

that given a syntactic description of a text, the words of which are some coded version of English, there are almost always several distinct ways of interpreting the text semantically, i. e. consistent with the semantics of the English language, making perfect sense to a native English speaker. The number of possible inferences that can be drawn from a given text without violating known language universals decreases as the length of a text increases but no theorem is known concerning the minimal length of a text that will receive an unambiguous semantic interpretation given the semantic structure of a language (85:183).

Recently attention has been focussed on the problem of grammatical ambiguity where the situation is similar to the above, given the knowledge of a grammar. The problem becomes particularly acute in a very different case of grammatical ambiguity when an attempt is made to construct a grammar for an unknown language from given texts of "insufficient" length which support a number of hypothesized grammars. Structural ambiguities may easily lead to semantic ambiguities, (99) i. e. to several content inferences that are equivalent under the criterion of concordance with the information available. Thus it is not implausible that the old Persian script could have been interpreted in an entirely different way without being inconsistent with what was then known about Persia. It is equally possible that the information in conjunction with which the inferences were evaluated had been distorted during the process of transmission through history and had therefore affected the deciphering process, etc. Although concordance

validity as a criterion for evaluating accomplished content inferences has certain recognizable pitfalls, it is certainly the best method that can be employed if the information used for validation is concurrent to the information used in the inference.

Pragmatic Validity

If the information used for validating message analysis is a posteriori to the information which went into the content inference, the validity may be established indirectly on the basis of information about the consequences that derive from it. This type of validation will be called pragmatic. It should not be confused with the same term used much more broadly by Selltitz et. al. (173:157). Pragmatic validity is to be understood as being only indirectly assessed, quite similar to the way Janis wanted to have the validity of content analytic results inferred from what he called productivity.

In many situations the problem domain of the message analyst is set up in such a way that the inferred content implies sequences of decisions, leading ultimately to specific actions directed toward the unobserved part of the object system having observable consequences. Such a situation existed for the cryptographer in III. His decipherment, although having at once a considerable degree of face validity and concordance validity could not gain further certainty until its consequences were put to test. If the cryptographer's interpretation of the cipher was correct, then certain military operations would have to lead to certain predictable results. Similar was the situation for

the war-propaganda analyst in VI. Here the problem domain was specifically delineated to satisfy the informational needs of the policy makers with the primary objective of recommending effective military strategies. Much of the case studies that George (71:125-250) describes were in fact concerned with only pragmatically confirmable inferences such as about anticipations concerning the success of planned military operations; elite expectations concerning the viability of the Axis or concerning Allied actions and possible preventive measures, perceptions concerning morale and public confidence in leaders. Unfortunately the practical consequences that may have been derived from such propaganda analytic results were not reported in this work. That the mass communications of Allies, opponents, and neutrals were monitored by all major powers during World War II and intensively analyzed by quite elaborate and specialized organizations suggests at least a considerable amount of pragmatic validity associated with their results.

The psychodiagnostic attempts in X to adapt message analytic procedures for therapeutic ends may serve as a third illustration for the pragmatic validation of content inferences. As mentioned before the psychodiagnostic inferences which are hoped to be obtainable from analyzing a patient's speech do not generally represent the person's internal states, unobservable as they are, but psychotherapeutic constructs that have been evolved in the context of the patients' behavior toward specific treatments. Here message analytic products imply recommendations of possible causes of treatments which will lead

to desirable and accessible results provided that the analysis is valid. Hence, the validation of message analyses in the domain of psychodiagnosis is dominantly a pragmatic one.

The nature of pragmatic validation is such that inferences can only be rendered invalid but can never be positively judged as being valid inferences, i. e. if content inferences do not lead to the consequences implied by it, the message analysis must be rendered invalid. While if the implied actions lead to the expected observations, these consequences may have been due to causes other than those induced by the action. Hence message analysis can be said to become pragmatically validated only insofar as no information becomes available according to which the content inferences would have to be rendered invalid.

Predictive Validity

The validation of message analysis may be based on information pertaining directly to the problem domain and received a posteriori to the analysis. Such validation is called predictive validation and is differentiated from pragmatic validation by the absence of any need for actively interfering with the behavior of the object system to produce the validating evidence. Predictive validity in our sense includes APA's concurrent validity. Assessing the predictive validity of a message analysis requires establishing agreement of the content inferred with a posteriori information obtained within the problem domain. This case of validation which is formally the most simple

was taken up in chapter four in order to define the amount of valid information conveyed by a signal, the evidence for "valid information" having been given as the "validating signal" first introduced in Chapter Three. The assessment of predictive validity by an external observer of the message analytic situation had been shown to be a prerequisite for determining whether some procedure satisfies the goal of message analysis.

The simplest example for a predictive validation has been described in working example IX where the task was adopted to develop a mechanical procedure for predicting whether or not a set of letters had been written by persons intending to commit suicide. After relevant constraints had been formulated and found to distinguish between such letters, the sources of which were known to the researchers, the predictive validity of the analytic procedure was tested. To this end another set of letters of unknown identity was subjected to message analysis. Only after the predictions were made was the identity of the writers revealed to the research team. That the psychological state of the writer had been inferred correctly for seventeen out of eighteen pairs of notes was used as an argument for the predictive validity of the message analytic procedure.

After World War II, the validity of content inferences from war propaganda was assessed and the performance of the propaganda analysis operation of the Federal Communications Commission evaluated. This could be accomplished by matching a large sample of inferences against relevant information contained in official German

war records, diaries, memoirs, captured documents, interrogation reports, etc. Since most of the predictions concerned issues reflected in domestic propaganda which was subject to instructions of the Ministry of Propaganda, Goebbel's diary proved to be the most significant source of providing validating information. For example, a prediction concerning anticipations of an opponent's actions:

FCC analyst:

Hence, it may be deduced that Berlin is convinced either that there will be no early invasion attempt along the Atlantic, or that any such attempt will be repelled (CEA #14, April 16, 1943, p. B-7).

Goebbels:

In the West only diversionary maneuvers will in all likelihood take place, assuming that the secret reports of our agents are correct. Personally I consider this plausible. I don't believe that the English and the Americans will attempt to break in on us in the West as they know only too well that they will bleed to death there (Goebbels Diary, April 11, 1943, pp. 324-325) (71:196-197).

And an example of an inference concerning changes in military operations:

FCC analyst:

Apparently to prepare for a (German) retreat from the Kuban bridgehead, there is detailed and comparatively large-volume reporting on the fighting in that sector. There is some reporting of (German) successes, especially in losses inflicted (on the Russians) but there is clear avoidance of any indications that the Germans intend to hold there indefinitely. Nor do the (German) propagandists...any longer inflate the importance of the bridgehead as a 'potential springboard'...as they formerly did in the apparent effort to get the Russians to divert as much as possible of their strength to that sector (CEA #36, September 16, 1943, p. C-1).

Order from Hitler to the Army H. Q. involved:

In order to free forces for other tasks, I have decided to evacuate the Kuban bridgehead and to withdraw the 17th Army across the Kerch Strait to the Crimea (U. S. Army, A. G. O., Departmental Records Branch, T. A. G. O., . . . p. 89) (71:240).

As illustrated by the comparisons cited, George matched each inference in the sample with the validating information now available and found about 80% of the FCC inferences to have been in fact accurate. As already noted, he found also that the accuracy increased as the analysts accumulated more and more information about the object system. Although the situation did not permit the application of statistical techniques for assessing the predictive validity, the unusually high percentage of accurate predictions could not have been due to lucky guesses and were in fact not solely the result of gifted intuition. Thus a considerable predictive validity could be associated with the inferential methods used.

Summary

An attempt has been made in this chapter to outline the macro-structure of message analytic procedures. An overview is presented diagrammatically in Figure 9. This figure also depicts the differentiation of message analysis in the narrower sense which is basically concerned with making specific inferences as elaborated in Chapter Four and message analysis in the wider sense which includes certain procedures that must precede such inferences. The most distinguishing procedure of message analysis in the narrower sense is content

inference. Constraint analysis provides the informational foundation of content inference and is hence a prerequisite of message analysis in the narrower sense. Recording and filtering may lead either to content inferences or to constraint analyses and may therefore serve different ends with profound empirical implications that would justify a nominal differentiation. Validation succeeds message analysis in the narrower sense. It evaluates the antecedent analytical procedures as a whole. A brief comparison of the goals, major problems and evaluative criteria of these five component procedures of message analysis is presented in tabular form in Figure 16.

	Goal	Major Problem	Evaluative Criteria
Recording	Representations of data, adequate for analysis	Raw data not acceptable to explicit processes by being non-formalized or in unsuitable notational terms	Reliability of recording, formalized character of notational scheme, maintenance of information relevant with respect to subsequent processes
Filtering	Transformed representation of data amenable for content inference or discovery of constraints	Quantity and complexity of data exceed limits of computability and/or contain too much irrelevant information	Maintenance of information in data relevant to available regularities and given problem domain Accuracy of executing the formal operations
Constraint Analysis	Formulation of regularities with inferential capabilities	Detection and formally accounting for suitable constraint among large numbers of variables	Severity of constraint having inferential qualities, adequacy of formalization
Content Inference	Selections of contents in unobserved problem domain	Transferability of regularities to present situation and their inferential use	Validity
Validation	Assessment of the message analysis procedure in terms of the quality of its results	Application of information not already consumed by message analysis procedure	-

Summary of Problems and Procedures

Figure 16

CHAPTER SEVEN

SOME FURTHER INFORMATION MEASURES

The previous chapter discussed some empirical problems of message analysis. These problems are far from being solved. The analytical procedures described therein can be considered as no more than a bare outline of what is typically required when scientific analysts attempt to treat available observational data as messages about unobserved components of the system of their attention. At several points in the discussion intuitive notions of information were used that had not been explicated in Chapter Five. In this chapter we wish to formally define some of those notions that were introduced in Chapter Six merely as a suggestion.

In the first section of this chapter a general measure of the severity of a constraint is developed which is extended in the subsequent section to a measure of the amount of inferential information that a given relation contains. Section three is devoted to how such measures may be utilized for the systematic analysis of relevant constraints. The fourth section elaborates on the notion of content and content inference which leads in the sixth section to a measure of the amount of information carried by a message, i. e., to a measure that is concerned with the content of a message as well as with the signal carrying it. The fifth section shows how some of the information measures are applicable for evaluating the adequacy of filtering procedures in message analysis. The chapter is finally concluded with a summary of the

more significant information measures developed so far and an example involving a dynamic system.

