From Personal Experience to Design: Externalizing the Homeowner's Needs Assessment Process

by

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ABSTRACT

Advances in building and computational technologies, coupled with a reorganized and integrated system of residential design, may make custom homes a possibility for a larger segment of the population in the years to come. While tools and materials that embody building and design expertise are necessary for making such a system workable, how the homeowner is supported and represented will determine whether the resulting houses are not just custom, but personally meaningful.

The particular focus of this work is on how to externalize the layperson's task of establishing needs and setting goals as an essential stage within a sophisticated design process. The work is informed by interviews with homeowners and a participant study of constructive and interpretative exercises. One such exercise asked participants to serve as investigators into their own practices through use of simple sensors placed in the home environment.

The work concludes with a proposal for tools and approaches to collect rich requirement data and prime users for design decisions by helping them to identify their perspective, needs, and goals.

KEYWORDS: home design, mass customization, participatory design, constructionism, reflective practice, adult learning, architectural program, HCI.

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Chapter 1 Introduction

Rediscovering the Familiar

When I was a child, it was a favorite pastime to sneak by my mom while she cooked in the kitchen. I would tiptoe and dart past, moving low, moving fast, once, twice, thrice, each time with her appearing to be oblivious. Then suddenly, she would grab me with a laugh. One day, I decided to get more sophisticated with my approach; I would create a map of the house, to detail my plan of attack.

I positioned myself in the hallway outside my room and began to sketch. Right away, I had to think about what I was representing. How large was each room and what were its boundaries? I saw that the rooms had straight lines, were in fact rectangles, and as I placed one and then another, I came on a startling discovery: a wall of one room could also be the wall of another. Indeed, each room was just adjacent to the next. They all formed a continuous whole. Before I must have believed that the rooms were floating, distinct entities, and having never brought that theory to the surface, it had been unquestioned. Dumbfounded, I walked into each room and tapped on the wall - *this wall is also the wall of the next room* - visualizing what was over there, and where I was, relative to that room.

Figure 1. Conceptualization of my "plan of attack" map.

I don't know whether I took this understanding and begin to apply it in new contexts, following through with ideas of parts and wholes, relative definitions, interconnections, better able to displace my perspective. What was more powerful to me was the recognition that I could be so familiar with something and yet not really see it. I both discovered a quality of my world that I didn't know was there and surfaced a belief I didn't know I held.

Converting Goals to Plans

My parents had this house custom built just before I was born. We were both their creations and I think now, looking back, we both represented my parents' confidence, at the ages of 32 and 33, that they were ready to take hold of their world and begin to

craft it. They spent their twenties breaking free from the paths that had been prescribed for them. They then had the opportunity to make a statement, a plan, of what their new life would be like for themselves and their children.

Figure 2. Our custom-built house in Colorado.

My two sisters were 6 and 13 when the house was built, and my parents were looking ahead to how we would all live in the space together. They decided that their rooms would be at one end of the house and their daughters' rooms would be at the other. The idea was that each party could play their music as loud as they liked without offending the other. So folk rock, embodied by James Taylor and Carole King, and hard rock, embodied by the Psychedelic Furs and the Lemonheads, were well represented in one household, and the family harmony was maintained.

In making this decision, my parents were converting a high-level goal, to be good parents, into a plan[1] for implementation (Gollwitzer, 1999). They defined being a good parent as respecting the self-expression and privacy of their children, and specifically as avoiding battles over trivial things. They connected this theory of parenting with the organization of their space, and in so doing, envisioned their goal being acted out on a daily basis, in a very concrete manner.

Their solution could have been inserted by the builder without my parents' involvement, and perhaps it would have still served the purpose of minimizing conflicts, but I doubt it would have been as powerful. My parents were able to see that being a good parent was achievable, and I bet every time they approached their daughters'

[1] Due to the cross-disciplinary nature of this research (education, psychology, architecture, technology), there are several terms used in the text that could have multiple interpretations without the supporting context. Framing can refer to the framing of a house or the framing of a problem. A plan can be a bird's eye view drawing of a building or a set of actions to meet a goal. I hope that the context of the sentence will make the intended meaning clear, but in most cases I am using terms in accordance with the meanings assigned to them within the fields of education and psychology.

rooms, and were greeted by loud music, it reinforced their commitment to this aspect of parenting. They were able to say, we are the kind of parents who… respect our children, who don't argue over small things. In this way, one solution could touch other behaviors in support of a larger goal.

Home Design for the Homeowner

These two examples, drawn from my personal experience, convey something of what it means to be a designer of a home environment, not as an expert, but as the inhabitant. It requires the re-evaluation of the familiar and reflection on the self: an understanding both of how your environment can shape your activities and how you experience that environment.

The focus of this thesis is on how to support laypeople in home design, not by trying to make them the equivalent of an architectural designer, nor by proposing tools that would have them be bystanders. Instead, home design for the homeowner[2] is conceived as an iterative learning process of defining perspectives, uncovering needs, expressing plans for the future, and making personal connections. The homeowner's first contribution is in providing the problem description, or "program," that will drive the design. The homeowner's continued participation is dependent on his or her ability to relate the evolving solution to the living patterns it should support and the core values it should reflect. The goal of this work is to identify materials and approaches that will collect information for expert designers or expert design tools, while preparing the homeowner to make design decisions and interpret design results.

Research Overview

In the past, the client's contribution to design has primarily been written about from the designer's perspective, in terms of extracting the needed information to initiate the design, not in terms of how the homeowner makes sense of the process. I was therefore cautious in making assumptions about what materials would best support

[2] The term "homeowner" is used throughout this text to represent the layperson or client who is involved or would be involved in home design. The "home" that is owned could be a house, a condominium, or a custom apartment. Although the term is singular, it is expected that in many cases it would be a couple or multiple family members who would be engaging in the design process. For the study described in chapter 4, "homeowner" may refer to someone who does not currently own his or her home, but may do so in the future.

homeowners, deciding to employ an exploratory research approach to find what would resonate with their thinking.

I began by examining how people independently prepare for home design in terms of needs assessment and interaction with expert sources. Individuals who were engaged in or had been recently engaged in home construction and remodeling projects were interviewed, with a focus on the artifacts they constructed to represent their ideas, such as clippings and sketches. These interviews were used to establish how homeowners' existing methods support or clarify their thinking. The interviews are discussed in chapter 3.

For the primary study, participants were asked to engage in constructive and interpretive exercises in support of a specific design task: creating a new kitchen. Participants were given a simple problem description and asked to select from "pre-design" exercises to do as homework over a two-to-three week period. Each exercise was developed to provide a kind of preparation for the design task and result in a material construction (e.g. checklist) that could be shared. Participants made recommendations about media and procedures for homeowners engaged in custom design. They also contributed to an evolving exercise done at the House_n lab that initially offered basic manipulable design pieces (e.g. sink, stove) and concept cards (e.g. "kitchen integrated with dining", "efficient"), and was expanded to incorporate the procedures and representations suggested by the participants. Sessions with the study participants are discussed in chapter 4.

Exercises ranged from image sorting to scenario building to collecting and reflecting on data about activities within the home. I believed that individuals would respond differently to representations and media. Conceiving of their experience as one of learning directs one to parallels with modern educational philosophies, which have come to recognize that learners have distinct ways of building mental models, connecting with ideas, and articulating what they know. An effective interface to custom design would respect these differences among users and provide multiple paths to accessing design.

Residential design is sufficiently complex, addressing aesthetics, functionality, shared histories, and projected futures, that any individual user may also benefit from employing materials representing multiple dimensions. One aspect of this, which is

examined in more depth as part of the study with the participants, is how multiple representations (e.g. verbal *and* visual descriptions) can reveal inconsistencies or provide validation for decisions.

One special class of exercises asked participants to serve as investigators into their own practices through reflection on data about home activity patterns collected with field investigation tools, such as time-lapse cameras, experience sampling on handheld computers, position-tracking wearables, and simple sensors placed in the home environment. The procedure and results of these, as piloted on myself and then participated in by a volunteer family, are discussed in chapter 5.

The work concludes in chapter 6 with a proposal for four pre-design tools and approaches to collect rich requirement data and prime the user for design decisions by helping them to identify their perspective, needs, and goals. These tools are discussed in the context of a reorganized system linking homeowners to suppliers and mediated by computational design tools for customized apartments in development housing, as envisioned by Larson, Tapia, and Duarte (2001).

Framework

This work draws on three interrelated theoretical traditions: reflective practice, constructionism, and participatory design.

Reflective Practice

In describing the work of professionals as diverse as therapists, athletes, and architectural designers, Donald Schön (1983) recognized that expertise is rarely about following a pre-scripted procedure to reach an expected goal. Referencing Polanyi's (1967) theory of tacit knowledge, Schön noted that the actions of a skilled performer are fluid and adaptive and betray a greater competence than the performer can describe. The professional knows, but doesn't always know how she knows, and can even express false assertions about her method. As Schön notes, this is vividly illustrated by asking someone what to do when riding a bike that begins to tilt precariously to the left. Most people will say turn the wheel to the right, with all confidence in their answer, but given that we don't see more tragic tilting bike accidents, one must presume that people know better than what they say and respond appropriately by blocking the fall with the wheel turned to the left.

Schön termed the kind of expertise that is exhibited through performance as knowledge-in-action, and elevated it to being consistent with "expertise," as it is an approach that makes perfect sense for situations that are dynamic, evolving, and uncertain. These situations, to which a professional must continually attend, are resistant to a rigid application of rules. They require an iterative process of action, feedback, correction, and action, and for cases that don't just offer variation, but surprise and uncertainty, they require a continual reinterpretation of the problem and the process.

Although professionals know more than they can say, in a traditional verbal sense, their process generates a kind of artifact that doesn't just serve as a precursor to the final result, but acts as a description of the applied knowledge-in-action. This is best illustrated by how professional designers gradually develop an understanding of both the problem and their process by attending to their developing sketched solution. The sketch "talks back" by revealing the nature of the task and triggering an iterative negotiation between problem and context, needs and resources. In their own construction, they may see unexpected constraints or opportunities, and in the midst of their fluid generation process, they engage in what Schön calls "reflection-in-action," to try to understand how their actions, based on implicit assumptions, led to the current state. They try to make sense of their own construction to understand how their process needs to evolve. Reflection-in-action often initiates a period of guided experimentation, where alternatives are considered, before a more certain approach is regained again for a time.

Each person has access to specialized knowledge about his or her needs, preferences, and responses to things and situations in the world. In this sense, each person is an expert of him or herself, but like the professionals that Schön describes, people may have difficulty adequately articulating what they know and how they know it. Many preference responses, which help filter and structure the constant interactions between people and things and people and people, are intuitive and fluid, so simple and so strong as to make the subjective seem objective. In day-to-day decisions, maintaining this kind of "knowledge-in-action" may be straightforward. Home design, however, represents a high level of complexity, in terms of the number of chained decisions, the balancing of constraints, and the need to satisfy both the now and the projected future. It also demands a coming together of perspectives between

family members, between current owner and possible future owners ("resale"), and between layperson and expert.

In this work, I recognize the homeowner as having knowledge that he or she can best reveal through performance, when provided with materials or representations that "talk back," in a cycle that mirrors a professional's reflection-in-action. The homeowner needs to be able to generate content that serves as a description of his or her own knowledge-in-action on the way to reaching a formal needs specification, just as producing a sketch supports an architectural designer on the path to crafting a design. Through generating this description, the homeowner may begin to make sense of his or her own thinking as it applies to the task, and begin to uncover assumptions, conflicts, and emerging opportunities. This is not a foreign idea to homeowners engaging in home design; as detailed in chapter 3, homeowners commonly use compilations of clippings of example homes from magazines to understand and communicate their own sense of aesthetics. This sensemaking process may also require reframing, through shifting representation or perspective, to support the coming together of viewpoints from multiple individuals, and sometimes multiple viewpoints within an individual (Schön and Rein, 1994). The interpretive exercises developed for the primary study, and selected and shaped by study participants, were designed to support reflective practice by 1) allowing a fluid generation of content that seems familiar and natural; 2) providing an evolving description that reveals the user's thinking process; and 3) encouraging reframing and perspective-taking by offering shifts in representation or categorization.

Constructionism

Implicit in much standard education is the message that you cannot contribute or be the authority until you have done the time and can use the tools of the domain. You are not a healer unless you have been trained in modern medicine (see Jordan's research on the perceived illegitimacy of indigenous midwives, 1989). You are not a mathematician unless you can manipulate complex equations (see Papert's discussion of mathematics education, 1980). You are not a home designer unless you can generate detailed floor plans and speak the language of design.

Constructionism is a learn-by designing, building, and constructing approach pioneered by Seymour Papert (1991). A consistent theme in constructionist environments is a reassessment of who can contribute to a domain and when. Children can build robots or program physics concepts without having the prerequisite years of math classes (Papert, 1980; Resnick, Bruckman, & Martin, 1996). They are able to do this because their materials, tools, and mentors let them speak in their own language, making personal connections, and constructing at a meaningful level. So physics doesn't have to be manipulated at the level of equations, but instead can be explored through behaviors and patterns. Similarly, home design shouldn't have to be engaged with at the level of measurements and spatial relationships, but in a form that draws on the expertise and personal experiences of the homeowner.

Papert's work, and that of educators who followed, demonstrates that complex and abstract ideas can become more learnable when they are appropriated through constructive acts that result in a meaningful and sharable product. Constructionist activities are characterized by a focus on process, whether in the programming of algorithmic steps or the slow build-up of robotic pieces. The constructed artifact represents the decisions to date and can change again to reflect updates to the learner's model and goals. Through tinkering, the learner is able to recognize the consequences of chained decisions, as the artifact succeeds or fails in behaving as expected in the relevant environment. A child building a robot will know something is not right when it spins incessantly in circles, and instead of evaluating the robot as an indivisible unit, something right or wrong, he or she is able to break open the "black box" and test out relevant modifications.

The constructionist process is not like end-of-chapter exercises; it results in a product that can be shared as a relevant contribution to the task or domain. For home design, the sharing can be with family members, other homeowners, or design experts. Artifacts (e.g. clippings, sketches) or descriptions (e.g. wish lists, stories) can support these sharing interactions, by providing a common language or space that can be acted upon and referenced. Within families, a common vision needs to be developed, in order to achieve a home that represents everyone. One family member may be interested in what the home reflects about aesthetic preferences; another may be more concerned about whether a particular activity will be adequately supported.

Effective output of a stage that precedes design decisions would therefore be "objects-to-communicate-with" that help families make their contrasting and complementary perspectives discernible, to carry to the next step of synthesis and compromise.

A consistent goal of constructionist environments is to give learners access to "powerful ideas" (Papert, 2000). Powerful ideas are not important because they meet some nationally determined curriculum or because they are part of an archaic rite of passage - something through which everyone has to suffer (e.g. sentence diagramming, trigonometry). Instead, they empower the learner to approach a subject domain and beyond with a model or process that is both view broadening and personally intuitive. Powerful ideas in constructionist environments have included algorithmic thinking (Logo: Papert, 1989), decentralized thinking (starLogo: Resnick, 1994), moral decision-making (Zora: Bers, 2001), and mentoring (MOOSE Crossing: Bruckman, 1998). Given this tradition of powerful ideas, it is useful to ask, what is powerful in home design?

Home design is about aesthetics, but it's also about usability, accessibility, safety, efficiency, maintainability, and durability. It is about layout, but also about materials, lighting, infrastructure, technologies, behaviors, and practices. It necessarily involves trade-offs, the balancing of constraints, and consequences of chained decision-making. If done well, it anticipates the future, as the homeowner projects forward in time. It is also nostalgic and visceral, expressing cultural and personal histories and giving form to identity ("this is who I am") and emotional well-being ("protection", "independence").

To avoid stereotyped home design solutions that are mismatched to the lifestyles of the inhabitants, assumptions about what is required and what is possible need to be examined. Why is there always a window above the sink in the kitchen? Will I only need to think about issues like safety when I'm older? Do I want this feature just because my mom had it in her home? Does a decision about flooring affect any other decisions I make? Recognizing assumptions based on outdated cultural norms or unconscious emotional associations can change how the homeowner thinks about the source of

knowledge, possibly leading her[3] to question behaviors or beliefs in a variety of everyday contexts.

Seeing everyday contexts and activities as material for critical reflection invites homeowners to appreciate their personal expertise. They build up a lifetime of experiences within homes, interacting with spatial structures, adapting behaviors, ordering activities, and occasionally, getting injured or inconvenienced when their space doesn't support them. In these experiences, they have answers and solutions, counterexamples and cautionary tales that could trigger innovation, or at least, if recognized, connect them with particularly effective designs.

The homeowner who connects with these ideas, the complexity of design, the need for critical reflection, and the recognition of everyday expertise, must then enter into a communicative relationship with a system of building and design, whether represented by independent builders and designers or expert resources and suppliers. Such an interchange, between client and supplier, novice and expert, is repeated in many other adult activities, including healthcare. To be able to describe needs, express ideas, and argue for one's vision, while benefiting from the specialized knowledge of a professional domain, expands one's expertise and knowledge in a way more powerful than any personally held information.

The approach taken within this research was to have study participants construct sharable products (e.g. scenarios, image collections) that they could use to communicate their design needs and preferences, to themselves, to their family members, and to me. While this was part of the participatory design methodology, described below, the exercises also mirrored my expectations for any tools that would be created for the pre-design stage: 1) they should allow homeowners to contribute by speaking their own language, 2) they should encourage the homeowner to tinker, explore, and see their thought processes and their environments as material for investigation, 3) they should allow the users to create artifacts that have some permanence and can be returned to or shared, and 4) they should give homeowners access to the powerful ideas in home design.

[3] I generally alternate between "he/him" and "she/her" when referring to an indeterminate individual to make the text more readable; I do not intend to make any assertions about which gender is more appropriate for a given role.

Participatory Design

In architecture, the phrase participatory design has been used to describe the greater involvement of the client in working with architects and construction professionals as part of a building design process, a central tenant in this research. The phrase, as it is understood in the more broad field of product development, particularly from the Scandinavian tradition of design, also applies to research methodologies that involve members of the target user group as co-designers with the researchers, employing design exercises and multimedia representations to provoke rich responses and actionable feedback (Ehn, 1988).

The traditional approach to product design limits users' involvement to providing feedback late in the process, when their reactions and critiques have limited power. Low-fidelity prototyping, which makes use of materials, such as paper, cardboard, or foam core, that are quick to mockup and require less commitment in terms of technical development, begins to address this problem by engaging the user sooner in idea elaboration (Rettig, 1994). Full participatory design[4] asks laypeople to collaborate with designers by modifying or adding to designs, responding to intentionally open-ended materials, or integrating simple prototypes into existing practices (Kyng, 1994). Brandt and Grunnet (2001), for example, had users act out their interaction with "dream" props, which allow certain freedoms (see whatever you want to see, store whatever you want to store) and are meant to help the user articulate what is needed in a given situation. The goal of participatory design is to develop ideas that are situated within actual practices and that resonate with and reflect the user's process,

A cooperative participant methodology inspired by this tradition was employed in this research to develop a description of homeowners' expertise and generate conclusions about the procedures, framing, and material that should be embodied in custom design tools. Participants were asked to act as my co-investigators, contributing their own interpretations and variations of the proposed constructive exercises, to supplement my analyses. I present the artifacts they constructed and the techniques they developed to guide themselves as recommendations for technology design which are more authentic to and supportive of the experience of the layperson in home design.

[4] Sometimes called "cooperative design"

Chapter 2, Addressed Problem: The Homeowner's Role in Custom Design

> *"You know when you're a kid you think, you know, people, what do you want to be when you grow up? I want to be a homeowner <laughs>. That's about the only thing that's you know like static from being a little kid to a teenager to college, I don't know what I want to major in, I just want to own a house <laughs>."*
> *– Interviewed participant*

The Need to Customize

The photo on the right of an apartment building in Taipei demonstrates the inhabitants' initiative to customize - to personalize - their home environment. This example of customization exists not as an organized effort to provide choices, but as an improvised response to a generic space. Why did these people feel a need to customize?

Figure 3. Apartments with exteriors customized by the homeowners, Taipei, 2003; photo courtesy Kent Larson.

It is possible that the initial space was poorly designed and using diverse materials at different points after the original construction, their patched solutions were unintentionally unique. It is also possible that each family had slightly different needs that the one-size-fits-all apartment couldn't meet, and so they had to seek out individualized additions.

Maybe most likely, these customized exteriors exist because humans have a need to articulate their identity, ideals, and goals through their living space. Custom home construction often functions as an expressive act, marking your success as an adult and communicating your faith in the future. At the end, you have something to share with your family and friends, structure your daily life, and give context to your memories. You don't just own your house; you *own the ideas* that are embodied by that house.

Obstacles to Custom Design

That custom design is desirable is not surprising, but given the agonizing process that most homeowners have to endure and the static, fractured nature of the home construction industry, its persistence is notable. Obstacles to wide-scale implementation of custom residential design with current approaches, from the homeowner's perspective, include: 1) concerns about preserving resale value, as most families don't remain in the same house for many years; 2) the availability of skilled labor; 3) the potential increased cost of design, labor, and materials; 4) the length of time required for the completion of design and construction; 5) the perception that custom is only an option for those building on a new plot of land; 6) the harrowing experience of working with contractors and supply stores; and 7) uncertainty about whether custom is needed and worthwhile given the other obstacles.

There are few who can afford a completely custom home, particularly one built with the involvement of an architect. Most people are placed into an uneasy relationship with builders, contractors, and supply stores, not sure of what they can personally contribute or control. Home design, for the homeowner, may be reduced to basic aesthetic decisions ("traditional or modern?") and the acceptance of canned solutions, resulting in just another cookie-cutter home.

New technologies and design principles are not readily available to the average homeowner and consequently do not become widely established (Partnership for Advancing Technology in Housing, 2002). Post-occupancy studies are rare in residential design, and lessons learned from individual acts of construction have little chance of being disseminated, as residential building teams are loosely tied, transitory, and autonomous. The building industry as a whole tends to resist change (Larson, Tapia, & Duarte, 2001); new living patterns may not be adequately represented in the standard design solutions. Concerns about resale have further constrained homeowners to build and buy generic homes.

Those homeowners who proceed anyway can typically tell a good "war story" about their experience with home construction, as reflected by its representation in popular culture (spanning from 1948's "Mr. Blandings Builds His Dream House" to 1986's The Money Pit).

New Approaches to Enabling Custom Design

Advances in building and computational technologies, coupled with a reorganized system of residential design, may begin to address these obstacles and make custom homes a possibility for a larger segment of the population in the years to come. If home construction in the past has been like sculpting clay, requiring significant expertise from the builders, modular building components may transition it to something more like erecting Legos, with a varied pallete that allows a combinational number of possibilities, but enforces a more consistent, and less error-prone, construction. The interlocking-nature of these components could also make homes easier to remodel. As envisioned by Larson (2002), and described and prototyped by Lawrence (2003), integrated, varied, and personalized "infill" components that connect in standardized ways to the base building "chassis," redefine how a house can be modified. Typically, homeowners recognize the cabinetry, the furnishings, and the basic surface finishes, such as wall paint, as the pieces of the home that are easiest, and most affordable, to modify. Renovations that require removing or adding walls, shifting or adding major appliances or fixtures, or making changes to the "footprint" of the home are rightly regarded with caution. In the new model, infrastructure such as plumbing, power, ventilation, and digital networking would be consolidated into a made-to-order frame or chassis. Exterior and interior wall panels, expressing a variety of possible aesthetics through use of materials, finishes, and attached cabinetry options, could be popped-out, shifted, or locked-in to alter the interior layout and the exterior footprint without damaging the structure of the house or requiring highly skilled labor.

These building technologies should make custom homes easier to construct, permit a greater level of personalization without threatening resale, and could make customization a continuing process over the life cycle of the home. Homeowners may feel less restricted by their initial decisions, even when children move out or parents move in, making them more willing to explore highly personalized solutions. At the same time, homeowners may view remodeling as a more routine activity, periodically changing their home environment to reflect their current needs and values.

Such a system has been described both for new home construction and for customized interiors of apartments or condos, meaning that "custom" might become more common within urban and other previously built-up settings.

Even with building components that are easier to assemble and refigure, the same substandard forms might be rebuilt without the contribution of elegant and intelligent design. Only a small segment of the population (currently about 4%) can afford to work directly with an architect (Kent Larson, personal communication), and they may continue to do so. For the remaining 96%, indirect representations of expertise are needed. A reorganized system of home construction would invite the greater involvement of the architect by embodying her expertise in computational design tools that operate on a library of components to generate custom design briefs (Larson et al., 2001). Such tools might be based on formally defined rules and shape grammars (e.g. Duarte, 2001) or learning-by-example machine algorithms (e.g. Williams, 2003). They would need to insure that certain design standards were met, such as universal design accessibility principles and local building code requirements, while representing the sensibilities and aesthetics of particular designers. When provided with site-specific information, linked to pre-fabrication suppliers, and completed by a new class of builders who act as integrators of modular components, such tools could reorganize the home construction system to one of "mass customization."

Home design has remained relatively static over the last few decades, but evolving lifestyles will make customization more important. Although humans are good at adapting to living spaces, as the population ages, there will be more interest in homes that are safe, supportive, and accessible to both the young and old. Combined households (with adult children or aging parents) and reduced households (the older adult or successful single living alone) represent very different patterns of living than anticipated by the suburban two-bedroom. Teleworking (working from home all or some of the time or working on the move) puts into question the division of work and living spaces. The management of chronic diseases, a reality for an increasing number of families, and the need for small everyday behavior modifications for the other side of the coin, preventative health, make living spaces healing spaces (Dr. Dan Carlin, personal communication, 2002).

Of the homeowners I interviewed, two couples were looking to work part, or even full time, at home, two women who hated cooking were remodeling their kitchens, and three single adults successful in their careers and not wanting to wait for marriage had bought their first homes. By sharing conversation with headset

telephones, one woman enjoyed cooking with her mother, though they were each in their own home, miles apart. Another woman related how she and her husband were utilizing their home in a radically different way with the introduction of a single technology: wireless networking. Their offices go unused, as they roam around the house with their laptops, pulling up work documents and the evening news. She responded to one of my emails with the laptop on the microwave, as she quickly put together her dinner. She also recounted how her niece and nephew were aghast when she pulled up a recipe on her PDA, setting down what they thought of as a "special" technology amidst the flour and eggs. Technology is creeping out of the corner study and into the messy, high-traffic areas of the home. More so than any technologist's predictions of future trends, these small examples help convince me that the way people experience and utilize their own homes is changing. The home will be increasingly important, but will need to be reinvented to fit these emerging societal needs and in response to the multiplicity of paths peoples' lives take. Even the typical physical dimensions of the home were demonstrated to me to be all too "average," with one of my women participants under five feet and another over six feet.

The Homeowner's Contribution

For the described technologies to take hold and for custom design to become more of a reality for those other than the fortunate few, considerable changes to industry will have to occur. Construction, infrastructure, component, and new service (including digital) industries will need to come to agreement about standard interfaces and protocols for integrating and combining their products. Early entryways into the market, where experimentation can take place, will have to be found before component production and integration can become affordable. Computational tools will have to insure workable designs, make the sharing of designer expertise straightforward and expressive (Williams, 2003), offer compelling visualization, and provide avenues for consumer feedback for manufacturers to find value in sharing product information (McLeish, 2003).

Technologies for building and designing custom homes are unlikely to make an impact without the central involvement of the homeowner. That there would be initial consumer interest in a system that makes custom housing more affordable and less of a

hassle is arguably a given. If there is to be sustained interest, however, consumers must believe that the kind of customization the system provides is preferable to simply selecting from pre-built homes. Without rich descriptive information about the user' s needs, practices, and intentions, design tools can accomplish the "custom," but won' t necessarily create something meaningful and personal (Thomke & von Hippel, 2002). Without an understanding of the homeowner' s needs and intentions, industry will find it difficult to anticipate how new technologies and components will be accepted.

Unfortunately, most tools available to laypeople are blind to the nature of their expertise or the particular challenge of their role in home design, which is to link personal needs to design decisions. These tools assume the user has imagined possible future scenarios, resolved conflicting perspectives between family members, prepared for the necessary tradeoffs, and formulated mutually supportive goals that the resulting design should meet. Jose Duarte's (2001) computational design tool, Malagueira, compellingly implements a particular design philosophy, the shape grammar of architect Alvaro Siza Vieira, to create workable custom home design briefs. The user, who is assumed to be the future inhabitant of the resulting home, is expected to be able to input a set of condensed requirements (e.g. number of bedrooms, desired quality, orientation), make revisions at the level of space topologies, and mentally apply personal evaluation criteria to the output design. Although Malagueira is a notable achievement in terms of both representing the designer and producing varied and novel designs, it is more about expressing and operating on a design space than articulating the user's personal vision. Here the user puts something in and gets something out and can only contribute if he or she speaks the metric of spatial design: topologies, adjacencies, and capacities.

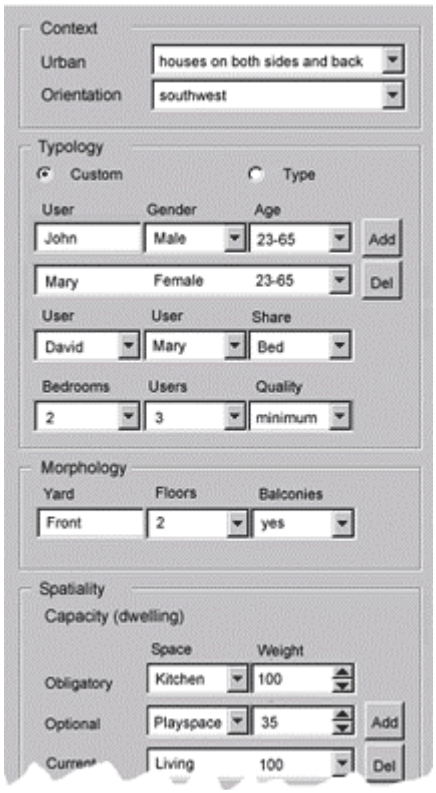


Figure 4. User interface to set requirements for design generated by Jose Duarte's Malagueira

Software tools that are widely available to laypeople attempt to make design more accessible to the non-expert, but are similarly restrictive in terms of the user's contribution. Bob Vila (http://www.bobvila.com/DesignTools/), Home Depot (http://designcenter.homedepot.com:8001/), and Merillat (http://www.merillat.com/planning/index.asp) provide design tools on the Web that incorporate actual product options in a visualization interface. The Bob Vila "3D Room Design Studio" and Merillat "My Design Kitchen Planner" tools offer a combination of plan ("bird's eye") view and 3D rendering interfaces within which appliance and cabinetry components can be added and positioned. The Home Depot "Kitchen & Bath Design Center" tool has the user select a photo of a kitchen or bathroom scene and "modify" it through material and product choices. The tools output documents that can serve as a consumer interface with the company/store.

Figure 5. Screen-shot of Bob Vila "3D Room Design Studio"

Figure 6. Screen-shot of Home Depot "Kitchen & Bath Design Center"

With each of these tools, design is minimized to a limited aesthetic process. In interview sessions, users have commented that they appreciate how the Home Depot Tool permits them to see choices in combination, a visual integration of decisions that is difficult for most laypeople to achieve. However, the scope of the tool, pertaining only to surfaces, is limiting. The Bob Vila and Merillat tools include operators for determining layout and positioning of components, but are tedious to manipulate. The responsibility is on the user to visually evaluate the design, and most of what one comes away with is frustration and a desire to get professional assistance. Although the Home Depot scene is photo-realistic, and the Merrilat and Bob Vila tools render in three-dimensions, the results are quite different from real homes, lacking objects and items, food, activity, and most significantly, people. No explicit effort is made to connect decisions being made in the interface with how they relate to the particular practices or goals of the user. Aesthetic preferences are often perceived as easy and enjoyable;

a kind of knowledge that anyone can have and express, but by simply focusing on visual taste, at a decidedly surface level, the tools are missing the opportunity to make connections with richer and more resonant personal models of the home environment.

We all have a kind of expertise about what makes a home livable, based on our experiences with adapting to and arranging our built environment, but it is not formally recognized for its role in home design decisions. I propose that placing laypeople (homeowners) in participant roles is essential if home design and construction is to become more responsive to the needs and values of the occupants. When provided with a meaningful level of representation and manipulation, users can build rich descriptions of their needs and practices and contribute to creating an optimal personal solution.

Within Larson's (2000, 2001, 2002) vision of mass customization, the homeowners play a central role. They seed the computational tools with their vision, facilitated by what Larson calls a "preference engine," a front-end that takes the user through design

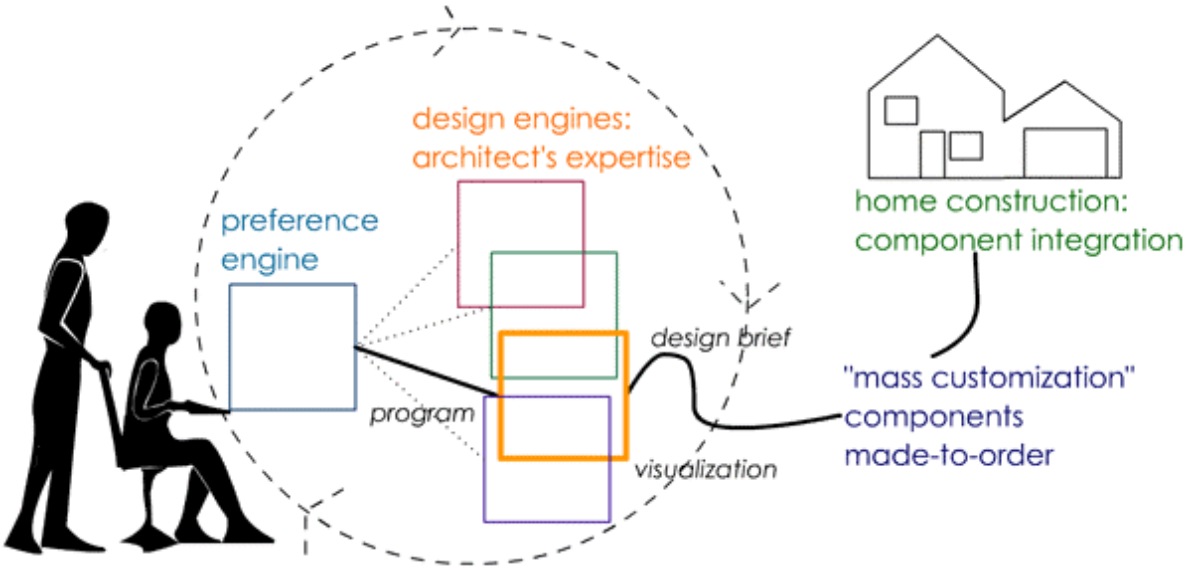


Figure 7. Conceptualization of the home customization process envisioned by Kent Larson.

games, questions, images, and other representations, to uncover needs, preferences, values, and reasonable tradeoffs. The preference engine builds a user profile that will be passed to an appropriate design engine or engines. Working in concert with visualization and manipulation tools (e.g. tangible interfaces prototyped by McLeish, 2003), the design engines seek to express the user's vision as a workable design. The

process is iterative, with significant modifications by the user expected and encouraged. Although the preference engine is discussed as a discrete component in the customization system, the user cycles between problem description and evolving design solution (Larson, personal communication, 2003). When tinkering at the design level is difficult or insufficiently meaningful for the homeowner, the user may choose to work again at the level of needs and goals.

The Program

The product of the stage represented by the preference engine is the *program*, a problem description for the architectural design of the space. Programs function, in part, as a contract between the client and the architect, both to layout what the design should seek to accomplish and to frame the constraints that will limit the design. For commercial buildings, it is not uncommon for clients to hire "expert programmers" as a go-between with the architects.

The program therefore is a communication interface between layperson and expert, client and professional. From the architect's perspective, it needs to be sufficiently rich to seed their initial design efforts, sufficiently constrained to guide iterative revisions, and sufficiently accurate to avoid costly mistakes. For the client, the program functions as a document that will represent them throughout the design process, and by which they can judge the end result.

The seminal text for architects on developing a program is Problem Seeking by Peña and Parshall (2001). Peña and Parshall recognize that design, which they liken to problem solving, cannot function without a problem description. They see the programmer as "separating wants from needs" and "identifying important factors while postponing irrelevant material." Both of these roles are related to prioritizing, though the second has more to do with the process itself, determining a path of decision-making. Peña and Parshall point out that programming is in fact a process, which requires it to be extended in time (and perhaps also for it to be interactive and iterative). Seeking responses using a prepared questionnaire doesn't constitute programming.