It should be emphasized that the theoretical and methodological problems posed in the previous outline of the empirical procedures cannot be solved on the basis of an information calculus alone. But it seems to be of interest, or at least challenging, to make an attempt to see how far such information measures are capable of clarifying some of the critical issues of this mode of inquiry.

A Measure of the Severity of a Constraint

Whenever an object system is not free to assume all of its possible states, cannot follow all the trajectories that are conceivable, or is restricted in exhausting its full combinatorial possibilities, then we say a constraint is present. We argued in Chapter Six that in order to discover a constraint a measure of its severity is needed. Such a measure is moreover indicative of the possibility of formulating a relation, a regularity, or any form of representation that can be considered to account for that constraint. Based on the idea of Fisher (63), we also argued that the measure of the severity of a constraint can under certain conditions be taken as a measure of the amount of information that is supplied when such a constraint becomes known or recognized.

As has been mentioned in the previous chapter, starting from Wiener's idea of identifying a relation R^* with the set R of many-tuples in the product set Θ^Z that satisfies that relation, Ashby (16)

defined a constraint simply and most straight forwardly as the set:

$$\Theta^Z = R \quad \text{whereby} \quad R \subset \Theta^Z. \quad /35/$$

In conjunction with our information calculus we can most naturally define the severity of such a constraint as the quantity:

$$\log \# \Theta^Z - \log \# R. \quad /36/$$

This quantity clearly satisfies the intuitive requirement on a measure of the severity of a constraint to which Ashby most probably refers when stating "...when $\Theta^Z = R$ the constraint is zero; as R shrinks, so does the constraint become more intense" (16:9) (original symbols replaced). /36/ gives this notion at once a definite quantitative form. With $\log \# \Theta^Z$ as a measure of the maximum range of freedom and $\log \# R$ as a measure of the restricted range, the expression in /36/ proves to be a particular interpretation of the general form of measures of the severity of a constraint referred to in Chapter Six.

The left part of the expression /36/ is clearly recognizable as U^Z according to the definition /22/ in Chapter Five. The right part of the expression may be defined for any subset G of Z , leaving Z as a special case, as:

$$U_R^G = \log \# \text{co}^G R. \quad /37/$$

Thus the more general form of the measure of the severity of a constraint expressed in /36/ may be defined as:

$$KI_R^G = U^G - U_R^G = \log \frac{\# \text{co}^G \Theta}{\# \text{co}^G R} \quad /38/$$

whereby R may be any subset of any subspace of Θ^Z and $\text{co}^G R$ is consequently contained in the arbitrarily chosen set of dimensions G . Capital letters as subscripts will from now on be reserved for subsets of a state space which satisfy a relation. The superscripts continue to denote the dimensions of that subspace to which the measures refer.

/38/ presents the measure of the severity of a constraint again as a difference of two uncertainties, the uncertainty before and after a constraint has been induced or the uncertainty before and after a relation R has become known. The quantity thus qualifies as a measure of information analogously to those explicated in Chapter Five. Yet there is a fundamental difference between the amount of signal information defined in /24/ and the quantity defined in /38/. The former is a measure of the amount of information carried by a single signal, the latter is a measure of the amount of information conveyed by the structure of the object system as far as it is manifest in the distribution of possible signals it emits or states it occupies.

Note that while the unconstrained uncertainties of distinct subspaces are additive, the quantity of information introduced by a relation into one subspace and the quantity introduced by the same relation into another subspace are additive only under very special conditions and reflect an important property of the relation which induces the constraint.

Let G and H be two arbitrary sets of dimensions, the deviation d from the case of additivity be:

$$\begin{aligned}
 d &= K_I^{GUH}_R - K_I^{G-H}_R - K_I^H_R \\
 &= U^{GUH}_R - U^{GUH}_R - U^{G-H} + U^{G-H}_R - U^H + U^H_R \\
 &= U^{G-H}_R + U^H_R - U^{GUH}_R \\
 &= \log\#\text{co}^{G-H}_R + \log\#\text{co}^H_R - \log\#\text{co}^{GUH}_R \\
 &= \log\#(\text{co}^{G-H}_R \times \text{co}^H_R) - \log\#\text{co}^{GUH}_R
 \end{aligned}$$

Hence, additivity exists only if co^{GUH}_R is a product of the two cojections of R onto $G-H$ and H respectively. Since the deviation d can only be equal to or larger than zero:

$$K_I^{GUH}_R \geq K_I^{G-H}_R + K_I^H_R \quad /39/$$

The condition of non-additivity gives rise to an important information measure which will be the subject of the next section.

A Measure of the Amount of Inferential Information

We argued in Chapter Six that a constraint analysis has to make use of measures of that aspect of the severity of a constraint that is significant for the analytical problem at hand, in our case, for making content inferences in the context of a specialized message analytic situation. Available data may exhibit constraints that are irrelevant

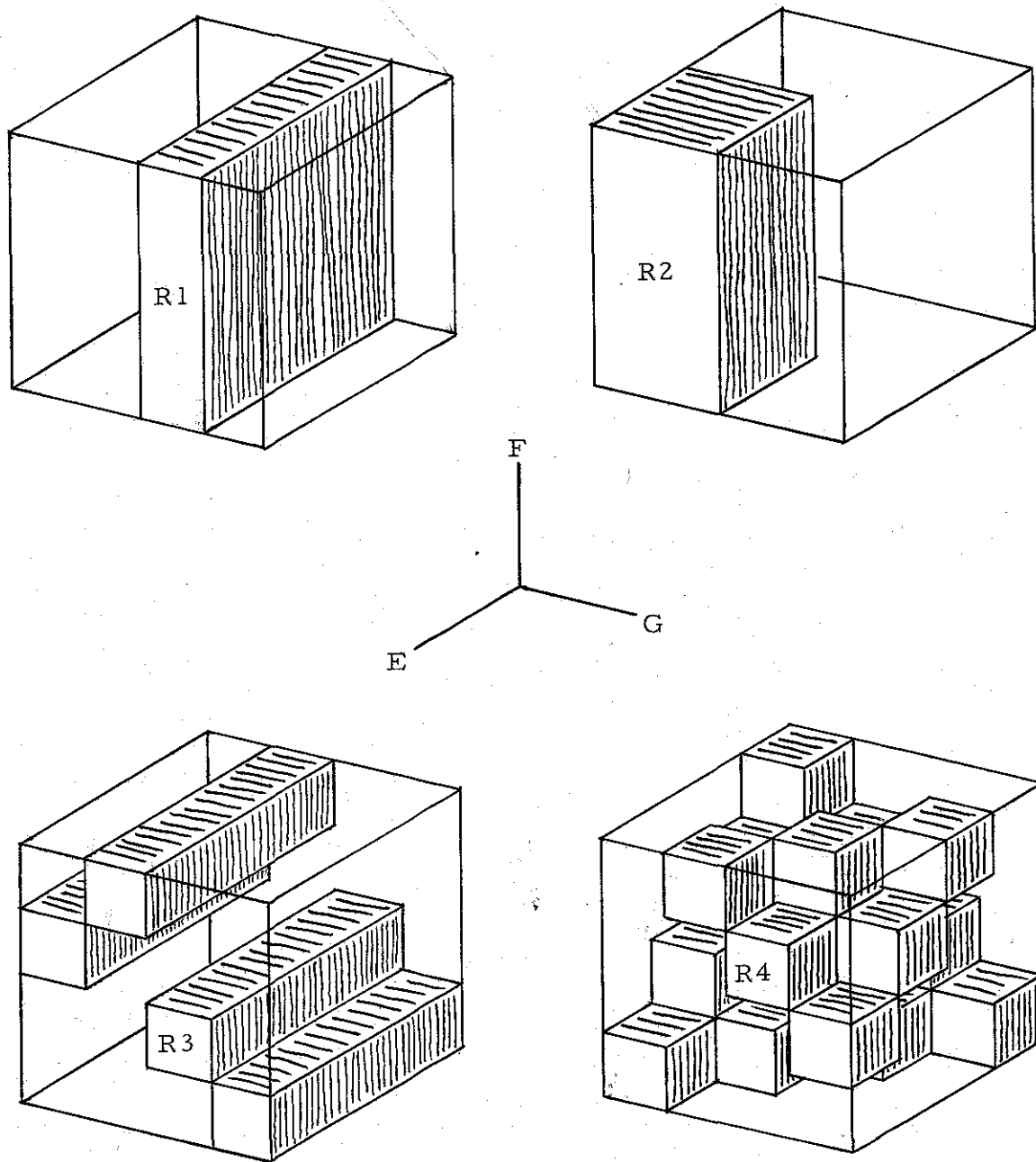
for any sort of inferences or others that possess constraints of the type needed but lead to inferences other than those desired. At any rate a specialized measure of the severity of that aspect of a constraint has to be developed which is to be utilized for specific content inferences. To illustrate the indicative power of the information measures so far defined, let us refer to four examples of constraints depicted in Figure 17, each is contained in the same state space but induced by relations of a different form.

In Figure 17 the state space $\Theta^E \times \Theta^F \times \Theta^G = \Theta^{EUFUG}$ has $4^3 = 64$ elements. The subsets R_i , $i = 1, 2, 3, 4$, are equal in size, i. e., have sixteen elements each but differ profoundly in the distribution of the elements in that state space. Hence for all R_i :

$$KI_{R_i}^{EUFUG} = U^{EUFUG} - U_{R_i}^{EUFUG} = \log_2 64 - \log_2 16 = 2 \text{ bits}$$

which is an indication of only one magnitude of the four constraints. Yet, the measure of this magnitude is obviously invariant to the distribution of R_i 's elements although it is this distribution which seems to account for the apparent differences in the properties of the relations. R_1 , for example, shows no constraint on the dimensions denoted by E and F . It induces a constraint on G only. R_1 can be considered a cojection of an element in G onto the total state space. It therefore follows that:

$$KI_{R_1}^{EUF} = KI_{R_1}^E = KI_{R_1}^F = 0 \text{ bits}$$



Four Different Constraints

Figure 17

while:

$$KI_{R1}^{EUFUG} = KI_{R1}^{EUG} = KI_{R1}^{FUG} = KI_{R1}^G = 2 \text{ bits}$$

The measures thus reflect what is visually quite obvious--that $R1$ induces a constraint only on G or that the constraint on G fully accounts for the total constraint on $EUFUG$.

$R2$, on the other hand, cannot be so analyzed. The figure indicates that while there is no constraint on the dimension F the constraints on E and G jointly account for the total constraint. The cylindrical base of $R2$ can be obtained by the intersection of the cojection of $R2$ in E onto EUG and the cojection of $R2$ in G onto EUG . When applying our measures we obtain the following:

$$KI_{R2}^F = 0 \text{ bits} ; \quad KI_{R2}^E = KI_{R2}^G = 1 \text{ bit}$$

and

$$KI_{R2}^{EUFUG} = KI_{R2}^{EUG} = KI_{R2}^E + KI_{R2}^G = 2 \text{ bits.}$$

This reflects the fact that F is unaffected by the constraint and the constraint on EUG is composed of two otherwise independent constraints in E and in G respectively. The additivity of our measures in cases of independence indicates the situation quite clearly.

The cylindrical base of $R3$, on the other hand, cannot be obtained by the intersection of cojections of constraints on F and G taken individually.

Hence:

$$KI_{R3}^E = KI_{R3}^F = KI_{R3}^G = 0 \text{ bits}$$

whereby:

$$KI_{R3}^{EUFUG} = KI_{R3}^{FUG} > KI_{R3}^F + KI_{R3}^G$$

This shows that while the dimension E is not contributory to the total constraint, the constraint in FUG cannot be reduced further into independent components. R4, however, induces a constraint that affects all three dimensions without permitting any decomposition. On intuitive grounds R1 may be said to represent the least and R4 the most complex relation depicted in Figure 17. This intuitive notion of complexity seems to correspond to the decomposability of a relation into smaller sub-relations.

We argued in Chapter Six that in order for a constraint to supply the information required for making specific content inferences it must impose a constraint on the interaction between at least two sets of variables or two subspaces of an object system's state space. For example, although both R1 and R2 induce some constraint on the state space as a whole, they do not represent any dependency between E, F or G. Each of these subspaces can be taken independently without loss. In fact while measuring some kind of severity of a constraint within a designated subspace in terms of our information measures KI, these measures do not in any way measure the quantity of information which

has to be supplied for making specific content inferences possible. KI does not take the relevant distribution of the elements of a subset of a state space into consideration. It does not measure the constraint on the interaction between subspaces.

The additivity of information measures applied on subspaces that a particular constraint renders as independent can now be utilized for defining a measure of the constraint-induced dependency between distinct subspaces. Let the amount of interaction information introduced by a relation R into a state space of which a typical dimension is denoted by i be defined as the following difference:

$$\Pi_R^{i:i} = KI_R^Z - \sum_{i \in Z} KI_R^i \quad /40/$$

This measure may be interpreted as a measure of the severity of a constraint on the interactions between the components of an object system; as a measure of the amount of communication between them; or from the point of view of a message analyst, as the amount of inferential information that can be utilized to make inferences from one set of the state space's dimensions to a distinct second set.

For purposes of message analysis in the narrower sense not all of the interactions that a constraint induces may contain relevant information. Therefore a more specialized form of the amount of inferential information, between just two arbitrary subspaces denoted by E and G , may be more convenient. Let this measure be:

$$\Pi_R^{E:G-E} = KI_R^{G \cup E} - KI_R^{G-E} - KI_R^E \quad /41/$$

where E may, for example, denote the dimensions within which given signals are considered and G may be conceived of as denoting the message analyst's problem domain.

The inequality /39/ moreover implies that:

$$\Pi_R^{i: i \in G \cup E} \geq \Pi_R^{E: G-E}$$

The difference between these two measures incidentally, expresses a quantity of inferential noise that a suitable filtering procedure will have to eliminate, among other quantities, when practical message analyses are attempted.

Inquiry into the Nature of a Constraint

The idea of discovering a constraint within dimensions of interest and of the kind that brings the given problem closer to a solution is always associated with systematically applying appropriate measures of the severity of the kind of constraint sought. The previous section suggested that the algebraic relations holding between the information measures over various subspaces yield some important properties of the relation that accounts for the constraint. Particularly questions concerning whether and how such a relation may be reduced to its elementary forms can be answered on the basis of the algebraic relations between such specialized measures. Such measures may therefore be utilized for systematic inquiries into the nature of a constraint thereby uncovering significant properties of the complementary relation.

Ashby (16) suggested a method for discovering the reducibility of a many-valued relation, which is only apparently complex by analyzing the constraint induced by it. The method has been presented as a sequence of set theoretical operations the result of each of which is submitted to a certain test that implicitly keeps track of the quantities we defined in /38/. The outcome of the test determines whether subsequent operations are to be applied and their results tested or whether the analysis can be considered terminated.

The method starts out with cojecting the subset satisfying a relation on each individual dimension, and tests for the identity of the product of the constraints on each dimension and the original constraint induced on the whole state space. For R2 in Figure 17, for example, such a test would be positive because the total constraint can be considered a product of the constraints induced by R2 on each individual dimension. In this case the constraint is decomposable and so the relation can be reduced to elementary relations holding in this case only in dimensions G and E. For R3 such a test would be negative as far as dimensions F and G are concerned. The next step therefore becomes one of considering all pairs of dimensions and testing whether they can fully account for the total constraint. R3 would turn out to be reducible to its projection onto FUG but R4 certainly could not be simplified into more elementary forms. The analysis continues in this manner until the simplest set of independent sub-constraints are found that fully account for the total constraint induced by the original many-valued

relation. Thus the analysis assesses how an apparently complex many-valued relation can be reduced in a systematic fashion. This suggested reduction of the complexity is achieved without any loss in the explanatory power of the original relation.

In terms of our information measures, Ashby's constraint analysis would suggest a reduction of the dimensionality of a relation by holding the value of KI_{R1}^{EUFUG} constant throughout the analytical process. Demonstrated on the constraints depicted in Figure 17, the method would yield the following:

$$KI_{R1}^E = KI_{R1}^F < KI_{R1}^{EUFUG}$$

$$KI_{R1}^G = KI_{R1}^{EUFUG}$$

indicating that the constraint on G alone is responsible for the constraint imposed on the total space. On the other hand:

$$KI_{R2}^E = KI_{R2}^F = KI_{R2}^G = KI_{R2}^{EUF} = KI_{R2}^{FUG} < KI_{R2}^{EUFUG}$$

$$KI_{R2}^{EUG} = KI_{R2}^E + KI_{R2}^G = KI_{R2}^{EUFUG}$$

making it clear at once that the total constraint can be viewed as the product of two independent constraints on E and on G. For R3:

$$KI_{R3}^E = KI_{R3}^F = KI_{R3}^G = KI_{R3}^{EUF} = KI_{R3}^{EUG} < KI_{R3}^{EUFUG}$$

$$KI_{R3}^{FUG} = KI_{R3}^{EUFUG}$$

demonstrating that dimension E can be simply dropped but FUG cannot be reduced further. The constraint on FUG takes up the total constraint.

$$KI_{R4}^E = KI_{R4}^F = KI_{R4}^G = KI_{R4}^{EUF} = KI_{R4}^{EUG} = KI_{R4}^{FUG} < KI_{R4}^{EUFUG}$$

Thus the constraint induced by R4 can in no way be simplified.

However, as we suggested in the previous section of this chapter, a constraint analysis for purposes of making valid content inferences from signals has to focus primarily on the constraint that affects the interaction between the dimensions of available signals and the dimensions of a delineated problem domain. We indicated that the property of a relation that is significant for content inferences is not assessed by any measure KI of the severity of a constraint but by measures II of the quantity of inferential information that a particular relation introduces between two distinct subspaces. Hence, if a constraint analysis such as the one suggested by Ashby is used to inquire into the nature of a constraint that is relevant for content inferences not some such quantity as KI_R^Z is to be held constant throughout the simplification process, but the quantity $II_{R}^{E:G-E}$ where E may denote the set of a signal's dimensions and G those of a subspace toward which inferences are intended.

In effect Ashby's constraint analysis can be used to analyze a constraint with implications for content inferences if the invariance of the quantity of inferential information is adopted as a test criterion but not the invariance of the magnitude of the severity of a constraint as measured by KI_R^Z . The essential tests referred to may be as follows:

Test 1: Is a relation R contributory to the solution of the inferential problem within the delineated dimensions E and G ? A positive answer to this question must be given when $\Pi_R^{E:G-E}$ takes a value larger than zero.

Test 2: Is there a set $E-Q$ of dimensions in E and a set $(G-E)-P$ in $G-E$ for which R provides no basis for the making of content inferences required by the message analytic situation? A positive answer would have to be given if the amount of inferential information introduced by the total constraint is not affected by the reduced constraint, i. e., a positive answer presupposes that:

$$\Pi_R^{E:G-E} = \Pi_R^{Q:P} \quad \text{and} \quad \Pi_R^{E-Q:(G-E)-P} = 0 \text{ bits.}$$

Test 3: Can the inferential relation in QUP be regarded as composed of elementary inferential relation in a partition of QUP ? Let $QUP = A \cup B \cup C \cup \dots$ and A, B, C, \dots be non-overlapping sets. A positive answer to the above question has to be given under the condition that:

$$\Pi_R^{E:G-F} = \Pi_R^{A \cup Q:A \cup P} + \Pi_R^{B \cup Q:B \cup P} + \Pi_R^{C \cup Q:C \cup P} + \dots$$

whereby the cojection of R onto A, B, C, \dots can be considered elementary inferential relations that can be taken independently.

The examples depicted in Figure 17 are too simple to demonstrate the simplifications that such a constraint analysis will have to

suggest. More elaborate examples for which this analytical method may indeed start to become productive beyond what is already visually obvious must be omitted in this presentation.

One of the roles that we assigned to constraint analysis as outlined in Chapter Five is the finding of a suitable filtering procedure which is capable of carrying the process of simplifying the relations further than was discussed here. We will take up information measures for evaluating filtering procedures after the next section.

Content and Content Inference

An appropriate definition of the amount of information carried by a message presupposes an explication of "content" and "rule of content inference" to which this section is devoted. The notion "rule of content inference" is also a prerequisite for the choice of suitable filters in message analyses. As we have argued all along, the notion of "content" is the distinguishing characteristic of a message as compared to a signal and is therefore essential to a definition of the amount of information carried by a message.

Once the irrelevant dimensionality of a relation has been properly reduced, i. e. the constraint has been identified and decomposed into a set of simple relations, the result has to be put into a form amenable to the making of content inferences. Chapter Six briefly discussed the transformation of formulated regularities of an object system into rules of content inference. A rule of content inference is always of the form:

$$(s)^E \longrightarrow \{(s)^C\}, \quad E \cap C = \emptyset$$

where $(s)^E$ is an observed signal and the set $\{(s)^C\}$ is the set of contents or the set of possible signals not observed, and the arrow denotes the direction of content inference. The set of rules of content inference implied by a given relation R may not be single-valued as suggested above and hence may not be a mapping.