For Peña and Parshall, programming is a discrete stage that *precedes* design. They stress that it is important not to rush to judgment or offer a preconceived solution before the problem is specified. They therefore would not approve of providing clients

with possible solutions (e.g. popular plans) before the program is developed. Their strong segregation of problem setting and problem solving is notable – on the one hand it suggests that programming is important in it's own right, but it also doesn't address how the problem may be better understood over the course of design, thus requiring it's redefinition. Their goal is to limit the extent to which the problem setting must be revisited – "indecision increases the complexity of the design problem."

Peña and Parshall describe five steps to the production of the program: establishing goals, collecting facts, testing concepts, determining needs, and stating the problem. They note that goals can initially be ambiguous, which may trigger deeper reflection, but ultimately should be described as a more detailed objective that describes something immediate and attainable. Being a good parent might be a more general goal that inspires the homeowner to reflect on how that might be achieved. A more specific objective might be to be able to reach the children quickly when they are in physical danger. Part of concept testing is in providing options and offering alternatives, but should be kept at level that has more to do with human activity than physical implementation. They recommend that the programmer only collect the information that can be managed and used by the designer. A question might be whether there is information that does not aid the production of the design but does help the client to understand or appreciate the design.

Peña and Parshall define the problem as having four dimensions: function (how will the space be used), form (what will the space look and feel like), economy (initial budget plus life cycle costs), and time (influence of history, projection of future). Function, form, and time are the primary focus of this research.

Peña and Parshall are writing from the designer's perspective, but they do acknowledge the role of the client ("Users are experts in the use of the building") as a contributing member. Although they frame their discussion in terms of users and owners (presumably with regard to a commercial building), their statement that exposure of their differences as an initial step toward reconciliation of design goals could apply to members of a household. Peña and Parshall believe that the programmer prevents the client from making premature decisions and raises the client's "appreciation and aspiration for better buildings." Therefore, apart from acquiring information for the

program document, the programmer has a role in mediating conflict, guiding the client's mental process, and educating the client.

Participation through Computational Tools

Writing in 1975, Nicholas Negroponte looks on the programmatic dialog with significant skepticism, taking the strong view that the residential architect merely "foists" his or her values on the client, getting between the homeowner's needs and the resulting home. He concedes that the architect can generate goals that the client may not have thought of, but there may also be "distortions and side effects" in the translation. He notes that the most expanded role for laypeople in architecture is in providing data about living practices, but even that is collected, interpreted, and decided upon by the experts. He contrasts the client-architect process with indigenous architecture, which develops without formal design, but maintains a coherency, operating on more organic constraints, such as material availability and climate. Homes in these systems may not be divided into the stereotyped spaces for which we have names – kitchen, living room, dining room – but instead are shaped by complementary activities. Negroponte has faith, therefore, that laypeople can in fact replace architects, letting their needs and living practices drive the design through use of appropriate computational tools.

Negroponte cautions about computational tools that repeat the mistakes of architects and subjugate the homeowners into accepting solutions that are not their own. He cites the following computer-user dialog from Rorick's ARCHIT program (1971, as cited in Negroponte, 1975) as an example of a program solicitation process that "bullies" the user into agreeing with design scenarios:

> *Computer*: Who does most of the cooking in your family?
> *User*: Carol.
>
> *Computer*: I would suggest that the dining area for your everyday meals be in the same room as the cooking area so that everyone can socialize while meals are being prepared and Carol won't be isolated in the kitchen. Don't you agree?
> *User*: Yes

In the second question, ARCHIT presents a design scenario that has an implicit value association: socialization in the kitchen is good and the cook should want to engage with the family. By structuring it as an agreement style question, the

responsibility is on the user to think of a positive and reasonable counter-scenario (e.g. Carol feels more comfortable cooking when she has some privacy) and assertively disagree with the computer expert. If it weren't Carol, it would be Ken or Sandy or Anna, all placed in the same stereotyped scenario, making it an oddly un-custom decision. Interestingly, the following questions, also from ARCHIT, employ the opposite approach.

> *Computer*: How often do you want these occasions to be formal (that is, other than casually joining you for dinner) in times per year?
> *User*: 12
>
> *Computer*: Keeping these answers in mind, do you feel that you need a separate dining area for more formal occasions?
> *User*: No.

The computer expert could take the responses from the initial questions and produce another agreement style question (e.g. I would suggest that you have a separate dining area for your more formal occasions, don't you agree?), but instead the final question has the user interpret his or her own answers. The restricted dialog doesn't permit the user to contribute an alternative way of handling formal occasions, or otherwise externalize their own thinking, but at least the essential decision is in still the user's hands. In spite of this inconsistency, Negroponte's point is well made that even a question-style interface, which on the surface appears to be solicitous of the user's knowledge, can strongly direct the user into stereotyped responses.

Negroponte draws issue with methods that try to rapidly determine the program with simplistic or leading questions, doubting that they will ever begin to get at the more complex and interesting patterns that should define the home. His focus is on how to remove the translation-aspect by essentially putting the layperson in closer contact with the design, with the tool "elaborating" and critiquing the user's actions. He acknowledges that the layperson doesn't have the same skills that an architect does, but finds these are mostly in terms of ability to output a visualization of the design. If a layperson can make decisions about furniture, paint color, décor, then perhaps their inability to sketch to scale and with precision is the only essential obstacle to making decisions about allocating space and deciding boundaries. To this end, Negroponte and his fellow researchers, describe an interface that allows users to describe space adjacencies in terms of a connected bubble diagram. In having them

draw their current space, it becomes clear that they can understand and express relationships between rooms, even if it would have been difficult to do so in a scale drawing. A design tool could then begin to question "what they mean" by the design, shaping a problem description from a physical description. Although Negroponte does not go further to describe how this interface would be used to create new home designs, his discussion hits on several important points: 1) a custom home should be one that reflects the vision and decisions of the inhabitants; 2) traditional methods such as question-centered dialog can unfairly position the user into accepting someone else's vision; and 3) finding an appropriate representation and means of manipulation can permit laypeople to express what they know about design and directly link intention with design.

Previous Work: Tools that Address the Program

Work at the University of Colorado is based on an expert system that provides argumentation for design decisions, specifically in the context of the kitchen (e.g. Fischer, Nakakoji, Ostwald, & Stahl, 1993). The interface consists of a plan view with movable components, such as the sink or stove, and information-based argumentation related to individual design decisions. The argumentation is triggered when a possible conflict is detected. In the original version, that conflict might have been making a potentially unwise design decision, such as placing a stove under a window. The argumentation would note that this might represent a fire hazard, if the window has curtains. One significant contribution of their work was providing argumentation at the "right time," letting the designer work freely until a conflict is detected. Their work is inspired by Schön's (1983) reflective practice and seeks to supplement the seeing-doing-seeing process, rather than automate design. They have a restricted material, plan view representation, and represent design as a rational process.

Nakakoji (1993; Nakakoji, Sumner, & Harstad, 1994) extends this work to include the problem specification as material that can be externalized, noting that problem framing and design are intertwined. She recognizes that designers start with a partial problem specification and develop and modify it based on their interaction with the solutions they develop. Her interface collects initial requirements, based on questionnaires that professional designers use. She links these requirements with rules

that are preferentially activated, creating a custom critic. A conflict may occur if a decision conflicts with an intention or if a decision forces a tradeoff between intentions. An example of the latter would be if the designer has specified that the cook is left-handed and that the client is concerned about resale, and places the dishwasher to the left of the sink. In this case, the decision fulfills one of the intentions, but is contrary to the second. The designer can then modify the problem specification, ranking resale above personal customization, for example, in response to the conflict. She notes that it is difficult to recognize tradeoffs between abstract intentions until a concrete example of their contradiction becomes apparent.

Nakakoji conducted user testing where users worked in pairs to make design decisions for a hypothetical client. The users were given a partial requirement list and provided with a few additional details on request. As they worked, they could request critiques from the knowledge delivery system. These critiques were appropriate for the current design decisions being made, under the specified program constraints, and they would trigger both re-evaluation of the decision and the understanding of the problem. In response, the user pairs could modify their design (e.g. move the refrigerator to be close to the door), request more information about the problem (e.g. how large is the family?), modify the problem description (e.g. the family needs a microwave, supporting multiple cooks is more important than eating in the kitchen), or verbally provide counter-argumentation for the supplied critique. In any case, supplying argumentation at the right time and place and consistent with the current conditions, inspired reflection and reframing. Externalization of the problem specification encouraged the users to include problem reformulation, as well as solution reformulation, as part of their reflection process.

Among her specific findings, Nakakoji found that users employed "mental simulation" to evaluate decisions – a kind of telling stories about the design that allowed them to develop their own heuristics or evaluate the provide argumentation. They did this without prompting, as a verbal conversation between them. Users had difficulty assigning weights unless given contradictory statements in context. For example, the statement supporting multiple cooks is more important than eating in the kitchen might be difficult to evaluate out of context, but when a decision about the layout of the counters puts the two intentions in conflict, a judgment can be made. A

negative side effect of the expert knowledge delivery system was user dependency on the critic messages. At times, the users would make changes until there weren't any critical messages to try to please; their own evaluation of the design didn't stimulate revision.

Kimberly Koile's work (2001) attends to the abstract quality of initial user goals. Her tool, the Architect's Collaborator (TAC), inputs an existing house plan and operates on dimensions such as privacy, openness, and natural light. The intended user is an architect, who is trying to achieve goals set by his or her client. For example, the client may indicate that living room does not have enough privacy with respect to the front door, or the dining room needs more natural light. TAC can evaluate spaces on these properties by quantifying how much light a room receives from windows or the degree of access between spaces. It can then suggest repairs to a design to better match the specified goals. Although the TAC is intended for an expert user, and assumes that the client has already decided on a set of high-level goals, it supports client-architect communication by requiring less precise, spatially-grounded specifications. The client is freer to talk in a language that is familiar and meaningful. Koile also notes that an iterative process that begins at a more abstract level and then provides concrete solutions can trigger the architect and client to pull out new goals that have been unspecified, such as the desired size of a room. Although this is also true of paper-based architect-driven sketches, the computational solutions are less costly in terms of time and effort; a client may feel more comfortable criticizing the design and requesting a revision of requirements. TAC serves as a strong example of artificial intelligence – driven design, but also demonstrates how computational tools can support the role of the homeowner by letting them speak in their own language and feel more comfortable with critique and exploration.

This Work in Context

Advances in building technologies, budding interest in mass customization within the home construction industry, promising developments in computational intelligence and accessibility (e.g. the Internet), and the multiplicity of modern living patterns signal that now is a good time to seriously consider how a custom home design system, directly linked to pre-fabrication and product suppliers, could be realized. The concept

of customization shifts the stimulus and control of design to the current generation of homeowners; its ultimate success, both as an approach to design and as a consumer solution, is dependent on whether homeowners see themselves reflected in the end result. Manufacturers too benefit most by a process that reveals and expresses the current needs, expectations, and interests of consumers. Custom home design can only benefit from the rich engagement of the homeowner, as someone who can act as an expert of her own needs and preferences.

The current work seeks to supplement the research discussed above, particularly as framed by a system of customization using mass customized components for home design. I aim to take the homeowner's perspective, emphasizing the importance of making personal connections with design and being able to relate design decisions to perceptions of identity and plans for behavior. Like Fischer and Nakakoji, I seek to support the iterative cycle of reflective practice in design, but taking a cue from constructionism, I am focused on materials and representations that will let homeowners make meaningful and sharable contributions, while "speaking their own language" and expressing their own knowledge about themselves within everyday environments. With my approach, homeowners are not given expert advice, but rather are prompted to articulate, question, and investigate their experiences, their responses, and their resources-at-hand, their current home environments.

I use a participatory design study protocol to look for approaches that are authentic and resonate with how people choose to guide themselves through home design. Through this research, I hope to demonstrate the value of two distinctive participatory design methodologies for the study of informal adult learning; they address how the participant can investigate and reflect on his own thought processes and his own environment, respectively. For the former, I ask participants to construct sharable artifacts with open-ended materials, such as images of example kitchens and scenario frameworks. For the latter, I revision technological field tools, such as sensors and experience sampling, as tools for self-directed investigation.

Chapter 3, Interviews: Independently Preparing for Design

At what must have been around the same time I was making plans to outwit my mother, I drew what was to be the first of many "elevation" views of a house, this one inspired I'm sure by my dollhouse. I doubt this drawing exposed any beliefs or helped

Figure 8. My "elevation" sketch of a house, 1985 (age 7).

me to understand spatial relationships, though perhaps it is significant that I made a point of having an exterior that peels off to reveal the interior. What I do think this view gave me was a way of talking about what interested me the most, the stories that were going on within this fictional home. While the plan view I created showed me adjacencies and connections, the elevation view let me express habitation and activity.

As an adult, I engage in a 20-minute exercise, proposed by Chuck Kukla, a researcher at House_n and proponent of ethnographic methodologies. He asks us to sketch our idea of a kitchen, keeping in mind that the kitchen doesn't have to be limited to a room. I decide to draw my childhood kitchen from above, but also include objects, transitions, and references to particular memories. I want to communicate something about my idea of a kitchen that would make sense to the design-oriented members of our group, so I choose plan view with arrows describing connections with

spaces. I also want to make a personal connection with the material, and to do so incorporate my childhood recollections.

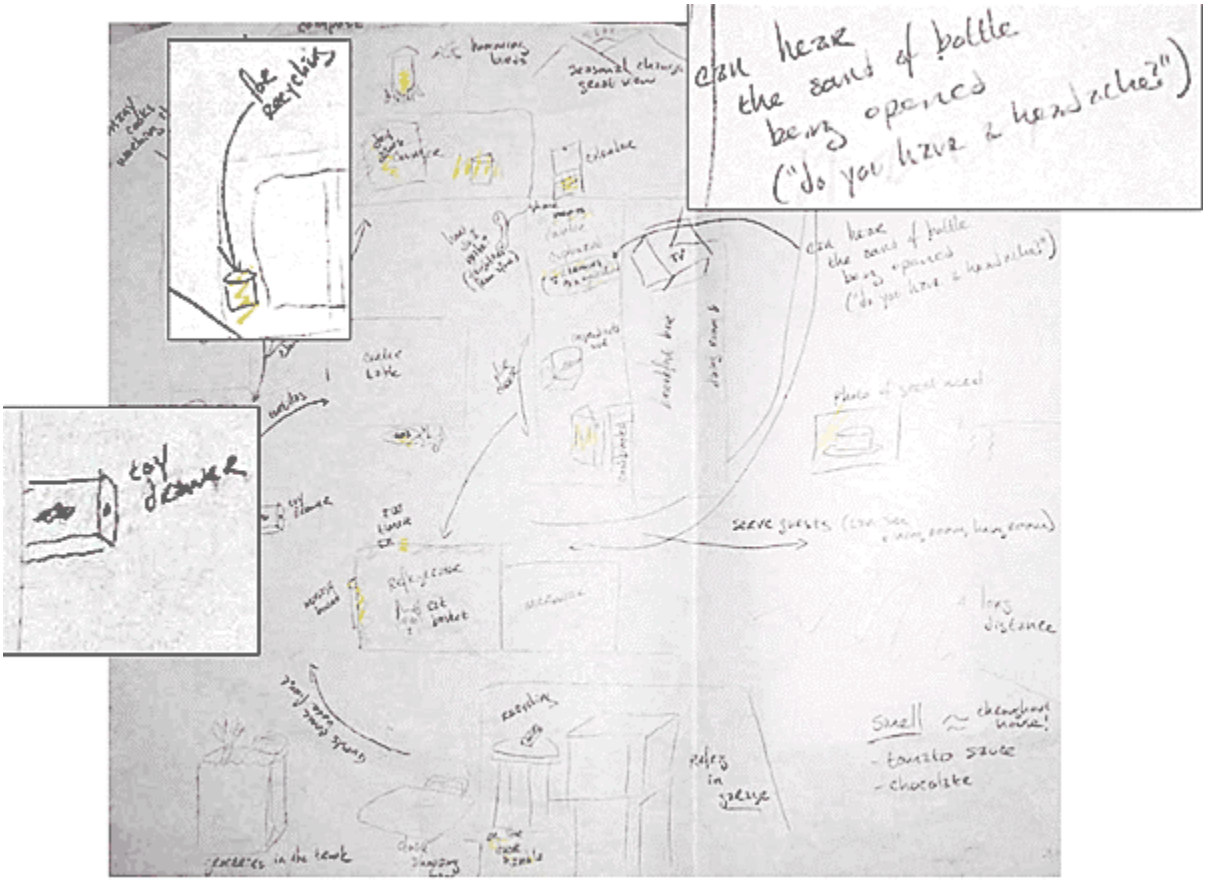


Figure 9. My sketch of my childhood kitchen, combing plan view with annotation.

In doing this exercise, I recall the toy drawer that my mom provided for me so she could watch me while she cooked and I played. I note that the central position of our kitchen and its open boundaries would allow us to hear the unscrewing of a pill bottle from down the hall, prompting us to seek out the bottle opener to inquire whether he or she was feeling okay. I also draw in the narrow section of counter between sink and wall where we end up cramming the tomato sauce and cat food cans before we take them to be recycled – one of the awkward spaces in the kitchen. Architecture student Xiaoyi Ma ('02) has commented that I "tell stories" about the design. I realize now that my recollections of home merge space with activity – a kind of combination of my childhood plan view and elevation view, which is reflected in my kitchen map. My method to connect with design is through memory and story.

I start with these examples because they describe the construction of artifacts that can be used to think with and communicate with, specifically about some of the ideas that are embodied by the home. Children create a lot of these: maps, sketches, Lincoln Logs, dollhouses, and forts. Adults create them too, in their process of learning about and preparing for home design and remodeling.

To understand the value of such artifacts, I interviewed several adults about how they compile and construct materials that represent their ideas, and how they incorporate them into their process of goal setting, decision-making, and communication with professionals. I didn't want to focus on do-it-yourselfers or individuals who choose to let experts make all the decisions. Instead, I wanted to talk with people who, like most of us, enter into an at times uneasy relationship with designers, contractors, and suppliers, contributing to the redesign of their homes by providing the problem, the requirements, the restrictions, and the personal vision. Two couples and four individuals were recruited from the Greater Boston Special Interest Group, Computer and Human Interaction (GBSIGCHI) electronic mailing list and volunteered to be interviewed without compensation. One couple and one individual were identified through word of mouth. Some of them invited me to talk with them in their homes, while others brought stacks of materials to me; all of them had a ready story to tell and solemnly acknowledged the challenge and fascination of what they were trying to do. I describe now the stories of three such homeowners.

Kristen: Materials to Explore and Express

Kristen[5] is in her late 20s, soft-spoken and pleasant. She has been in her condo for two years, her first home. When she first moved in, she was struck by the generic white walls and has been working since then to fix the nicks and mistakes of previous work and decorate it in a way that is "comforting" and "soothing."

> Somewhere along the way, I don't even know where I heard this, I read something that said to help figure out what you want, figure out what styles you like, start pulling pictures out of magazines, anything you like, just start ripping it out and keeping it. So I did.
>
> My mom had a whole year of Martha Stewart's that she was going to throw out, so I looked through them and pulled out anything I liked and kept it. Here and there I would get magazines at the supermarket. What else? Oh, Pottery Barn catalogues, just to get ideas for designs. After doing that for a while, I

[5] The names of interviewees and study participants are pseudonyms.

> started recognizing what I liked, what kind of styles I liked, and started formulating ideas in my head of what I wanted to do.

This is her first time doing any sort of decorating or repair work. I ask her if she knew what she liked about the images she clipped.

> Not always, I think that was a process too. At first I kind of just took anything I liked, that felt like me I guess, well, I shouldn't say anything I liked, there are certainly things I like that I wouldn't want for myself. So things that I liked that I could see myself living in, I guess. That was a starting point. From there that helped me figure out color schemes that I liked.
>
> Another thing that helped me, I visited a friend's house during the process when I was making these decisions and I loved their house. It's old farm style house. I realized I really loved that time period and that whole look. So the combination of seeing their house and some of the pictures that I had pulled out that were of that style too, I realized I like that kind of country feel. I noticed the colors that I had torn out were colors they had used, so that helped me figure out some of the color schemes I liked.

Kristen uses examples she sees in magazines to help her determine what she wants to express in her home. When she finds a correspondence between an actual home that she likes and the colors she has already identified, it is a confirmation of her discovery process. She also clips out how-to articles and prints-out products that she wants to consider from the web. She shares these clippings with her friends, letting them in on her current understanding of her own style sense, but this is not always a positive experience.

> I would show them, what do you think of this? Or I like that. Which was good and bad, because if somebody had a very different style than I did, they'd be like oh, I don't like it, you know, so I learned that, after a while to be careful about sharing my ideas with people. Because if they didn't like it, it would kind of bum me out, I'd be like, is this what I really want? There were so many things to decide, once I narrowed it down, I was careful what I told.

The clippings that she has compiled help her try out aesthetics and clarify her own response. They also serve as a means of expression about what she wants to achieve, that she can share with family and friends. When someone responds negatively to what she has created, it causes her to question her own sense of aesthetics, a disturbing experience that she seeks to avoid.

Her process of idea seeking and reflection occurs over several months, as she carefully ponders how she wants to paint her kitchen, bedroom, and living room. She takes "before" photos of the kitchen, knowing that she will want a record of the changes she makes. These photos are digital and they give her an idea about how to test out her color scheme idea.

Figure 10. Kristen's before and after photos of her redesigned kitchen.

> I worked at a web design shop. So I brought these photos in and had my friend change them with Photoshop. So we actually experimented with colors.
>
> *[Jennifer:] So did it actually help you come to that decision? You saw yellow on it and –*
> Yeah, and it looked really good. That helped. That was a cool thing. My friend did it – it wasn't easy, he had to draw all around it.

She also experiments by moving around her table and hutch in her kitchen. At work, when she's bored, she doodles sketches of this space, re-arranging these pieces in a rough plan view.

> *[Jennifer:]<referencing the photos> I see you moved the table, did you have to arrange that?*
> Yeah, I had to play with it a lot, it was an awkward space and I settled on the table in the middle, it fills the room, and makes it less blocky, less square.
>
> *[Jennifer:]And you said that took some experimenting? You moved it around -*
> Yes, it took a lot of experimenting, I'd move it here and there. I would sit there and draw layouts, and draw my furniture in again and again.

With the aid of her mother and decorating how-to books, Kristen preps the walls, paints, rearranges, and adds her mother's handmade curtains. Following this success, Kristen moves on to her bedroom, this time trying a new technique to determine her color scheme.

> Somewhere along the way I learned a tip, if you see an item you like, you can kind of build your room around it. So, I had this little book, like a blank journal, it's really pretty, it's like this pale green color with a little square in the middle with a little pink rose on it. Just looking at that very pretty and soothing, feminine, but not overly feminine, and I decided that was the kind of feel I wanted for my room.
>
> I also invited the creative directors from my company over – oh, help me figure out what to do! So they did some interesting things, they would try to pick out a contrasting color to what I may have first had, it just made me think about other options I hadn't thought about.

> This book was maybe something that my friend may have noticed. I think he brought it over to my bed, the quilt, and noticed there were several of the same colors in it, he did something like that and that prompted me to notice it and that I liked it. He also took something in my kitchen, a bottle that had cranberry and vinegar and brought it into my bedroom to contrast with the colors. And it was something that I never would have thought of. Little things like that made me think about things differently, get another perspective.
>
> *[Jennifer:] Do you think it mattered that you already had those objects in your apartment?*
> Um, yeah – somewhat yeah. He was working with what I had, what I had already known, helped bringing together things I already had.

Kristen recognizes the value of another adult's perspective to help her see the possibilities in an environment that has become familiar. Her friends help her to understand herself by noticing objects she has placed into her personal environment.

Kristen has now completed the living room and is considering a remodel of her bathroom: a project for which she believes she will need a professional. She is pleased with what she has been able to accomplish.

> It's so much more comforting, finished looking, real. Not so apartment looking.
>
> *[Jennifer:] Do your friends notice when they come over?*
> Oh yeah. Some of them helped with it and they hear about everything. They've been very good. So everyone's like, what're you doing now, what's the latest? And they want to see photos. So I learned that I need to have both before and after photos, if they can't come by to see it.

It seems at first puzzling that Kristen has put so much effort into changing her home on a limited number of dimensions, chiefly color. She has spent over a year contemplating such decisions and learning the skills necessary to make the changes. In addition to consulting how-to sources, she has created a sharable artifact representing her aesthetic sense, experimented with imagery, sketches, and her actual physical space, and drawn on friends for a new perspective. Although the scale of her remodeling is by relatively small, the essential acts of externalizing her aesthetics and changing her environment so it can represent and affect her are significant. Kristen's first forays into home remodeling have allowed her to define her own style sense and make her home personal. It helps to define who she is as an adult, something that her friends inquire after and that she can share with confidence.

Ben and Sarah: Materials to Communicate and Problem Solve

Ben and Sarah are working with an architect to remodel their main floor, adding a limited amount of space, tearing down and adding interior walls, adding a bathroom, and redoing the kitchen.

Because they are working with a professional, they have to find ways to express their needs and ideas and in turn understand the options that he presents to them. For their first meeting, they prepared a brief text document, with a budget, a list of priorities, one through ten, and a few notes about important issues for each room. They instruct the architect to get them as far down the list as possible within their proposed budget. Ben advises:

> The other thing, that I think is really important, is to be prepared as possible. This exercise was a great thing to really say what is it that we're going after, what's most important. For a long time, we debated or discussed our ideas, we wanted to do the first floor and second floor, but to have the discipline to sit down and actually put it in order was really helpful. That made it a lot more concrete for us. And I think it was helpful for the architect too.

Design constraints/requirements/ideas

Spaces in general well defined, but visually open

Kitchen -
- possible bump outs for counters (see picture)
- large enough for two cooks
- lots of storage
- island -
  - for cooking
  - for seating if the dining area is not accessible enough to the kitchen

Dining area -
- easily accessible from kitchen
- not a formal dining room
- flexible enough to accommodate large gatherings

Family room -
- Visually open to kitchen

Figure 11. Part of the description Ben and Sarah provided to their architect at the first meeting to discuss their home renovation.

Budget $200,000

Priorities

1.) 1st floor bathroom with shower
2.) Mud room
3.) 1st floor laundry
4.) New kitchen
5.) Outside updated, new windows

Figure 12. Part of the Ben and Sarah's renovation wish list.

Ben and Sarah have been thinking about remodeling for almost ten years, since they first moved in. In addition to drawing on a book about a particular design philosophy of which they approve (The Not So Big House (Susanka & Obolensky, 1998)), they use the everyday examples that are available to them.

> [Ben:] We talked about looking at, when we'd go to someone else's house, we'd come back and say oh, I love this, I love that, and we could kind of between us go through the list of houses we liked or didn't like or aspects of them.
> [Sarah:] Yeah, we rated every house we went to <laughs> This won't get back to our friends will it?
>
> [Ben:] <laughs>, No not really a rating, but in our discussions we had in our minds, guide points of what works. Like our one set of friends' house was actually very visually open, but we never liked it. It was always kind of our bad example of, we don't want to end up like that. …all these rooms we can visit and talk about. These examples, what is it, they're all open, but we like some better than others, and just what is it – we're always worried that we're going to end up something, like this person's house, that we don't like – and we're still worried about that, honestly, until we see it.
>
> [Sarah:] I think that's what we kept stressing to our architect. I think he's really good and that's what he would have done anyway, he would have wanted to do – but I swear those words came out of our mouths a million times with him –
>
> [Sarah,Ben:] open, but not too open <laugh>

Real examples such as their friends' houses let them explore the particular issue that currently dominates their design process: "open, but not too open." Like Kristen, they also compile clippings from magazines.

> [Ben:] We've been getting design magazines for a number of years and clipping, we've had piles of magazines and went through some of them and put together a notebook through this process. We have a lot of clippings to say things we like. All those hours of going through design magazines and clipping was helpful for us to try and decide what we wanted and it's helpful for us to communicate, like the open but not too open was difficult for us to express, but we could show him (the architect) in pictures.
>
> [Sarah:] We actually gave him our notebook of clippings and clearly, because we went in and met with another person in his office, and we were talking about kitchens and stuff, and clearly she knew what was in our book, so they're looking at our book, because she made reference to it.

Figure 13. Ben and Sarah's notebook of clippings.

In addition to using clippings to communicate their ideas, Ben and Sarah interpret and build on the sketches that the architect provides for them.

S: The first drawing that he gave us, he had the bathroom in the middle of the house, and it just felt like that was not going to solve any of our problems. So then we asked him to try to get it out of here –

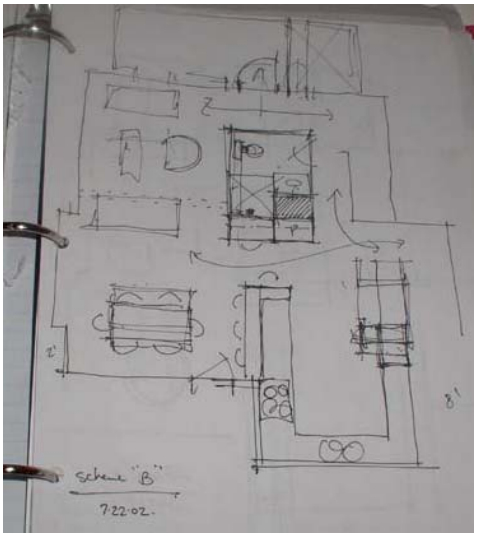


Figure 14. A base sketch that Ben and Sarah evaluated and adapted to address the issue of "open, but not too open."

[Jennifer:] Because of the openness issue?
S: Right. The openness. And this room right here? This room has always been a cave, this room that we're in right now. We had originally set it up as a living room, which is what it is intended to be, but we were never in here, …the thought, okay we're going to go out and spend $200,000 on this renovation and we're going to be stuck with the same room that's a cave, it's no different from where we are now. You know, I was just not interested in that. So we had him take this out so we could open up the whole.

[Jennifer:] Did he initially place it here because?
B: He did a very good, almost too good a job, of sticking to exactly what we wanted and trying to keep the budget down. So he did minimal changes to the interior, which was great budget wise, but it wasn't meeting our needs. So we looked at this and said that's not enough of a change for us, it's not going to solve the problems.

S: We spent 2 or 3 hours with us when he presented this to us with his little see-through paper, whatever that is. And we went through, let's try this, let's try this. He did all these sketches with us here.

B: A couple of hours, all these variations, and then actually then it was kind of interesting, I think we actually ended up here at that meeting. And then Sarah and I went off and we thought about this, and it's got some good things, but it makes a real awkward space here so we started saying how do we get the bathroom out of the house? So we got out our ruler and sketchpad and said couldn't we just move this porch back, what if take the same sketch, but take the bathroom out of here, and move it here, and then came to the architect.

Ben and Sarah were able to use a problem that they had identified in their list and explored through real life examples and clippings, to guide their evaluation of the architect's expert sketch. Realizing that it did not meet their essential need, they began their own revisions, working in the plan view format that their architect had begun, to problem solve and express their resulting solution. They are, however, uncomfortable with evaluating the plan view sketches with regard to how the space will be experienced and used.

> B: The hardest part is imagining, looking at this. We're actually struggling with that now with our current plans, just how is the furniture all going to fit? How is it going to make sense. Is this going to be – we have little cut out pieces of furniture and we've been playing around with that. And also I've done a little, I haven't gotten far enough, but I have a 3D design program that I've started to put the space together for walk-throughs, but I never quite trust it. Is that giving us good feedback?

Ben and Sarah are taking on a large project, while working with significant constraints of budget and space. They are trying to achieve some specific goals of aesthetics and use, and to do so, must find a language that illuminates the issues and helps them to communicate with an expert.

Arlene: Materials with a Message

Arlene is married and in her 30s. She punctuates her speech with wry laughter, describing the challenges of kitchen renovation with a mixture of amusement and frustration.

When I ask her to start by describing her house to me, she asks to borrow a pencil, and begins sketching a plan view, starting with the kitchen and working out to the connecting spaces.

> It's a two family house built in 1920. The kitchen is very small. Here's the set of stairs that come up like this. They don't build stairs like this anymore <laughs>. On the second floor. And there's a porch here that's falling over. This is the 2nd bedroom, smaller than the kitchen. So it's got a door here that opens right into the refrigerator, which is here. Then there's a counter, there's a window, another counter, an archway that goes to the hall, another archway here that goes to another little hall, that actually goes out like this. One of these very badly laid out 1920s houses.

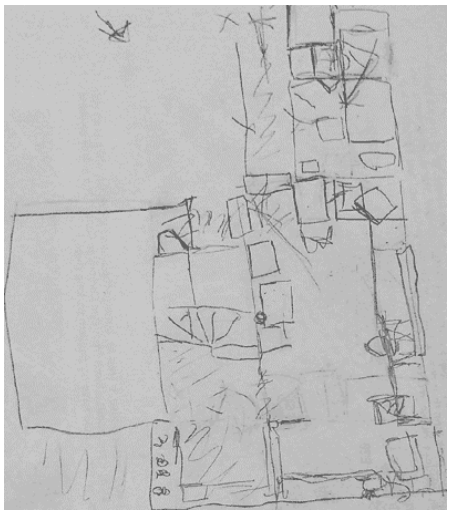


Figure 15. The sketch Arlene draws as she describes her house at the interview.

Arlene describes the reason why she and her husband are remodeling in terms more personal than needing extra space:

> One of the jokes is we need a place to put the refrigerator, we need a place to put the sink, and we need a place to put Randy. <laughs> Randy's our friend who drops over at dinnertime every couple of weeks. And you get three people in that kitchen and usually it's just the person that is cooking and the other 2 people stand in the doorway.

Arlene has had her tenant's bathroom remodeled, but says this time is different because it is her personal space, which she will have to see everyday. She is concerned about the number of decisions she will have to make and alarmed when she is reminded (by an article reviewing microwaves in Consumer Reports) about something important she hadn't considered.

Figure 16. Arlene's printout of an under-the-sink sponge tray; one more option to consider.

> With the kitchen you got the stove, the sink, and the oven, and the cooktop, and the hood, and the microwave, and the dishwasher, and you know storage for your spices, and storage for your garbage, and storage for your big pots and storage for your glasses. I mean there's just so many things and one of the things I did do was go looking on the web, for things I wanted in the kitchen. Like this thing here, this storage thing under your sink for your scrub pad, there's just so many things to think about, that eventually I got, you know, a little distressed.
>
> One thing, that I didn't even think about – is that the thing that I use the most, besides the sink and the refrigerator, is the microwave, and I never even thought about that – where's the microwave going to go?
>
> Yeah, I mean there's so many variables, that something that looks good on paper, when you get it in there – like the vanity, looked like it was going to fit, and then I put it in there and the door was like that far away from it. Yeah, it fit, but it didn't really fit, and it looked good on paper.

Although Arlene readily began describing her space by sketching a plan view, she distrusts the translation between plan and reality. Like the other homeowners with whom I spoke, she was frustrated with home CAD software, finding the 3D renderings unhelpful, and the 2D plans difficult to generate. To produce a representation of their home, homeowners trudge through user manuals and enter precise dimensions but it is not an arena for experimentation or descriptions of use.

Arlene is not going to work with an architect, but will instead go directly to a contractor.

> [The next part] is to make enough decisions so that I feel comfortable calling in a contractor and saying this is what I want, cause I don't want to bring him in and say, I don't have a clue <laughs>. My experience is that if you don't tell them what you want, they will tell you what you want and you'll be unhappy. If you tell them what you want and they tell you no, or even better, why don't you consider this, you get a dialogue going and have a much better chance of it turning out the way you want it to.

Arlene has an appreciation for the usability issues of design. She explains, gesturing with her hand, that in a typical bathroom mirror, only the top half of her face is reflected and the bottom half of her husband's, as they stand respectively at 4'8" and 6'4" ("all elbows and ankles"). A cabinet sales clerk suggested a continuous counter on a wall where they currently just have a "free floating table." Arlene agrees that you can never have too much counter space, but as she talks about the proposed changes, she notes a problem with replacing the table, related to their current practices within the kitchen.

> So we were thinking that there would just be cabinets under here, maybe some open space for a stool. So I could sit there and cut up onions. Whatever. That's another thing you have to think about, I always use the table, because it's low, and my husband uses the counter because it's higher.

I ask her if she has become more conscious of her space, now that she has to prepare to make these decisions.

> Oh yeah. Yeah, absolutely. Whenever I – I'm always got it in the back of my mind that I'm going to forget something, like the microwave.
>
> *[Jennifer:]So you're more conscious of what you're doing?*
> Yeah. Whenever I do a big cooking, I'm always, here I am getting out a big pot, and in order to get out the big pot, I've got to push this out of the way, and how would it be easier, and oh they have this little, the little pull out drawers, I got to get one of those, better put it down on the list. <laughs>
>
> *[Jennifer:] You actually have a list of these? <R points to head> Just in your mind.*

Unlike the other homeowners, who have shared their compiled materials with some mixture of pride and fascination, she brings in a thin stack of grayscale images she has printed from the web and 2 cabinet catalogs, and references them with some disdain.

> That's the one thing I always see in the magazines, is the pet, as part of the décor. If it's the living room, it's usually a dog on the rug, a cat curled up in the easy chair.
>
> *[Jennifer:] Do you ever see people?*
> No, it's funny. You never see people. You never see clutter. And you never see tv sets… they always have these big armoires, that you can close the doors, and pretend you don't watch television. <laughs> That's one of the problems I find with those magazines is that they're aimed at this kind of pie in the sky, high level idea that there aren't any people in your house, and there's a dog, but no dog hair. <laughs> They always seem to me to feel very cold. You know the Italian contemporary ones always seem cold because they are so severe, but even you look in the ones for *Country Living* or *New Victorian Living* or something like that,

> and they just seem like sets, to some movie. You can't imagine people actually being in them. You go in the [cabinetry] store and of course it all looks like this, and the flowers are all plastic and the lemons are made out of glass. <laughs> They had some very interesting plastic food at the [cabinetry] store.

Arlene considers the underlying message of these photos as one of pushing the latest expensive trend.

> They're often as just as confusing as helpful, because they give you so many options and you really got to whittle them down. I would imagine that most people when they decide to redo their kitchens just go into one of those places and say give me whatever the latest style is and everyone ends up with stainless steel and it looks bad in 2 years. <laughs>

Near the end of the interview, she puts aside her concerns about the many decisions in home design and speaks with some warmth about what will make it worthwhile.

> There's always something, when you're redoing a room, that is kind of the impetus for why this project even started, that's always the focus you have to keep on.
>
> *[Jennifer:] And yours is the –*
> The extra space. The light here is going to be so nice, and that's, you know
>
> *[Jennifer:] And that's going to make it worth it?*
> That's going to make it worth it <laughs>. In the last place we lived, it was a much larger 2 family, and it had a little breakfast nook, and the morning sun came right in the window, and Sunday mornings, it came in the window in the wintertime when it was cold. So Sunday morning, get up, get my paper, lay it out on the breakfast nook with the sun streaming in. It was wonderful. One of the things I miss most about that apartment.

Preparing for Home Design as a Process of Learning

Kristen, Ben and Sarah, and Arlene have committed themselves to revisioning their homes, investing time and thought, drawing on informational, technological, and social resources, and learning to think and communicate in unfamiliar ways. To say their process is about basic consumer decisions and budget setting is to fail to recognize the exploratory and constructive nature of what they do. The amount of time spent, the reflection, experimentation, idea seeking, evaluation, and emotional turmoil (as one participant acknowledges, "if we're not divorced by the end of this…") signal that it is something more – more like a process of self-realization and learning.

When asked what the process is like, what it reminds them of, most participants struggle for a while and then propose that it is somewhat like major purchasing

decisions, requiring research, decision-making, and conversations with professionals. Having talked with patients and doctors during the same period when I was first investigating home design, however, led me to make a connection between home design and health. In both situations, there is a client or layperson who must work with an expert, or more often, a loosely connected team of experts. Both medical patients and homeowners feel they need to "do their homework" in order to participate in the process, but are often overwhelmed by the many options and generic bits of advice out there. Their challenge is to link what the expert can provide to their individual context, to personalize the solution. This requires some establishment of common ground between layperson and expert, where each contributes and learns from the other.

Homeowners appear to be more effective at going beyond information browsing to create artifacts that can they can use to think and communicate with, albeit in ways limited by the dimensionality of the materials they employ.

Kristen creates an artifact, a compilation of clippings, that she can use to identify her sense of aesthetics. By collecting examples to which she has responded on some level, she can spend time with them, evaluating and reflecting on her emotional and expressive identity. Kristen makes an effort to link her developing sense of aesthetics that she gains from her clippings artifact to examples in the real world. She even begins to author imagery, by digitally altering a photo of her own space. Kristen uses these materials primarily as a means of understanding her preferences, but she can also share them with friends. Her concern over their critique of her choices suggests that this discovery process is still somewhat fragile. Along with examination of examples, she experiments with objects in her space, going between rough plan view representations (doodling) and actual re-arrangements within her home.

Ben and Sarah are less concerned with social critique than with their ability to communicate a goal that they want to achieve with their space. Like Kristen, they use clippings, which they smartly bind in room-by-room divided binder, to remind them of options and clarify their thinking. In addition to positive examples, they also collect negative examples, both of which they also find in the real world friends' homes that they visit. Rather than simply looking for ideas that they like, they seek a specific abstract principle "open, but not too open," which accords with their belief about how

space should be optimally used. They use imagery as a language, and "their book" lets them be more expressive, and thus more involved, when working with their architect.

Their architect employs plan view notation to communicate his design ideas. Although Ben and Sarah often feel concerned that they cannot visualize the plan, they use it to experiment and suggest a solution back to their architect, when they evaluate the original drawing to not meet their "open, but not too open" goal. Both the plan view and the 3D renderings that they construct with their 3D software fall short for them in terms of understanding the finer arrangements and activities that will go on in their space.

Arlene has the same concerns about these traditional representations of architecture. She recognizes that there is something beyond "fit," that will impact the way space is functionally used. Unlike the other homeowners, Arlene rejects clippings, because she doubts the message that they convey. They are not an authentic medium for the kind of concerns she wants to communicate and she senses that there is an agenda behind the gloss. Without a replacement however, Arlene is becoming overwhelmed with the task of narrowing options and developing a design vision that she can present to a builder to start a dialogue.

Kristen, Ben, and Sarah are benefiting from the constructionist act of compiling clippings. It gives them the opportunity to project their identity, externalize their thinking, synthesize general concepts, and experiment. It also helps them get social support and collaborate on their project, with both friends and experts. Ben and Sarah are additionally aided by their ability to "converse" in the sketch notation of architecture. The homeowners who had materials to share were also able to reconstruct their preparation process with ease, recalling the evolution of their thinking and guiding me through their experience.

However, Arlene's distrust raises a critical question: are these materials sufficient for expressing the complex, real-world, multi-dimensional issues that determine whether a solution is just custom or truly personal? Do their constructions offer the opportunities to explore rich questions about their identity? Do these representations give homeowners access to the powerful ideas in home design?

Two Scenarios of Home Design: Doorknobs and Future Plans

Having conducted several interviews, I begin to look for patterns: magazine clippings, web research, plan view; speech peppered with new vocabulary: Shaker and Arts and Crafts, dove-tail joint and kickplate; the fervent first response to my how-long-do-you-see-yourself-living-here that they are "staying there forever"; and one item, again and again: doorknobs.

Figure 17. Collage of dizzying array of cabinet knobs available on the web.

The first time doorknobs came up, I was prepared for a discussion of accessibility and functionality, for that is what they had come to represent to me. I had been reading up on Universal Design, as it applies to homes (e.g. AARP "a home for all ages", http://www.aarp.org/universalhome/), and had learned that a simple change from doorknob to door handle meant easier grasping for people with arthritis (my mom), people with Parkinson's (my boyfriend's dad), small hands (my nephew), and hands encumbered with groceries or covered in cookie dough (well, frequently me actually). Instead, doorknobs to these homeowners symbolize the many disconnected and often trivial decisions that have to be made along the way. They clipped out examples, researched them on the web, tried to match them to their existing knobs, and continually reminded themselves that this is only one decision that shouldn't take more budget than its worth. Arlene recounts this story:

> I was talking to a friend of a friend who's an architect, and he does mostly public buildings, big ones, but he knows a little bit about, his company also does big house developments. He said one of the odd things about the way people do their kitchens now of days is the knobs. If they have extra money, they'll upgrade the knobs. There's all these companies coming into existence to produce weird kitchen knobs, like in the shapes of fish or shells or something like that, instead of the pulls like that. On the flipside of that, if you're finishing your kitchen and you find you're running out of money, people will decide not to put any knobs on the doors at all, so you hook your finger around the bottom of the thing and just pull it open. And his kitchen cabinets didn't have any knobs on them. <laughs>

Here is a striking depiction of a design and decision process gone wrong – a series of discrete decisions that fail to produce a workable kitchen, much less a personally creative vision. In some ways, aesthetics is a dimension that opens up design to laypeople; most individuals can feel comfortable stating their opinion about an aesthetic preference, even when in opposition to a design expert. However, it can turn their focus to a relatively unexciting landscape of options that do not speak to the psychological and functional dimensions of design. This focus on arguably insignificant product choices contrasts with the few examples of homes where the design decisions reflected something about the way the homeowners lived or wanted to live – homes that reflect future plans.

The concept of *affordances* was first introduced by Gibson (1977) to describe the way a situation, including the physical context, can suggest opportunities and constraints for activity or use – what can you do and how can you do it. Norman (1988) illustrates this compellingly by noting that vandals will break glass barriers and paint on wood ones – though either material could be easily broken or painted. Through cultural associations and physical limitations, the environment suggests action.

Kirsh (1995) noted that people take advantage of the affordances of the environment, by managing their spatial resources to cue and constrain them. A cook sets out his equipment and ingredients in part to remind himself of what to do next, limiting the cognitive load of moment-to-moment decision-making to focus on a larger goal. If impromptu alteration of the physical environment can support smaller tasks, changes on the scale of the structure and arrangement of the house have the potential to guide living patterns – but do the inhabitants have access to and flexibility with this kind of space management in the same way?

The design of space offers us an opportunity to make concrete the ways we wish to live our lives, expressing our philosophy and in part directing us to follow through. It is one thing to say that we wish to be good parents, the kind of parents that value personal expression or seek to involve our children with what we do. To design an environment with these goals in mind, however, is a kind of world-making, a way of setting what Gollwitzer (1999) calls an implementation intention – a plan to fulfill a goal.

Laura and Evan: Plans for Work and Living

Laura and Evan have kindly invited me to sit in on one of their first meetings with their architect, and with his permission, I sit at the table listening and watching as they hash out what the goals of their home renovation should be. Laura and Evan have both done remodeling before and are active in the conversation, pointing out problems and making suggestions. They tell me later that they believe they are capable of doing the redesign themselves, but like having an architect to keep them organized and help them achieve a unified design vision. They have just learned that they are expecting their first child and one thing that strikes me about their planning is their inclusion of their yet-to-be children as though they are already actors on the stage. The architect suggests that one thing they may want to do is have a separate family room and living room, so the children can play in another room while the adults entertain. After a few minutes of discussion about other details, Laura returns to this point with a serious intensity:

> [Laura:] I don't really do, I'll do a separate formal dining room, and separate every day eating area, (laughs) but I really don't do separate fancy living area with white carpets, you know, velvet couches, and then separate family room area, because I think we're always going to end up on the south sunny side of the house, that's where the kids are going to go, in the day time, so I would rather use this as kind of the central office area. It's very likely that I would be working at least a few days out of the house and I would want to be on the main living floor, kind of hearing what's going on.
>
> [Architect:] but you don't think that there might be a need, for example, to have a room where the kids can play while adults are visiting, for example, in this room, or that might be their own rooms, or that might be in the basement -
>
> [Laura:] um, it might be their own rooms, it might be that I put the you know dining room furniture aside and say, okay, go, don't play with the china <laughs>, and we're right next door so don't, we can hear you -. I kind of see this as more flowing, and a little bit more multi-purpose.
>
> [Evan:] yeah, it is true, cause I always hate the sort of never used, hermetically sealed guest living room, like my parents had, you know there was that one room in the corner that we never used.

I ask them about this later and they elaborate:

> [Laura:] If I do formal entertaining it's in the sense of having a lot of people over for dinner, you know I have a good number of family, my family lives on the West Coast so that when they're here, they're here, and I like to do that, but we don't have you know a very formal tea in the living room sort of thing, we kind of expect we'll have more barbeques on the decks, we'll go trooping in and out.

> [Evan:] Not like lock the kids in the basement and have a, whatever you want to call it

Laura and Evan are also trying to envision a home where work and life merge, as one or both of them will be teleworking as their children grow up.

> [Evan:] Making things multi-functional, it is a real tough problem, the problem where I have this dichotomy where it would be really nice to have that real sort of ideal thing where the kids are working on the homework at the dining room table and dad's right next door in the room with the French doors and they're sort of closed, but he can run in and help any time. Then there's also that time when I want to be having a conference call and I want to be able to shut the door really tight.
>
> [Laura:] I also think it is important to separate the house into sort of a rest zone and then the daytime activity zone. You know, I don't believe in having a television in the bedroom, definitely want to have that as a retreat, to take time and relax, moving toward sleep.
>
> [Evan:] and if you are working at home, if it's your office, the difference between office work and home is definitely better firmly delineated. Like I'm using the bedroom up here as my office and literally like on the weekends, some weekends I don't even check my email, don't set foot in that room, except maybe to charge my phone, all weekend.
>
> *[Jennifer:] So you're able to say I'm not working now?*
> [Evan:] Yeah, I just like have no desire to go in that room whatsoever, it's like I don't want to see my email because there's going to be something in there that is not going to make me happy.
>
> *[Jennifer:] Do you think this is kind of a new thing or do you think your families went through similar kind of issues?*
> [Laura:] I don't think so, because they always had the kind of jobs that you just went to and you know, my parents were very good that way, both my parents worked, but they got home as soon as they can and then they were home.
>
> [Evan:] Yeah, my parents too… it was kind of you go to work then you come home, no carry over in a home office or anything like that, except for the den area where dad balanced the checkbook and stuff, so it is a bit different for us.

Laura and Evan recognize that their built environment influences the way they will be able to parent and work. They want it to match the way they already do things, but they also want it to support how they intend to live, balancing work and life, their roles as individuals and as parents. This idea, that space affects behavior and that changing behavior is more achievable through supportive spaces, is powerful, but often ignored. We are so good at adapting to space, at making do.

Dan and Marie: Missing Models and Deliberate Non-Planning

I spoke with Dan four years after he and his wife Marie had moved into their custom renovated townhouse. Their architect was able to help them work through the major structural and exterior work, but was not strong with interior design. When it came to the kitchen, Dan and Marie had no idea how to decide on counter and appliance placement. They were each individually living in homes, presumably with kitchens, but couldn't draw anything from their experiences in them to help them with design. Now, four years later, Dan points out how he drips on the kitchen floor as he takes chicken pieces cut near the sink across to the opposing garbage. He squeezes in awkwardly to reach from dishwasher to cabinet. Somehow in the kitchen that they have had built, they are able to understand the functional significance of decisions, though their previous experience in kitchens went unexamined.

Figure 18. Dan and Marie's dishwasher is in an awkward location, a possibility that they didn't know how to investigate or anticipate.

Dan and Marie are also notable because of what they chose to ignore. Not sure that they would be able to have children starting later in life, they explicitly decided not to consider how their space needs would change, concerned that if children never arrived, their home would serve as a painful reminder of that missing piece. As evidenced by the scattered toys and safety outlets, that concern was unnecessary, and trying to keep up with their energetic toddler, they are beginning to think about remodeling the tenant apartment to serve as a nanny's quarters. Dan and Marie's decision is a testament of the significance of these life plans, expressed through home design; you do not direct your life down a path without believing it is a journey you can fulfill.

For the homeowners swamped with decisions about doorknobs, home design can become a rather tedious experience. They may feel involved because they are making the decisions, but their resulting home may not represent concepts that are personal or powerful. In contrast, the interviews with Laura and Evan and Dan and Marie suggest that there are deeper issues in home design that could provide

opportunities for homeowners to contribute their personal expertise. This expertise is in knowing, or coming to know, their personal routines, their physical needs, the way they employ space to achieve complex life activities. It is also in accepting or rejecting the identity representations and life patterns that personal histories, culture, and yes, glossy magazines project. Design experts (or design tools) may have a particular ability to translate these needs and values to effective design, but without the initial problem framing, there is insufficient material with which to work.

Failed custom home design

What does it mean for custom home design to fail? Can it fail? What is really at stake? It is certainly easy to find examples of bungled home construction, due to errors in building, poor quality materials, technical mistakes in the design, miscommunications in the implementation, and unexpected constraints on the logistics or budget. These problems need addressing and should inspire new building approaches, but they mask the more emotional disappointments of a failed process for the homeowner, which can occur independently of the actual construction.

I heard from a colleague about Neil, who has come away from his own negative custom design experience embracing the pre-built suburban home. Neil is in his 40s, married with children, and works as a business consultant. He remembers his childhood custom home with admiration, both as a living space and an architectural work, but disparages his custom home, from which he has since moved away.

> And my big argument was, about the house that we built, was that the library was a warehouse for books and the children's play house was a warehouse for toys, and there wasn't any real, there wasn't really in that house, any sort of communal living space where people get together in some fashion. And um, there was no sense of, what's the right word… there was no sort of continuity or sense of organization, it was just a bunch of rooms stuck together. I'm exaggerating it to make a point, but, the, it didn't seem like the house took into consideration how you felt about the space, how the space worked in some fashion. The distances were so great, still it wasn't a palatial mansion, but still it was large enough that you were, even though it was an open plan house, everyone was always far away. There was no sense, we didn't have a lot of furniture in some of the rooms, but there was no sense of a place to sit and do things.
>
> And then I was disappointed, because the way it looked wasn't the way I wanted – I didn't want it to look big and fancy, and that's what it ended up looking like, so I wasn't very enthusiastic about the, I mean I told the architect

> that I thought the house was a failure, which was probably not a sensible thing to tell.

Neil now lives in a pre-built home and finds it far superior to his custom home. He is articulate about his design philosophy, rejecting oversized spaces and surfaces that have a specular quality, causing undue reflection and refraction of light and sound. He speaks with passion about natural materials and the psychological quality of the home. Neil freezes, however, at the prospect of expressing specific decisions about design. I interviewed him about his experiences at the same time I was conducting my participant study (see chapter 4) and asked if he would like to try the "evolving exercise" that each participant was contributing to at the lab. Neil doesn't wait for me to set up the recording equipment, he's already shuffling through the words, the cards, and then he stops. He doesn't want to continue. He believes that this is the designer's domain, and that he has nothing to contribute here.

Neil is somewhat uneasy throughout the interview, flipping between conviction and uncertainty, querying whether there are any other homeowners with similar views. Soon after his condemnation of his custom home as a failure, he discusses his role in the failed house.

> Part of it was our problem, because we would look at it, look at the plans, and say oh, change this, and by the time we would change this, whatever architectural coherence they might have had, we destroyed. I mean I don't think there was any question that our input, to the extent that the house might have some architecture coherence when it started, when they designed it, that was in their heads, we certainly made sure that it went away. Because we said why don't you change this and why don't you do that? And we couldn't understand what the implication were.

Architects often dread clippings (Peña & Parshall, 2001; Paul Lukez, personal communication, 2003), because clients may use them to request very specific solutions (e.g. these colors, this layout, this archway, this sink) before a more unified vision is established. Neil's account of a failed custom home, provides evidence that the "disrupted vision" issue exists, as Neil and his wife's piece-meal modifications worked to undermine the aesthetics of the home. In this instance, the architects did not collaborate with the homeowners to develop a program based on living patterns and personal identities, and the homeowners were left to exert control in an erratic and fragmented fashion.

The discomfort that Neil reveals, in his words and reactions, may be a reflection of his personality or a particular response to the nature of the study, but I sense that it signals a negative outcome of his custom design experience that overshadows any material disappointments: a loss of faith in himself as someone who can successfully engage with design.

Chapter 4, Constructive and Reflective Exercises

> *…one of the mistakes that I've had friends make, is that they redecorate their house, and they find they've redecorated their house and it looks just like mom's. And then they realize that it has all the problems that always went on at mom's house and they've kind of brought it on themselves, because it felt comfortable and familiar and they didn't go back and do some of these emotional things.*
> *-Interviewed participant*

The homeowners with whom I spoke demonstrated a variety of approaches to preparing for home design, but were necessarily restricted by the materials and ideas to which they had access. Collecting clippings is a relatively well-known recommendation from design books, while the use of plan view, both on paper and through software, is directed by the established practice of architectural design. The participant study gave me the opportunity to examine whether other representations and approaches, selected from and inspired by the fields of design, social science, and education, could be beneficial to the homeowners during the pre-design stage. Given that there are multiple dimensions of design, including aesthetics, functionality, efficiency, and behavioral affordances, it seemed reasonable to expect that varied representations would be needed to adequately address the totality of the needs assessment task. I also anticipated that different individuals would reveal distinctive paths for their thinking and learning process. By employing a participatory design methodology, I was able to work with homeowners as research collaborators, searching for the set of materials that would best support their experience with design and express their considerable knowledge of themselves and their homes environments.

Pre-design Exercises

For this study, I developed ten interpretive and constructive pre-design exercises for study participants to try on their own. Each exercise was designed to have general characteristics inspired by the theoretical frameworks of reflective practice, constructionism, and participatory design.

From reflective practice

- The exercise should give the participant the opportunity to fluently generate content, using tacitly held knowledge, which can then be reflected on and analyzed in an iterative cycle.

- The exercise should provide an evolving description of the participant's knowledge-in-action.
- The exercise should encourage reframing, to help the participant discover conflicts, linkages, assumptions, and emerging opportunities.

From constructionism

- The exercise should not require a specialized knowledge, but instead support connections based on existing personal models and understandings.
- The exercise should result in a product that is meaningful and sharable.
- The exercise should not just be about expressing existing knowledge, but should offer the possibility of acquainting the participant with powerful ideas that can affect the way she approaches design.

From participatory design

- The exercise should focus the participant on actively contributing insights, rather than passively providing data.
- The exercise should be open-ended and alterable to permit design contributions, in addition to feedback and critique, from the participant.
- The exercise should be something that can be integrated into a real-world context to reflect authentic practices.
- The exercise can serve as a low-fidelity prototype, and in so doing, inform the development of actual technology design.

Based on the interviews and my other experiences with design and adult learning, I additionally make the following assumptions with these exercises:

- Homeowners will achieve a more satisfying and successful custom home experience if they learn about themselves and their needs and make personal connections with design.
- Homeowners have considerable and valuable knowledge about themselves within their everyday environments that can aid them in accessing and contributing to the design of their homes.

- Homeowners' personally held knowledge should begin to be expressed before solutions or advice are provided to encourage them to build their own model of design and assume an active role in the design process.

Despite these expectations and assumptions, the ten pre-design exercises were kept relatively simple so that they would not overwhelm the participants and could be done without direct guidance in a relatively short period of time. The media for the exercises (e.g. questionnaires, images, stories) reflect both formal and informal methods of preparation, drawn from the interviews I conducted with homeowners, advice from home design books and web sites, techniques in work environment design (where more attention has been focused on connecting design with the evolving needs of the inhabitants), and approaches in other fields where personal perspectives and contexts are relevant (healthcare, therapy, virtual communities). Participants were given the following master list of short exercise descriptions.

1. QUESTIONNAIRES – Fill out traditional needs assessment questionnaires – by answering questions, form a description of what you need and value
2. IMAGE SORTING – Sort images of kitchens into categories – by categorizing examples, understand your preferences.
3. REFLECTION – Reflect on what meaning the kitchen has to you, examining your possessions, recalling childhood memories, and recognizing cultural assumptions.
4. SKETCHING – Sketch in plan (bird's eye) view to understand the relationships in your current kitchen and envision ideas for your new kitchen.
5. SCENARIO BUILDING – Describe what you do now and what you think you will do in the future for the provided scenarios.
6. STORY TELLING – Tell a story about people who live in a kitchen for which you have photos and a plan (bird's eye) view.
7. WISH LISTS – Create a wish list for your new kitchen; recreate it when you are given new constraints or opportunities.
8. PHOTOGRAPHIC INQUIRY – Use images to describe a day in the life of your kitchen and pinpoint issues or ideas that you want to explore.
9. FIELD EXERCISE – Collect and reflect on simple sensor data and time-lapse images of your kitchen activities.
10. DESIGN YOUR OWN EXERCISE – Design your own exercise for needs assessment and preparation for home design.

Participant Study Protocol

Participants were again recruited from the GBSIGCHI electronic mailing list, as well as the electronic mailing list for the Technology In Education program at the Harvard's Graduate School of Education (HGSE-TIE). One couple and three individuals were identified through HGSE-TIE and three individuals from the original interviews agreed to participate. They ranged in age from approximately 25 to 55 years and had varying levels of experience with home design. Consistent with their recruitment source, their primary occupations were in usability (through GBSIGCHI) and education (through HGSE-TIE), but all could be reasonably classified as "non-experts" in architecture. They each received $10 travel compensation for participating in an interview and task session at the MIT House_n laboratory, but otherwise took part in the study as volunteers.

Participants were sent packets of information and materials in the mail and were emailed the URL for the study web site. The packet of information contained consent forms, instructions for the study, text-descriptions of the pre-design exercises, and materials that were needed for individual exercises, such as questionnaires, printed images, and colored pencils. I confirmed in an email that each participant had access to a camera, preferably a digital camera, for use in the photographic inquiry exercise; otherwise, a disposable camera would have been included. I wanted to insure that all materials would be "ready-at-hand," so that the participants' selection of which exercises to do would be based on preference for the exercise.

The web site was designed to act as a supplement to the packet, providing duplicates of all the documents, illustrations for the exercise instructions, additional questionnaires and image examples, and after the first sessions had taken place,

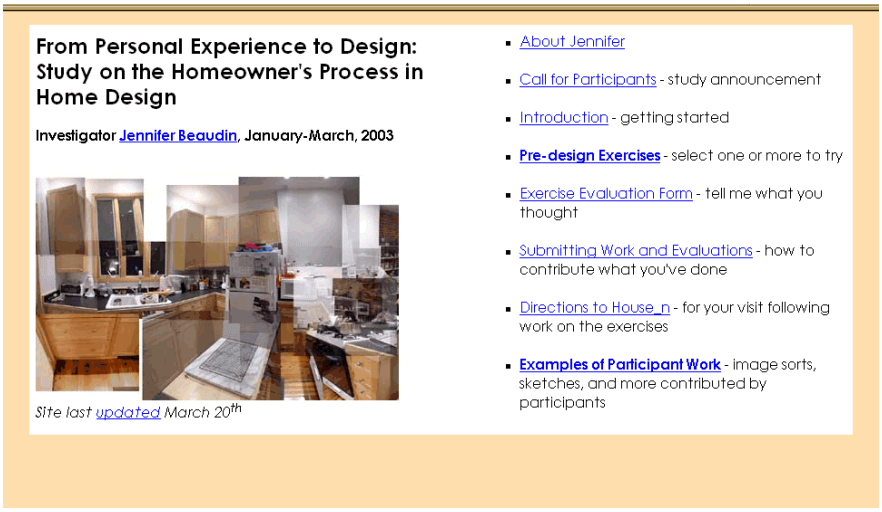


Figure 19. The study web site acted as a supplement to the mailed packet and displayed shared participant work.

examples of participant work. The wish list exercise initially required participants to email me their initial list for assignment of restrictions and weights. When I did not receive any such requests, I decided to alter the exercise to be self-contained and posted the updated instructions on the web. Complete exercise instructions are provided in Appendix A.

Within the instructions, a simple problem description asked the participants to focus on the design task of a new custom kitchen:

> **TASK:** I would like you to role-play that you are about to have a home custom built and will have a new kitchen in this house. You may imagine that the new house is your current house, rebuilt from scratch on the same lot and for a budget that is constrained, but perhaps more than you can currently afford. Although it is on the same lot, it might take a different form, with the kitchen in a new location. Alternatively, if you prefer, you can imagine that the new "house" is actually a custom townhouse.

I decided to focus on the kitchen, rather than the whole house, to provide an appropriate scale of design task for the limited time period of the study. The kitchen was chosen over other parts of the house for several reasons. First, it is a room that everyone in the United States, is virtually guaranteed to have experience with and immediate access to. The kitchen has undergone the most significant changes in the last century related to use, being consolidated from an exhaustingly distributed series of rooms (e.g. cellar, scullery, wet and dry larders), acting as a catalyst for the layout of rooms to become more central and the division of spaces to have more open access to family activity areas, and in recent years, reflecting both the need for convenience and the desire for creative expression in modern living; one can only assume it will be a primary setting for significant advances in technology and design in the future as well. The kitchen is the most frequently remodeled room and has the kind of semi-built-in customized components (cabinetry and major appliances) that may eventually come to characterize the rest of the house. As I will discuss in chapter 5, it is an ideal room for field investigations that use time-lapse cameras, being a less private, shared space, or open-close sensors, with its cabinetry, appliance doors, appliance dials, and portable containers.

It should be noted, however, that the narrowed focus on the kitchen may have made the pre-design process easier, as it is a structured, familiar environment that is arguably more accessible to non-designers than the allocation of other less specialized

spaces. It seems reasonable to suggest that the kitchen would be a good starting place for homeowners to begin thinking about the entirety of a custom home, and that pre-design approaches that work at this starting point could scale up to cover the entire process, but future research about that issue is required.

Consistent with both constructionism and participatory design, participants were not required to try particular exercises, but were instead asked to select the exercises that looked appealing or interesting to them. Exercises follow a basic format, which includes preparation, a main task, extensions to the task, and options to construct more elaborate artifacts or share work with friends or other participants. Although each exercise has an extended structure, participants were told that they could just do the preparation and basic task first, if they would like to get a feel for the exercise. This permitted breadth-first exploration, while the extended instructions provided an in-depth examination of the medium and embodied techniques of each exercise. The exercises were numbered for easy identification.

After participants received their packets, they had at least two weeks to work on the exercises they selected. They were free to work with friends or family and could determine the amount of time spent on each exercise. Evaluation sheets were provided and participants were asked to spend a few minutes after completing an exercise to jot down their thoughts and recommendations. Participants were then scheduled to come to the MIT House_n lab for a two-hour interview and exercise session. As they were all working adults, scheduling was one of the more challenging aspects of the study, but each found time to come in on an evening or weekend.

Figure 20. Participants shared the pre-design process they had developed with the at-home exercises during an interview conducted at the House_n lab.

During the interview, participants shared the work they created and described the process they went through in selecting and doing the exercises. Participants were also asked to consider

which exercises they would use to communicate their understanding of their needs and preferences to three different audiences: a spouse or family member, an architect, and a future potential buyer of the home, who was exactly like the participant. This question was designed to ascertain the usefulness of the approaches embodied by the exercises for coming to consensus, expressing a design problem specification, and providing a justification for choices made, respectively, from the homeowner's perspective. Finally, participants offered recommendations for other homeowners. With the participant's permission, the interviews were audio-recorded and later transcribed. After the interview, participants were invited to contribute to an evolving exercise, described in more detail later in this chapter.

Interview Case Studies

Table 1. Selected exercises by each participant; exercises and exercise components are listed for each column, participant names are listed for each row.

	1. Questionnaires basic	1. Question slips	2. Image sorting basic	2. Image sorting resorting	2. Image sorting tours	3. Reflection	4. Sketching	5. Storytelling	6. Scenario building	7. Wish lists	8. Photographic Inquiry	9. Field Exercise	10. Design your own
Arlene			■	■		■		■	■	■			
Emma	■		■	■	■					■		■	
Gwen	■	■	■	■	■	■	■		■				
Kristen	■		■			■			■		■		
Patricia	■		■			■	■		■	■			
Tom and Barbara	■	■	■	■	■				■	■			
Zach	■	■	■	■	■	■	■	■	■	■	■	■	

■=tried; ■= recommended or would have tried; ■=applied some aspect

Each of the participants defined their own path of pre-design work, selecting which exercises to try and applying their own interpretations. As an overarching theme, participants chose more traditional media, such as the questionnaires and image

sorting, and expressed approval for exercises that would result in a clear output. In almost universally describing themselves as "practical" (as though it were a distinguishing quality), they avoided the more "touchy-feely" exercises, such as reflection and storytelling. Additionally, it appeared that participants would typically start with a medium that was familiar, the questionnaire, but as a result, they ran out of time to try many of the other exercises in which they nevertheless expressed a strong interest (especially scenario building, wish lists, and photographic inquiry). In doing the more conventional exercises, however, they applied more complicated and often emotional techniques, drawing on storytelling, personal reflection, and evaluation from multiple aesthetic and critical perspectives.

Two of the participants from the original interviews who participated in the study, Arlene and Patricia, were nearing the end of their own kitchen remodeling projects and chose not to do many exercises in part because they were personally past that stage. They approached the exercises they did do, questionnaires and image sorting, from a more evaluative perspective ("are these like what I am familiar with?") than a goal seeking perspective ("what do I need?"). The experience of the participant family who did exercise 9, the field exercise, is described in chapter 5. The following are three example case studies taken directly from my interview sessions.

Pre-design Exercises, Case Study 1: Zach, Iteration and Discovery

Zach is in his early 30s, an MIT alum and engineer, who speaks with great energy and thanks me later for the "great time" he had participating in the study. In responding to my recruitment email, he mentioned his frustration with cooking in his apartment kitchen, and after getting engaged just before our interview, is now looking ahead to when he might buy or build a house. Zach has no experience with design or remodeling, but dove into the exercises with enthusiasm.

Image Sorting

Zach did the image sorting first, jotting down a few notes about his expectations for what he will see in the photos (e.g. "baskets of fruit") and then quickly developing a technique to generate his two piles of "I like" and "I don't like" by gut reaction.

> I went through, it was kind of fun, because you did the expectations of what you might see, then as you saw them – *yeah!* There's a lot of pictures and a lot of them are similar, so you get kind of frustrated, like well, do I like it or not, it's kind of

> close, but you just kind of try not to spend a lot of time on it, that's a little easier… Given that the quantity of them is so high, it was almost better to let your gut, let subconscious work, instead of the conscious, and see what you wound up with.

The image sorting exercise was the most popular exercise, with each participant submitting at least the basic content of the exercise, a list of numbers for "like" and "dislike" that correspond to the identification numbers written on the back of the provided images. Like Zach, the other participants switched to a tacit response approach after noticing the large quantity (50) of images. The image sorting seems fun and fast and most participants went on to try resorting by the additional categories (e.g. "my parents would have chosen," "modern," "high-priced"), resorting by their own categories, and creating image tours. Additional categories were designed to help the user reframe his understanding of his preferences. While one participant used "what I liked 10 years ago" to find the aspect of her aesthetics that has remained constant, resistant to fads, other participants, including Zach, used it to better describe what is important to them now that they have more experiences on which to draw.

Figure 21. An example kitchen that Zach "would have liked 10 years ago," but wouldn't choose today. Please see figure list for credits.

> "What I liked 10 years ago" was sort of an interesting category, because there's some of these minimalist ones in here, and 10 years ago I would have thought that was cool, but now that I've cooked a lot more, it's no, not so much. So that was an interesting, it highlights what you value, more so than not.

I have a duplicate stack of images at the interview, and participants sift through it to find an example image to demonstrate their evaluation process or to comment on something they found quirky or telling in some particular kitchen. Zach picks out an image of a minimalist kitchen (Figure 21) from the stack to show me his "10 years ago" aesthetic. Participants universally declare the zoomed-in photos of kitchen pieces and the plan view drawings hard to categorize, but gamely try anyway.

At the beginning of the interview Zach told me how he made an exciting discovery by iteratively connecting the exercises: after completing the sketching exercise, he found an example kitchen among the images that bore a striking resemblance to his sketch. He refers to this image as his "#13" (Figure 25) and as he explains his image sorting process to me, he is again looking for connections that will help him interpret what he's drawn.

> The aesthetic categories were kind of fun because I went with "traditional", then "boring apartment", there were a couple in there that just seemed very bland. Then "modern". Then a category I invented "Look, we just redid our kitchen", which was kind of like, look how cool our kitchen is. So I wonder, again, where did #13 fall into… oh, "modern", okay, it's a modern kitchen.
> Then these are the other categories that I invented here, that were also important to me, to look for these categories.
>
> *[Jennifer:] Because they're descriptive of you?*
> *[Zach:]* Yeah, or things I would like to see in a kitchen. My #13 doesn't fall into that one [good for multiple cooks].

I ask him how he determined membership in his "good for people with kids" category. He explains that there were some images that implied they were good for families simply by having the inclusion of toys, but he developed a more specific functional objective by applying a concept he had begun thinking about with the questionnaires exercise.

> …other ones sort of implied that you could be cooking and watching someone at the same time. Later on, I noticed there was one of your "place near your.." things [question slip], where it was sort of like, and I've often thought of this too, when you're at the stove, you're always facing a wall, that really drives me crazy, so there are a lot like that, that imply that you could be cooking, and looking at the children play. I forget there's one in here too, I even put it on one of my pieces of paper, yeah, this one, where they're like "look at her, cooking and watching the kids."