To operationalize the set of rules of content inference for our purposes, let us first consider a "R-restricted cojection" which may be defined as:

$$\text{co}_R^G A = \text{co}^G (\text{co}^Z A \cap \text{co}^Z R) \quad /42/$$

where A may be any set in whatever dimensions of a state space and R takes the position of a relation imposing the restriction on the cojection. Applied on a single signal, the R -restricted cojection becomes analogously:

$$\text{co}_R^G (s)^E = \text{co}^G (\text{co}^Z (s)^E \cap \text{co}^Z R). \quad /43/$$

The range of an R -restricted cojection onto G is the set $\text{co}_R^G R$ which can be easily obtained from the definition /42/ as follows:

$$\text{co}_R^G \Theta = \text{co}^G (\text{co}^Z \Theta \cap \text{co}^Z R) = \text{co}^G (\Theta^Z \cap \text{co}^Z R) = \text{co}_R^G R$$

The domain of an R -restricted cojection can be considered as partitioned into two sets. According to /42/ the R -restricted cojection is everywhere defined only within the set R or any projections co_R^H thereof,

i. e., only within the set of possible signals. Within the set $\Theta^H\text{-co}^H R$, the constraint, however, the R-restricted cojection is not defined. Therefore, whenever R induces a constraint on the domain of a R-restricted cojection, the operation is not a mapping. But as long as R adequately represents all the possible states an object system can take, then every receivable signal is an element of the set for which the R-restricted cojection is everywhere defined. Hence, under the assumption that the regularities of an object system are known, the R-restricted cojection is everywhere defined for all possible signals that an object system can emit.

It is evident that the nature of the R-restricted cojection is entirely determined by the nature of the constraint induced by R and the arbitrarily chosen domain and range of that operation. Note that the set of signals for which an R-restricted cojection is well defined is identical with the domain of the set of possible rules of inference that is induced by R. Furthermore, the range of the R-restricted cojection, as far as it is distinct from its domain, contains all possible contents that are inferrable from the signals in the domain of the R-restricted cojection. We therefore can say that a R-restricted cojection includes the possible rules of content inference.

When applied on a given signal $(s)^E$, a rule of content inference that is implicit in the R-restricted cojection onto G-E produces elements in the respective subspace which we must identify as

contents. Following from the definition /42/:

$$\text{co}_R^{G-E} (s)^E \subseteq \text{co}_R^{G-E} \subseteq \Theta^{G-E}.$$

To the extent $\text{co}_R^{G-E} (s)^E$ is contained in and not identical with co_R^{G-E} we could argue that some selection has been made among those content elements that remain in Θ^{G-E} after the object system's constraint has become known. Thus, whenever these two sets are not identical, there is always a set $\{(s)^C\}$ of elements in co_R^C , $C \subset G-E$, for which it is true that:

$$\text{co}_R^{G-E} (s)^E = \text{co}_R^{G-E} \{(s)^C\} = \{(s)^C\} \times \text{co}_R^{(G-E)-C}$$

and

/44/

$$\emptyset \neq \{(s)^C\} \subset \text{co}_R^C$$

If this condition is satisfied, the set $\{(s)^C\}$ can then be identified with the set of contents that are being inferred from a given signal $(s)^E$ on the basis of some rule of content inference. If the set $\{(s)^C\}$ is identical with the set co_R^C then it is reasonable to argue that no inferential effort has been made. In this case we have to consider that only a signal has been received and not a message, at least as far as the chosen problem domain is concerned.

Thus we can characterize the process of content inference more fully as any process going from received signals to a set of possible contents that is smaller than the set of possible contents

implied by the relation R apriori to receiving the signal. This process may be depicted as follows:

$$(s)^E \longrightarrow \{(s)^C\} \subset \text{co}^C_R, E \cap C = \emptyset$$

That is, the set of contents inferred must be a proper subset and not identical with a cojection of the relation R onto the dimension of that content. Note that this process of content inference is implicit and a special case of R -restricted cojections.

R -restricted cojections can be considered a formalization of the set of rules of content inference determined by R . Some such rules may associate a single content with each given signal, some others may exhibit no restriction in which case it operates in effect as an unrestricted cojection. For a quantitative measure of the amount of information conveyed by the content of a message it is therefore of interest to determine how many content elements are inferred from each of the possible signals. Or, more specifically, whether and the degree to which the rules of content inference are single-valued as a whole. This degree of single-valuedness is important because it can be thought of as the extent to which certainty can be gained within an unobserved problem domain or the extent to which a message is ambiguous with respect to a certain delineated set of contents; or the extent to which the content of a message is specific.

If a R -restricted cojection co^G_R is single-valued with respect to the possible signals $(s)^E$, then the number of elements in the

domain and range of this operation are related as follows:

$$\#_{co}^{EUG_R} = \#_{co}^{E_R} \geq \#_{co}^{G-E_R} .$$

If this condition is satisfied then the quantities can be written:

$$\frac{\#_{co}^{E_R}}{\#_{co}^{EUG_R}} \cdot \#_{co}^{G-E_R} = \#_{co}^{G-E_R}$$

which implies that:

$$\log \#_{co}^{E_R} + \log \#_{co}^{G-E_R} - \log \#_{co}^{EUG_R} = \log \#_{co}^{G-E_R} .$$

According to the definition /37/ the above expression is equivalent to:

$$U_R^E + U_R^{G-E} - U_R^{GUE} = U_R^{G-E}$$

and can be rewritten according to the definition /41/ as:

$$II_R^{E:G-E} = U_R^{G-E} \quad /45/$$

Thus, whenever a R-restricted cojection is single-valued for the possible signals in its domain, the amount of inferential information equals the amount of uncertainty in its range. The equation /45/ implies that R provides a satisfactory inferential basis for making unambiguous content inferences from given signals that totally reduces the uncertainty in the chosen problem domain.

The uncertainty in the range of the R-restricted cojection or in the problem domain towards which content inferences are intended is evidently the limiting value of the amount of inferential information. If

some of the possible signals in the R-restricted cojection's domain are multi-valued, i. e. if contents are ambiguous, then:

$$\# \text{co}^{\text{EUG}} \text{R} > \# \text{co}^{\text{E}} \text{R}$$

in this case the amount of inferential information becomes smaller than the amount of uncertainty in the range of the operation. Hence, generally:

$$0 \leq \text{II}_R^{\text{E:G-E}} \leq \text{U}_R^{\text{G-E}} \quad /46/$$

This shows $\text{II}_R^{\text{E:G-E}}$ to be a measure of the extent to which some signal in E can be expected to convey content referring to some unobserved part of an object system in G or the extent to which signals can be expected to become messages about the states of an object system within a problem domain. If the relation between the possible signals and the possible contents is a one-to-one mapping then evidently:

$$\text{U}_R^{\text{E}} = \text{II}_R^{\text{E:G-E}} = \text{U}_R^{\text{G-E}} \quad /47/$$

Referring again to Figure 17 for examples

$$\text{U}_{\text{R3}}^{\text{F}} = \text{II}_{\text{R3}}^{\text{F:G}} = \text{U}_{\text{R3}}^{\text{G}} = 2 \text{ bits}$$

which exhibits R3 to be a one-to-one relation between the sets of possible signals and contents within the two dimensions F and G. This is quite obvious from Figure 17. That the quantities of inferential information introduced by R4 can be similarly obtained:

$$U_{R4}^E = U_{R4}^F = U_{R4}^G = 2 \text{ bits}$$

$$U_{R4}^{E \cup F} = U_{R4}^{E \cup G} = U_{R4}^{F \cup G} = 4 \text{ bits}$$

$$\Pi_{R4}^{E:F} = \Pi_{R4}^{E:G} = \Pi_{R4}^{F:G} = 0 \text{ bits}$$

$$\Pi_{R4}^{E:F:G} = \Pi_{R4}^{E \cup F:G} = \Pi_{R4}^{E \cup G:F} = \Pi_{R4}^{F \cup G:E} = 2 \text{ bits}$$

The above equations indicate that none of the possible signals $(s)^E$, $(s)^F$, or $(s)^G$ can be assigned a unique content under $R4$ when taken individually. On the other hand, the $R4$ -restricted cojection is single-valued if applied to signals $(s)^{E \cup F}$, $(s)^{E \cup G}$, or $(s)^{F \cup G}$ to which it assigns a unique content in dimensions not specified by those of the signals. For example:

$$U_{R4}^{E \cup F} > \Pi_{R4}^{E \cup F:G} = U_{R4}^G$$

Such a condition suggests moreover, that if the complexity of a relation is increased, more information may be needed at the signal end to allow for adequate content inferences. Such is the situation of the jury in court where the relations to be considered are so complex that a tremendous amount of information has to be processed to make an inference that yields just one bit of information: "guilty" or "not guilty." We will come to a measure for the amount of such inferences after the next section.

Quantities of Information Relevant for Filtering

The notion of filtering was introduced in Chapter Six where it was characterized as a procedure for eliminating or at least reducing the quantity of noise in the available data, i. e., the amount of information which is irrelevant to a given problem of message analysis. While constraint analysis presents a method for systematically discerning the nature of a constraint, particularly for identifying the decomposability of a constraint that is accounted for by a relation which is required for making content inferences, a filtering procedure may be regarded as a particular realization of the results obtained by constraint analysis. A filtering procedure has been described as a mapping of one representational system into a simpler second one such that relevant regularities of an object system are maintained. In other words, a filter in message analysis is a homomorphic transformation under which relevant inferential information is invariant.