Several homeowners made best use of the questionnaires by zooming in on a couple of surprising or interesting suggestions embedded in the questions and pursuing them in the other exercises. The image Zach refers to is one he used as part of an image tour, one of the construction options for the image sorting exercise. Participants stapled selected images to a page or pages and provided explanatory captions or titles. Zach give this caption to his tour: "this highlights the separation of the kitchen from the rest of the house – why?" He explains,

…these two highlighted just the idea of, even though it seemed to be a nice kitchen, it seemed to be deliberately, you know, the loft sort of space, but separated, while these had the more open, that allowed you to cook while viewing the rest of the house, making the kitchen more inclusive as opposed to a hidden place.
[Jennifer:] So this was an issue you identified
[Zach:] That was something that I thought was a tradeoff. In the end, I kind of, when we get to the other exercises, there is a compromise that I think you can make with it.

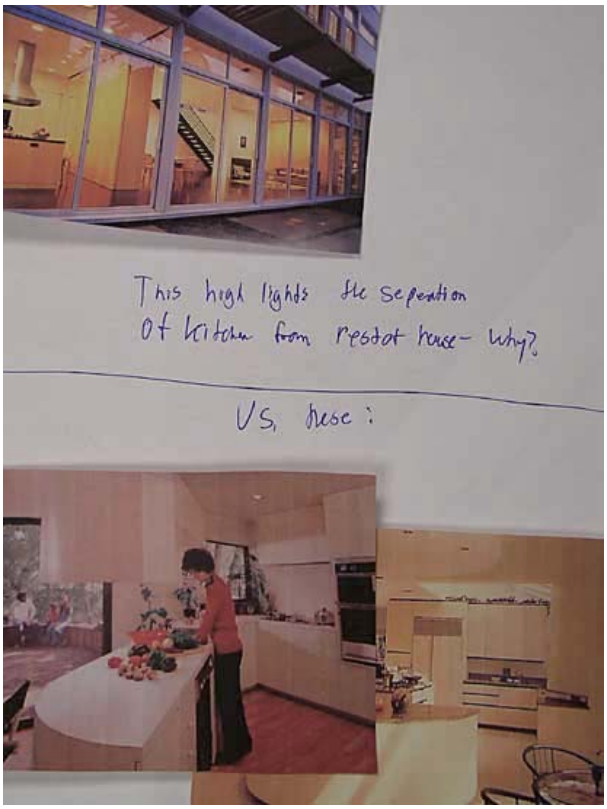


Figure 22. One of Zach's "image tours," illustrating the issue of kitchen integration within the house. Please see figure list for photo credits.

Zach identifies a decision tradeoff for the placement of the kitchen within the house; the kitchen can be open and integrated with adjoining spaces or closed-off and separate. His "why?" tag-on to his caption indicates that this is an issue he wants to better understand, and as he notes, he returned to this issue in the sketching exercise.

Sketching, Mental Map

The sketching exercise includes a preparation component that asks the participant to create a "mental map" of his kitchen – a sketch of what he can recall about the space when he does not have it as a reference (accordingly, the preparation should be done *outside* of the kitchen!). This procedure draws on the work of Kevin Lynch (1960), who found meaning in the mental maps citizens drew (or verbally described) of their city, in what they included and left out and in the distortions of scale and connections. The exercise had an upper time limit (9 minutes) to increase the likelihood that some elements would be left out and involved a color-change protocol, where the participant was instructed to use a different colored pencil for each of three 3-minute period subdivisions, to visually record the sequence of recollection[6]. After

[6] Thanks to Bill Porter for this suggestion.

sketching for 9-minutes, participants were instructed to compare their sketch to their actual kitchen and add in elements that were missed in a fourth color. Zach describe his preparation,

> So drawing my own kitchen without looking at it, that was kind of fun…And I like the idea of the timing, because it did give you a sort of appreciation of the things that you thought were important and necessary… it's almost the later things that you think are cool or maybe not cool, but the later it is, the maybe perhaps more important it is, because at some time you are going to stop and then those last few things you think of, it's like ooh, I can't forget to put this in, I don't want to leave this out of my picture. So when I got to the end, it was like, oh my goodness, I forgot the disposal in the sink, I would die without my disposal now. Or, it could be the other extreme too, like oh, I forgot that I keep my pots in this silly little drawer over here and it drives me crazy. So that's a pattern to look for.

Zach describes two ways to interpret his recall sequence. In the first, he notes how time became a prioritizing constraint that in the final 3-minute period, forced him to bring to mind all the elements that were required to complete the definition of his kitchen. In the second, he notes that items that he forgot or added late may be those that are irritating or insignificant. In addition to reflecting on the sequencing, Zach also noticed the relative scale of elements within his sketch,

> The scale was actually the coolest thing, I noticed, after I was done, this is like my 10 minute color, I realized I sort of inflated the scale, partially to fit stuff in, but partially to, well, yeah, I really wish this space was bigger than it is, that was what I thought, you know because things were bigger, but not every where, but certain things were bigger than they really are, like this clutter is probably only this big, not that big
>
> *[Jennifer:] but it sort of looms large*
> [Zach:] It looms large in my mind, yeah, so I think it would almost be cool to come back with a ruler now and see, really compare the scale. It could also be that I'm a poor artist. <laughs> A little bit of each.

Zach deduces that his inflation of counterspace actually expresses a desire for there to be more space, while his inflation of the clutter reveals that it is a significant concern. Whereas another participant spent a considerable amount of her effort trying to get the scale correct, Zach kept the sketching rough and later used its distortions as a dimension for analysis.

> Zach also left out an element that was of significance,
> Oh, actually I thought it was kind of funny, I forgot to draw the window, and yet that's something I value a lot. Perhaps because there is only one and there's a building right here, so you don't get much light, so maybe
>
> *[Jennifer:] You maybe weren't thinking of it as a window.*

> [Zach:] Yeah, exactly. And I usually have the shades down, so it doesn't much function as a window. Yet, looking at the other things that I value, it's kind of interesting.

This example illustrates that important features can hide in plain sight. As mentioned in chapter 3, in her preparation for a kitchen remodel, Arlene overlooked the all-important microwave, much to her dismay. Coming late in the process, it added to her unease that she did not have all the important features covered. In Arlene's case, the familiarity of the microwave and its easy integration into her daily routines led her to overlook it. In Zach's case, the element had been symbolically redefined (or rather merged into the wall) because it did not fulfill its intended function, and hence was hidden from his recollection. Here, Zach is directly addressing this natural tendency to forget and using it to identify elements that are of importance to him.

Zach also made discoveries by having to develop a technique for recall during the sketching of the mental map.

> Little things, I realized as I was sketching it that I hadn't really thought about, like I put in my salt and my pepper, it's important to be right there. As I was drawing this, I stopped and thought what are the things I use when I cook or everyday, and it was like oh, those are two things.

Zach also tried to think through what he calls "the interactions of the kitchen," particularly with regard to multiple cooks,

> It's annoying when I'm here cooking and someone here's chopping and I can't get to the sink

Transitioning between his mental map and his sketched ideal kitchen, Zach identifies some interesting areas for future investigation.

> I'm embarrassed by how much clutter there is in my kitchen, it just highlights it – but if I had more counterspace would I have more clutter? That would be interesting.
> It's so weird actually, now that I think about it, it's kind of I have lots of small cabinets which annoy me, but at the same time they allow for this nice organizational, sort of tradeoff. I don't have one cabinet with tons of stuff in it, which would be nice because I have a lot of stuff on counters that I would prefer to have in cabinets, but the little ones that I do have allow me to organize things well.

Zach poses two interesting questions in his reflection on his current space. First he wonders whether his proposed solution to clutter, extra counterspace, will actually change that characteristic of his kitchen, or whether, like Parkinson's law, which states

that work will grow to fill the time one has available for it, the clutter will grow to fill the added space. He also notices that his structured storage, while not sufficiently flexible for the kinds of items he wants to store, helps shape his behavior to be more organized. These are both important observations about the behavioral impact of changes to space. Zach understands that a design solution can fail to change a living pattern if it does not address the underlying cause, in this case perhaps that Zach uses spatial cues in deciding whether items can be and should be added to the kitchen (increasing clutter). He also recognizes that a design change can meet certain goals, but may result in other deficits, if the hidden affordances of familiar environments are undiscovered.

Sketching, Desired Kitchen

On the other side of his mental map, Zach drew his desired kitchen, using the same color-coded timed approach (Figure 23). He confesses that one of his concerns, that other participants have also expressed, is that he'll create something that is too conventional.

> When I first started drawing this, I was like "I don't want to draw my parent's kitchen, I don't want to draw somebody else's kitchen," you know? Which is almost a bad constraint, because there are some good things, but you're like ooh, yeah I got to be creative, and pick it out of a hat.

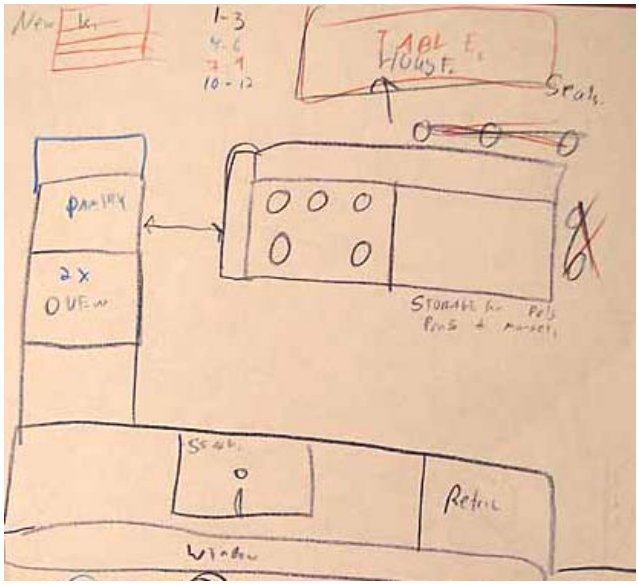


Figure 23. Zach's sketch of his desired kitchen, using color-coded timed approach.

Zach began his sketch by focusing on an issue he identified in the image sorting, in developing his "good for kids" criteria,

> My main thing was sort of I wanted to be able to cook and watch people. So it was the whole, move the cooktop to the island. I almost started with that. Then I started with, have a big window, then outside wall. So you're at the back of the house, facing out, or the front, I suppose it doesn't matter. The back would be nicer, because then you could go out and cook or do things on the deck
>
> Then it was like okay, what other features do I need? I need the refrigerator. I actually put the refrigerator in last and then I was kind of like ooh, is that the best

> place for the quick access to the refrigerator, which is more common then, how often do you use your oven? So that would be something I would reconsider.

As Zach added elements to his sketch, and then discusses them again with me, he identifies points of decision, possible argumentation for the decision, and queries that might provide additional information. In determining the placement of the refrigerator, he formulated the question of which major appliance actually gets the main use, and thus needs more careful positioning.

> ..now the other funny thing was I kind of drew this and then I was like ooh, where do I keep my food? This was more about how I cook, then I was like, oh I need a pantry, and that's why the pantry is actually in the second color, I need a pantry to keep some food. And I think some of that comes from my current apartment, where I don't keep a lot of food on hand, because A. I don't have the room, and B. you know, I'm right by the supermarket.
> I was focused more on the preparation of the food more than the actual
>
> *[Jennifer:] Because that's what you're doing now.*
> [Zach:] That's what I'm doing more of, then do I need to keep 6 boxes of Ritz on hand, or I don't know, whatever. Where do you keep everything? Then that was why my afterthought was oh, I need a pantry, and it better be bigger. <laughs> It's kind of the realization there.

Like with the mental map procedure, Zach uncovers missed elements that remind him that he may be basing his decisions too closely on his current living situation or the most conspicuous activity of the kitchen: cooking. It is easy to forget that the kitchen is as much about storage and cleaning as it is about food preparation. Zach returns later to this idea of contrasting the features of his current situation with a proposed new kitchen with the wish list exercise:

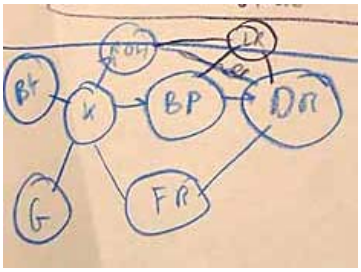
> I did list the things I wanted in a kitchen, which was a good thing to do, if you are going through this process, because this is where, toward the end, where I realized a display area would be a good thing, and then oh, I left out a computer. Because now, in the apartment, it's very easy for me to go from my recipe on the screen over to cooking, but whereas it would be easier if there was just a machine in the kitchen, that you could look at.

It is hard to know whether through the recall aspects of the sketch exercise, Zach became more aware that there are affordances of space that are easy to overlook, particularly when they are successful at supporting rather than hindering, but he carried through a similar reflecting technique across exercises.

A difficult decision in the sketching exercise led Zach to begin to address the wider context of the house.

> Then I was really indecisive as to whether I wanted … the island to have a place to sit at or I wanted a separate table. …later on, that Home Depot questionnaire or something, it was like would you like to be able to sit at your workspace when you are cooking or chopping, and I was like, oh that would be very nice, because I do notice when I'm cooking for an hour and half that my back hurts from standing there all the time.

Zach linked an idea that strikes him in another exercise, in this case the questionnaires, with his decision process for the sketch. In thinking about whether to include a kitchen table or breakfast bar, Zach began to consider the connections between the kitchen and the rest of the house. He employed one of the techniques suggested in the exercise extensions and drew a bubble-diagram of room connections (Figure 24).



<u>Figure 24.</u> Zach's diagram of room connections in his desired home.

> …the kitchen should go directly into the family room, so you could look out the family room and see people doing things, or maybe through an arch over here, or something like that where you can stand here and see things, or like the kids are sitting here, or watching television or doing homework or something at the table.
> I do like the concept that the dining room is off by itself, you're not going to have traffic through it, you shouldn't be able to see back into the kitchen. Yet at the same time you want the kitchen, to me anyway, there's some pictures in here <image sorting> where the kitchen seems isolated. To me the kitchen is like the nerve center of the home, it's where all the business is going on, especially now of days, when you come home from work and you know you got to make dinner, and that's your primary time when you're interacting with people. I think the kitchen should be very visible but then you still want the dining room to be isolated, but clearly they need to interact, so it's kind of an interesting constraint.

In constructing his room connections diagram, Zach drew on ideas of visual connectedness between rooms, particularly in the context of placing people as they do specific activities. He brings forth the issue he identified in his image tour, whether the kitchen should be isolated or integrated, and addresses it by assigning another room, the dining room, a more formal function, and providing alternative traffic options that re-center focus on the dining room, away from the kitchen, during special occasions.

Zach finally comes to the point where he can explain his #13 (Figure 25[7]).

[7] Full credit information couldn't be located for the original photo, so a substitute image, which is similar, is displayed.

Figure 25. Zach's "#13" – the image he found that resembles his desired kitchen sketch.

I saw this one, and then I was like whoa, that's that and that's pretty cool. And when I looked at this, it was kind of fun, because you could notice things you forgot or things you like. So I was like, this is a really neat concept right here, this place, because on another list <the wish list exercise> I said, I really want a computer in my kitchen, to look up recipes and stuff like that and that would be a nice place to put a little laptop or something. Plus when I drew the kitchen like this, I kind of didn't think about the fact that you need a hood and a over the cooktop stove like this, and suddenly go back, and this is what you *think* you like, but you're going to have to have one of these and that adds costs and different aesthetics. At the same time, it's like this is a lot of what I kind of drew, this is what I like, to the fact that there's a pantry where a pantry, an oven where there's an oven, a sink where there's a sink. And then I realized, ooh, a dishwasher, I never drew in a dishwasher, like that – oh interesting.

Zach says that finding the matching image validated his work, indicating that many of his ideas that he expressed in plan view were reasonable. The image also guided him to think about elements that he had forgotten, and their implications (e.g. a different aesthetic from the inclusion of the hood) and opportunities (e.g. a place for a computer).

Question Slips

Zach decided to look through the questionnaires, and as cited above, pulled out some ideas that he was more tuned into with the other exercises, but did not spend the time filling out responses. He is, however, one of three participants who decided to do the question slips extension of the questionnaires exercise. Two to three questions, such as "Do you need more counter space next to the sink for dirty dishes?", were included on each slip under a heading that specified where the slip should be placed, such as "place by sink." The idea behind the question slips was that questions might be easier to answer accurately in the context of doing activities in the kitchen.

Somewhere along the lines I found these (questions slips) and started to go through them, and thought they were really helpful

[Jennifer:] So you actually put them in your kitchen?
[Zach:] I put a few of them around, some of them was just kind of like yes, yes, yes, yes, but some of them, I'll leave them around, see what happens to it. So a lot of my answers, there were so many that were yes, yes, yes, no, yes. This was also useful though, because it was like, as I would do stuff, this! (taps on table) yes! Most of my yeses are yes! Emphatic yes or emphatic no, you know. …it was kind of funny though, because a lot of these, I know the answer, but I am just waiting for the situation to come up, because I know what the question is.

[Jennifer:] Looking for confirmation.
[Zach:] Right

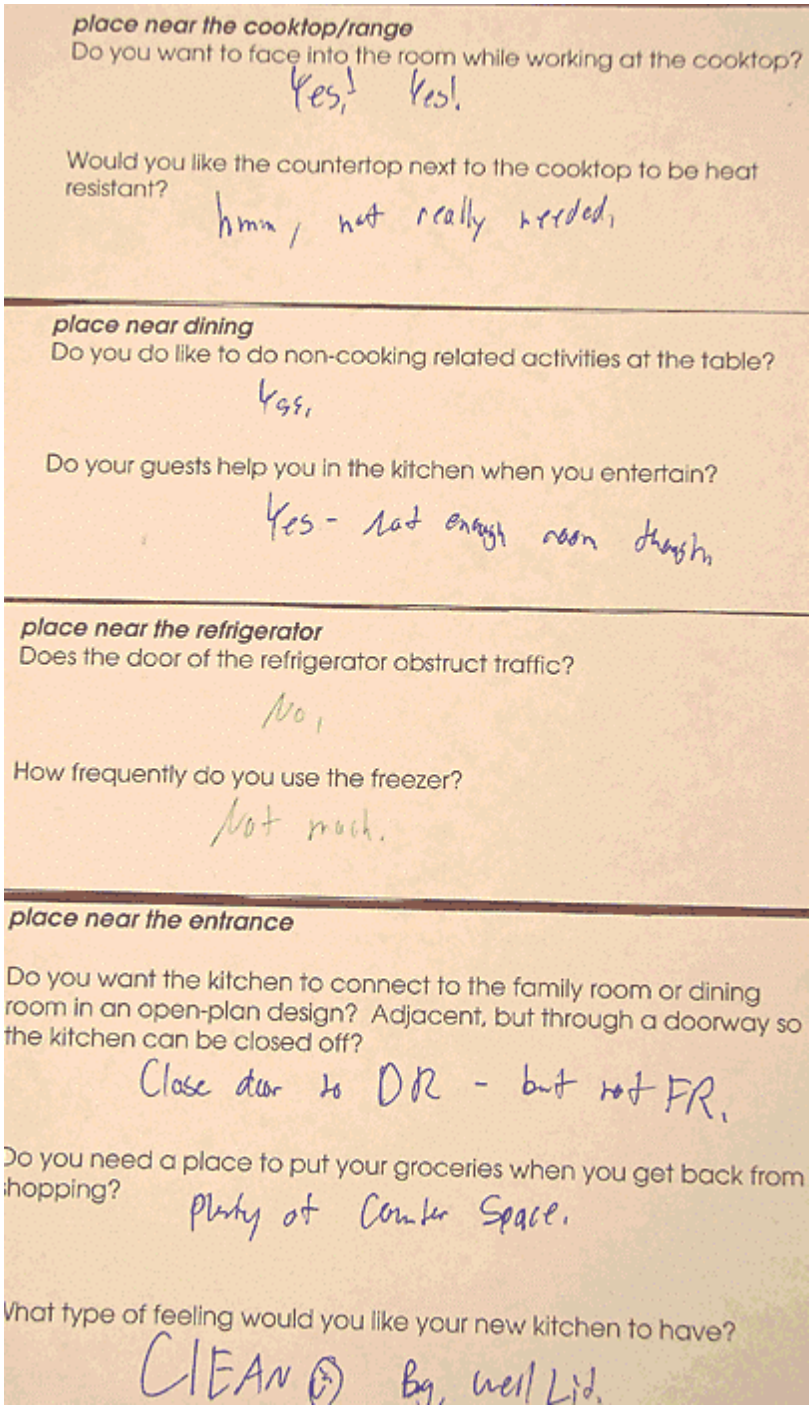


Figure 26. Several of Zach's question slips that he answered in the context of his kitchen.

Although Zach felt he knew the answer to most of the questions, he used their placement in the kitchen as an opportunity to express the importance of the decision (i.e. his emphatic yes) and to confirm and validate his assessment of his needs. I ask Zach whether he felt he ever answered in a different way, because he was answering in context.

> "Would you like the countertop to be heat resistant?" I might have said yes, but in reality, not really. Then I was thinking, because I use cast-iron, would it really be heat resistant? That's pretty hot stuff, and that also went through my head. On the face of it, I probably would have said, why not?, But in reality, *why*. So that one was interesting. The groceries one, again I think here I would have said yes, I need <a place> to put my groceries, but it's more like, don't you have counterspace? It struck me as an odd question, it's like would you have the "this is my grocery space," it seems odd to find any place for that, when you should just have space.
>
> *[Jennifer:] It's multifunctional.*
> [Zach:] Yeah, exactly, that didn't strike me as something that would need to be specified.

Using the question slips, Zach is able to do one of the more difficult tasks in home design, distinguishing what he really needs from what simply sounds good. Going through a standard kitchen questionnaire (e.g. Home Depot (http://designcenter.homedepot.com:8001/)), it's easy, as several homeowners found, to decide that every option would be nice to have; the real challenge is to, as Peña and Parshall (2001) describe, separate needs from wants. While cooking in his kitchen, Zach first questions whether a special feature is really needed, and then wonders what the true value of the feature would be under the kinds of real-world situations he would encounter, such as using a cast-iron skillet. Zach also collapses an issue, finding a place for groceries, into a more general need for counterspace, simplifying the decision space. Finally, Zach identifies a mundane, but important, quality that is consistent with how he actually uses the kitchen.

> The "what type of feeling would you want your kitchen to have", after a while I decided "clean" is the number one answer that would be nice, based on my actual experience in my kitchen.

Pre-design Exercises, Case Study 2: Gwen, And Yets

Gwen is in her early 40s, has a background in mathematics, and professes a budding interest in design and architecture. I am impressed with both her understanding of her self and her willingness to try out unfamiliar perspectives. She lives alone in her condominium and is willing to put up with small spaces for the cultural affordances of her urban setting, but dreams of a kitchen that better matches her vision of how to entertain her guests.

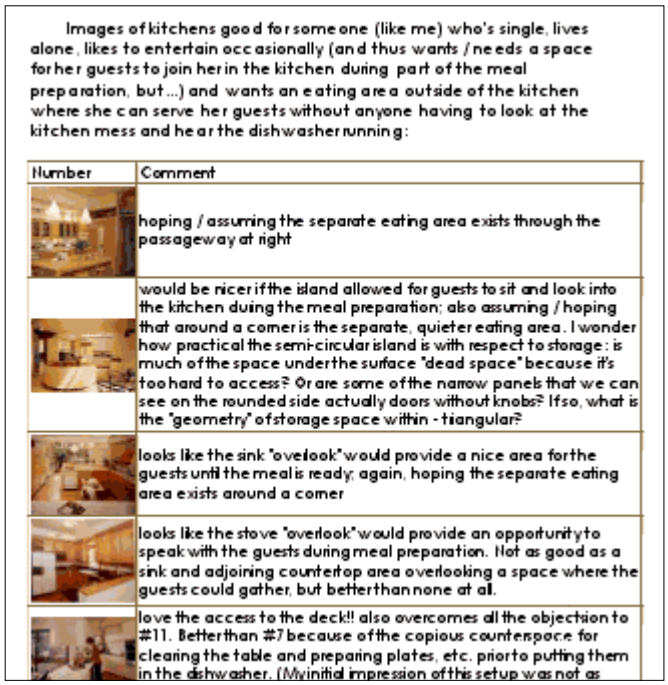
Gwen also describes a "gut reaction" first response to the images. She pulls out particular features that can determine negative decisions, such as the glass cupboards or presence of a thoroughfare.

> Mum and I are in concert, we don't want glass in the cupboards <laughs>, we want to hide the mess, so kitchens with glass cabinets are leaning to the "don't like pile."
> I think I tended to definitely put in the "I don't like" pile those that seem to have a thoroughfare through the kitchen for you know, coming in the back door from the garage or off the backyard or something and have people tromp through the kitchen. I would rather have a sort of work area where it's not quite so "grand central station"- like.

This was common across participants, to have a few strong dislikes or "pet peeves" about appliances, layouts, or cabinet features, which they could express with confidence; windowed cabinets, formal dining rooms, hanging items such as pans that could get dusty or greasy, and hooded exhausts were mentioned with some frequency as the sins of modern home design.

By sorting the images, Gwen developed a description of what she liked that she then used to construct an image tour, as an extension to the image sorting exercise. She placed twelve images, with comments under the general heading:

> "Images of kitchens good for someone (like me) who's single, lives alone, likes to entertain occasionally (and thus wants / needs a space for her guests to join her in the kitchen during part of the meal preparation, but...) and wants an eating area outside of the kitchen where she can serve her guests without anyone having to look at the kitchen mess and hear the dishwasher running"



Images of kitchens good for someone (like me) who's single, lives alone, likes to entertain occasionally (and thus wants / needs a space for her guests to join her in the kitchen during part of the meal preparation, but...) and wants an eating area outside of the kitchen where she can serve her guests without anyone having to look at the kitchen mess and hear the dishwasher running:

Number	Comment
	hoping / assuming the separate eating area exists through the passageway at right
	would be nicer if the island allowed for guests to sit and look into the kitchen during the meal preparation; also assuming / hoping that around a corner is the separate, quieter eating area. I wonder how practical the semi-circular island is with respect to storage: is much of the space under the surface "dead space" because it's too hard to access? Or are some of the narrow panels that we can see on the rounded side actually doors without knobs? If so, what is the "geometry" of storage space within - triangular?
	looks like the sink "overlook" would provide a nice area for the guests until the meal is ready; again, hoping the separate eating area exists around a corner
	looks like the stove "overlook" would provide an opportunity to speak with the guests during meal preparation. Not as good as a sink and adjoining countertop area overlooking a space where the guests could gather, but better than none at all.
	love the access to the deck!! also overcomes all the objection to #11. Better than #7 because of the copious counterspace for clearing the table and preparing plates, etc. prior to putting them in the dishwasher. (My initial impression of this setup was not as

Figure 27. Gwen's image tour for homeowners who live alone and like to entertain.

Gwen explains her criteria,

> I reacted more positively to the designs where there was kind of a more open plan where the guests would have a place to sit and especially in exercise 2, the extension that I did – that was actually the set of conditions… that I'm looking for, so there's some kind of island or some kind of tabletop or whatever where a guest

> could sit, and I could speak with them without having to shout around a corner or through a wall or something. But then I also want a separate eating area so I can serve the serving dishes out to a dining area, closed off visually, and in terms of sound, from the kitchen so we can have a nicer space to eat then. So I don't want them necessarily to have to help with the preparation in a big way and sit amid mess, <laughs> which they have to do right now. Just help me a little bit, but sit with me so I don't have to feel that I'm not playing hostess, but then let's leave the mess behind and go elsewhere.
>
> *[Jennifer:] So it sounds like you're thinking about it both in terms of the staging of the event*
> [Gwen]: Yes
>
> *[Jennifer]: and also what role each of you would play?*
> [Gwen]: Exactly. And some of that is clearly sort of traditional training. This is the way mum did it. This is the way I would like to do it with a few modifications, given then mum had me to help <laughs> I don't have help.
> And also thinking that mum also sat a beautiful, we had a nice dining room, and she set a beautiful table, and I always liked joining her in that activity, seeing visually the table before people came to sit at it, and then seeing how that space worked and didn't, it was just a little tight once you got everybody in there, so getting around the table to serve or to clear was difficult. But sort of having that image in mind and liking that separation from the kitchen.

Gwen expressively describes how she wants to experience a dinner party in her home, from cooking to setting the table to enjoying the meal, borrowing from memories of her mother, and situating the scenario in space, as a series of stages defined by what can be seen or heard (or not seen or not heard). She recognizes that the design of her environment helps to define the roles that she and her guests will play and determine the focus of attention for each stage of the party. Her recollections emphasize the importance of ritualized activities in familiar contexts, such as a formal dining room, setting the scene, physically and psychologically, for events that will follow. In creating her image tour, Gwen developed a concrete, environment-based definition of a particular desired life pattern, personalized for her unique situation.

Gwen knows herself well enough to identify triggers of stress that she can control through modifications to her space.

> I do know that one of my other traits is that an excessive amount of noise is both distracting and raises the amount of stress, so if I can close off some of that noise, keep the traffic out for example, it's that idea of separating, having a separated eating space, so that if I turn on the dishwasher while we're at dinner, I can close that off and we're not hearing that noise.

Gwen is also aware of how her perceptions of her kitchen influence her actions upon it,

> There's very little counterspace to work on, so occasionally, I'll use the kitchen table, but more often, the sink itself becomes an extension of the counter – I need to put something down, and free up the actual counterspace to chop or whatever – set it in the sink, or set it on top of the stove, or I'll set it in the dish strainer or something. So I kind of make counter space out of those pieces that aren't necessarily counter. But I'm not tempted to turn around to my kitchen table, and I think if it were more of an island, I would be, but I think of it as the table, the place where I'm ultimately going to sit. It typically has a tablecloth on it, so it's going to get wet, or it's going to get icky if I try to use it.
>
> *[Jennifer:] That's interesting, it's almost as though it's symbolic, you don't want to think of it as a different function*
> [Gwen]: Right, right.

Gwen demonstrates that a workable, functional kitchen cannot simply be one that follows rational design guidelines, but also must be one consistent with the inhabitants' interpretation and expectations.

Gwen is at an interesting place with design; recognizing that her traditional Midwestern background limited her to particular aesthetics, she is now beginning to open herself to new ideas. She compares this process to her developing an appreciation for a wider range of music,

> I'm breaking out of the, even though it doesn't look like <pointing to her turtleneck> – breaking out of the turtleneck mode <laughs> breaking out of – musically, I've always loved classical music, and sort of the oldies in terms of pop stuff, but I find that I get bored with a steady diet of Bach, Beethoven, Mozart, and so forth and I want to stretch a bit now with some of the more 20th century composers, not the real far out ones, but those who will, you know, just kind of put in an interesting harmony or rhythm and shake things up a bit.
> So from an interior design or an architectural perspective, in terms of the whole space that we're working with, I tend now to look and respond more positively, or at least be open to more contemporary looking spaces, more modern.

Gwen credits this ability to broaden her perspective to her first becoming comfortable with and trying to understand what was familiar.

> And so at least for me, raised in the Midwest and not exposed to a whole host of modern stuff, and having parents that sort of turned up their nose to modern stuff, and people around me who turned their nose up at modern stuff, kind of needing to see enough of the traditional and feel well grounded in that, to feel comfortable in saying that I really like this other thing, and not necessarily having to justify why I do. But just feeling like, I'm grounded enough, that I can move on.
>
> There are probably more of us who feel comfortable either incrementally moving from what we are already familiar with to what we want or what we have to what we like, then making just a huge leap.

Professional designers appreciate when clients are able to consider new aesthetic perspectives, and by extension, it would be a desired trait for users of design systems, because it opens up the opportunity for new solutions that borrow from multiple traditions (Kent Larson, Jarmo Suominen, Ed Steinfeld, personal communication, 2003). Now that Gwen is at a place where she can explore, she has developed an interesting heuristic for re-evaluating the images that she calls "and yets."

> This one <Figure 21> I had a strong, I don't like – it's too severe, too uncluttered if you will. There's no, other than this wooden wall, there's not warmth to it. And yet, so that's my initial reaction, and then I go into the "and yets".
>
> So the starkness of this one, I did then think, okay, it has no, right at the moment, as pictured it has no sort of stuff softening it, but would it allow me the opportunity to – could I put up curtains, could I do something to alter it. I don't think, you know without altering the main installed pieces, and on the whole, I don't think is allows too much for it <laughs> this is not the kind of kitchen where you put magnets on the refrigerator. But um, those kinds of things to make it a little bit more your own.

Gwen takes images to which she has an initially negative response and looks again, trying to determine what it would take to make the space workable, either through changes in design or by the way she would live in it. She essentially asks, what could she bring to the design to make it work for her. Her "and yet" procedure also helps her see possibilities hidden in images that her gut has told her to avoid.

> Like one of the designs that I initially kind of turned up my nose at <Figure 28>, but then as I got a little closer, … I realized I was liking it more than I thought I was. This one.

Figure 28. An image to which Gwen initial reacts negatively, improves on second-look.

> The woman is standing at the sink, plenty of counterspace, allows her to look out, and maybe her guests are seated here at the table, so that she can talk with them. My initial reaction <was> – oooh, this is kind of weird, it's going to be tough to get between this piece of the counter and, what is this little thing – I still haven't figured that one out. I imagine it's cabinet, but am I going to have to duck to not hit my shoulder or something like that. But what I recognized as I went through the images, and kind of studied everything, if there isn't

> a sink or stove kind of overlooking the guests or on island where the guests can sit, then my back would always be to my guests… I don't figure the oven is that important, and the fridge isn't that important, because you *stand* at the sink, say washing vegetables, preparing a salad or something like that, or stand at the stove, doing stir fry kind of stuff or whatever…
> This one came to be more appealing, the more I kind of studied it and thought about what it was bringing to me. So there was an initial thought about how I would work my way through this kitchen, that wasn't appealing, but as I got to thinking about how I would want to use the kitchen, then yes –
> And then I also noticed, like initially I hadn't noticed the deck, because I don't have one right now – so it's like a non-thought. So I thought, oh this would be fabulous, because I've always wanted the deck right off the kitchen, to be able to grill and just extend the space outside.

By giving the kitchen a second chance, based on an evaluative criteria that she developed looking at the series of images as a whole ("the sink or stove should be positioned so the cook can overlook the guests"), she was not only able to respond in a more positive way to qualities of the kitchen that are beneath the surface, but also discovered elements (the deck) that she had missed on her first pass. In combing tacit response with critical re-evaluation, Gwen expressed a set of assumptions or aesthetic hypotheses ("I don't like this kitchen") and then put them to the test with a more methodical investigation.

Pre-design Exercises, Case Study 3: Kristen, Scenario Teller

Kristen, from my original interviews, agreed to participate and talk with me again for this study. In chapter 3, I described how she began to explore her own sense of aesthetics and experiment with alterations to her condominium. Like many of the study participants, Kristen sent me her work before the interview, and I wasn't surprised to find among her items a list of like/don't like numbers for the image sorting exercise, both because every other participant had chosen image sorting and because Kristen had shared so many nice examples of visual techniques, including the collecting of clippings, in her initial interview with me. At the interview, however, Kristen told me that she had actually had her mother, who was visiting with her, do the image sorting exercise.

> So I had my mom do it, because I didn't want to.
>
> *[Jennifer:] So you didn't like the task because it was -*
> [Kristen:] There were too many, way too many – it was just, it got to be, I don't know, it got hard to really think about that many images at once, and so it became kind of a chore.

> You can respond to something where you like one piece but not the whole kitchen, so that was the other thing – it was like well, I like the island, but I don't like the wood, so do you put that in the like or don't like category?

Kristen commented on the quality of the images and the examples that were shot at odd angles or showed only sections of kitchen. The supplied images were reprinted on my deskjet printer, and were therefore not of magazine quality, and she was not alone in expressing confusion over some of the more unusual images, but Kristen's primary negative response seemed to stem from the directed aspect of the exercise. She reminded me of her own collection process.

> What I would do is, if there was something I liked in the picture, I would tear it out. Um, for instance yeah, I like the idea of having a thing with stools, so I might choose that, pull it out…If I like certain color schemes or certain looks or feels of the room, if they're comforting, or I like the style, I'd pull them out. So when I did that, I had this whole stack, so I went through them every once in a while, then I would start noticing that there were similar looks that I liked.
>
> *[Jennifer:] So it was kind of a slower filtering process and then you start to –*
> [Kristen:] Yeah, yeah... seeking out the pictures, or noticing things, figuring out what about them makes you comfortable. For me, I figured out a style, this is the style I like, and I went through a process of figuring that out, and then figuring out colors I liked and figuring out that I wanted to feel soothed by the colors in the environment I'm in, and figuring out what things made me feel that way, what colors, what elements, what styles.

Kristen did try the questionnaires exercise, doing two of the three supplied questionnaires (Home Depot (http://designcenter.homedepot.com:8001/) and Kitchens That Work (Edic & Edic, 1997)), but was dissatisfied with the focus they took.

> I was really challenged by the question "What do you want to show off?" <from Kitchens That Work> - cause that's just now how I think about my kitchen, I was really stuck on that, I was like I have no idea, no idea how to answer that, I didn't want to but did somehow.
>
> I guess I felt they didn't ask me enough about what I do in the kitchen, what my activities are, like how many people, what are they doing, what times are you in the kitchen most – like the scenario exercise that I think that I did, I think that was kind of neat because it was getting at what my activities are in the kitchen and the questionnaires didn't address that very well.

Somewhat surprisingly, most of the participants meticulously completed the questionnaires, spending two to three hours writing out responses. Questionnaires were sometimes praised for their ability to bring up issues that could be investigated further through conversation between a couple or other exercises, and cited as something

necessary for participants who identified themselves as research-fanatics who are constantly worried that they'll miss something. They did, however, leave many participants feeling like there were too many decisions, and that the individual responses didn't add up to a strong vision for their home. As Kristen alludes to, they did not typically let homeowners express what they know about themselves. She found satisfaction, however, with the scenario exercise,

> That one I enjoyed. I like that one because it was interesting to think about my activities in the kitchen, like what I do, what space I use, how that changes in different situations, and so it was very useful in thinking of, oh, if I could do my ideal kitchen, this is what I would want, because this is how I would use it in different times of the day or different situations, so it made me think of things I wouldn't have thought of.

Kristen wrote text for three scenarios: "My friends come over for an informal dinner," "Bring in groceries," and "Cooking dinner for self on a weeknight." In developing the first scenario, she went over a typical dinner in her mind, thinking about what she does, what her friends do, and what her friends ask her about during the event (for example, where is an item located?). In doing these scenarios, she tried to think about how she could improve the situation in her existing home, and what ideas she would carry forward to a new home.

1. My friends come over for an informal dinner.

Everybody likes to cook, so everyone wants to pitch in. Though my kitchen is open to the living room (except for a large post), everyone gathers in the kitchen to talk and help. There is little counter space, so when one person is at the counter, it's hard for anyone else to do too much—maybe someone is at the stove or using the sink, but then you have to walk around the table in the middle of the kitchen to get around them. The table in the middle of the kitchen is useful. When you are facing the sink/counter, it is directly to your back. That is useful for extra prep space. But when a real dinner is being cooked, there is just not enough counter space or table space. The table also is used to sit down for dinner, so then it has to be cleared. Often there are 5 of us, and the table only seats 4 comfortably. My friends help themselves to finding things in the kitchen cabinets… they mostly know where things are, but have trouble finding some things that aren't used everyday. Since there is not much storage space in my kitchen, entertaining items like serving bowls and wine glasses are in hard to reach places, so I have to get on a chair and dig them out.

Future: There would be much more counter space, so there would be separate 'workstations' for everyone to help out. Ideally, there is an island with an extra sink for prep work or doing dishes. The island would allow socializing while preparing the meal and would be a great, informal gathering spot. There would be a separate seating area, so the table could be set ahead of time, and there would be enough seats for everyone, yet the table wouldn't be so far away as to have to carry all the food very far. Also, there would be more storage room so it wouldn't be so difficult to reach the lesser-used items in the kitchen such as serving platters & bowls and wine glasses.

Figure 29. One of Kristen's scenarios, "my friends come over for an informal dinner."

> I think you can assess your needs better by first knowing what you do, thinking about what you do, and then you can figure out, beyond the obvious things, like traffic flow issues, like when I did that in my mind I thought of things like, oh, it would be great to have a TV in the kitchen because I'm always trying to watch TV while I'm cooking, and I can't really see it

Kristen used her activities as a way of exploring design space, thinking through what could serve her needs under different circumstances. In the collage exercise, described below, Kristen makes strong connections between her work on the scenarios and the ideas she develops using a more spatial medium.

Participant Pre-design Recommendations

At each interview session, participants provided their evaluations of the exercises and recommendations for other homeowners. Some of these recommendations were necessarily conjectural, as the participants imagined what they would have done if they had worked with a spouse or family member, and identified situations when they would have chosen exercises that they had examined, but didn't do.

As mentioned earlier, participants indicated that their tendency toward being "practical" dictated their choice of the more traditional, output-oriented exercises, such as image sorting and questionnaires, but several individuals felt there was a place for exercises such as reflection and storytelling:

> [Arlene:] I think a lot of people start here <with sketching>, because they could buy software or whatever. Or, you know, looking at the magazines. But … that's not your life, you know, that's somebody else's; you've got to start with your own life. … I would say, if you're stuck in the magazines, if you're stuck in the software, maybe you need to go all the way back to doing some of these seemingly impractical, emotional kind of things. Cause in the end it's all just nails and wood, but it's a very emotional place.

Arlene, who had expressed pointed skepticism about the glossy magazines in chapter 3, believes that people can easily fall into repeating patterns, either of their parents' home or of the latest fad. She sees the more open-ended exercises as serving the role of refocusing the process on the personal and emotional aspects of the home. Some of these exercises may have been perceived as more doable if I had had an already-created database of examples, to demonstrate that something physical does come out of the process. Most participants did try extensions that shared qualities with the reflection exercise, such as sorting their images by the "I would have liked 10 years ago" category.

Ultimately, time was often the deciding factor for which and how many exercises were completed. Patricia, another participant from the original interviews, felt a lack of motivation to work independently restricted her to doing the more straightforward exercises, to the exclusion of others she would have tried:

> These were all good, but finding the time, it's like anything. If you had said, okay, we're going to schedule you for three hours in the lab and you're going to come in and do these, then it would have probably worked, but trying to sit down and do them at my house was hard.

In spite of time challenges, most participants felt that doing the exercises iteratively could be helpful, to develop links between ideas in different representations, as Zach did, and to get some distance on gut reactions in order to identify the real source of the response. Participants often reacted with surprise and disdain, as they browsed again through their "I like" pile at the interview, indicating that a second-look could direct them to different features that were less appealing and help them to situate themselves within the design. As one participant (Barbara) noted,

> in the first go through the kitchens you liked, I picked this <Figure 30[8]> as a kitchen I liked because it was pretty uncluttered and lots of light and tile floor, and then when I really looked at it, the design, and imagined being in the kitchen, I was like "ooh, I don't like this kitchen at all." So it was interesting what was attractive to me was the open space.

Figure 30. On re-inspection, Barbara decided that she didn't like this image, noting that the open space had driven her initial response. Please see figure list for photo credit.

Over the long term, many participants, who identified themselves as research-fanatics, would rather go through an exhaustive process, where they had a strong sense of the design space and ideas for alternatives, before feeling ready to proceed with their designs.

Recommendations for Couples

As the one couple that participated in the study together, Barbara and Tom were remarkably complementary in their approaches and ability to communicate. Looking a few years ahead to the home where they will retire, they are already working

[8] Full credit information couldn't be located for the original photo, so a substitute image, which is similar, is displayed.

with an architect to envision their space. Barbara comments on how home design is rarely about just one person's wants and needs:

> Well, one interesting observation that I had was, I would, in my mind think that the kitchen was mine, because I do most of the cooking, and through this process <the study> and through talking with the architect, I realized that everybody thinks that, everybody who lives in the house thinks the kitchen is theirs – that they have a relationship with the kitchen that would prescribe how we change it. That was kind of an eye-opener <laughs>. And I also became aware that we spend a lot more time in the kitchen than I would have thought we do.

Barbara and Tom attribute their ability to come to consensus to personal style, but also note that they give each other veto power and are being careful not to rush. They enjoyed talking about the questionnaires together on their 2 and half hour commute to work, and Tom notes that apart from the end product, the home design process itself has been valuable:

> It's been really fun; it's some real nice quality time together. It's given us the opportunity to think about lifestyle, think about what's important, … if there are people contemplating retirement, and our older, we spent a lot of time together and we are rediscovering things about each other that are real nice.

Architects can attest to the unpleasant results of having one or more family members unrepresented at the beginning of a design process, both in terms of lost time and increased stress on all involved (Paul Lukez, personal communication, 2003). As Arlene proceeds with her own remodeling projects, she notes this as well,

> You know that's probably another area that married couples can make a mistake on, when they don't push their spouse hard enough to get the real answers, sometimes you know, "whatever you want, dear", but you know then, push comes to shove. And my husband will do that.

Several of the participants were in long-term relationships and could speak to techniques they would use to get their partners involved. Suggestions included doing the reflection and wish list exercises to identify differences on "what a home ought to be," before detailed decisions are made; using the image sorting to directly compare aesthetic perspectives, looking for agreement and dissonance; referencing homes of friends and family ("think about cousin Bob, look at his kitchen, remember how he has this little drawer that comes out, how helpful that was last Easter?") or shared anecdotes ("Remember when we tried to cook this and could not, or when this went wrong or a I stubbed my toe on the door last week or you had the refrigerator open,"); and that a construction, wish list, sketch,

or image sorting, is helpful for making comparisons and exemplifying a point, but it should be accompanied by explanation and discussion – as Gwen notes,

> With the sketch, I wouldn't think of it living on its own anyway, that you would talk someone through … this is why I put this here, and this is how I envision these pieces working or if the two of us are working in the kitchen together, then you've got space here and I have space here, we have space to move between and not bump into each other.

Perspective on Working with Architects

Far from wanting to do it all by themselves, participants identified an important role for the designer or architect. They noted that homeowners can be good at critique and good at contributing "small chunks," but that the designer can help them to integrate those ideas into a more complete and innovative vision. Tom and Barbara feel that the homeowner's role should be in identifying the activities and personal interactions within space,

> [Tom:] I think that I don't want to prescribe to an architect what I want.
> [Barbara:] But I don't think we want the architect prescribing to us what they are going to do.
> [Tom:] It's a give and take. You have to give them something to go on. I don't want to do what architects do – the stools there, the sink there – I want to say here's a space, here's what we want to do with it, we're going to interact with each other in this space,

Recalling the Process

The final question I ask is about what they would tell potential buyers of their custom homes, five years into the future, and it tends to evoke a moment of pause, as it's not something people usually think about in making their initial design decisions, but Tom smiles and answers:

> If we were selling a house that we had a big hand in the design in, it would be fun to say well we designed this this way because… I think what we would do if we were selling it to somebody is explain the thought processes that went into it from our perspective and they can either like that or not.

Collage Exercise

After the interview, participants were asked to contribute to an evolving collage-style exercise at the House_n lab. The basic exercise was designed to embody an integration of several of the pre-design exercises (image sorting, sketching, wish lists, scenario building) and require a level of decision-making somewhat intermediate between the pre-design exercises themselves and the more formal design stage. I wanted to use the in-lab exercise both as an opportunity to evaluate how well the

exercises had primed the participants for a more traditional design task and as a malleable protocol that could be shaped by the participants to reflect their cumulative abilities and needs. After completing the exercise, participants would make recommendations for additions or modifications to the materials and suggest protocols for future participants.

Figure 31. Quality words included broad descriptive adjectives.

Participants were given the following media to use:

- quality words – adjectives that can describe the kitchen or elements within the kitchen, such as "efficient" or "elegant"

- concept cards – index cards with a simple illustration and label that represent kitchen decisions at four scales: 1) objects and materials (e.g. prep sink, granite countertops, appliance garage); 2) counter layout and appliance arrangement (e.g. L-shaped kitchen, dishwasher to left of sink); 3) adjacencies and level of access to nearby rooms (e.g. connects to laundry, open and integrated with dining); and 4) position within the home (e.g. central, peripheral); structural details (e.g. window over sink). As described below, the concept cards grew from approximately 50 to 100 cards, based on the specific recommendations of participants, and to

Figure 32. Concept cards represented kitchen design ideas at multiple scales and levels of abstraction, combining illustrations, simple labels, and associated vinyl pieces.

represent a more activity-based category (e.g. place for groceries). Cards could be yellow or green, based on whether the decision could be reasonably judged as "premium" based on availability or cost. For example, terra cotta flooring is premium, whereas linoleum flooring is not.

- vinyl pieces – color illustrations of plan view kitchen components (e.g. sink, cooktop, refrigerator) on pieces of static cling vinyl; as several participants noted, these pieces are reminiscent of "colorforms," reusable stickers for children, first introduced in the 1950s. As described below, additional vinyl pieces, linked with the concept cards, were added based on participant recommendations.

- glass table with dry-erase markers - surface and markers for rough sketching and revising. My neighbors in Colorado, Mel and Mary Sinton, are remarkable do-it-yourselfers who, with some help from friends, not only designed, but built their first home as a couple in the 1960s. In the months before the construction, each night after dinner, they would sketch ideas for their new home on the Formica table in their apartment kitchen. They wanted something that could be rough and freeform, something that could be wiped away without hesitation. After a while, they began to commit their ideas to paper, and then Mel took classes to convert sketches to diagrams with engineering precision, but the

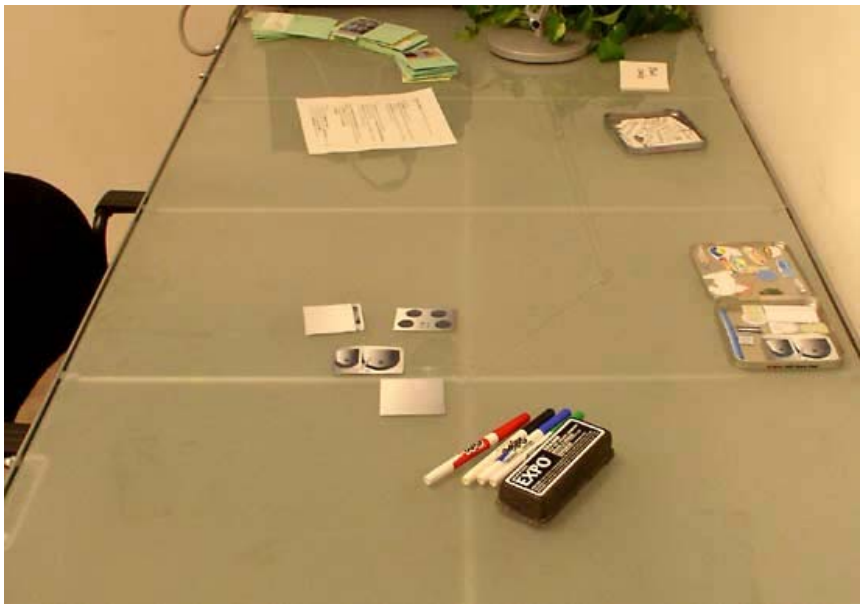


Figure 33. Glass table at House_n where participants worked on the collage exercise. Dry-erase markers, vinyl pieces (center), concept cards (top left), and quality words (top right) are also visible.

table saw their initial explorations, when they were defining what their home would be. Thanks to a bit of serendipity, I was able to employ a glass-surface table for the exercise, echoing the Sintons' improvised drafting table.

Each of these media had a kind of playful quality; the glass table and "colorform"-like vinyl pieces in particular evoked responses of delight from the participants ("We get to draw on the table!"). Participants would be seated at the glass table and given an overview of the exercise, with any recommendations to date from previous participants. They were told that they did not have to create a workable design, but instead should focus on trying to express some ideas they had for their new kitchen. They could then choose what order they would like to apply the media and how they would like to structure the task. Participants were asked to talk-aloud while they worked and with their permission, were videotaped and photographed. At the end, they were asked for their recommendations and a final photo of their work was taken, which was given to them to keep.

Additions and Modifications

Concept cards were added to represent some of the specific concepts, pet peeves, and preferences mentioned by the participants during the course of the interview and session.

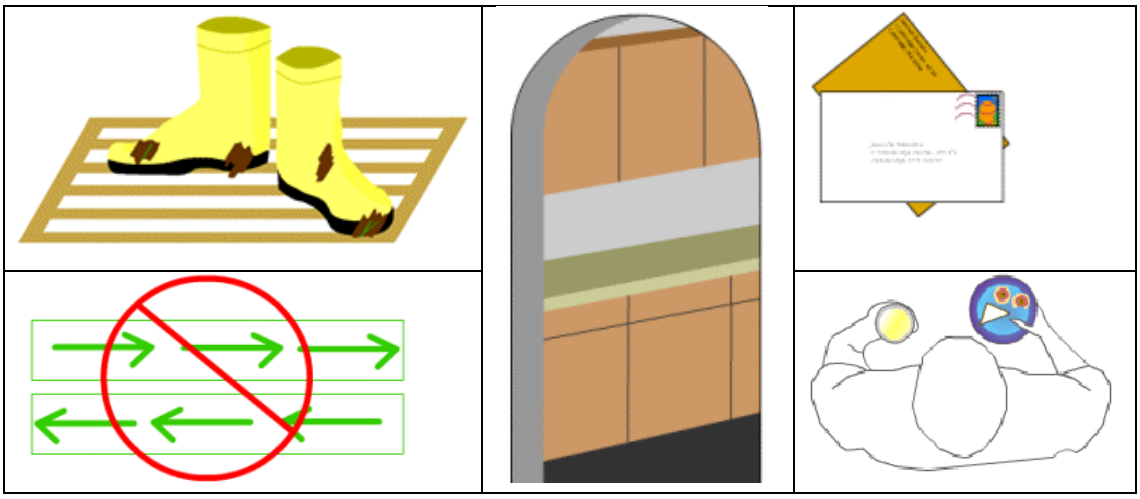


Figure 34. Examples of the added concepts include "mud room," "arched doorways," "a place for mail," "no thoroughfare," and "a place for guests."

The collage exercise was also expanded and elaborated based on the participants' explicit recommendations with regard to materials and protocols.

- Expanded set of vinyl pieces - In addition to the basic kitchen components, such as the sink and cooktop, which commonly act as "anchors" for the sketched layout, one participant suggested that there should be corresponding vinyl pieces for the concept cards:

  > there should be more of these placeable elements within the picture, like when it said hutch, should there be a little hutch that you could put right there, and the kitchen table that I could put right here. I think that would be helpful, to be able to place more and more pieces out here, to get a feel for what's really in the kitchen.

  In response, I gradually added vinyl pieces for the concept cards that might be reasonably "placed" or positioned, including the breakfast bar, the hutch, the lights, the TV, and later, for the added activity-oriented cards, including the mail, the groceries, multiple cooks, and guests. A second set of the basic components was added based on a participant's recommendation that it should be possible to work on two alternative possibilities (kitchen A and kitchen B) simultaneously. Vinyl pieces for counter appliances were also suggested, to provide a functional context. Another participant recommended larger sections to change out, such as different islands or counter layouts. Although I did add some more complete pieces, such as a pantry, this idea was not fully implemented for the study, but shared with subsequent participants to get their impressions.

Figure 35. An added vinyl piece, a toaster-oven, recommended by participants to give functional context to sketches

- Scenario cards – Two participants recommended that after expressing some basic design ideas with the cards and sketching, homeowners should go through a simulate-and-test process where they walk through steps in scenario. Patricia, who participated in both the original interview and the study, told me about how she evaluated proposed solutions for her current kitchen remodel by considering the scenario of getting up in the middle of the night for a glass of water. She recommends,

> So one good thing might be to do this, and then give them a scenario and say okay, now you've got friends over and you're doing this, or now you have to make dinner for twenty.
>
> *[Jennifer:] And how does it play out?*
> [Patricia:] Yeah, exactly, and actually think about the steps – okay, you've got to make dinner for twenty. You've got to buy the food, am I going to have enough storage here? Where else am I going to store refrigerated items, that could be a problem. Do I have enough dishware? That could be a problem, but I have a hutch, so I probably have enough dishware. I only have one stove, that's going to be a problem. Um, but I've got a good entertaining space and a good space to make drinks, so one person can make drinks while the other person is cooking. So, you know, that kind of thing. You'd probably have to have some hints, so did you think about this, did you think about this, to go along with the scenarios, to make sure.
>
> *[Jennifer:] Can you think of some kind of vinyl piece or other kind of representation, to help them?*
> [Patricia:] Well, you could certainly do some cards. Like hand them a card deck for a dinner for twenty, that included, extra food, need to make drinks, all that good stuff. Extra pieces… you could actually, you could have extra pieces if you wanted to, here's the extra food you've got to store somewhere, here's the extra table and chairs that you rented, where are you going to set those up? So that might be kind of fun, but definitely cards.

Activity-style vinyl pieces were added, some connected with concept cards as mentioned above (e.g. a place for guests) and others as stand-alone pieces representing common kitchen preparation activities, such as baking, getting snacks, and chopping vegetables. A card deck representing a set of steps in a scenario was created for the last few participants.

- Procedures – In additional to making suggestions about the content and form of the media, participants made recommendations about how to do the exercise as a method for preparing for design. Zach, for example, recommended sorting the words first, sorting the concept cards and sketching, and then linking the expressed ideas back to the selected words. He found a place for "elegant" and "formal" in the attached dining room, while "social" and "airy" were placed at the island with cooktop, and "quiet" was limited to the dishwasher.
  Tom and Barbara, who did the exercise together, recommended examining the words and concepts that were not chosen, which they noted didn't have to be ideas that the homeowner opposes, but may not be the focus of the design. For example, they put "investment" and "economical" in their "no" pile because they

want to think about the home they will retire to, which will be just for them, not dictated by resale.

Many of the participants didn't do the words until after they had gone through the concept cards and sketch, and found them unhelpful once they had already gotten to a more concrete stage. They recommended doing them first, or not at all. Patricia, being in a later stage of her own kitchen design, was ready for information and advice, and recommended having a grid mat available, to be more precise with placement, as an eventual refinement to an original rough sketch.

I now describe two example experiences with the collage exercise, those of Kristen and Emma.

Collage Exercise, Case Study1: Kristen, Giving Structure and Making Discoveries

Kristen is the last participant to come to House_n for an interview-session and is one of two participants to try the scenario cards. I describe the scenario, "you decide to throw a dinner party," which is quite familiar to her, and she begins stepping through each card, reading it aloud, commenting verbally, and then, when appropriate, adding a note. Her first edit is to the number of guests attending the party, taking it down from 10 to a more manageable 6. A few cards in, she stops and backs up to add two initial cards, which describe how she decides to initiate the party and contact her guests. As per the instructions I gave her, she writes in blue to indicate details that may be restricted to her current situation and in pink to indicate details that pertain to a projected future.

> Okay. So what is this future? <referring to pink pen> <annotates first card>
> Probably the future could be more formal, so it's now it's kind of an informal, everyone bring something. I imagine that if I got married, it would be a more formal dinner party where I make all the stuff and a few people bring things – less participation. It depends; it could go either way, hard to tell.

Unlike the first participant to try this exercise, Kristen decides to keep every card, though some she notes don't apply to her current situation. Some edits are directly related to a decision about the design of the house (e.g. a note that in the future, the dining table is located in a separate dining room, card #22), others are a qualification on the use of the space (e.g. a second refrigerator would not be used for party items, card #5), and others are focused on the lifestyle or activity within the space (e.g.

spouse helps with dishes). She also maintains the order of the cards. After she has finished, I have her set them aside.

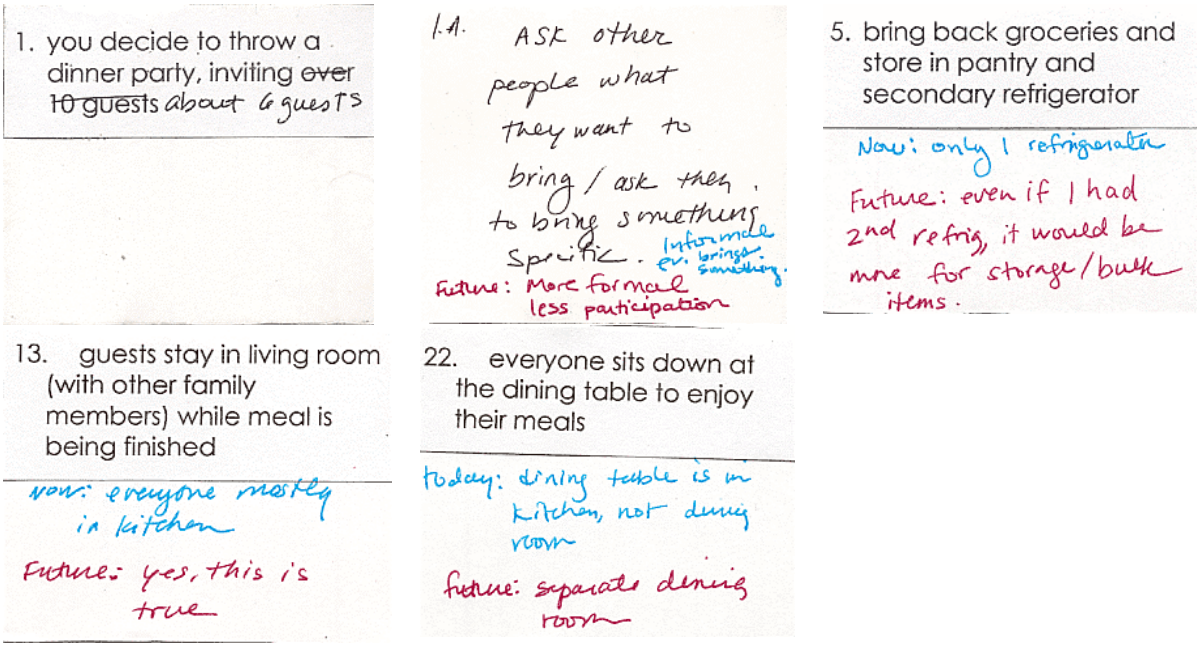


Figure 36. Scenario modified by Kristen; black ink signals an essential change, blue ink represents her current lifestyle, and red-pink ink represents her projected future lifestyle

Kristen decides to start the collage exercise by looking at the words.

> So I'm just organizing these by, I'm just picking out words I like, that I guess matter to me. These ones either don't matter to me or don't mean anything in this context

Figure 37. Kristen divides up the quality words into two categories.

She identifies 20 words, including popular choices like "uncluttered" and "aromatic," and more individualized words, like "gourmet" and "cozy." She puts the rest away. She then turns to the concept cards and begins to sort them into three piles, as everyone has done, something equivalent to "yes, probably," "no", and "I don't know, maybe." She talks out her reasoning on a particular decision, a simple rationale or sometimes an extended story from her own experience.

> Dishwasher to left of sink, hmmm, any time I've had a dishwasher it has been to the left of the sink, but I've never thought about it before. I don't know if that

> matters or not… Wine rack and custom cabinetry, wine racks are one of those things that look nice, but you really have to drink your wine fast because it gets exposed to sunlight, it's just not practical, I've ruined some really nice bottles of wine that way, so I wouldn't want one in my kitchen and end up ruining good wine.

After she has finished looking through the cards, which number over 100 by the time of Kristen's session, she removes the "no's" and the portion of "I don't know's" that had had spread closer to a negative response, and instinctively begins to sort the remaining cards.

> Okay. Now I'm sorting them into structural, like layout kinds of things, I guess structural-layout, like pull-out shelves is kind of structural.
> Design, structural, comes later.. there needs to be a category of where you want your kitchen to be in relation to the rest of the house. These are kind of secondary, … I'm kind of ordering them, these need to be decided first, then you put on the extras, then later these things… These are kind of like activities, ways I see the kitchen being used, so I guess I need to make sure that when I'm all done, that those fit in, those work.
> I guess what I'm trying to do is decide what kinds of decisions to make first, and then what decisions can be made later.

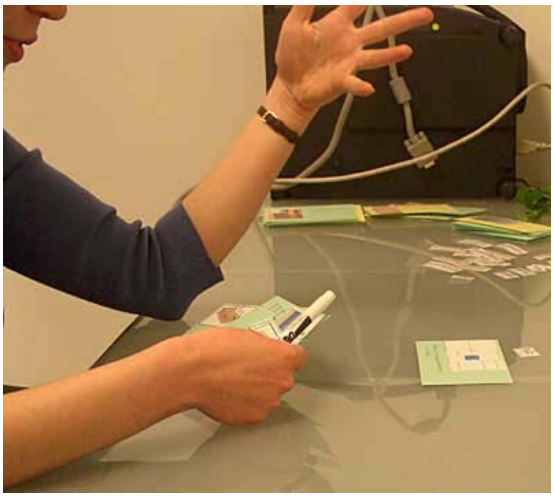


Figure 38. Kristen reasons about how to order decisions about her selected concept cards.

Kristen develops a sorting method based on decision dependencies and ordering. She first sees a distinction between structural decisions (e.g. cabinetry, adjacencies, layout) and stylistic decisions (e.g. flooring, countertops). She also has a third category of kitchen activities that she plans to use to evaluate her work. She filters the stack by looking for concepts that she calls "duplicates," which express a similar concept or a similar solution (e.g. "formal and everyday dining," "kitchen table," and "place to eat family dinner").

After this second sort, Kristen puts off "the extras" and concentrates on decisions that may exert a more constraining influence on later decisions. From here, she focuses on decisions that belong to what I classified as "scale 4," that relate to the positioning of the kitchen within the home and room adjacencies.

> So, I've learned that I want it to central to the house, so it's kind of a hub of activity. "hub" was a word that jumped out at me over here, I don't know where it went, but I like the idea of it kind of being the center of the house, where it's

> family and everybody kind of meets, because a meal itself is I think kind of a meeting place for people, where people get together to talk about things. Food naturally brings people together, I think

Kristen relates one of the quality words she chose, "hub," to a concept card she selected "Kitchen is in the center of house." Both word and concept were chosen quickly, but she now expands on what the idea means to her. Kristen also addresses issues of room adjacencies and issues of openness and integration. She acknowledges that she can't think of the whole house, but she decides to dry-erase sketch a rough plan, focusing on the relationships between kitchen, the family room, patio, and the dining room. She draws this off to the side of the glass table, leaving room for a detailed sketch of the kitchen itself.

> Not sure if it's big enough, but it's a start. But back here is the patio, and grill, living room/family room, dining room, laundry – I have no idea where that would go. But that's the idea, these things are connected to it, so I learned that I want connected to patio/grill… I want a window over there, something that looks outside, dining room connected to it, and open to the living area.

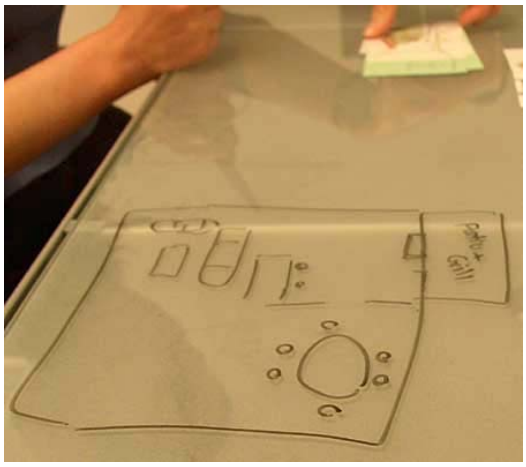


Figure 39. Kristen sketches an overview layout for the home before turning to the kitchen.

Kristen now turns to "play" with the layout of the kitchen, bringing over the main appliance vinyl pieces and looking through the remaining cards that she has categorized as structural. She decides to set aside an area on the table for what she calls "design considerations," concepts that she is unsure how to implement and on which she would want an architect's advice. Kristen puts aside some cards that are less important to her ("warming drawer") and begins thinking about the sink, the cooktop, the breakfast bar. Faced with this many decisions, she pauses.

> So what I'm finding out here is I can't really do everything I want, because I want an island, I want a breakfast bar, but I want it looking out towards the TV, and if I had a family, I wouldn't want TV in the kitchen… <laughs>, I can't really answer that one yet. And I also want an extra sink and a cooktop, but that's like too many things to do on an island. So it's not just making a wish list, it's a matter of making it, like work. I could put it on the side like that. The sink is probably the most important thing, from my perspective. The sink and the seating. So, I guess it's prioritizing what you want.

She places the vinyl piece that represents the sink and begins to sketch in counters and an island. She again turns to the issue of adjacent rooms, thinking about dining and the pantry.

> So now I'm throwing out some things, now that I realize I got to make choices, things I care less about, I'm discarding. I'm also throwing in things like place to put down mail, because activities will help me think about how to structure and place things. Guess it really depends on the rest of house though, the flow of where you walk in, so it's kind of hard to say… yeah, it really depends on the whole house because thinking of different places I've lived, right now I walk right into the kitchen, but that's because where my doors are, where I come into the house, but in other places, the kitchen is in the separate part of the house. So I'm doing this based on my current layout of my home, but it may change

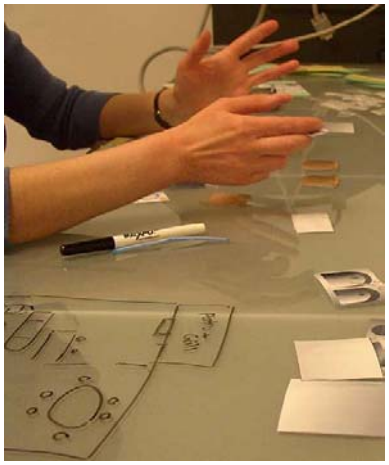


Figure 40. Kristen begins to prioritize what she wants in her kitchen.

Kristen decides to begin using the activity/use-related cards, which she had earlier identified as serving an evaluative function. She quickly notes, however, that the activity card she wanted to apply had a high context-dependency. Within her current home, the bringing in and placement of mail is shaped by the structural aspects of the building, and therefore this activity might not hold constant in a new house. She conclude that the decision, along with one about "place to set groceries" is best made in consideration of the general flow of the house and determines not to worry about it for now.

She expresses uncertainty about whether she will be able to work out the design, but notes that she does know a few things, and turns her focus to the island.

Figure 41. Kristen focuses on orientation of elements within the island.

> So I know some of the activities I would want at the island, definitely a sitting area, I'm not sure which way I would want them to face. Actually, this might be kind of nice. If I had a family, I would probably want them in facing towards the room, where the cooking is going on, so there would be more of an interaction. So again, it depends on the situation. Right now, where I am by myself, I would want it to be – I wouldn't care about that so

> much. Maybe when friends are over, but most of the time, it's just me, so I would probably want to be facing the other way and have the TV over there. If I'm designing for the future, I'd probably turn these facing in, throw out the TV.

Kristen identifies a distinction between her current needs and projected future needs, when she her life patterns change to accommodate a family. With the exception of Zach, who confidently addressed having kids in his plans for a home, the other single or childless couples were cautious when it came to expressing decisions that were tied to the addition of family members.

Kristen finishes placing the vinyl pieces, adds counterspace and her own drawn-in feature, a mud-room, and begins to go through the remaining structural and activity/use-related cards, making notes of where items could be placed and verifying that conflicts don't exist.

> Now I'll check on these things. Place for guests to socialize with cook and/or each other. Yeah, that works with this area. Guests help with dishes, there's more area now. Multiple cooks – one person is cooking, washing, one person is chopping over here.

Figure 42. Kristen extends her counter to mirror the concept expressed in the "L-shaped" card.

Kristen places two cooks in active positions and different work stations. She is pleased to find that some already-made decisions satisfy other goals as well, such as having the cooktop on the island allows there to be an unobstructed view of it from the adjacent room. She looks through the counter appliance vinyl pieces and employs the cutting board piece to signify that a section of the counter on the island can be cut on and worked on directly, consistent with the concept card she had selected. The cooking-style vinyl pieces, which include icons to represent chopping vegetables, snacking, and baking, remind her of other, specialized uses of her kitchen.

> I'm trying to decide if I have enough – I think I accomplished, for baking, you need more room to roll things out, I think with all this, I've accomplished more space, and with the island, that could be used too. It's kind of hard to tell from the drawing, but I think…

Kristen decides that some decisions require research and should be put off to another stage in the design process.

> Alright, this is really flooring, ceramic tile, I don't know, like this requires more investigation, going out and looking at things in stores, asking questions about materials, durability. This stuff has to be figured out first, this can happen later.

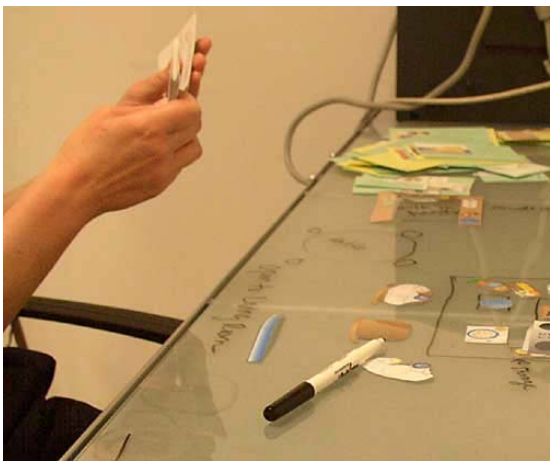


Figure 43. Kristen goes through her modified set of scenario cards, one step at a time, to evaluate the design she has assembled.