Let the operation of filtering be defined as the homomorphic mapping: μ :

$$\mu : \Theta^G \longrightarrow \Theta^{G'} \text{ such that } \mu \text{ co}_R^G = \text{co}_{R'}^{G'} \mu$$

/48/

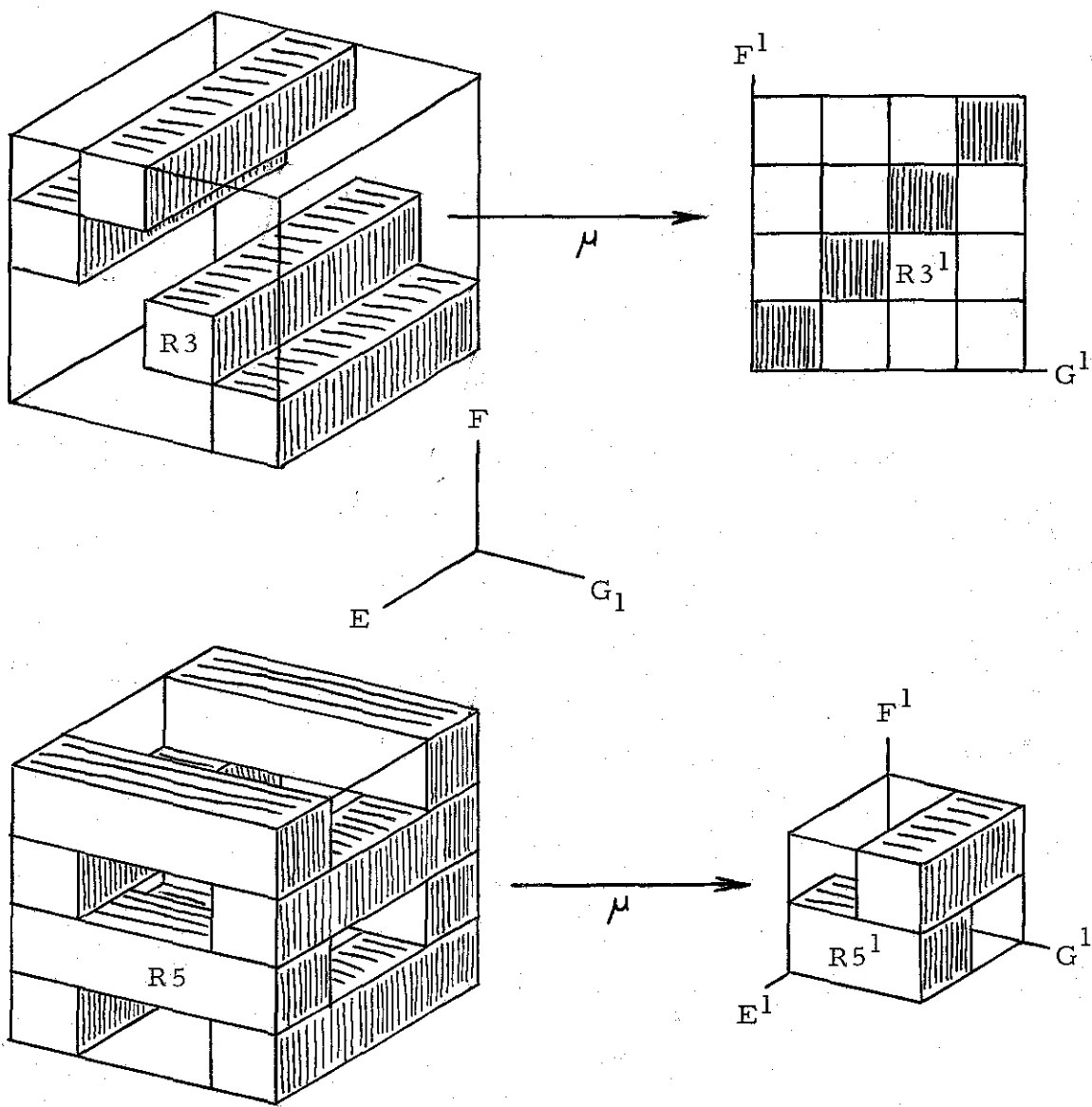
whereby $R' = \mu R$. One of the conditions that a suitable filter must satisfy has been mentioned above in conjunction with analyzing a constraint: the invariance of the quantity of inferential information. That

is, given the signal dimensions E and the problem domain denoted by D :

$$\Pi_{R}^{E:D-E} = \Pi_{R'}^{E':D'-E'}$$

In accordance with results obtained from inquiries into a given constraint, one of the operations that is to be incorporated into filtering is a projection. This function can be chosen in such a way that those dimensions of a state space are eliminated that do not contribute to the relevant amount of inferential information. Depending on whether and how the relation can be decomposed into less complex sub-relations, the filtering operation may be regarded as a set of independent operations having distinct ranges and domains. The constraint analysis previously discussed provides a rationale for the design of a filter that can be regarded as a composite of these two types of reductions of the apparent complexity. It does not indicate however, a further reduction that is due to simplifications within the subspaces of the total space. That is, a partition of the state space which discards the distinctions that are irrelevant with respect to the inferential problem at hand. Such a simplification can be visualized in Figure 18.

In this Figure two constraints are presented. One, R_3 , has already been presented in Figure 17. As we demonstrated earlier R_3 can be simplified by simply dropping the dimension E of the original state space since it does not affect the quantity of inferential information provided by R_3 . The transformed version of Θ^{EUFUG}



Two Constraints and their Simplifications

Figure 18

shows $R3'$ to be a one-to-one relation between the dimensions F' and G' .

The constraint induced by $R5$, on the other hand, cannot be reduced by eliminating any dimensions in which it is contained. This can be easily seen by the distribution of the amounts of inferential information within the subspaces:

$$\Pi_{R5}^{E:F:G} = U_{R5}^E + U_{R5}^F + U_{R5}^G - U_{R5}^{E \cup F \cup G} = 1 \text{ bit}$$

$$\Pi_{R5}^{E:F} = \Pi_{R5}^{E:G} = \Pi_{R5}^{F:G} = .42 \text{ bits}$$

$$KI_{R5}^E = KI_{R5}^F = KI_{R5}^G = 0 \text{ bits}$$

The measures moreover indicate that the relation $R5$ cannot be decomposed into sets of simple sub-relations. But a considerable reduction of the complexity can be evidently achieved by partitioning the subspaces as shown because the distribution of elements constituting the relation $R5$ appears to contain a certain symmetry, i. e., can be regarded as an arrangement of identical subsets of $R5$.

While we have not developed a measure of symmetry, the examples make it evident that the invariance of the amount of inferential information cannot be the only criterion for evaluating the adequacy of a filter. The quantity $U_R^{E \cup D}$ must be reduced to a minimum as well. Therefore a second criterion for assessing the adequacy of a filter in a given situation has to be found and can be derived from the inequality /46/. The inequality states that:

$$\Pi_R^{E:D-E} \leq U_R^{D-E}$$

equality holding whenever co_R^{D-E} contains only single-valued rules of inference. If both co_R^{D-E} and co_R^E contain only single-valued rules of inference then according to /47/:

$$\Pi_R^{E:D-E} = U_R^{DUE} = U_R^{D-E} = U_R^E$$

which is indicative of a condition that presents in a sense, the ideal of rules of content inference, rules that are most easy to handle, rules that assign to each signal a unique and distinct content and not sets thereof. A coefficient for the degree to which such an ideal is approached may be in place here and can be defined as:

$$0 \leq \frac{\Pi_R^{E:D-E}}{U_R^{EUD}} \leq 1 \quad /49/$$

According to /47/ the coefficient assumes the value of unity whenever the set of signals are in a one-to-one relation to the set of contents that can be legitimately inferred from them.

Hence a suitable goal for selecting the homomorphic mapping μ defined in /44/ which is to be used as a filter in message analysis can be stated as:

$$\mu \left\{ \begin{array}{l} \Pi_R^{E:D-E} = \Pi_{R'}^{E':D'-E'} \\ \frac{\Pi_R^{E:D-E}}{U_R^{EUD}} < \frac{\Pi_{R'}^{E':D'-E'}}{U_{R'}^{E'UD'}} \longrightarrow 1 \end{array} \right. \quad /50/$$

The arrow denotes the direction of a process converging towards unity.

It is clear that this goal implies that of minimizing noise in the sense that irrelevant varieties of any kind are absorbed in the filtering process and do not enter the process of content inference.

In terms of the examples in Figure 18:

$$U_{R3}^{EUFUG} = \log_2 \#R3 = \log_2 16 = 4 \text{ bits}$$

$$U_{R3'}^{F'UG'} = \log_2 \#R3' = \log_2 4 = 2 \text{ bits}$$

$$II_{R3}^{EUF:G} = U_{R3}^{FUG} + U_{R3}^E - U_{R3}^{EUFUG} = 2 \text{ bits}$$

$$II_{R3'}^{F':G'} = 2 \text{ bits}$$

Hence:

$$II_{R3}^{EUF:G} = II_{R3'}^{F':G'}$$

and:

$$\frac{II_{R3}^{EUF:G}}{U_{R3}^{EUFUG}} = .50 < 1.00 = \frac{II_{R3'}^{F':G'}}{U_{R3'}^{F'UG'}}$$

in which case $co_{R3'}^{G'}$ is known to contain only one-to-one rules of inference for the possible signals.

$$U_{R5}^{EUFUG} = 6 \text{ bits}$$

$$U_{R5'}^{E'U'F'UG'} = 2 \text{ bits}$$

$$II_{R5}^{EUF:G} = \log_2 12 + \log_2 4 - \log_2 32 = .58 \text{ bits}$$

$$II_{R5}^{E'U'F':G'} = \log_2 3 + \log_2 2 - \log_2 4 = .58 \text{ bits}$$

Hence:

$$II_{R5}^{EUF:G} = II_{R5}^{E'U'F':G'}$$

and:

$$\frac{II_{R5}^{EUF:G}}{U_{R5}^{EUFUG}} = .097 < .79 = \frac{II_{R5'}^{E'U'F':G'}}{U_{R5'}^{E'U'F'UG'}}$$

While μ can achieve a considerable reduction of $R5$'s apparent complexity in the original state space, the measures indicate that it is not possible to bring the rules of content inference into a one-to-one relation.

It should be noted that we have been explicit only concerning filters that operate on a state space which is conceptualized as a product set. If domain and/or range of the filtering procedures involve representational systems that are formally different from the above, for example, when statistical properties of an object system are represented in the range of a filter, then a constraint analysis will have to focus on different properties of a relation that can be discerned as accounting for the constraint observed. But in all message

analytic situations in which filters are selected, the two goals defined above seem to be prevalent: firstly, the relevant inferential information is to remain invariant throughout the filtering process or at least should not diminish below an acceptable level. Secondly, the complexity of a relation, for example, the number of terms needed to specify that relation, is to be reduced to a point at which it is rendered more manageable or easier to handle in subsequent content inferences.

However, since the filtering procedure μ is conceptualized here as a homomorphic mapping which maintains all relevant relations for the intended content inferences, and since neither R-restricted cojections nor the set of rules of content inference need to be mappings, i. e., since:

$$\mu^{-1} \text{co}_R^G \mu = \text{co}_R^G$$

it does not seem necessary to account for the quantities of irrelevant information that a filter reduces when we explicate the amount of message information in the following section.