After she expresses satisfaction that she has gone through her selected cards, I ask her whether she would like to review the scenario cards she had selected, ordered, and edited. Starting from the top card of her stack, she reads each step and looks to her layout. The first step, finding a recipe for the meal, reminds her that she needs a place for cookbooks, which she adds to her "design considerations" list. The next scenario card makes her rethink her adjacencies.

> "Bring back groceries and store in pantry and secondary refrigerator." So here's an issue, my pantry is way over there. It's not that big a deal though. I could put it over here. That might actually work with my design. If I have this space for mudroom, laundry. Then I got the dining room over here <annotates>. I might want it more by the living room. I don't know. I can't decide all this, but it's helping me get a sense of what might work.

Kristen begins to re-evaluate the placement of the refrigerator, given its prominent role in the party preparation scenario. She also reexamines the sink and the "multiple cooks" vinyl pieces that she has placed, one at the island and one over at the sink.

Figure 44. Kristen discovers that her appliance placement also meets the goal of supporting multiple cooks.

> That sink works well too with dishwasher. Because if that person was helping to clean dishes, in addition to that person here, this person could be rinsing dishes and putting them away.

She notices that she has forgotten the table for everyday dining and begins to think about how she could use the bar side of the island for buffets and appetizers. Shuffling through the remaining scenario cards, she looks at her division of "now" and "future" edits and pauses to contemplate her design.

This is helpful actually to think about whether this is meeting what I want for the future. It doesn't really match, so it's like is this what I want, or is this what I want. I don't know.

[Jennifer:] So it matches more the informal as opposed to the formal?
[Kristen:] Mm-hmm. And I like, I don't know, I may be saying in the future I would want something different because that's what my growing up experience was like, and I don't know if I would go that way or not. It just depended on the situation. Like I said, I'm more of an informal person, so I would probably lean that way.

Kristen recognizes a conflict between her expectations for her life patterns and her understanding of herself. She has the option here of rejecting her design as reflecting too much of her current experience, representing an open, informal interaction style that she will dismiss once engaged in a more structured family experience. Instead she reconsiders whether her earlier projective description was just a response to how she was raised. Perhaps even when she is married and has children, she will want to continue to express this style of living. A moment later she is looking through her words, and finds supporting evidence in the selected word "informal," and the exclusion of "formal."

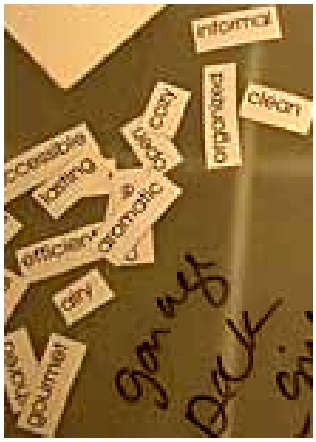


Figure 45. Kristen notices "informal" in her quality words, confirming her belief that what she may really be wanting in her future home does not accord with her childhood model of a "formal" adult lifestyle

Now I'm looking at these words, organized, *informal* – see? Clean, cozy, open, stylish, aromatic – even this works, because if I have this oven there and the stove, it's like right in the center where everyone can smell the good stuff. Convenient, spacious, functional… I met my adjectives pretty well.

Like several other participants, Kristen uses the words to validate her work. She confirms her decisions and gives concrete definitions to previously vague quality words. Now that she has used each of the different media options, words, cards, vinyl pieces, dry-erase, and scenario cards, I ask for her recommendations and evaluation of the experience.

I think thinking about the activities that I would do or someone would do was helpful. Like when I looked at these, it was like oh, when I'm baking, maybe I need something else. I don't have any ideas off the top of my head. I think this was really helpful, things like the <scenario> card that said, people are over helping you cook, so I was like okay, figure out if this is working, this activity. That's kind of neat.

Kristen particularly likes the aspect of the exercise that is consistent with the scenario exercises she did and it seems to fulfill the goal that previous participants had in mind in recommending it as an addition. Her general evaluation,

> Yeah, I think this is a really good exercise to really think about the things you want, and even the way you make the decisions, like when I took those cards, and then I was like okay, I had to think about what decisions had to be made first and then what could be made later.

I ask her whether it would have just been better to have the cards pre-sorted and ordered.

> No, no that was useful. That was just the way I had to go through it in my brain to get to this. I don't know if everyone thinks that way, but that's the way I think about it. Yeah, it seemed to work pretty well, I mean I feel like I got, it actually worked better than I thought, I didn't think I'd get this close to what I might actually want <laughs>, through this exercise – I thought I might have some rough sketch, like oh it doesn't work and then I give up <laughs>. But actually, it was like oh, this might actually work. Something like this.

Kristen was hesitant beginning the exercise, but she demonstrated a cogent and productive process that led her to some interesting, and legitimate, design discoveries. Kristen was the last participant to try the collage exercise and arguably had the best experience. She benefited from the additions of previous participants, as well as her own ability to reflect and experiment.

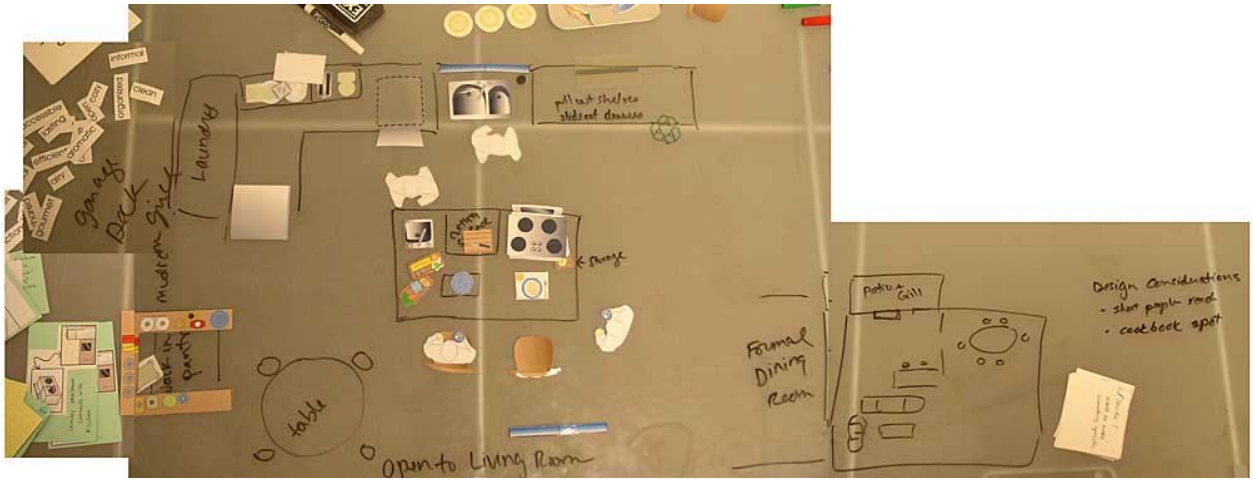


Figure 46. Kristen's completed work on the at-lab collage exercise.

Collage Exercise, Case Study 2: Emma, Expressing Partial Ideas

Emma speaks in quick bursts to express her distinctive viewpoints about home design, zooming in on the elements of a kitchen that she might bump into or collide with, like sharp-edged counters or overbearing hoods, critiquing the energy efficiency of oven placement and window installations, and being wary of anything that might be difficult to clean. Having grown up in cramped urban apartments, when she moved into a three-story house with her husband, it was something of a revelation. She recounts, for example, how with her bedroom on the top floor and her kitchen on the first floor, she has had to reorganize her morning routine so that she completes dressing before heading downstairs, ending up uncomfortably hungry as she starts her breakfast; something she never would have considered in her apartment days.

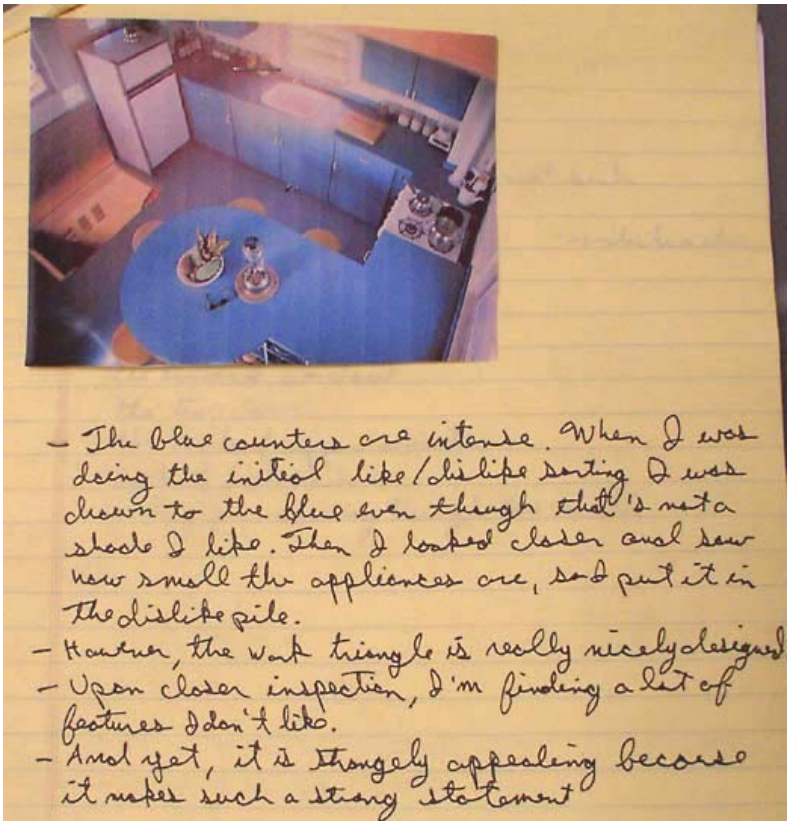


Figure 47. Emma annotated this example kitchen which she was draw to "because it makes such a strong statement." Please see figure list for photo credit.

As she reveals with her "10 years ago category," her preferences have evolved from large, showy kitchens, to a bottom line of is it efficient and is it easy to clean? Like Gwen, however, Emma enjoys spending time with extremes, trying to understand the vibrantly blue kitchen, wanting to uncover her values without succumbing to a boring design. Emma and Gwen are also alike in their response to the collage exercise. Although both express interesting ideas and uncover possible conflicts, they become frustrated with the spatial aspect and are dissatisfied with their end product. Perhaps their most telling action: at the end of the exercise, they each try, without conscious deliberation, to "clean up" their work before I can photograph it, and though they both

stop and okay me to take the pictures, it seems to signal their discomfort with what they have created, as not being sufficiently innovative to keep.

In the course of working on the exercise, Emma begins thinking about her own kitchen and the process she went through to organize it.

> In my current… what do you store where, you want your dishes stored near your dishwasher, because you want to be able to unload real fast. You want your spices where you can reach them easily, but you don't want them near the stove, because they'll lose their potency. You don't want food items also kept near the stove. So it was hard for me to figure out, the way my kitchen is now, where to put – the spices have ended up over the dishwasher, that's the farthest away from the stove, but still on the counter, that I could put them. The baking items, the flour, the sugar, the vanilla, are on the other side of the room, and that's probably because I don't bake that often, I bake more than I should, I like baking, but I'm not supposed to eat sugar, so I keep it on the other side of the room in an attempt to keep myself from baking.

Emma's account highlights that homeowners do have experience with the complexity of design, having to determine the arrangement of the movable components within their home. Emma applies multiple design heuristics and even developed an interesting "inconveniencing" approach to modifying her behavior through spatial arrangement, deliberately making a particular kind of food preparation, baking, harder to do. It is also clear from her description that the sheer number of competing decisions weighs on her. Like several other participants, Emma describes herself as someone who has to research every decision, and constantly worries that she'll make a mistake.

> I want the house by the ocean with the view of the mountains in the city at the same time. I can't combine all the disparate things that I think I want.

After she sorts through the words and concept cards, she puts them aside and pauses. She begins to list the major components that are of interest to her, the prep sink, the dish sink, and the stove. After some initial tinkering, she turns to me and asks,

> Do I have to come up with an actual design?
> *[Jennifer:] No*
> [Emma:] Oh good, because this is the part I got hung up on when we were <thinking of> designing a house. <laughs>

I suggest that she just try to express some of the design ideas that are important to her. Relieved of that task, she focuses on the relationship between the stove and the prep sink.

Figure 48. Emma identifies a work area that is important to her, the space between the cooktop and a prep sink.

This is the part that is important to me <begins to draw> This area is where I do all my work, because I'm chopping vegetables, and I'm washing them or throwing stuff down the disposal, I'm gathering them in dishes, and then I can put them on the stove, but I need space on the side, you now … I need space on both sides of both, but this space right here - here's me <places vinyl "cook">, my chopping board <places vinyl "veggie prep">, lights… it's hard to visualize space without the <third dimension>, and I have the TV, lights there <puts task lighting above counter> there where I'm working. This is what is really important, then there is the issue of light, hiding the dishes, and where do you put the monstrosity that is the refrigerator?

This is strangely unsatisfying. There's just too many things I haven't quite figured out how to stuff in there. I can say that this is the only thing that I can define very well, my workspace and the stove and that is the place I need to be able to work. I would need someone with a better sense of the space to figure out how to fit everything else in, or I would need time.

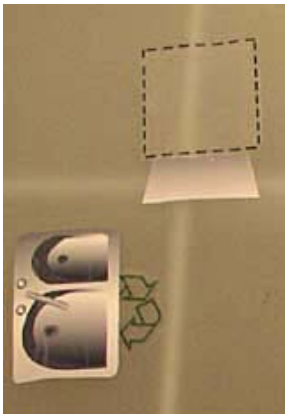


Figure 49. Emma speculates that a corner placement might help hide the stacked dishes ready to be cleaned.

Emma then moves to the sink and dishwasher, focusing on the issue of hiding the dishes, she decides that a corner placement might achieve that goal and takes some satisfaction from the new arrangement. Looking through the other vinyl pieces that she has pulled from the concept cards, she finds the groceries and mail.

Now the question is, what about my groceries? Where is my door? Right now the door is here and the groceries end up on the counter. The mail ends up cluttering the dining room table. You know what? This is what I need a mudroom for. <moves vinyl pieces to side>

Emma considers more options with regard to storage, pantry placement, and relationships between workspaces. When she gets to a crossroads, wanting to know what the end product should be, I remind her of the procedure that another participant went through in linking the words to the to the expressed ideas. Emma

places "efficient" on her stove-to-sink workspace idea, and "hardworking" on the cook that represents herself. She then focuses on "social" and locates the vinyl pieces that represent the guests. In working with the scenario cards prior to the collage exercise, she agreed with a card that states, "<guests> start to come over and ask if you need any help," but added "and I wish they wouldn't." She tells me now how she hates to cook with other people, as the kitchen is the one place where she likes to exercise full control.

> *Social.* Here we are with the people are hanging out while I'm cooking, but there's like a physical – *they are not in my kitchen!*

Emma places the guests outside the kitchen perimeter, to signal that they are out of the way. She then gets an idea looking at the breakfast bar vinyl pieces, and places each guest under a breakfast bar chair.

> This is new, I haven't thought of having them, a place for them, not a breakfast bar, but a place for guests to cook and talk to me while I cook <takes chairs from breakfast bar card and places under guests> Being able to combine the colorforms is very cool

<u>Figure 50.</u> Emma uses a combination of vinyl pieces and a quality word to express the idea of having a place where guests will socialize, but not try to interfere with the cooking

In so doing, Emma combines the vinyl pieces to represent a more complex idea: a comfortable place for guests to be, not participating in the cooking.

Finally, I ask Emma to talk to me about what was hard about the design task.

> It's hard to think outside of what I have now… This is the part I'm not good at, designing, but I'm actually very good at looking at something and telling whether it is right or wrong. I don't think far enough to the extremes, I basically created a box and it's not what I want.

She notes that the prep work she did, the questionnaires and image sorting, led her to think about more than just individual items, but concepts that she then expressed in the collage exercise.

> I need this space in between the sink and the stove. I need to hide the dishes. I want the people to be able to be out of the kitchen, be not helping, but be social with me in a comfortable space, not just standing and talking with me like they are now. I need a distraction, its them or this <the TV>. I need noise, guess it comes from growing up in the city. I need air and I need light.

Although the collage exercise was frustrating for her as an end to itself, she is more accepting of it as an intermediary stage, as something she could do with her husband or in the context of working with an architect.

> <we could use it to…> figure out our own priorities, have my husband do the sketching, and it could be negotiating fodder.
> Even if they are contradictory, Trying to do this helps identify contradictions. I created a bunch of little ideas that I could hand to an architect.

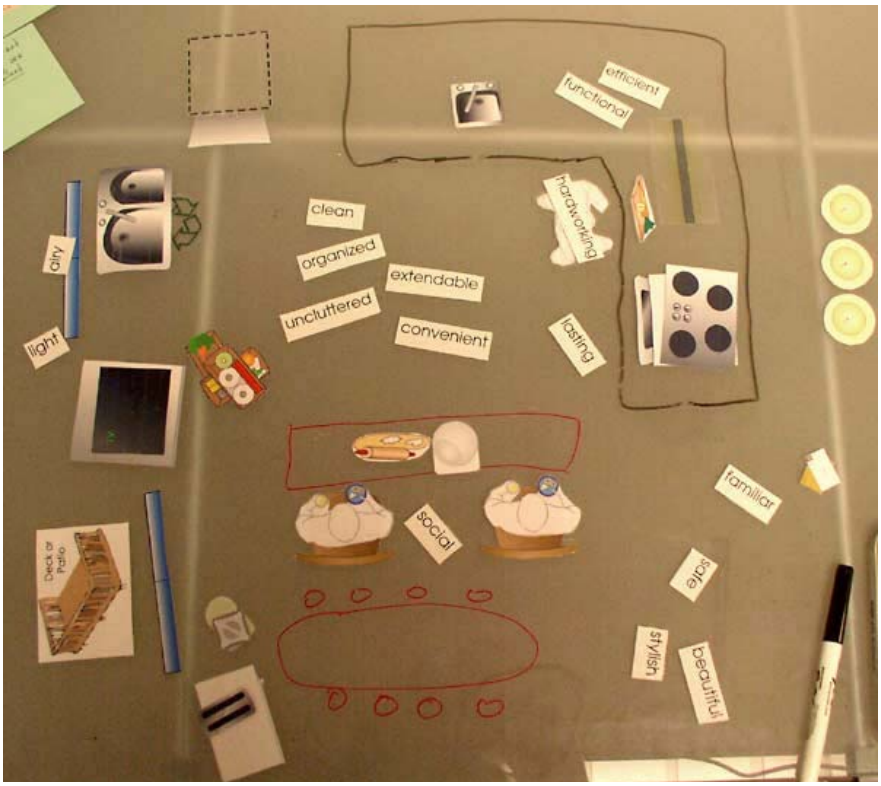


Figure 51. Emma's completed work on the at-lab collage exercise.

Chapter 5, Field Exercises

> *You got to think about how you live in the kitchen before you can even start thinking about where you're putting stuff. I think that's probably the step that people miss that they most, <laughs> they most regret.*
> *-Interviewed participant (in the middle of a remodel)*

The constructive and interpretive exercises discussed in chapter 4 are focused on having homeowners be investigators of their own cognitive processes and emotional responses. In this chapter, I explore exercises that have homeowners be investigators into their activities within their home environments.

A Problem of Recall

When asked to provide information about lifestyle and activities, homeowners are asked to recollect the experiences from the past few months and years that define the way they live. As has been well established in psychological research, however, human recall is fallible, because to remember is not simply to retrieve, but to reconstruct. In their analysis of the barriers to getting an accurate description of behaviors outside of the lab, Stone and Shiffman (1994) review several types of biasing and errors that can affect participant reports:

- Reporters can reinterpret past activities based on their own beliefs about how they do behave or should behave. For home design, example statements that might exemplify this error include "I make home-cooked meals on a regular basis" (when most meals have a significant frozen component) or "I get all the ingredients out ahead of time" (consistent with someone who believes she is organized, but may be routinely having to do significant improvisation).
- Reporters can use the knowledge they have of recent events to bias their recollections of the past. For example, if a dinner party turned out well, the cook might overlook the stress and chaos of the preparation.
- Reporters may be overly focused on events that are salient or recent. If it is winter, a homeowner may forget that she grills in the summertime. Most people remember their cooking activities in the kitchen, but forget that they spend as much time or more cleaning.
- The current state of the reporter can act as a filter for recalled memories, so that happy memories are better recalled when one is happy and sad memories are

better recalled when one is sad. Depending on how the homeowner is approaching the design process, he or she may filter out either positive or negative experiences, and may remember times of feeling in control, and miss times of confusion or stress.

- Finally, as with participants reporting on behavior in research, homeowners are generally asked to summarize their experiences (as a brief lifestyle description), rather than report on actions at a more micro-level. As a result, they may condense their understandings of their activities into average states that misses out on important extreme examples, such as the big holiday family dinner, or difficult to label examples, such as feelings of well-being that arise from routines.

Previous Research

Serious data-directed research into how we use the home and what that should mean for design may begin with Lillian Moller Gilbreth, a psychologist who studied the efficiency of movements with her husband, Frank Gilbreth. The Gilbreths were following the tradition of science management begun by Taylor, but unlike their predecessor, were interested in how improvements in efficiency could reduce the fatigue and stress of the worker, rather than increase output (Karsten, 1996). They employed early motion capture photographic techniques and studied people in their real environments. Lillian, along with fellow researcher, Christine Frederick, proposed changes to the design of kitchens that would reduce effort spent in terms of steps, and focus work within the typical human reach. In addition to recommending best practices for kitchen design, Gilbreth stressed that each kitchen should be customized to the individual.

In the decades following, with the success of suburban developments such as Levittown, homes became designed for the "average family," based perhaps on some early research done by Gilbreth and others, but necessarily limited to a stereotyped idea of the American home experience.

In the 60s (Kent Larson, personal communication, 2003), efforts were again made to understand actual activities within the home, this time using time-motion studies based on direct observation. Unfortunately, this technique proved to be significantly invasive, as observers had to essentially cohabitate with the observed. Research largely turned away from the use of space and instead focused on the use of time,

through questionnaires that ask participants for time estimates (vulnerable to the recall errors discussed above), limited direct observation, and time diaries. The time diary method asks participants to report on immediate, specific events, typically over the course of one day. After decades of using this method, Robinson and Godbey (1999) have been able to present results that dispel many common assertions about the home life that were made from time estimate based research. For example, they found that modern families actually have more free time, not less, than their counterparts from previous decades and using modern appliances does not decrease the amount of time spent on housework. Their research has been limited by what people are willing to report and by the restriction of looking at just one day from someone's life (the method is too effort-intensive for the participant to reliably report longer periods of time). They benefit from letting participants openly report activities, rather than using predefined categories, as they have been able to track unanticipated trends, but it is difficult to compare across participants, because each may measure and divide activities in a unique way. When one participant reports doing 30 actions in one day and another participant reports doing 5, is this a real difference in level of activity or does it reflect different conceptualizations of what is reportable?

In recent years, researchers, particularly at the MIT Media Lab, have suggested that not only can data collection of everyday activities be better mediated by technology, but be made meaningful to the individual being observed, in addition to contributing to a more aggregate understanding of human behavior. In their *Beyond Black Boxes* project, Resnick, Eisenberg, and Berg (2000) demonstrated how children can come to question their understanding of everyday experiences and environments by making otherwise difficult to observe qualities explicit. In one example, a group of students and adults took temperature sensors on a walk and subway ride. In graphing the data, it followed many of their expectations, with dips when exposed to the outside weather, and gains on entering buildings, but surprised them by challenging their assumption that the subway ride, the more salient feature of the trip, would dominate the data, when it only took a small section of time. Children using light sensors at home tracked bathroom use frequency, with temperature sensors qualifying the data to suggest when showers were being taken. Placing temperature sensors in the fridge, they were able to see when it was being opened (rise in temperature), a human

behavior that was expected, but also observed the feedback temperature cycles of the refrigerator itself; by being based in the immediate, familiar landscape of the home, the data could both validate the children's personal understandings and lead them to pursue interesting surprises. One child investigated an unexpected temperature spike at 2:00am in her kitchen data to find that she had discovered her dad's late night microwave popcorn snacking.

While the *Beyond Black Boxes* project was focused on acquainting children with more open-ended ideas of scientific data collection and analysis, along with human behavior and discoveries such as feedback and perception of time, Jeana Frost (2001) investigated more purposeful applications of reflection on data in working with adults with diabetes. She asked adults belonging to a diabetes support group to take photos of things in their daily environment that might have a bearing on their experience of the disease; these photos were then correlated with daily insulin data. Participants took photos of their meals, of the contents of the refrigerator, of opportunities for exercise such as a stairway, and of areas where they failed to get exercise, such as the recliner in front of the TV. By graphing insulin data and displaying the photos from that day, she let participants apply causal tracing, looking for possible reasons why spikes or dips occurred, involving them in understanding the repercussions of their own behavior.

Investigative Tools

The current research also takes a technologically mediated approach to address the issue of recall, provide comparable and quantifiable data, and support longer periods of investigation. Focused on the home environment, it offers homeowners, like the children of *Beyond Black Boxes*, the opportunity to first confirm their own sense of how they use the environment, and then reflect more critically on unexpected findings. Like Frost's research, these investigations are centered on a directed, practical goal, and by establishing a framework of experimentation, encourage participants to not just interpret, but also propose changes to their behaviors or their environment.

Four investigative tools were employed for the field exercise:

1. simple, "stick-on" open-close sensors - Developed by Emmanuel Munguia Tapia (2003) for the MIT Media Lab House_n Group, these simple devices can be placed

on appliances, cabinets, light switches, and other fixtures and furnishings that have physically-based open and close (e.g. a door) or on and off (e.g. a toggle or dial) states. The device consists of a small 1 by 1.5 inch sensor-board, encased in a small plastic box with an ID label. Attached to this board is a switch sensor that detects when it is close to, or apart from, a tiny magnet. The sensor-board stores data for a period of several weeks, runs on a coin battery, and includes a tiny LED that lights up when events are detected.

These devices, hereafter referred to as open-close sensors, are temporarily affixed to furnishings and fixtures using common adhesives such as electrical tape. Installation of an open-close sensor typically takes between 3 and 15 minutes, depending on the nature of the hosting object (refrigerators are easy, but sinks can be tough!).

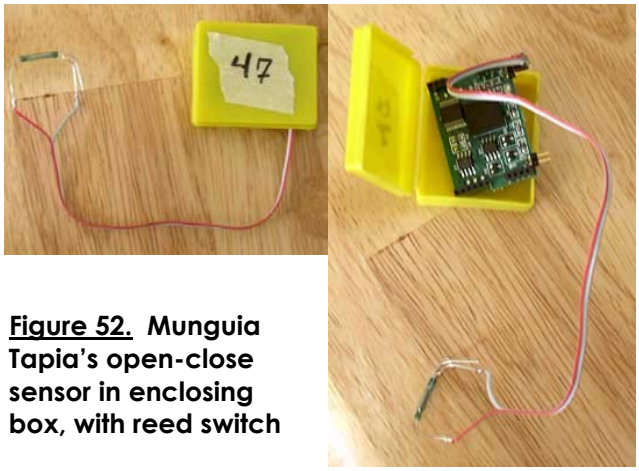


Figure 52. Munguia Tapia's open-close sensor in enclosing box, with reed switch

The open-close sensors collect and store date-timestamps for each open or close event. For example, when someone opens the refrigerator, the date and time is recorded:

Open/close	Day	Month	Hour	Minute	Second
o	16	03	10	09	07
c			10	09	10

The refrigerator was opened at 10:09:07 a.m. on March 16th and closed three seconds later at 10:09:10. After data has been collected for a period of time (up to 5000 activations and within the life of the battery), it can be uploaded via a serial connection. Munguia Tapia developed a Java interface to do initial set up of the sensors, including clock synchronization and ID labeling, and to read the data and save it as a set of simple data files. Data from these files can then be combined in Matlab into a master matrix with appropriate user-entered location (e.g. "Kitchen") and type (e.g. "silverware drawer") information.

2. position-tracking sensors with wearable receivers – Using components developed by members of the MIT Media Lab Human Design and Wearables Group[9], this tool employs a system of devices to permit position-tracking within the home. Infrared beacons called SQUIRTS, measure 1 inch by 1 inch and emit simple identification information using the Sony IR protocol. Affixed to the ceiling (for this research), they broadcast their individual IDs about once a second. An infrared receiver, directly below within an approximately 2-foot radius, can pick up this information, triggering an event date-timestamp to be recorded in an attached storage board called a "hoarder." The hoarder, receiver, and SQUIRTS were previously used as wearables to study social interactions (Choudhury & Pentland, 2002).

Figure 53. The infrared receiver was placed on the top of a baseball cap to provide line-of-sight to beacons affixed to the ceiling.

For this research, the hoarder was placed in a simple pouch backpack[10] and the infrared receiver was connected by a thin cable and positioned on the top of a baseball cap. The goal was to make a wearable device that would be comfortable for adults and children, that could be worn with ease during household work, and that would provide clear line-of-sight between receiver and the broadcasted infrared signals as the participants moved about their home.

[9] I would like to thank Michael Sung and Tanzeem Choudhury for sharing their technologies for use in this research.
[10] A modified make-up bag with covered elastic and flat-cord straps

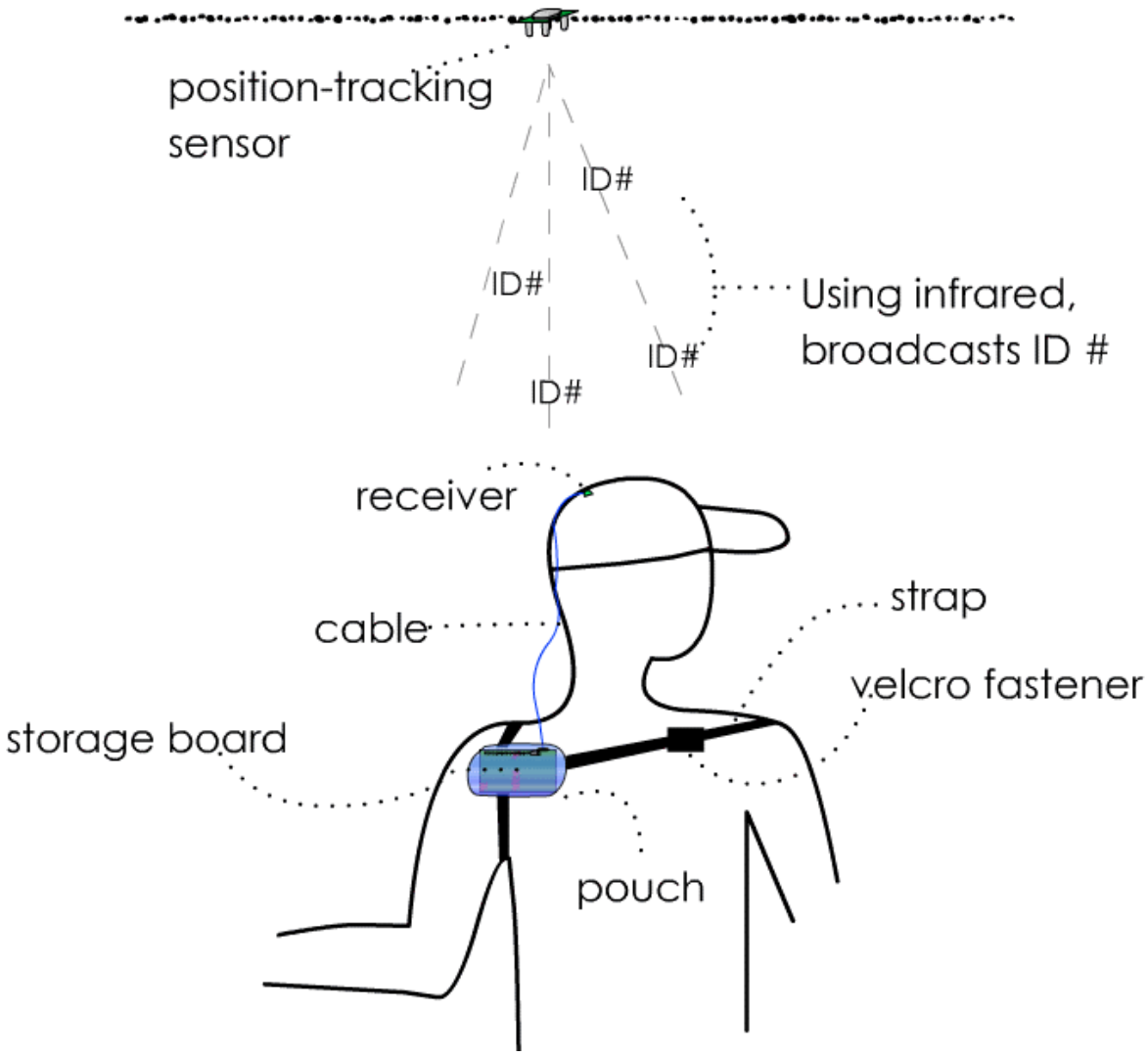


Figure 53. Participants wear receivers and data storage boards so they can be tracked as they walk under infrared beacons affixed to the ceiling.

Munguia Tapia modified the hoarder code to optimize data collection for the primary task of position-tracking. Recorded data includes a date-timestamp and the ID of the detected sensor. For example, when a participant stays underneath one sensor (e.g. above a couch) for several seconds and is then, a few moments later, recorded passing under another sensor (e.g. above a doorway), the collected data might look like:

ID	Day	Month	Hour	Minute	Second
8	6	06	18	21	08
8	6	06	18	21	12
8	6	06	18	21	16
31	6	06	18	24	54

3. experience sampling on a handheld computer (PDA) – John Rondoni (2003) developed software for the iPAQ handheld computer (PDA) to conduct experience sampling research in the field. Experience sampling is a research methodology pioneered by Csikszentmihalyi and Larson (1987) that was developed to capture participant responses about events, behavior and cognitive and emotional states at the time when they are experienced. The participant is interrupted during normal activities with a signal and asked to answer multiple-choice questions (e.g. "What are you doing now?", "How would you rate your mood?"). Normally, this is accomplished through use of an alarm and paper-based diaries. Rondoni's technologically-mediated approach insures consistent, accurately time-stamped responses, allows custom, researcher-set interruption scheduling, and supports a remarkably flexible question-protocol, permitting chained questions and random question selection.

   The experience sampling software was developed primarily with the needs of the researcher in mind, and by default cannot be turned off or initiated by the user. However, Rondoni generously accommodated my research by adding features that would allow user-initiated scheduling.

   For this research, I developed a simple question protocol that has the user answer design questions in

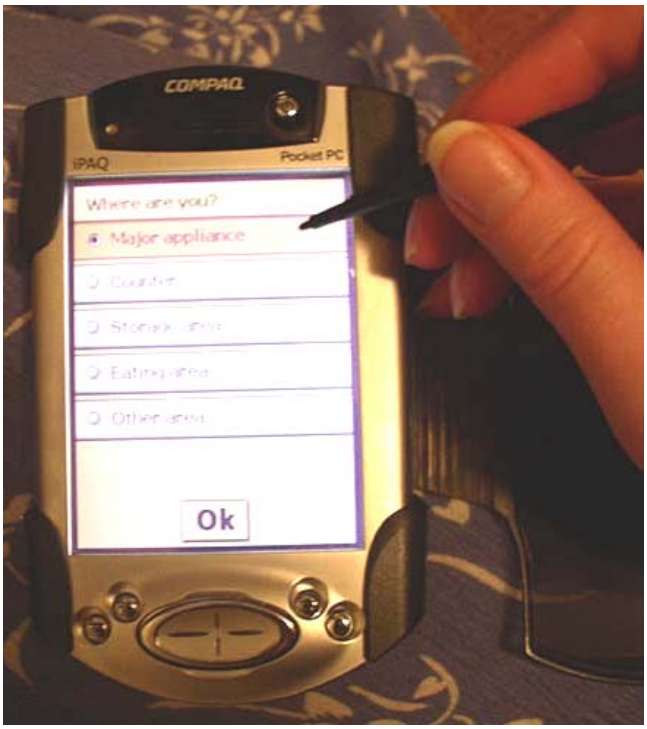


Figure 54. Kitchen design question protocol for experience sampling on the PDA.

the context of the home and when doing cooking, eating, or other activities. When the user turns on the PDA, a default question appears asking whether this is a "good time for design questions." If the user answers "no," no further questions appear and the PDA eventually goes to sleep. If the user answers "yes," a "where are you?" orienting question is scheduled to repeat every 10 minutes, along with a set of randomly selected design-oriented questions. At each scheduled 10-minute interruption, the first question to appear is "Is this a good time for design questions?" If at any time the user answers "no," all questions are removed from the queue and the repeated scheduling stops until the user re-initiates the cycle by turning on the PDA again. An example question-answering exchange might be:

```
Is this a good time for design questions? Yes
Where are you? At a major appliance
Which appliance? Sink
Are you currently multitasking? No, I'm working on one
main task
Are you working at a comfortable height? Yes, it's fine.
Would you be comfortable if friend were with you? Yes, I
would love the company.
Could you hear talk from the eating area? Yes, and it
makes me feel involved.
```

The questions fall under two main categories. "Frequent" questions are not activity-specific and when individually answered, don't convey much information, but with repeated responses, may generate a condition-dependent pattern that would be of interest, like more traditional experience sampling questions. These questions include "Are you currently multitasking?" and "Is there too much noise?" "Triggered" questions are meant to be location- or activity-triggered and are more directly connected to a design decision. These questions include "What kind of view do you have from here?" and "Do you see reminders of your childhood kitchen?" All questions pertain to the user's current situation. A complete list of the experience sampling questions is in Appendix B.