The Amount of Information Carried by a Message

This section tries to develop a measure for the amount of information conveyed by a signal that can be regarded as a message about some unobserved part of an object system. A proper measure for the amount of message information should include the quantity of information conveyed by the content that can be legitimately inferred from a signal as well as the quantity of information conveyed by the signal,

some constraints on the signal's dimensions being known. Such a measure would regard the quantity conveyed by the content alone as a special case of the amount of message information. We will develop such a measure and show some of its quantitative relations to other information measures of our calculus at the end of this section.

The notion of content inferred from a signal $(s)^E$ was defined as a non-empty set $\{(s)^C\}$ of elements in a problem domain denoted by D which does not overlap with the signal's subspace. We can argue that the set of contents induces a certain constraint on the subspace which is not observed. If the argument is sufficient, then this constraint can be easily measured by one of our information measures. For instance:

$$KI_{\{(s)^C\}}^C = \log \frac{\# \text{co}^C \ominus}{\# \text{co}^C \{(s)^C\}}$$

But the condition under which we can view the subset of the space as the content of a message requires the set of contents to be a proper subset of and not identical with the set of elements excluded by the constraint within the dimensions of the set of contents. /44/ implies: For

$C \subset D-E$

$$\text{co}_R^{D-E} \{(s)^C\} \subset \text{co}_R^{D-E}$$

If the two sets are identical then we argued that in effect no choices have been made among the possible contents contained in co_R^{D-E} in which case the amount of content inferred should be zero. But,

$KI_{\{(s)C\}}^C$ is not zero when $\{(s)C\} = co^C_R$ which proves the above measure to be insufficient as an acceptable explication of the quantity of information conveyed by the content inferred. Since:

$$\{(s)C\} \subseteq co^C_R$$

we can equate:

$$co^C_{\{(s)C\}} = co^C_R \{(s)C\}$$

and extend the above measure of the constraint induced by the set of contents as follows:

$$\begin{aligned} KI_{\{(s)C\}}^{D-E} &= \log \frac{\# co^{D-E}_{\Theta} \cdot \# co^{D-E}_R}{\# co^{D-E}_R \cdot \# co^{D-E}_{\{(s)C\}}} \\ &= \log \frac{\# co^{D-E}_{\Theta}}{\# co^{D-E}_R} + \log \frac{\# co^{D-E}_R}{\# co^{D-E}_{\{(s)C\}}} \end{aligned}$$

The left part of the sum is nothing but a measure of the constraint induced by R as defined in /38/. The right part of the sum comes closer to our intuition concerning the amount of content: the right part is a measure of the amount of uncertainty reduced beyond what was already known by R. If this part of the expression is zero, condition /44/ is not satisfied which means that no content is inferred. If this part of the expression is not zero then some inferred content can be said to have caused a reduction of the uncertainty that persisted after the constraint existing in the object system became known.

Since we want to trace back the origin of this additional constraint to the set of signals from which the set of contents are inferred, we can write the following expressions as:

$$KI_{\{(s)C\}}^{D-E} = KI_R^{D-E} + \log \frac{\# \text{co}_R^{D-E} \Theta}{\# \text{co}_R^{D-E} \{(s)E\}}$$

The right part of the sum now expresses what we wish to define: the amount of information that a signal carries with respect to an unobserved part of an object system. It is the amount of information carried by the content of a message alone. The logarithm of the numerator of the proportion is already known to be U_R^{D-E} . The logarithm of the denominator of this proportion may be given the general form:

$$U_R^G(\dots, (s)_i, \dots) = \log \# \bigcap_i \text{co}_R^G(s)_i \quad /51/$$

This quantity can be interpreted as the uncertainty remaining in G after signals have been received and content inferences made from them. Obviously the definition of $U_R^G(\dots, (s)_i, \dots)$ in /23/ is a special case of /51/ in which case $R = \Theta^G$ and the cojection employed in /23/ is unrestricted.

A measure of the amount of information carried by a signal including the contents that are inferred from it can be defined as:

$$MI_R^G(\dots, (s)_i, \dots) = U_R^G - U_R^G(\dots, (s)_i, \dots) \quad /52/$$

Where G is again an arbitrary subspace and R the relation inducing the constraint on the total state space. This measure is to be interpreted

in analogy to the amount of signal information as a difference between the apriori uncertainty within G, the constraint due to R being known, and the uncertainty a posteriori to the reception of a message. We will call this measure function "amount of message information."

The amount of information carried by the content of a message alone can now be interpreted according to the expression above:

$$MI_R^{D-E}((s)^E) = KI_{\{(s)C\}}^{D-E} - KI_R^{D-E} \quad /53/$$

the severity of a constraint induced by the set of contents inferred from a given signal minus the severity of the constraint induced by the relation R.

The quantity of message information lends itself to various equations that are of interest to message analysis. For instance, the total amount of message information conveyed by signal and content jointly, R being known, can be expanded as follows:

$$\begin{aligned} MI_R^{DUE}((s)^E) &= U_R^{DUE} - U_R^{DUE}((s)^E) \\ &= U_R^{DUE} - U_R^{D-E} - U_R^E + U_R^{D-E} - U_R^{DUE}((s)^E) + U_R^E \\ &= U_R^{D-E} - U_R^{D-E}((s)^E) + U_R^E - U_R^E((s)^E) - II_R^{E:D-E} \end{aligned}$$

$$MI_R^{DUE}((s)^E) = MI_R^{D-E}((s)^E) + MI_R^E((s)^E) - II_R^{E:D-E} \quad /54/$$

Thus the total amount of message information in the dimensions of the signal and the problem domain can be considered as the sum of the quantities of information carried by the signal and the content individually

minus the amount of inferential information supplied when regarding a given signal as a message, i. e., when making specific content inferences.

The amount of information carried by a signal, R being known, can be expanded as follows:

$$\begin{aligned}
 MI_{R((s))^E}^E &= U_R^E - U_{R((s))^E}^E \\
 &= U^E - U^E + U_R^E \\
 &= U^{DUE} - U^{DUE}_{((s))^E} - U^E + U_R^E \\
 MI_{R((s))^E}^E &= SI^{DUE}_{((s))^E} - KI_R^E \qquad /55/
 \end{aligned}$$

The above can be interpreted as the difference between the amount of signal information, R not being known or ignored, and the amount of information contained in the constraint induced by R on the signal's dimensions.

Inserting /55/ into /54/ yields the following:

$$MI_{R((s))^E}^{DUE} = SI_{((s))^E}^{DUE} - KI_R^E + MI_{R((s))^E}^{D-E} - II_R^{E:D-E} \qquad /56/$$

This shows that the amount of message information in the dimensions of the signal and the problem domain, R being given, is composed of the quantities: the amount of signal information minus the quantity of constraint induced by R within the signal's dimensions, plus the amount of information carried by the content alone, R being given, minus the

amount of inferential information supplied by R .

Numerous other theorems can be derived from the axioms and the definitions all of which seem highly meaningful on intuitive grounds but we will focus only on some inequality involving the quantity of message information of the content inferred. According to /46/:

$$0 \leq \Pi_R^{E:D-E} \leq U_R^{D-E}$$

The amount of message information referring to the content of a message has identical limits. According to the definition of this quantity, /52/:

$$0 \leq MI_R^{D-E}((s)^E) \leq U_R^{D-E}$$

But the two quantities are identical only at their extreme values which is quite obvious from the above and occurs either when co_R^{D-E} is single-valued or when it is not R -restricted, respectively. The fundamental difference between the two quantities is that the amount of inferential information is an over all measure of the extent to which a R -restricted cojection from E onto $D-E$ is single-valued, given the set of all possible signals; while the amount of information referring to the message content is a measure concerned with the effect of only one out of a set of possible signals. Whenever the measures deviate from the two points of equality, they vary relatively independently of each other. All that can be said is that the amount of inferential information can neither exceed the maximum nor be smaller

than the minimum of the amount of message information carried by a member of the set of possible signals. Hence, putting these arguments together, we can state:

$$MI_R^{D-E} ((s)_i)_{\min}^E \leq \Pi_R^{E:D-E} \leq MI_R^{D-E} ((s)_j)_{\max}^E \leq U_R^{D-E} \quad /57/$$

According to this inequality we cannot say that the amount of content inferred is absolutely limited by the amount of inferential information supplied. This limitation is only a relative one. The amount of inferential information also can not be interpreted as an average of the amount of message information concerning the inferrable content. This average, when computed, may take values slightly different from the amount of inferential information. But we can say with full confidence that on the whole the amount of message information that can be inferred from a signal is limited by the amount of inferential information available.

If the difference between the nature of overall measures and measures of individual cases is taken into consideration many more meaningful limitations and inequalities can be derived. For example: the amount of signal information is on the whole larger than the amount of information that can be inferred from it. This shows the process of interpreting messages on the whole as one of only losing information.

Information About a Dynamic System: An Example

The previous discussion limited the representational system of a message analyst to a product set having many dimensions along which the states of an object system's components are represented. From the

point of view of the analyst such a representational system implicitly restricts the message analytic situation to a kind of diagnostic situation. This is a situation in which the knowledge of co-occurrences of events provides the basis for making inferences from observations to non-observed phenomena of which the observations are said to be symptoms.

We claimed generality for our argument, tried to support this claim by referring to numerous entirely different examples in such and similar modes of inquiry as content analysis, but restricted the explication of our calculus to just this simple kind of representational system. Giving just one more example does not of course fully support our claim, but shows at least that our efforts are not confined to the situation we assumed at the beginning of Chapter Four. Moreover it seems that the extension to other message analytic situations which are in a sense more complex, shows additional features that are even more interesting than the one to which we restricted our previous concern.

For example, we mentioned in the requirements for a measure of signal information that if a representational system is not powerful enough to represent the object system in question, i. e., if the quantities of signal information turn out to be infinite, then the representational system has to be altered. We were mainly concerned with signals that provide the basis for content inferences, but in addition signals may convey information about the structure of the object system itself. Thus we have to consider that a single signal may simultaneously convey information on three levels: (a) information concerning the

adequacy of a representational system. This information has not been and may not need to be quantified in this study. (b) Information concerning the structure or regularities of the object system on the basis of which content inferences may subsequently be made; and finally, (c) information concerning unobserved states of the object system, i. e., information that is the characteristic of messages.