The current state of the experience sampling software did not permit the complexity required to chain to a pool of possible questions for a given response to a location or activity orienting question. Instead, the "where are you?" question provided context for later evaluating responses and a "not relevant" answer choice was provided for each question.

4. time-lapse cameras – X10[11] webcam cameras, with supporting X10 XRay Vision software, can be set to capture images when motion is detected and store them to a local computer as 320x240 pixel .jpg files (with associated date-times). Experimentation revealed that a 10-second comparison interval was ideal for capturing each step within a task sequence. In this research, with a camera placed in a kitchen used by one to three people, about 450 images per day were captured on average, with up to 1500 images captured on high-use days. Typically, one third to one half of the images are erroneously triggered based on changes in light in the room.

Figure 55. X10 camera set-up for time-lapse images, placed in my kitchen.

Figure 56. Time-lapse images can be perused quickly to identify activities; here I am washing dishes.

Time-lapse images offer benefits over straight video by being easier to peruse and edit. The participant can preview what the camera sees at any time and can relatively quickly scan the images for a broad sense of the day's activities and to locate (and delete) any images that are uncomfortably exposing. The large number

[11] I would like to thank X10 for donating equipment to House_n for this research and Kenneth Wacks for facilitating the donation.

of accumulated images, collected over several days, however, is best accessed through more narrow queries.

These tools were each developed to study behavior as it occurs in real home environments (Intille et al., 2003). Each tool, when used individually, can provide a relatively low-bandwidth type of data that is easier filter, query, edit, analyze, and display than video or direct observation. The tools can be positioned to focus on particular locations (the kitchen), can be left unattended, and are minimally invasive. All of the tools collect time-stamped data that can be combined into a richer dataset. Although these technologies were designed to aid researchers in observing and analyzing participant behavior, they are re-visioned for this research as tools for self-investigation, where the participant observes and evaluates his own behavior and environment.

Pilot Efforts

While the open-close sensors were still in development, I used a modular computational prototyping system called the Tower, developed by the MIT Media Lab Grassroots Invention Group (Gorton & Mikhak, 2002), to collect an initial dataset of activity patterns in my apartment kitchen[12]. The Tower runs an interpreter for the Logo, an easy-to-program language that permits the rapid generation of scripts for data collection. I programmed the Tower to respond to open-close sensor events by storing a date-timestamp in a format similar to Munguia Tapia's open close sensor-boards. After initial experimentation, a half-second delay was included to avoid the capture of "cabinet jiggle" on open and close. A tricolor LED was attached to the sensor to signal green for open events and red for close events, providing confirmation that the technology was functioning and

Figure 57. "Two-penny" sensors, connected to the Tower, on cabinet containing plates and bowls.

[12] I would like to thank Bakhtiar Mikhak and Tim Gorton for their encouragement and assistance with use of the Tower.

reinforcing in-context awareness of the data collection. I constructed simple "two-penny" and "three-penny" sensors that operate simply by establishing a physical link across pennies on the main cabinet or appliance when a penny on the door acts as a bridge in the close state. These sensors were placed on eight cabinets in the kitchen.

Several initial observations came from the use of the Tower:

- Although all sensors were affixed to the same type of object (cabinetry), because inhabitants arrange environment in a non-arbitrary way, each sensor had a functional significance ("glasses and cups for drinking," "dish cloths for cleaning," "pots for cooking").
- Time of day, sensor labeling, and sensor sequencing each contribute to activity identification.
- Daily routines such as "making breakfast," "making dinner," and "washing dishes" could be identified visually from just three sensors (the plates and bowls cabinet (d), the silverware cabinet (s), and the glasses cabinet(g)).
- The actor could be identified by time of day of routine; at the time of data collection, my roommate and I were on overlapping schedules, with him waking and arriving home before I did.
- The sensors primarily detected the first 5 minutes of longer events (as identified through the time-lapse images).
- Whether open-close events were tightly paired (cabinet 1 opens and

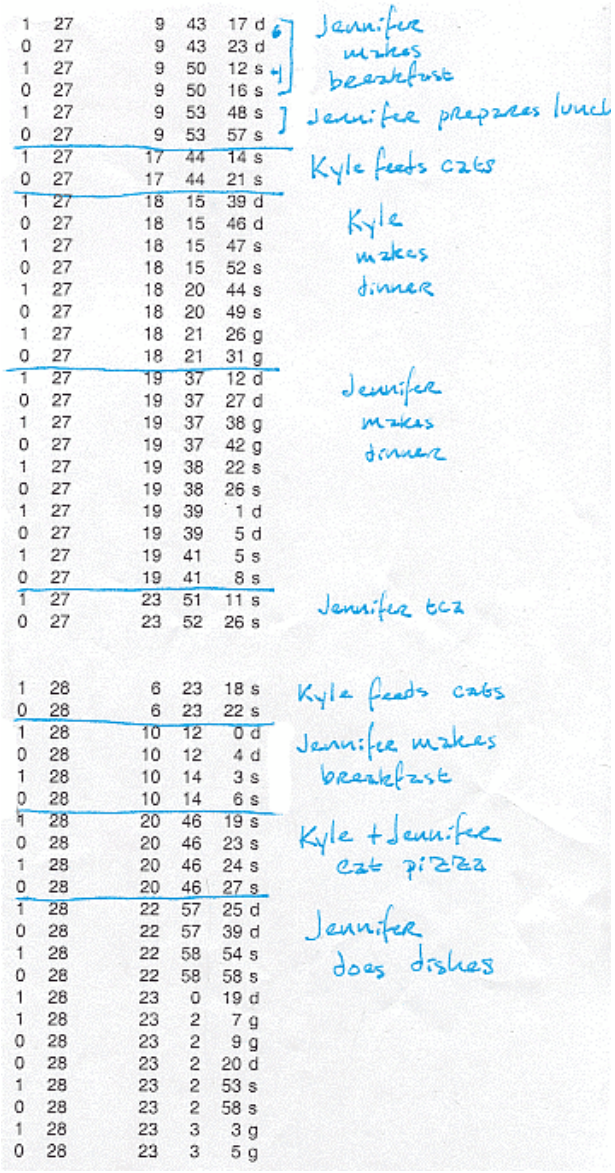


Figure 58. Annotated Tower data from three cabinet penny-sensors.

closes before cabinet 2 opens and closes versus cabinet 1 opens, cabinet 2 opens, cabinet 1 closes, etc.) seemed to be correlated with the type of activity, with preparation activities following a sequential pattern and cleaning activities having an overlapped pattern.

- The presence of sensors made me more aware of my behaviors with respect to sequencing and task-related duration. I also noticed how often I use objects that are ready-at-hand preferentially over objects that are in drawers, for example by retrieving a spoon from the dish drain rack, because I knew those actions were not being recorded.

The Tower and the penny sensors do not scale up to an entire kitchen, but offer the advantage of being highly visible, which is of benefit for this kind of exercise because it constantly reminds the user to be aware of her own behavior.

My Kitchen Investigation

Following these pilot efforts, Emmanuel Munguia Tapia provided me with 50 open-close sensors to install in my apartment. These sensors were primarily installed in the kitchen, but also on my sock drawer and jewelry box in my bedroom, on the door, sink faucets, and light switch in the bathroom, on the shared washer and dryer in the basement, on the telephone, and on light switches and doors in connecting spaces in the apartment.

Figure 59. Examples of open-close sensor placement in my apartment kitchen; on the left: flour and sugar containers, center: silverware drawer, right: bathroom sink faucets.

The sensors were installed for a total of 74 days, or about 10 and a half weeks, recording a total of **19,992** activation events (272 a day, on average). During this time, a time-lapse camera was variously positioned to collect images of kitchen activities.

Approximately **27,000**[13] task-related images were captured, averaging about 350 a day.

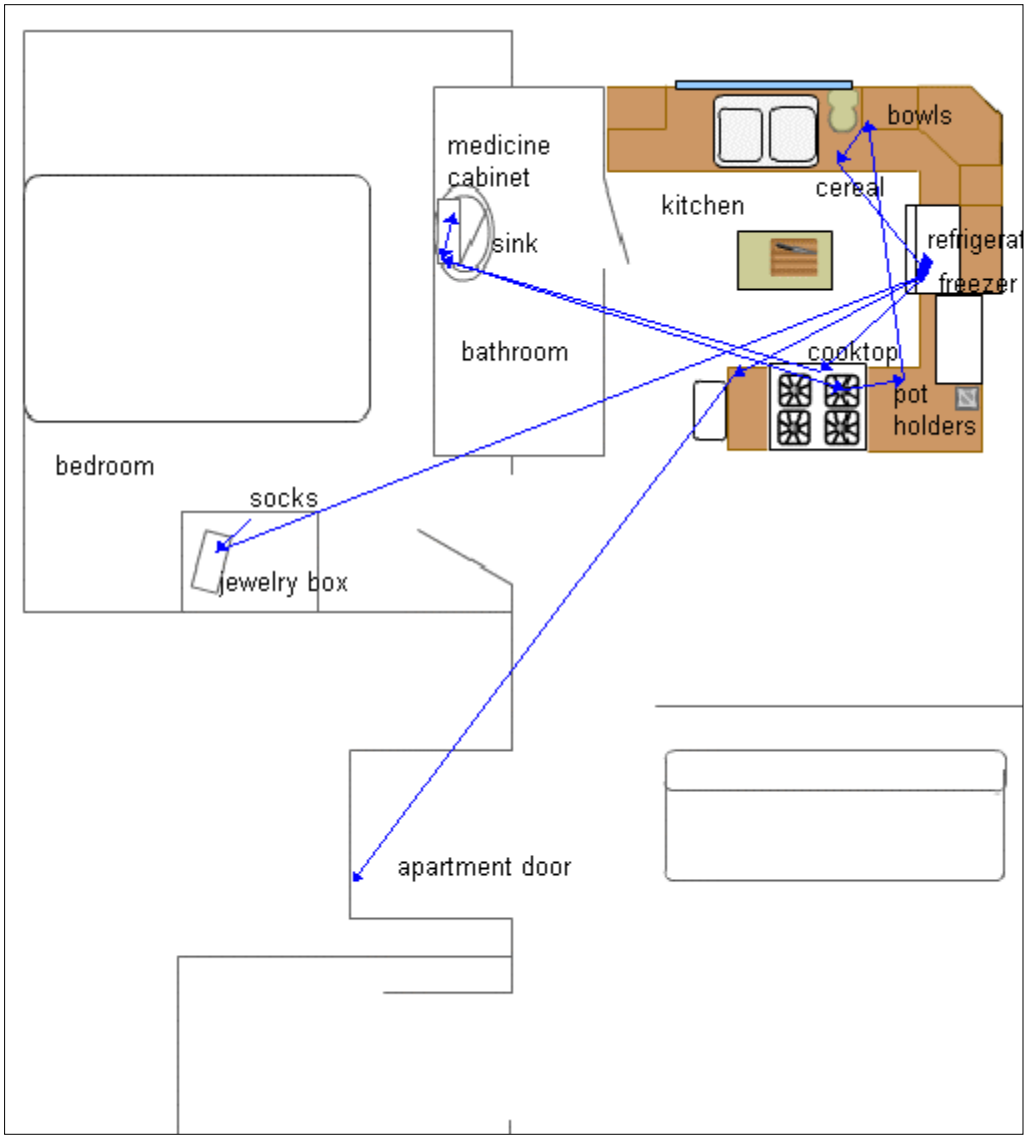


Figure 60. My breakfast routine on March 24, 2003; the first open activation is sensed on the sock drawer, which transitions to the jewelry box, to the kitchen and bathroom, finally ending at the apartment door as I leave for work.

I employed Matlab scripts developed by Emmanuel Munguia Tapia for his research on activity-recognition and programmed additional scripts for location-based display. One type of display that I created was consistent with the traditional time-motion studies, showing action that occurs over time, linking place to place. In the

[13] 40,296 total images were captured, but an estimated third of these were light-triggered and did not record actual activity

following example, my breakfast morning routine is mapped. My breakfast routine begins in my bedroom, as recorded by the sensors on my sock drawer and jewelry box. I then go to the kitchen to begin to prepare my tea. While the water is boiling, I brush my teeth in the bathroom, as recorded by the hot water faucet and the medicine cabinet. I then go to turn off the kettle, fill my tea cup, and prepare a bowl of cereal. My eating activity is not recorded, because I do not act on the environment in a way that could be detected with the open-close sensors. Finally, I get an ice pack from the freezer and lunch items from the fridge, get a plastic bag from the a cabinet drawer for some pita slices, and leave the apartment to go to work. Like Emma described in chapter 4, my morning routine combines dressing and making breakfast, benefiting from the close arrangement of rooms in my apartment.

The aggregate movement for the entire day of that breakfast routine, for March 24th, is mapped using what one observer calls "ant tracks," connecting activations with randomly scattered dots that produce a weighted line. "Joints" or junctures have been inserted (e.g. when bedroom sensors go to kitchen area 3 sensors, follow a path stopping at junctures x, y, and z) to provide a more realistic mapping.

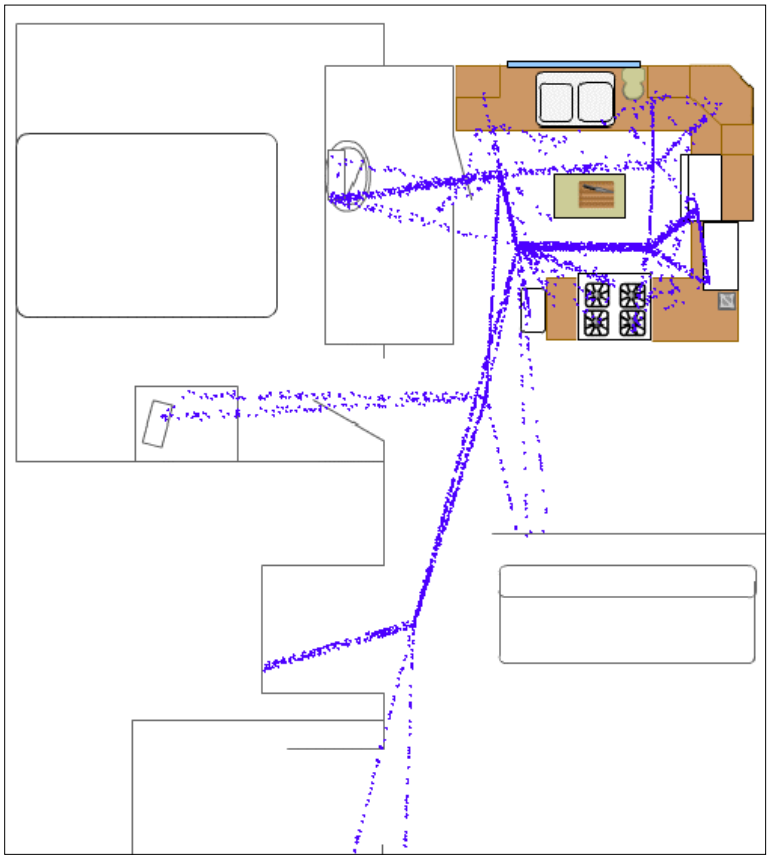


Figure 61. Our aggregate activities for March 24, 2003.

In addition to these visual displays, which can be quickly generated for any queried time period, I also produced a variety of data charts to mirror those provided for the participant experiment, described below. Some of the specific displays or measures I looked at include total activations by day, activation frequency by sensor,

sensors that are used everyday, sensors that are used throughout the day, and average activation over the hours of the day. The date-timestamps of the collected images can also be charted and images can be associated with sensor data for improved activity identification.

Observations from my kitchen investigation:

- I was initially focused on how I have several daily routines that I can describe as a series of microactions tied to objects that open or close. Making tea is glasses-and-plates, burner (on), burner (off), tea cabinet, potholder, fridge (for the milk), trash (for the tea bag). I was surprised at how these patterns are habitual, and tied to me as an individual within a particular time period.
- My next observation was that though I have routines, there is considerable variation from day to day in sequencing and membership in the sensor set. Did I put away the dried dishes last night? If not, grab a mug from the dish drain. Am I having trouble getting up on a particular morning? If so, fail to efficiently sandwich cereal pouring between putting the tea on and brushing my teeth.
- I was amazed at the number of actions we take on the environment each day and began thinking about both the benefit of having familiar rituals and points of reference and the opportunities for linking information and activities (e.g. taking vitamins) to a frequently returned to location.
- The time-lapse images reinforced that my roommate and I have strongly established routines – it even seemed as though we yawned at the same time each day or held the door in the same manner. Not surprisingly, it is difficult to get away from analyzing one's own appearance, as I quickly became concerned with my posture!
- In reviewing the images, I became particularly aware of how frequently we used the rolling island, an object that is not sensed. It becomes the center point for meal preparation, getting a drink from the fridge, and putting away groceries. Its proximity to the refrigerator appears to be particularly functional in this regard.
- My mom was visiting me during the first three days of the installation and there is a clear differentiation between data collected during that period (when up to three people were activating sensors) and data collected during the remainder of the study (when two people were activating sensors). Aside from an increased number

of activations, indicative of both the change in number of inhabitants and the level of kitchen use, there were distinctions in the most frequently activated sensors.

- In initial searches of the data, I have been able to distinguish between nights when I was baking, or nights when I was preparing a simple dinner, but there are also many days that defy a straightforward explanation. One day appeared very much like an involved cooking night, with a long period of evening activations with a higher peak than average, which was odd for a weekday. Only when I spotted myself holding cough syrup in one of the time-lapse photos, did I remember that this day was indeed a bit different, with frequent preparation of tea and retrieving of orange juice and water from the fridge, boosting the sensor activations.
- I noticed that I changed my behavior in two primary ways in response to being sensed. First, I became more aware of the duration that I had appliances and cabinets open, and tried to be more efficient in my actions, particularly with regard to having the refrigerator open or having water turned on. I determined that having a cabinet open indicated something about my activity and my cognitive state – did I know what I was looking for? Did I open the wrong drawer because my mind was on other things? Was this a familiar activity or something that I needed to improvise? Second, I found myself wanting to complete patterns of activity on my environment, even if it wasn't necessary. For example, I wanted to retrieve a spoon from the drawer, not the dish rack, so I could have a more fleshed out routine, or always use the potholder when picking up the kettle, because it was so distinctive of my making tea.
- In looking at the images from the first few days, I became more strongly aware of the great skill with which my mom approaches housework, based on her years of experience and natural ability to be what my dad and I term, "the white tornado." I saw evidence of this in how she is constantly switching tasks, such as attending to laundry while doing prep work in the kitchen, using open cabinet doors to help her seamlessly return to interrupted tasks.

Overall, the experience in my kitchen provided insights into my own kitchen behaviors, instilled a fascination in the nature of routines in spatial context, and inspired me to think of new measures of kitchen activity, such as division by duration categories ("false starts," "knowing-retrieving," "searching," etc.), relative quantity of

simultaneously open cabinetry to distinguish accessing versus putting away or different strategies to support task adherence, task switching as defined by shifts between rooms, and consistent sensor activations across days within a constrained time period, but without strict regard to sequencing, to indicate daily routines.

Participant Experiment

The participant family was identified through a research meeting for the MIT Changing Places consortium. The mother, Susan[14], an employee at a company affiliated with House_n, learned about the ongoing research and shared with me that her family's activities at home would be a source of interesting data and that they might be interested in trying the field exercise. The family chose to use all of the available investigative tools, except the time-lapse cameras, which one member felt would be uncomfortable.

An initial conversation was held with Susan at the family's home; we provided details of the technological tools, answered her questions, and took basic measurements of the house to create basic plan views. Susan was given the option of selecting or contributing her own questions or setting the scheduling pattern for the experience sampling, but decided to try the default set of questions and 10-minute user initiated interval. I stressed to Susan that she should think of the technologies as investigative tools for her family; they would determine the placement of the sensors and they would choose when and for how long they wanted to use the experience sampling or wear the position-tracking wearables.

Five graduate students from House_n[15], including myself, arrived on a Wednesday morning to install the open-close sensors and position-tracking beacons. Susan gave us a tour of the home and specified possible locations for the sensors, including on cabinetry, appliances, light switches, and doors. She also recommended transition spaces for placement of the position-tracking beacons, such as the stairway and the area between kitchen and great room. The installation, which included a period of documentation and photo taking, took four hours. Forty-three position-tracking beacons and 99 open-close sensors were installed.

[14] The names of the participants are pseudonyms.
[15] My thanks to Tyson Lawrence, Matt Mankins, TJ McLeish, and Emmanuel Munguia Tapia for being an excellent installation crew

Figure 62. Examples of open-close sensor placement in the participants' kitchen; on the left: kitchen sink, center: dishcloth drawer, right: refrigerator milk shelf.

Along with the sensors, we left four wearable packs and caps for each member of the family, two sets of batteries with charger for each pack to insure that they would be ready to use at any time, and a PDA with the experience sampling for Susan, who had decided she would be the family member to use that tool. The sensors were checked on at the study midpoint, and then collected during a one-hour removal procedure.

The collected data was uploaded, combined, and formatted. Using the Matlab scripts that Emmanuel and I had developed, I generated multiple displays of the data from the three investigative tools. These displays were given to Susan for her response and interpretation at an interview was conducted at the family's home. Susan also told me about the family's experience during the study and what value she gained from participating.

Experiment Results

The sensors were installed for a total of 12 days, including two half-days, recording a total of **7,374** activation events (670 a day, on average). Additionally, position-tracking data was collected for three of the family members: 5 hours and 41 minutes over two days for the older daughter, 7 hours and 14 minutes over three days for the father, and 13 hours and 40 minutes over four days for the mother.

Post-study Interview

Susan acts as the family spokesperson during the post-study interview. I first ask her about the experience of having the sensors in her home for almost two weeks. Almost all of Susan's conclusions come from her experience during the exercise and not her evaluation of the data; instead, she uses the data to validate her assertions.

> It made me much more conscientious of how we actually are using, especially the kitchen area, in terms of the number of times I'm opening the refrigerator or opening up the cabinets, and also in terms of how I might be more efficient in terms of opening up, especially the drawers with the utensils. You know, you'll open a spoon, a fork, and then you go back and grab something else. <laughs> If I had kind of thought ahead, I'd get it all at once.

Figure 63. The participants' trash can and cleaners cabinet.

Susan had mentioned to me during the study that she had become particularly aware of the trash barrel, which is positioned under the sink. The number of times she opened and closed the cabinet holding the trash led her to suggest to her husband that it might be better to have the trash out in the open. At the interview, she describes the one time she believes she may have altered her behavior during the study:

> The one thing I did do at one point, I kept noticing how many times I was opening the trash, the cabinet for the trash barrel, and at one point I saw this cup in front of me, and I had this little trash item, and I said let me just store these here, so I did start, temporarily just putting some of the trash stuff, grouping it, then throwing it away, because I knew I was getting more. That was the only time I think it altered my behavior.

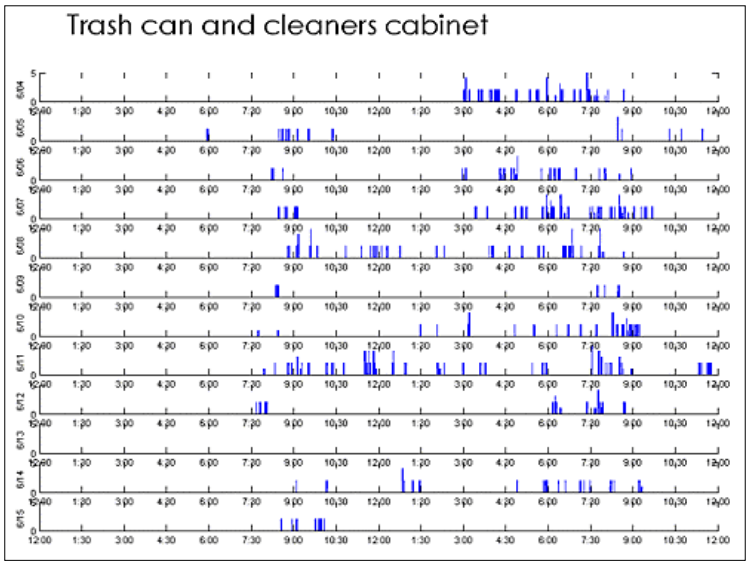


Figure 64. Activations of open-close sensor on trash can cabinet across time (horizontal axis) and days (vertical axis).

Susan thus became aware of the frequency and grouping of micro-actions within activities. She responded by considering both a spatial solution (to move the position of the trash) and a behavioral solution (to consolidate trips to the trash by creating a temporary cache). Susan also identifies their organization of items within the space as a focus of critical analysis.

> …the main pantry, which has like cereals and snacks, and just some of the more day-to-day type items, and whether some of those items should even be there … So for lunch in dinner you're having to go to the other part of the kitchen, in the corner, whereas if we had placed that closer to where the oven is, you wouldn't have to go over there to go get it.

Figure 65. The participants' dry food pantry.

When Susan sees the data for total activations of cabinet doors in the standing pantry, totaled over the 12 days, she uses it as confirmation of her assertion. She decides that it doesn't make sense to have so much activity focused on a corner of the room, and that some of the items within the pantry should be moved closer to what she defines as the main working areas, based on the data, near the oven, sink and refrigerator. Within these high use areas, Susan became aware during the study of how frequently they were using appliances.

> ..it made me think about how often we are opening the refrigerator for a meal, you know just one meal, it must be six or seven times that we open the refrigerator up, and we tend to co-cook, you know, it's like I'll do one thing, and my husband will do another, and we do kind of get in each other's way and it built that awareness, kind of the importance of where the appliances are and the amount of space that you actually have in a kitchen for two people to cook, not just one.

The family remodeled their kitchen two years previously, and saw a remarkable improvement in efficiency of the workflow and social interactions with the kids at meal time, making Susan a believer that design matters. She is therefore largely satisfied with her kitchen, but does identify a few decisions she would rethink if she were to do it again, based on her experiences with the field exercise.

> And also the whole issue of the location of the sink. I think it's made me more aware of that my back is really to where the kids are located. So if I were to rethink the design of the whole setup of the kitchen, I would probably setup the sink, position it in such a way that it is actually facing this den area. So that was a key kind of observation.
>
> Also not trying to have the refrigerator in a high-traffic area, you know the way it's set up right now, there is a little traffic going back and forth and I think it makes it difficult, you can't basically open the refrigerator and have people walk by, because of the island in the middle.

Susan points out that when a space is working well, there is less discernable evidence of that fact.

> When I did have position-tracking, I thought, you know, we've spent a lot of time in this area and I wonder if she is going to get valuable data because all I'm doing is moving from this side of the room to the other, but I'm technically in the same space, so we'd be in the eating area, and then when I was cleaning up, to put the dishes away, all I did was move over from one side to the other side and

> then I came here and maybe watched a little television or news, but this all was within this 200 or 300 square foot area. So on the outside it might look like, oh she hasn't really moved that much, but in reality I have cleared the table, washed the dishes, and kind of relaxed. So that was three big activities that were done in this relatively smaller space.

The position-tracking focused Susan on broader aspects of the use of space.

> And when I did go upstairs, I would notice how many times I'm actually going upstairs. Things like if the kids need something, this is a colonial home, and that's why I got strong leg muscles <laughs>, because of the number of times you are going up and down for something simple, like she needed her book, and it's upstairs, I'd run up, get her book, come back down. Or go up, make sure she's practicing her piano, then come back down. It did make me much more conscientious of how many times I'm going upstairs.

This observation is confirmed when Susan examines time-staged displays of data, printed on transparencies that overlay onto the base plan. With each family member represented by a different color (orange for Susan, blue for her husband, green for her oldest daughter), she is able to talk to me about what events are occurring in each 10-minute period, from dinner preparation, through bath time for her youngest daughter and piano practice for her older daughter. Looking at the number of times she is going up and down stairs, she talks to me about how her role, as the mother, is to keep the process organized and moving along, making sure that everyone has the necessary items and support, and that each task segues smoothly to the next. It seems like this is the kind of knowledge, situated within the context of the home, that childless couples and single individuals don't know how to anticipate (such as Kristen in chapter 4).

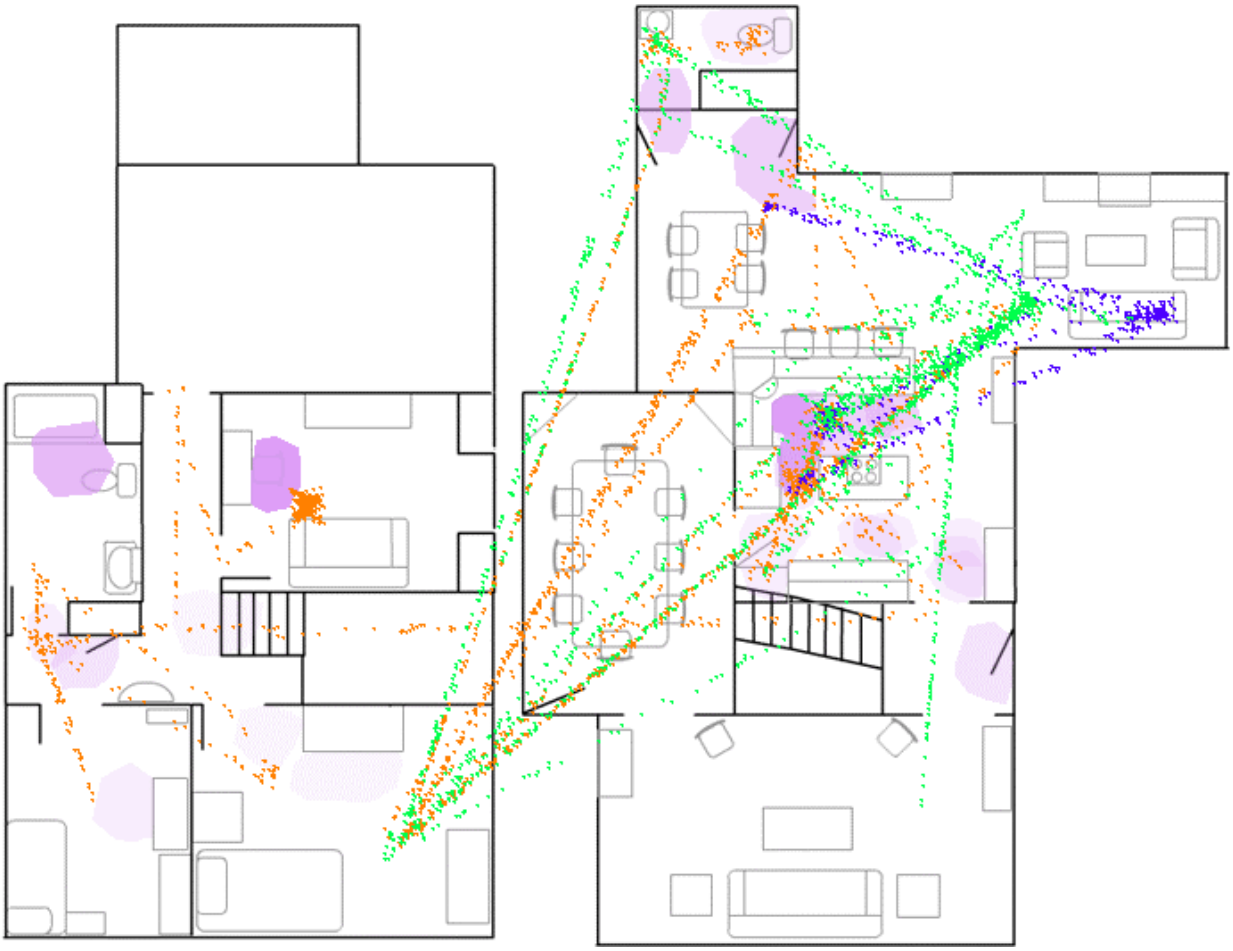


Figure 66. The family's movements, as recorded by the position-tracking, and actions, as recorded by the open-close sensors, for two hours on a Thursday evening. The mother's path is orange, the father's path is blue, and the daughter's path is green. Approximations of where the actor stands when an open-close sensor is activated are indicated in purple.

Susan very patiently attended to the experience sampling on the PDA, even though it unexpectedly began to pose up to 30 questions at a time and then continued to reschedule, despite her answers of "no" to the "is this a good time" question. She identified issues such as insufficiently exhausted odors from the downdraft cooktop and obstacles from family members getting a snack or co-cooking. She had two primary recommendations for the experience sampling. First, that the questions need to be activity-triggered, because it was awkward to answer questions that weren't relevant to the current situation, such as the question about how guests should be involved in food preparation, when no guests were there. This goal may have been better met if the location-triggered aspect of the protocol had been doable, but it is notable that

Susan would be more interested in activity-linked questions. In general, she stated that she was more interested in how their activities were playing out in the kitchen, than in the physical objects of the kitchen. Following up on this idea, she wondered whether the questions could be framed more as a reflective "what went well" and "what could have gone better" framework, that encouraged the user to gradually pinpoint the aspects of the physical environment that contributed to the physical, cognitive, and emotional experience.

How Home Activity Data Can Inform Design (and Homeowners)

The time constraints of the current research necessarily limited the dimensions of the data that could be linked to design, displayed, and reflected on by the participants. In examining the collected data, both from my kitchen investigation and the participant experiment, however, I can propose aspects of the data that are potentially relevant, and powerful, for design.

- Total sensor activations – Sensor activations can be graphed against time to get an indicator of peak levels of activity and distinctions between days, time periods, and areas. When compared with other homeowners, total activations provide a measure of relative use that might dictate where energies, and budgets, should be focused. More concrete decisions can also be informed by examining activation distributions. For example, a decision can be made to place the sink so it faces the social areas, and not a window, if most dishwashing takes place after dark.
- Frequency – The most frequently activated sensors can be determined for a given time period, particularly for appliances and cabinetry. Frequency may suggest an order for decision-making and prioritization in terms of time spent on the decision and budget devoted to the item. For example, if the cooktop is a high-use item in the household, than its placement and model should be chosen with more care. These estimations are easier to make in comparison with other people (is it meaningful to compare use of the dishwasher with use of the cooktop in terms of open-close events?), but some values, such as the number of times the refrigerator is opened and closed each day, can stand by themselves as reminders of the level of use the home environment receives.

- Clustering – Activations may be grouped by time and location, with group boundaries determined by location changes or periods of activation "silence." These groups may provide information about task-switching, multitasking, and concurrent activities, which in turn can inform decisions about regions that should be combined (e.g. dining and kitchen), adjacent (e.g. laundry and kitchen), or segregated (e.g. TV area from kitchen).
- Combinations – Each sensor can be associated with the sensors with which it is often activated. Some sensor groups may point to specific tasks (freezer-microwave = frozen food meals). A simple task recognition approach might help homeowners better describe their lifestyle (e.g. predominantly frozen meals) or identify items that work in concert (e.g. microwave and freezer) and therefore should be decided together.
- Duration – As mentioned above, the duration which a sensor is opened or closed or on or off can be used for activity recognition or action-style discrimination. Peaks in durations might correspond to the following styles of use:
    - False-starts ("oops, I didn't mean to open this drawer")
    - Knowing-getting (know what you want, know where it is, no obstacles to retrieval – what would be expected for efficient behavior)
    - Searching ("what was I looking for?" or "where is it?")
    - Gapping doors (attending to another task or leaving the room without closing a cabinet or appliance)
    - Mechanical error (sensor doesn't register open or close event)

  If these peaks, or similar categories, can be distinguished, they can be used to describe qualities of tasks, such as familiar versus improvisational. They may point to situations (days/times/objects used) that require more context support (visual aids) or help better define individual styles. If, for example, current activations indicate that the cook is doing a lot of search-style activity in the morning, when time is pressed, concrete solutions, such as glassed cabinets or appliance doors, or more segmented, and organized, storage space, may be suggested.
- Overlapping – Simultaneously open cabinetry or appliances, aggregated by time period, may identify activities that tend to have a high-degree of overlap, where

multiple items are left open at once, such as putting dishes away or putting groceries away.