Let us therefore consider a dynamic object system, i. e., a system in which attention must be given to changes over time. Given that the observer of such a system has access only to a short and even incomplete sequence of signals which may not even pertain to all states of the object system, one of the questions that may be put to the message analyst concerns how much inferential information is contained in the observed history of the object system to anticipate its future states. The answer would at once indicate how futile predictive efforts are bound to be. Another question may have to do with how much additional information is needed or how long a sequence will have to be observed to predict with reasonable certainty the next state of the object system. One may also ask whether the most recent signal received contributed to the making of inferences concerning unobserved states, i. e., whether that signal can be regarded as a message about states of an object system not accessible at the time.

To force the discussion to become more concrete let the following protocol be given which records signals that have been received by an observer at successive steps in time. Dots represent "nothing observed" in the dimensions in question.

Time t	G					
1	.	.	0	.	.	1
2	.	.	0	.	.	.
3	.	1	.	0	0	1
4	.	.	1	.	.	.
5	.	.	.	0	.	.
6	.	0	.	1	0	.
7
8	.	.	1	1	.	.
9	.	.	0	.	.	1
10	0	.	0	.	.	.
11	0	.	1	.	.	0
12	0	.	.	1	1	1

Suppose we were to fail to view the object system as a dynamic one, i. e., we were to make use of a representational system that does not consider changes over time, we would start as follows. Let the state space of our interest be $\Theta^G = \{ \langle 00 \rangle, \langle 01 \rangle, \langle 10 \rangle, \langle 11 \rangle \}$. With $n = 2$ components each of which can take $k = 2$ states, the maximum uncertainty would be:

$$U^G = \log_2 \# \Theta^G = \log_2 k^n = 2 \text{ bits}$$

and the accumulative amount of signal information would be:

Time	1	$SI^G((s)_1)$	=	1 bit
	2	$SI^G((s)_1, (s)_2)$	=	1 bit
	3	$SI^G((s)_1, \dots, (s)_3)$	=	2 bits
	4	$SI^G((s)_1, \dots, (s)_4)$	=	∞

Without even attempting any inferences we would at least at time 4 discover that the representational system Θ^G is not powerful enough to adequately represent the object system of which we have obtained the protocol.

However, a dynamic system can be said to follow some trajectory within a representational system of its possible states. Let us therefore take another representational system into consideration which represents not states, but all possible sequences of states such an object system may follow - provided that it behaves in a determinate manner. Let us begin with a behavior space B^Ω that contains all possible trajectories generated by mappings of the type $\Theta^{G,t} \rightarrow \Theta^{G,t+1}$, where Ω denotes a finite sequence of steps 1, 2, ..., t, ... in time. If such a behavior space again leads to contradictory signals then another, more powerful representational system will have to be employed. As has been stated before, to determine the adequacy of a representational system is the first use that we can make of a signal.

Given the behavior space, each set of signals $(s)^t$ can now be cojected onto Ω whereby a constraint is induced that hopefully becomes

successively more severe upto the point where just one trajectory remains in the space. The maximum uncertainty that has to be eliminated, the maximum amount of information a set of signals may be able to convey, now becomes the logarithm of the number of possible trajectories.

Again for $n = k = 2$

$$U^{\Omega} = \log_2 \sum_{v=1}^{k^n} \sum_{w=0}^{k^n-v} \frac{k^n!}{(k^n - v - w)!} = \log_2 196 = 7.61 \text{ bits.}$$

Now the amount of information a given set of signals conveys about the structure of an object system, i. e., the quantity it introduces into the behavior space can be measured by $SI^{\Omega}(\dots, (s)^t)$. This is a second use to which a signal may be put. We will give the measures of amount of signal information referring to the structure of the object system shortly.

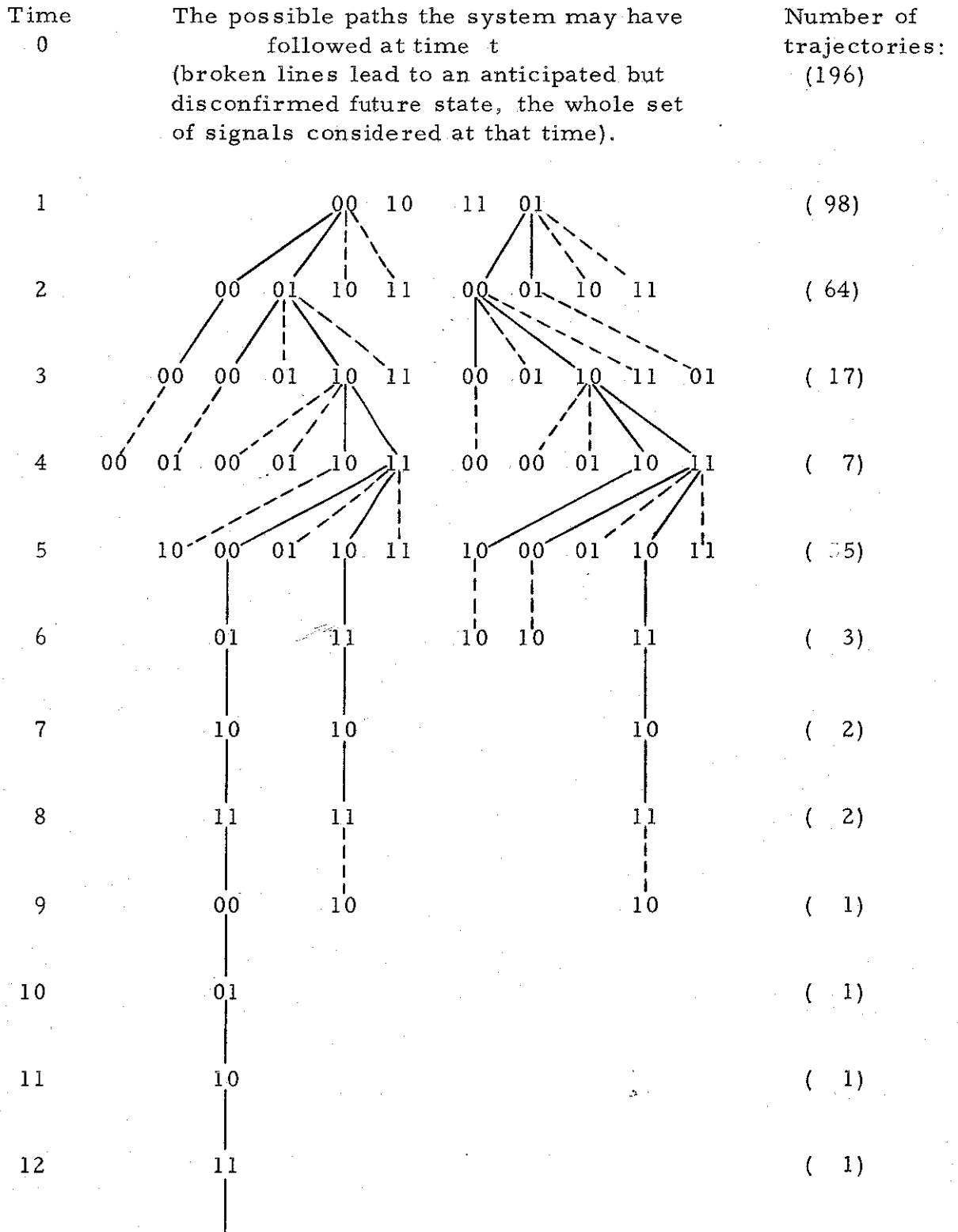
At the initial state of the analysis, where nothing is known about the object system, when all possible trajectories are equally likely, any attempt to make content inferences would be futile. It is only after some signals have become known that some behavioral property of the object system may appear which manifests itself as a constraint on the conceivable behaviors the system may follow. The behavior space into which the signals are cojected was defined as the set of trajectories that are generated by all possible mappings $\Theta^{G,t} \rightarrow \Theta^{G,t+1}$. Let us now define the set R as a subset of $\Theta^{G,1} \times \dots \times \Theta^{G,t} \times \Theta^{G,t+1} \times \dots$ which at each state t accounts for the possible trajectories in the behavior space. Thus, R can be considered a representation of those

trajectories that are left in B^{Ω} after the set of received signals have been cojected into it.

The constraint which R induces on the possible mappings now provides us with the basis for content inferences from the signals, it provides us with the necessary inferential information. Inferences from available signals to unobservable states is the third use to which such signals may be put. The quantities conveyed by the signals as messages about some other states can now be measured by $MI_R^{G,t}((s))$. We will present some such measures in a table to follow.

With the first signal $(s)^1 = \langle 0, . \rangle$ it becomes known that the system's initial state is either $\langle 0, 0 \rangle$ or $\langle 0, 1 \rangle$ of Θ^G . Thus, not all four but only two of the possible initial states have to be considered whereby the number of possible trajectories reduces from 196 to exactly half that number. Therefore, $(s)^1$ conveys $SI^{\Omega}((s)^1) = 1$ bit of information. The cojection of $(s)^1$ and $(s)^2$ causes a further shrinkage of the set of possible trajectories to 64. And so the process continues, hopefully, until the last uncertainty is removed and the structure of the object system is perfectly known to the analyst. The successive elimination of trajectories is depicted in Figure 19 and the amount of accumulated information due to this process tabulated in Figure 20. It can be seen that at time $t=9$ perfect certainty is gained where every additional signal is merely redundant.

The amount of message information that signals upto time t convey about the object system's state at time $t+1$ is evidently related



Successive Changes of the Content Inferred from Accumulating Signals

Figure 19

t	$(s)^t$	$SI^{\Omega}(\dots, (s)^t)$	$SI^{G,t}((s)^t)$	$MI_R^{G,t+1}((s)^t)$	$MI_R^{G,t+1}((s)^{t-1}, (s)^t)$	$MI_R^{G,1}((s)^t)$
1	<0, .>	1.00	1.	0	0	1.
2	<0, .>	1.61	1.	0	0	0
3	<., 0>	3.53	1.	0	0	0
4	<1, .>	4.81	1.	0	0	0
5	<., 0>	5.29	1.	.42	.42	.42
6	<., 1>	6.61	1.	1.	$2. = U^{G,t+1}$	1.
7	<., .>	6.61	0	0	2.	1.
8	<1, 1>	6.61	$2. = U^{G,t}$	1.	1.	1.
9	<0, .>	$7.61 = U^{\Omega}$	1.	1.	2.	$2. = U^{G,t}$
10	<0, .>	7.61	1.	1.	2.	2.
11	<1, .>	7.61	1.	1.	2.	2.
12	<., 1>	7.61	1.	1.	2.	2.

Quantitative Changes of Information as a Function of Accumulating Signals

Figure 20

to the amount of information that can be supplied at each interpretive stage. The table shows that it is hardly possible to say anything about the next state of the system until a relatively large amount of information about its structure has been accumulated.

The table moreover shows that the amount of signal information within a state space affects the predictability of the next state. If only signals at time t are considered as messages about the subsequent state, no perfect certainty can be reached at time $t+1$ as far as our protocol shows. If however, signals of two preceding time periods are taken jointly, the lack of information due to incomplete observability during a single time period may be compensated by the additional quantity that a longer observational history provides. As the table indicates, the message information conveyed by two successive signals is always at its maximum from time $t = 9$ onwards.

One of the columns shows in addition the quantity of message information that a signal at time t conveys with respect to the initial state of the object system. As Figure 19 already demonstrates, this content cannot be perfectly inferred before time $t = 9$.

A few concluding observations should be mentioned at this point. We specified numerous paper and pencil machines, made them incompletely accessible in various ways, and investigated the different quantities of information signals convey. This was frequently quite painstaking since the variety within a representational space increases exponentially as a few variables are added. But this makes the need for

some powerful information calculus even more urgent.

Intuitively acceptable and clearly supported by our experiments was the hypothesis that a higher degree of incompleteness indeed requires a longer time period of observation before reasonable quantities of message information do appear. This is already seen in the previous example.

If some variables are not accessible at all, it is possible to specify the maximum quantity of information needed to make the desired inferences, and this quantity may indeed correspond to the maximum amount of communication that may take place from the unobserved components to the dimensions of the obtained signal. But very little can be said about the direction of such communication.

If a system is observed incompletely before it reaches its equilibrium, uncertainty as to the initial states of that system may remain no matter how long the system has been observed and how accurate predictions as to its future states may become over time.

Cases where the observed part of an object system is relatively small and the communication between that part and the rest of the system is very rich, require consideration of very long histories of such systems, very powerful representational systems and constraints and considerable information processing capacities. This is the situation in which the majority of practical message analyses take place, a situation in which information from the past history of an object system must be utilized more effectively and economically in order to come to content inferences with reasonable certainty. To reduce

such complexity is a considerable challenge. To measure the quantities involved is just a first step towards meeting that challenge.

Summary of Terms

At this point a brief summary is in order. In Chapter Six we developed a conceptualization of the empirical procedures of message analysis. In that chapter an outline of four such processes were depicted in Figure 9. Chapter Seven was primarily devoted to some informational aspects of message analysis and developed explicit definitions of the procedures in question. The procedures are adequately defined for use only in representational systems that are many-product sets. But the basic nature of these procedures, it was claimed, is general. Figure 21 of this chapter provides an over-view of the terms used as far as they refer to processes, products and operands. Following the diagram in that figure is a brief summary of the definitions of various quantities of information that pertain to our calculus. Only the more significant definitions are included. Equations that hold between these terms are not repeated here.

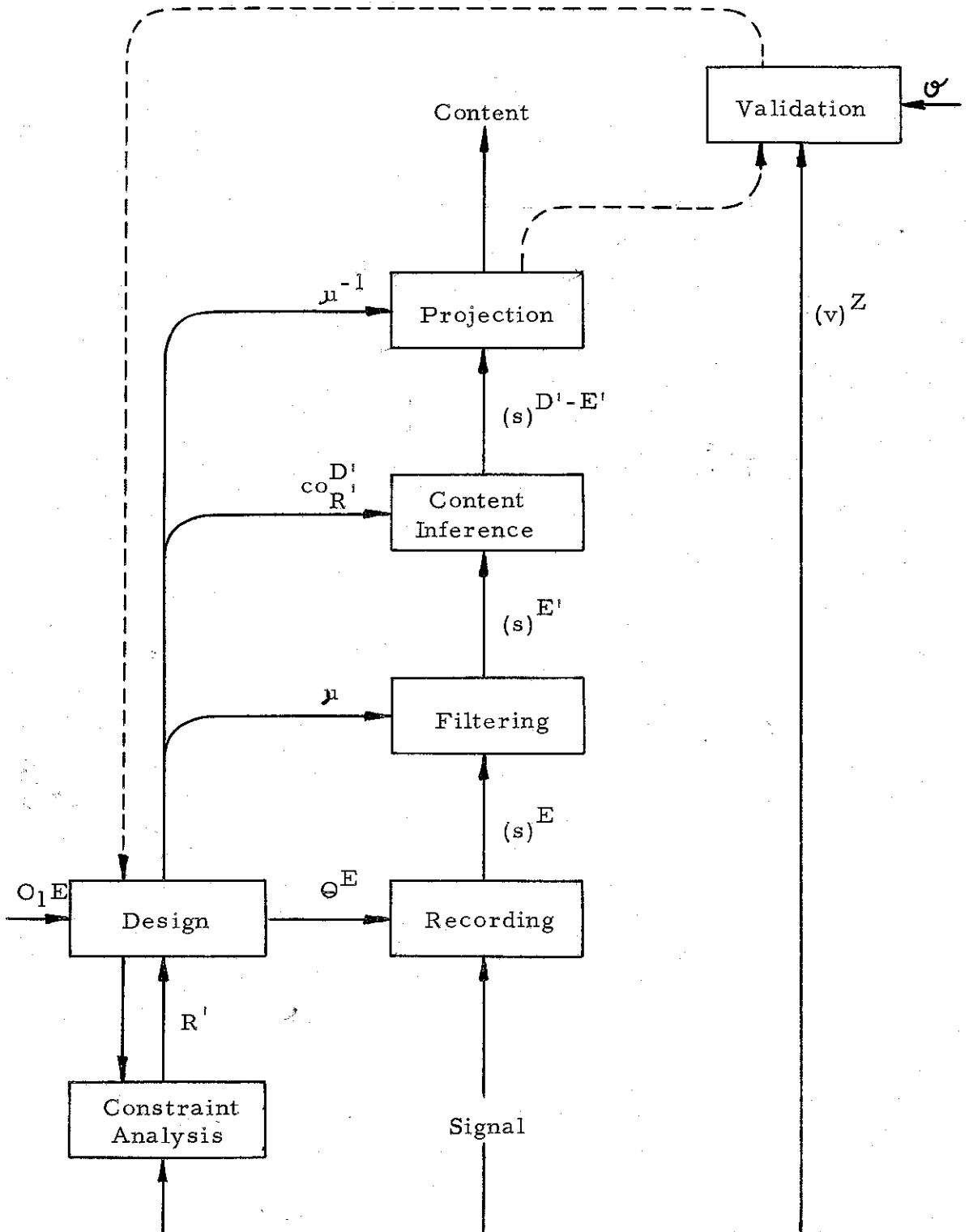


Diagram of the Message Analytic Procedure (Formal)

Figure 21

Primary Definitions

The uncertainty within a state space Θ^G denoted by the set G of its products or dimensions, a constraint induced by the relation R being given or known:

$$U_R^G = \log \# \text{co}_R^G \Theta \quad /37/$$

With U^G defined in /22/ as a special case in which no constraint is present and the subscripts are accordingly omitted.

The uncertainty in Θ^G after a set of signals have been introduced or become known, the relation R being given and considered:

$$U_R^G (\dots, (s)_i, \dots) = \log \# \bigcap_i \text{co}_R^G (s)_i \quad /51/$$

With $U^G (\dots, (s)_i, \dots)$ defined in /23/ as a special case in which no relation R is considered.

The uncertainty in Θ^G as in $U_R^G (\dots, (s)_i, \dots)$ but of signals or inferences that are verified according to a validating signal $(v)^Z$:

$$V_R^G (\dots, (s)_i, \dots // (v)^Z) = \log \# \mathcal{U} \left(\bigcap_i \text{co}_R^G (s)_i, (v)^Z \right) \quad /58/$$

With $V^G (\dots, (s)_i, \dots // (v)^Z)$ as a special case analogous to the above.

Secondary Definitions

The severity of a constraint within Θ^G or the amount of information introduced by a relation R into a state space:

$$KI_R^G = U^G - U_R^G \quad /38/$$

The amount of inferential information contained in the relation R between two distinct sub-spaces of Θ^Z denoted by the sets E and G of their dimensions respectively:

$$\Pi_R^{G:E} = KI_R^{GUE} - KI_R^G - KI_R^E \quad /41/$$

The amount of message information, i. e., the amount of information a set of signals and/or the contents inferred from it conveys:

$$MI_R^G(\dots, (s)_i, \dots) = U_R^G - U_R^G(\dots, (s)_i, \dots) \quad /52/$$

The amount of signal information can be regarded as a special case of the amount of message information in which the relation R is either not known or ignored:

$$SI^G(\dots, (s)_i, \dots) = U^G - U^G(\dots, (s)_i, \dots) \quad /24/$$

The amount of redundancy conveyed by a set of messages or the degree to which a set of signals and/or their content are superfluous with respect to what they convey:

$$RI_R^G(\dots, (s)_i, \dots) = \sum_i MI_R^G((s)_i) - MI_R^G(\dots, (s)_i, \dots) \quad /59/$$

The amount of redundancy contained in a set of signals ignoring the existence of a relation R is a special case of the above:

$$RI^G(\dots, (s)_i, \dots) = \sum_i SI^G((s)_i) - SI^G(\dots, (s)_i, \dots) \quad /25/$$

The amount of valid message information:

$$\text{VMI}_R^G(\dots, (s)_i, \dots // (v)^Z) = U_R^G - V_R^G(\dots, (s)_i, \dots // (v)^Z) \quad /60/$$

Of which the amount of valid signal information is again a special case:

$$\text{VSI}^G(\dots, (s)_i, \dots // (v)^Z) = U^G - V^G(\dots, (s)_i, \dots // (v)^Z). \quad /31/$$

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VITA

Klaus Herbert Krippendorff was born March 21, 1932, in Frankfurt a. M., Germany. He attended Gymnasium at Halberstadt and Dresden and graduated with an Ingenieur (Grad.) degree from Hannover Engineering School in 1954. After two years of working as an engineering consultant, he resumed studies at the Ulm School of Design from where he was awarded the Diploma in 1962. During the final year of his graduate studies he held the position of a research assistant at the Center for Visual Perception of the same institution. In 1961 he was granted a Ford International Fellowship for two years and a Fulbright Travel Grant. He studied for one semester at Princeton University and then joined the communications program at the University of Illinois, Urbana, where, during the last year of his residence, he held the position of a research assistant at the Institute of Communications Research. In 1964, he obtained a research fellowship from The Annenberg School of Communications, University of Pennsylvania, and is currently appointed assistant professor of communications.

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