- Distance - Distance traveled is difficult to absolutely determine, without position-tracking at a high level of granularity, but patterns of movement and ambulation may be suggested by series of discrete activations. Distance-type measures may place a focus on efficiency of movement, to minimize motion required for a task.
- Specific queries - The homeowners' interests can define queries of specific events or specific sensor activations. Example comparisons include microwave versus stove versus toaster, right-side doors versus left-side doors, above counter versus below counter, and formal entry door (front door) versus informal entry door (garage door).
- Concurrent use – Using position-tracking data, times when more than one person is using a room or room element may be identified. Also important is when adjacent rooms are in simultaneous use. This information may suggest whether rooms need to be designed to accommodate more than one main actor (e.g. two cooks) and whether divisions between rooms would protect from excess noise (e.g. one person cooks while the children watch TV) or overly isolate (e.g. one person needs to clean up while other socialize).
- Simulation – Existing patterns, of both open-close activations and position-tracking paths, can be transplanted to a new space as a hypothesis of how unique living patterns will play out there. Simply determining the mapping of sensor locations from one space to another can be a discovery process, as decisions have to be made about sensors that are in rooms subsumed (e.g. no separate formal/everyday dining) or elaborated (e.g. work areas in multiple rooms) in the new design, emphasizing the constraints and opportunities that the homeowners should expect (Figure 67). Paths that are blocked or lengthened may be of special interest. When interpretation directly on the plan becomes difficult, due to leaps in the recorded path, mapping to bubble diagrams may clarify relationships such as rooms that are used concurrently.

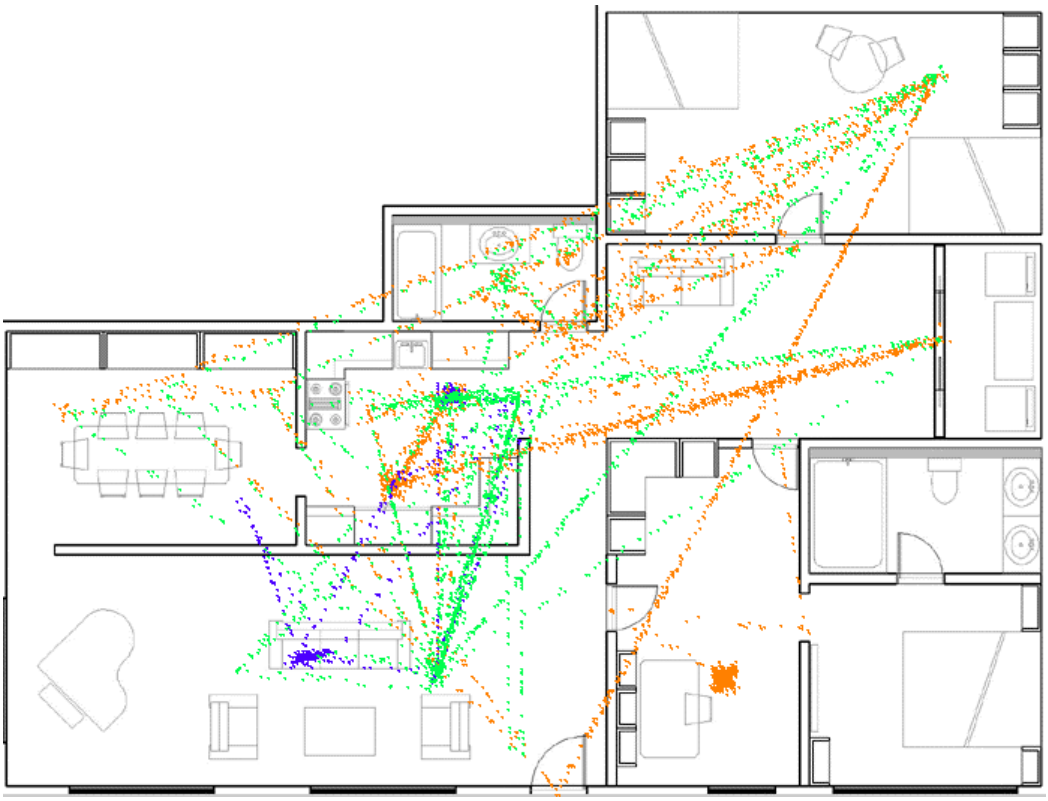


Figure 67. The Thursday evening activity pattern translated to a new plan by MIT undergraduate, Jennifer Gaugler. Sensors from the living room and family room were remapped to the same space, while the sensors from the study, near the daughter's keyboard, could be placed in either the children's bedroom or the work area near the master bedroom. Pathways of the daughter and father, as they move between watching TV in the family room and using the kitchen, are blocked by a wall.

Patterns may be statically applied or simulated over time, with varying levels of richness and elaboration, ranging from the simple "ant tracks" shown above or Sims-like (developer Will Wright) interaction, possibly allowing the homeowners to introduce new elements (e.g. a wall) or define reaction-rules based on observed patterns (e.g. people will tend to congregate where the TV is, family members will gravitate to the sunny-side of the house, blocking a thoroughfare will result in fewer interruptions in the kitchen[16]) to speculate about pattern changes.

[16] These "rules" have been suggested by homeowners in the interviews

Chapter 6, Tools for Pre-design

"I got a lot of comments from people about how I designed, decorated my place, and that's great, but for me, it comes down to me, I'm comfortable there, I created something that I'm comfortable in, and that's what really matters – so whatever that is, you've got to figure out what it's going to make you comfortable to be in your own place and then do it."
– Interviewed participant

"I have the power to change things about it."
– Interviewed participant

How Homeowners Approach Design

From my interviews with homeowners engaged in or looking back on construction and remodeling projects, I was introduced to the challenges of home design from the homeowner's perspective. Homeowners initially approach their task of specifying the design problem as a consumer process, drawing on books, web sites, and home CAD software to become aware of options and expert advice. This type of procedure may work well for something like the purchase of a digital camera, where one needs mainly to know the available models and the relevant comparison variables, without serious reflection on personal needs or values, beyond assessment of the spending budget. Most adults are familiar with these techniques and the primary issues relate to having access to good informational sources. It becomes quickly apparent in home design, however, that a research comparison process for each decision will be unmanageable, without a supporting framework of personal aesthetics and goals.

Residential architects can offer a unified design vision for those who can afford to work with them. However, as exemplified by Neil's experience, homeowners may dissociate from the vision if they distrust that it represents their personal needs and reflects their identities. In these situations, they may seek to gain control late in the process through fragmented alterations. Builders give homeowners more direct decision-power, but tend to present decisions serially, as dictated by the construction schedule, resulting in discrete decision-making without a prioritizing or linking thread. Homeowners here can often get into the trap of the "doorknobs" scenario, burning-out on surface details and relinquishing the remaining decisions to the default options. These observations can already begin to inform the design of home customization tools. They suggest that the degree of integration and connectedness of decisions will be

paramount to avoiding user burnout or piecemeal design. A technological interface could provide an overarching framework, allow the order of decisions to be dictated by the user, offer visualization of the combined decisions to date, and permit an extended period of experimentation and revision.

In chapter 3, I noted that though homeowners may not recognize it, their independent efforts at guiding themselves through home design can constitute a process of learning and self-realization. Through research and interaction with professionals, they develop a design vocabulary, peppering their speech with terms such as "soffit," "Arts and Crafts," and "frameless cabinetry," and gain familiarity with interpreting plan views and 3D renderings. It can be said that being able to name new items in their environment and engage with new representations allows them to think and talk about design options of which they were previously unaware. It is notable, however, that very few of the terms they learn and use inspire them to talk about lifestyle and activity, with the exception of the occasional "traffic flow" or "work triangle." What they primarily appear to be learning is a "way of talking" that gives them legitimacy as members of the design process (Jordan, 1989). Because the vocabulary and representations are rarely linked to their personal models and understandings, they are difficult to apply in a generative fashion.

Homeowners also apply less systematic approaches that hint at their interior processes for connecting with design. They may use stories to situate themselves within the design, such as when Patricia evaluated a 3D rendering of a proposed kitchen remodel by considering a "get up in the middle of the night for a drink of water" scenario. They may use strong symbolic images to help them filter choices and assert their own identities, such as when Laura referenced "white carpets and velvet couches" to reject her architect's proposal of a formal living room. Homeowners frequently fail to find models of reference in their home environments and activities and seem hesitant to question advice or critically reapply concepts. Homeowners who get over their initial reluctance about tearing pages from magazines[17], however, may go on to construct collections of images that they can use to investigate and experiment, either to identify a personal aesthetic, as Kristen did, or pursue a focused inquiry, as Ben

[17] Adding dashed lines to images in design magazines and books would be a good starting place to encourage homeowners to utilize the materials that are currently available to them.

and Sarah did with the abstract concept "open, but not too open." Their collections of clippings "talk back," helping them to define their own knowledge-in-action about preferences and needs and stimulating further refinement and elaboration, much as the act of sketching functions for design professionals. While their efforts tend to be idiosyncratic and limited in dimensionality, they suggest that materials that permit the externalization of thinking processes, emotional responses, and beliefs may shift the homeowner's role from simply that of a consumer, to an active, contributing member of the design process.

Enriching and Capturing the Pre-design Process

When given a wider range of media, and techniques inspired by theoretical traditions in professional practice and learning, volunteer participants demonstrated a process of externalizing their intuitions, personal models, and thinking, described in chapter 4, and their activity patterns on the environment, described in chapter 5.

Composite Paths of Material and Method

In these studies, I sought to develop a more comprehensive understanding of how homeowners can be supported in design, by providing richer and more varied materials that were alterable in a way that would let participants shape them to their desired learning approach. Each participant developed their own path of pre-design, by selecting which exercises they would do, applying their own interpretation of constructive and reflective techniques, and generating sharable products. By taking a first-person perspective, envisioning how they would use the techniques to prepare to design their own homes rather than applying it to a more hypothetical task, they asserted their own heuristics, aesthetics, and goals. Beyond having an interest in what is rational or workable, the goal of most expert-guided systems, they also expressed, through their work and explanations, a desire for that which is personal.

Participants by and large chose the more traditional media (image sorting, questionnaires), but also tried sketching, wish lists, scenario building, and the field exercise. They expressed approval for "practical" exercises with tangible output, perhaps reflecting a focus on product over process, which is prevalent in our culture. However, they acknowledged the importance of the more "emotional" techniques (e.g. reflection, storytelling) for conflict resolution and to get out of ruts. They also

tended to select extensions and apply independent methods that were more open-ended and emotional to the more conventional representations.

Material for Reflection and Investigation

Participants generated material that served as a description of their preferences, beliefs, and experiences, including:

- physical-psychological responses to the environment
- anecdotes or referenced experiences
- traces of actions on the environment
- aesthetic and emotional responses
- perceptual responses or models
- knowledge model or rules-of-thumb
- plans or stories of the future

The initial generation process was primarily based on tacit responses, existing cognitive and perceptual models, and immediate experiences. This allowed a fluid, non-intimidating entry into thinking about design. Constraints, errors, and reframing prompted participants to treat these descriptions as hypothetical, leading to questioning, investigation, and revision. Constraints included time limits, imposed implicitly by the number of examples in the image/concept sorting and explicitly in the mental maps, as well as detection granularity, the limitations of what can be sensed with the investigation tools. Participants produced and became aware of errors in representation and recall, when sketching mental maps, in preference selections, when re-evaluating their "I like" image sorting categories, and in projective assumptions, when applying scenario cards to spatial design ideas. Reframing occurred when participants explicitly took a different perspective, as in the resorting of example images, when connecting representations, such as words and spatial ideas, and when applying their own methods of evaluating negative examples, giving a second-chance to rejected images or developing a description from words in the "not" pile of the collage exercises.

Participants linked representations (e.g. image sorting with sketching, concept cards with quality words) to provide validation or to identify elements that needed further elaboration. Finding duplicated ideas expressed in different media or through

different exercises confirmed that they were significant and reflected an enduring need or preference. When a link was discovered, discrepancies could be evaluated, to develop a more full description of the idea, such as when Zach found an image from his "I like" category that matched his sketched kitchen, allowing him to fill out details (e.g. inclusion of the dishwasher) and investigate consequences (e.g. a cooktop on the island will require an exhaust, and that may change the aesthetics of the design). Extending design thinking into everyday experiences, participants considered decisions against actual needs and resources, encouraging more directed evaluation, and developed an experimental approach, considering both behavioral and spatial solutions.

Participants had the most difficulty with questionnaires and generating content through spatial representations. Although questionnaires were used successfully to identify issues to investigate in other representations and when used in the context of the home, participants frequently approached them passively, filling in answers with little evaluation or iteration. Participants expressed the most frustration when they made the task of idea expression (e.g. in the sketching exercise or in the at-lab collage exercise) too much about spatial relationships; beyond having difficulty with scale and precision, they were concerned about developing spatial solutions that were too conventional or derivative.

Participants demonstrated, however, that they have learned from their current space and have rich anecdotes about routines, preferences, and heuristics. They were fluent in describing scenarios on a temporal dimension, as they are staged over time with the support of structures and objects in the environment. Within these activity descriptions, participants frequently described the roles that individuals play (e.g. the cook, the guests, the children) with respect to what they see, hear, and can reach, particularly relative to each other.

Generating Examples of Powerful Ideas

In doing the exercises, participants generated their own examples of several powerful ideas in design. They noted how design solutions can fail to work if the underlying issue is not addressed (e.g. more counterspace may just mean more clutter), or can introduce new problems if what is being replaced is not appropriately

recognized (e.g. Emma and Zach, transitioning from compact apartment to extended house will require a shift in routines and easily accessed resources). They discovered that it is easy to repeat ideas from one's current space or pursue goals that are artifacts of childhood, or stereotyped, expectations (e.g. Kristen's "formal" kitchen). They explored how solutions can be spatial, organizational, or behavioral (e.g. Susan's approaches to reducing actions with regard to using the trash). They identified essential conflicts, such as between openness and privacy, formality and informality, and developed approaches to addressing those conflicts, including prioritization, compromise, co-existing alternatives (e.g. Zach's informal kitchen with formal dining room), and appeal to an expert ("the architect can solve this, but I've identified it").

Four Tools

To illustrate how these observations may inform technological development, I propose four "pre-design tools" to support the programmatic stage of custom home design. Within each of these tools, there is an implied range of technological intelligence and intervention. In the ideal case, the technology can capture, interpret, and build on many of the intentions and heuristics that homeowners are inspired to express, to better initiate and guide the generation of design, to inform the designers and manufacturers who support the system, and to serve as example material for future users. I cannot say, however, what all the obstacles to this vision might be, particularly in finding a balance between richness of expression and sufficient computational constraint. A more realistic perspective proposes that many of the pre-design tools and approaches that would be supplied in a technologically-mediated system of custom design would mainly exist for the users alone, to prime them to be in a better position of confidence and awareness, so that they could fulfill their role in making meaningful decisions and interpreting design: less the smarter tools, and more the smarter users.

In pulling out ideas from the unique pre-design paths that participants followed, I have been faced with the challenge of selecting which learning styles to model, which to support, and at the very least, which to permit without impedance. The participants described in the case studies applied and elaborated approaches that led them to make interesting discoveries and pose important questions. They were given considerable freedom to develop these approaches and drew on their existing abilities

to reflect, evaluate, and create. I am including in my recommendations materials and methods from the exercises that seemed to be the basis of the most successful approaches. Additionally, I am suggesting interface supports that would encourage users to adopt the investigation and thinking styles exhibited by the participants, as model learners. Finally, I hope that the materials (e.g. scenario steps, images), along with the mechanisms to generate, manipulate, and employ them, are sufficiently flexible to permit unanticipated design preparation styles.

1) Questions in Context

In chapter 3, I described a meeting between clients, Laura and Evan, and their architect, which took place at their kitchen table. The project they were undertaking was a renovation, and so it made sense that they would give their architect a tour, on which he asked questions to try to understand their home, as they used it and experienced it. On the other hand, many homeowners end up making decisions at the cabinet store or sitting at a computer terminal, viewing web sites which rarely encourage a simple technique to getting acquainted with design: looking around at the layered, detailed example at hand, one's current home environment.

The first tool that I propose for pre-design represents a progression of ideas from the traditional design questionnaires, to the low-fidelity question slips that participants pasted around their home, to the experience sampling protocol tried out by Susan in the field exercise. It addresses the context of where decisions are made and the integration of the design process with normal life activities. The tool also draws inspiration from the vision put forth by Intille, Kukla, and Ma (2002), of a handheld-based experience-sampling device for design.

Questionnaires are prevalent in adult life (e.g. medical forms, feedback surveys, personality "quizzes") and can represent a range of roles for the respondent, and not all of them are active, in spite of their "dialog"-like feel. As many participants discovered and demonstrated, it is easy to exhaustively complete a questionnaire about wants and needs and still not have a cohesive vision or series of goals. This is because questions can be framed to make assumptions, limit options, and perhaps most commonly, put the respondent in a position of passively supplying input rather than critically thinking about what their answers may mean.

The questions provided on the question slips were not radically different than those found on the questionnaires, but by virtue of being placed within the homeowner's context, they encouraged a different way of responding. Participants frequently used them to confirm or validate responses they already felt they knew; in a sense, tying them to examples, much as people commonly use anecdotes ("remember that time...") to illustrate a point. This process also helped them express the importance of certain decisions (Zach's emphatic "yes").

Answering questions in context helped participants "get real" with their responses, separating genuine needs from what might sound good on the surface. Although enthusiasm for features motivates engagement with design, there is a point where everyone has to filter, prioritize, and constrain. As Zach demonstrated, juxtaposing a decision with the actual activity to which it pertains helps one to first recognize the other resources that are available, whether spatial or behavioral, that can fulfill a similar role (e.g. if I don't have heat resistant counters, I can just use racks and pot holders) and also to pose directed queries about whether the idea is a good match with the circumstances and activity style of the individual (e.g. I use cast-iron, does heat-resistant work for that?).

In addition to stimulating homeowners to frame ideas by their lifestyle and other resources, integrating questions into normal activities was remarked on as a time-saving method for the decision process,

> [Gwen:] I think because it was broken up, because you could think about the answers in the normal course of things, but for the others in the exercise, I actually had to set aside some time to sit down and focus on it. So this one allowed me to slip in an answer here, slip in an answer here, and then kind of collect up the whole lot of them.

As was readily apparent by the scheduling difficulties for the participant study, adults today have multiple demands on them and often don't feel they have time to set aside for research and reflection. Breaking down the initial stages of design thinking into more manageable chunks both lessens the perception of stolen time and encourages homeowners to "be thinking in the back of their minds" about design ideas, which may prime them to be more efficient when it is time to sit down and make final decisions.

To make this aspect workable, the questions asked in context should tend to be immediate, pertaining to resources and experiences that are easy to access either in memory or through simple sensory (e.g. visual) investigation, and non-binding, perhaps relying on patterns emerging from repeated observations over several weeks or months so homeowners won't have to struggle with the "accuracy" of response. The questions developed for the experience sampling protocol (in Appendix B), when triggered by location or activity, follow these guidelines, and can be easily coupled with equivalent decision-oriented questions that are asked in a more reflective setting. A homeowner who is baking (or who has just finished baking) may be asked, through a handheld computer or embedded interface located in his kitchen, to observe how comfortable his feet are, whether the oven is at the appropriate height, and whether he is listening to music or watching TV while he works. Later, the following weekend, he might sit down at a computer and after transferring his responses from the week, get posed questions about whether he wants linoleum or tile flooring, would like an oven separate from the cooktop, and needs an open layout to the family room where the TV would be. Rather than falling back on a stereotyped model of what his answer should be, he can reference recent memories from the week when he was able to briefly step back and observe himself and his environment in the course of an activity.

As noted above, it is easy for questions like these to not add-up to a more cohesive understanding of what is needed. For homeowners who are seeking more than help with specific decisions, Susan's recommendation of a stepped, activity/behavior/event oriented protocol should be considered. She suggested that the questions begin with "what went well?" and "what could have gone better?" This approach makes particular sense for her situation, as a working mother with two energetic daughters, managing the home with the help of her husband and mother. On a given night, she is the force that ensures everyone has what he or she needs and is following on course, from dinner, to study, to bath time, to play, to bed. Any one of several factors can contribute to her feeling stressed and disorganized – or relaxed and on top of things, and what she proposes is something like detective work, where the protocol begins at a high level, and over time helps her to pinpoint causes and solutions. If she's feeling tired on a particular night, when did she begin to feel it? Did

she fall back on a less effective strategy because she didn't have access to the appropriate resources and environmental supports?

The challenge is to develop a protocol that can provide helpful investigative queries that gradually focus on more concrete, environment-based decisions. Homeowners might be able to help each other in this regard by authoring linked questions that are shared through a web site or networked custom design system for broad lifestyle categories (e.g. singles, families with working parents, couples preparing for retirement, etc.). From my own experience, developing questions was an engaging and enlightening process in itself, as I thought through what can be observed in terms of sensory and psychological experiences in a home environment. A question authoring and assembling interface, for users to develop and share investigative protocols, could allow users to share their process. For those individuals who do not have the time for deeper content generation, a search process of selecting relevant questions or categories of questions (submitted by design experts or other homeowners) can be a more condensed, yet powerful, exercise in defining one's lifestyle.

A major focus of Rondoni's work (2003), in developing the experience sampling software used in the field exercise, has been to determine the appropriate time for interruptions. He employs biometric signals, such as heart rate and body limb positioning, to identify periods of transition. Intille at al. (2002) suggested that users could initiate review of recent experiences, as recorded by camera-stills taken in the home, outside of the context during periods when they were left with extra time, such as when riding on the subway or waiting for an appointment. The current research tried two approaches: 1) with the question slips, users took on the task of placing questions in the environment and then chose to attend to them in the moment; 2) with the experience sampling, the user initiated a periodic sequencing of questions either during or after an event. Any one or a combination of these approaches might be used, depending on the preferences of the users and the available technology. It may be possible, for example, for users to take an active role, at the beginning of a week or month, to specify where questions should appear and under what situations. Someone using the tool to make more concrete decisions (what kind of flooring?) would be best served by answering questions with direct access to the relevant sensory experiences (standing in the kitchen), whereas someone starting at a higher level, with a busy

lifestyle, may prefer to initiate brief reviews of the daily events during periods of rest. Ultimately, being able to "teach" a tool when is an appropriate time for questions of particular types may also help the user identify pertinent times and locations, that indicate, for example, when and where they rest, when and where they are more conscious of their experiences, and when and where they complete relevant task groupings that can be evaluated. Regardless, a balance has to be struck between badgering or disrupting and failing to help users seize the chance, in small bits and bites, to accumulate design awareness.

2) Field Investigation Kit

The actions we take on and with the support of the home environment are largely unavailable to both the design community and individual inhabitants due to errors in recall, a lack of critical awareness conditioned by familiarity, and the difficulty of conceptualizing larger patterns of ephemeral, simple routines. Sensors can make visible these hidden traces and tracks as material for reflection and as a source of input to inform design. Without requiring complex recognition and analysis algorithms, the data can be mined for aggregate qualities, such as total activations by location, or time of day, frequency of activation by sensor or sensor-type, and presence of simple sensor combinations, such as freezer-microwave, to get clues about the basic needs and lifestyle of the family, especially when compared to collected data from other homeowners. Aggregate qualities that can point to problematic or beneficial aspects of the current living situation, such as distance traveled, frequency of concurrent activities, overused and underused areas, and qualities of task execution (e.g. leaving the cabinets open, multitasking), can also provide the basis for reflection, decision-making, and in the next stage, proposed solutions. Simulation, particularly of patterns transferred from the current space to a design under consideration, may lead participants to identify ways their patterns will be distorted or stymied, unless they are prepared to adapt their behaviors or make modifications to the design.

As demonstrated in the field exercise with Susan's family, however, the most immediate contribution of observation is not in the data, but in the being observed. In the 12 days when the sensors were installed, family members developed a new way of describing what they do, by quantifying their actions (e.g. how many times the refrigerator is opened during meal preparation), emphasizing necessary and sufficient

sequencing patterns (e.g. for the children, using the bathroom means closing the door, flushing the toilet, and washing hands), and defining an evaluative criteria that knows to look for "less varied data" as an indicator that activities in space are well synchronized and organized (e.g. setting the table, cleaning, relaxing, in one concise space).

Susan was particularly focused on the efficiency of her movements. It's important to note that the sensors only get a "glimpse" of activities as they occur. The recorded actions may be focused on the edges of events (e.g. the taking out of ingredients, the putting away of dishes), and may miss important behaviors, such as planning, reflecting, relaxing, and socializing. By quantifying actions, much as the early proponents of science management did, recommendations based on this data may boil down best practices to a reduction of steps or event duration, when the comforting ritual of the routine (e.g. evoking a memory, building up anticipation) or the improvisational or creative quality of execution should have equal or greater weight. The user will need to be encouraged to interpret data with these ideas in mind.

Susan exhibited an experimental approach to her routines, identifying an issue, the high frequency of opening the trash cabinet, and considering both spatial and behavioral solutions. This example may seem small, but these are the kinds of incremental changes that can add up when continued on an everyday basis, both in terms of developing intuitions about what makes good design and in adopting new behaviors. Field kits that include methods of real-time feedback (e.g. "you've been running the sink faucet for 15 minutes," "the refrigerator has been opened 5 times") and authored messages (e.g. "remember to make use of the prep space to the left of the stove") can encourage a continued process of experimentation when the novelty of simply being observed wears out. This application widens the custom design of the home to include situated information and interventions. Instead of limiting the process of wedding goals to their concrete implementation in space to the period when the house is built, the inhabitants may experiment and self-intervene on an ongoing basis, as they customize their own routines.

Although Susan and her family reported feeling comfortable with the investigative tools, a participant in Munguia Tapia's (2003) activity recognition study shared with us her feelings of being judged and exposed, feelings that she did not

expect to have. Family members could feel uncomfortable if their individual activity patterns are made explicit for evaluation by other family members (e.g. family member A is much more active in doing household chores than family member B) or by a system trying to describe the family (e.g. this is a family that mainly makes frozen dinners). Possible approaches to counteracting these effects may include placing an emphasis on aggregate qualities, rather than individual patterns, and encouraging the family to put their patterns in the context of the range of lifestyles represented by modern American culture (emphasizing there is no "should be" pattern). These problem situations can also be sources of design inspiration, however, by identifying the mismatch between the current and desired patterns. Does a family member not help out as much as others would like? Perhaps the kitchen should be designed to make that person more comfortable (with height-adjusted shelves), provide special "workstations" (e.g. Susan's daughter has easy access to the plates and cups from the breakfast bar, and setting the table has become her special task), or support more collaborative work (e.g. a prep sink and a dishwashing sink). Does a family rely on quick meals but want to have more sit-down meals? Perhaps eating areas need to be placed where the family gravitates or the bedrooms should be near the kitchen to encourage more prep work in the morning. One interesting aspect about these solutions in response to problems identified through the data is that they can continue to be investigated after the family has moved into their new home, by re-installing the sensors in correlate locations and conducting "post-occupancy" studies. Did the family intend for a solution to have a desired effect, but it hasn't? Perhaps the underlying problem wasn't addressed and the family needs to re-evaluate their behavior or consider making a modification to their home.

The issue of privacy should not be overlooked, and one of my primary interests in using these tools has been to think about how people can take control of their data by understanding them and applying them to personal goals, rather than simply handing over data to experts or expert systems. Rather than just placing sensors "everywhere," homeowners can be encouraged to design particular personal investigations, agreed to by all members of the family, explicitly stating their hypotheses about what they will discover, being reminded that the investigation is underway through non-disruptive visual feedback (one of the biggest threats to privacy is forgetting that one is being

observed), and developing successive investigations based on what they see in the data. While the most commonly proposed application for home sensors today is monitoring (particularly for aging adults living alone), using them first as a tool for self-awareness and experimentation gives homeowners the opportunity to fully understand what it means to be observed, as an individual and within families, how activities on the environment translate to data, and how they may respond, both unintentionally and proactively, to having their routines made explicit, all within the less threatening application of design discovery. Whether such experiences lead to greater experimentation with adapting behaviors and environments to meet goals (e.g. to spend more social time together as a family, consume less energy, remember to take medications, eat more veggies) or to a rejection of sensing technologies, is something that homeowners should be able to openly explore.

3) Reflective and Constructive Interfaces

While the questions-in-context and the sensor kit would make use of resources and referents available in one's local environment, with the last two tools I propose, it is the homeowner's emotional responses, beliefs, cognitive and perceptual models, and tentative first decisions that serve as material to reflect on, investigate, build on, and share. I propose for the third tool a series of linking interfaces to help the homeowner identify his sense of aesthetics, uncover issues of concern or interest, prioritize early decisions, and express partial ideas to initiate the design stage.

The technological implementation of these interfaces may be achievable through a traditional screen interface, at the risk of becoming less manipulable, or through physical media that can be printed and then scanned (e.g. printed image cards with bar codes) or otherwise inputted, assuming such methods would become affordable and easy to manage by the non-expert. In either case, a digital representation can offer the benefits of preserved work that can be easily revisited, explicitly stored links between representations or examples of work, quantified comparisons between examples from the same or different users, and more sophisticated analysis, such as the development of personal critics that virtually represent the user.

Image Sorting to Define Personal Aesthetics

An image-sorting interface has the potential to help users to first uncover and understand tacit responses, and then, through iterative redefinition by sorting, develop a more rich and deliberate personal aesthetic. Homeowners may choose to go through a gradual collection process, as Kristen did, to accumulate images to which they first have some kind of response, whether negative or positive, before sharply categorizing them. If they are overwhelmed with the different stylistic combinations, they may begin with images of homes that are more familiar, as Gwen recommended, by selecting particular aesthetic or cultural categories. Other homeowners may seek out more extreme examples as being more stimulating for definition and investigation.

Employing either a set of personally collected images or system-grouped image sets, users may initially sort according to the "I like" and "don't like" categories, encouraged to apply the gut-level approach by being made aware of the number of images (either explicitly on screen, or through quantity of materials when printed). These categories can be stored and compared on resorting.

Through resorting and re-examination, the user can develop a description of the kind of home they are wanting (or wanting to avoid). Particularly effective resort categories would include:

- Separating "I like" versus "I see myself possibly living in," a common distinction made by study participants
- Discrete labels, either offered by the system or inserted by the homeowner, such as "modern," "efficient," "economical", to begin to describe images belonging to like/dislike categories
- Other assumed perspectives, such as "I would have chosen 10 years ago" to identify aesthetics that have remained the same or to highlight how aesthetics or the conception of the home may change with greater experience or in response to the coming and going of fads
- "Good for" categories that match potential evaluative criteria, such as "good for single people" or "good for entertaining"

Simply waiting and resorting a few weeks later can also provide a source of surprise, and hence reframing. Several participants, when looking through the images again at the interview, looked on several of their "I likes" with disdain, and then noted

that they "must have been attracted to…" a particular feature. Although somewhat unsettling, it would be important for homeowners to be wary of the impact of novelty, familiarity, and hidden cues (e.g. the high-tech orange juicer on the counter, not the counter itself) in order to pinpoint the aspects and features that provide a more enduring positive response.

A technological interface can help the user to identify threads that link images, if information, contributed by the system developers or other homeowners, is available. The user may see that 75% of the kitchen images that she liked contained islands or that none of the bedrooms she chose had elevated ceilings. She may also directly identify (and annotate) features that she believes drove individual categorizations. Detected common features or user-identified features could then be used as search terms for additional images, some of which may be in the opposite preference category. Conditions under which the feature matters could then be identified (e.g. I rejected all kitchens with a thoroughfare, except one – what makes that one workable? Or was it just an oversight due to the prominence of other features?).

Gwen's second-chance heuristic should be encouraged, simply by entreating the user to think through what would make the example room workable or, given a technological interface with appropriate source material, by allowing the gradual transformation of an image, with the inclusion or exclusion of elements, color and surface alterations, or added representations of behavioral or object-based solutions (e.g. curtains to soften a minimalist room). The second-chance approach appears to be particularly good at revealing decision-driving elements (it's okay, except for x) and encouraging compromise.

The image sorting represents a good opportunity for comparisons between family members, focusing on those examples that they have in common, and perhaps identifying "fringe" images (perhaps determined by a system that scores images and determines similarity distance) in each individual's groupings that could widen the overlap. A technological interface could store labels and annotation, and even offer the feature of "presentation assembly" for other family members or "tours" for other homeowners, directing the user to try to explain and link aesthetic responses. The presentations wouldn't have to be stand-alone and complete; instead they may serve as starter for conversations. They could include explicit description, layout and

annotation; but also display information stored by the system, such as the evolution of the user's response to the image (e.g. the image was originally in the "dislike", but after sorting on "what the typical family would choose", the "I like" widened to include it) to help the person explain their evaluation process, or allow for impromptu searching of similar images or images that include/exclude annotated elements.

Mental Maps for Issue Identification

Given that several participants shied away from sketching with concerns about their ability to work with spatial relationships, it's interesting to note that the participant who dove into the exercise with enthusiasm, Zach, wasn't particularly adept at drawing. Indeed, Zach produced errors in both recall and representation, but he used them productively to identify interesting distinctions between the experience of space and the objective reality of space. The second interface I would recommend, therefore, does include sketching, but does not expect the user to generate novel solutions; instead it focuses on opportunities for discovery that come from *errors* in representation of familiar spaces. Knowing that it is common for homeowners to overlook even important items in the decision-making process (e.g. Arlene's microwave), this interface takes the approach of using the forgetting and other distortions as material for investigation.

As with the "mental map" portion of the sketching exercise, the user would be invited to sketch their current home, either a room at a time, or at a more broad layout level. The time constraint would be imposed to increase the likelihood of error and provide a method of evaluation. As a final stage, the user would be encouraged to investigate and update their sketch with items they had missed. If they are like Zach, they may evaluate ordering as follows: the first elements may indicate what structures and defines boundaries of the room, as perceived by the user, the salient items may be added next, the critical must-have-or-it-isn't-my kitchen may be added in the last minutes, and the missed elements may fall under "not important", "not desired", and "too familiar" categories.

The sketching could be done on paper and reported on, done on paper and scanned, or done on screen through mouse pointer or sketch device. A technological interface could automatically change colors as time progressed and could "replay" the sketching to heighten awareness of order.

To model Zach's discovery approach, the user could be encouraged to interpret their mental maps by being given an interactive checklist of items to inventory, paying attention to items that exist in the home, but are not included in the sketch. For each missing item, she may be encouraged to select a possible reason for the exclusion – is it not important? Does she wish it wasn't there? For each remembered item, she may be asked to speculate whether it is significant (e.g. Zach's salt and pepper shakers) or simply salient (e.g. each of the major appliances). She could then be prompted to evaluate each item in terms of its relative scale (larger or smaller) and positioning and explicitly speculate about possible reasons for distortions (e.g. I wish it were bigger, it looms large in my mind, it's positioned closer to another element because they are used together). From this evaluation, she can indicate which items and issues she finds interesting or important, both as a way of providing information about their needs (e.g. large counterspace, garbage disposal) and to suggest order-of-decisions and evaluative criteria for future design solutions.

During the process of evaluation, it may be possible for homeowners to annotate their sketch, whether produced on screen or scanned, producing a machine recognizable rough description of the room or home. A physical description can inspire a problem definition, in this case by applying lifestyle-assumption rules to the presence and positioning of elements. For example, a system may assume that the number of bedrooms equates with the number of inhabitants plus one guest, that an open kitchen-dining plan with no separate dining room suggests the family holds primarily informal parties, and that a dishwasher to the left of the sink implies a left-handed cook. In this case, a system that was somewhat error-prone could still be beneficial, because it could encourage homeowners to question and explore the reasons for mistakes in a design situation where they are more confident in their perspective (i.e. how they live in their current home). Users could agree or disagree with the heuristic (e.g. handedness doesn't matter for the placement of the dishwasher), discover that they use their home in a more adaptive way (e.g. family members are willing to give up their bed for the occasional guest and sleep on the couch), and assess to what degree the design of space dictates lifestyle and use.

Qualities, Concepts, and Placeable Components for Partial Idea Expression

An interface based on the at-lab collage exercise could be a central linking point for interfaces such as the image sorting, mental maps, scenario cards (described as part of tool 4 below), or others, providing a space for initial decision-making and partial idea expression. As with the exercise, this tool would include varied media, taking linguistic, figurative, and spatial forms, to support individuals with different perceived abilities and interests and to facilitate validation and framing through the linking of issues and ideas. The supported process for this interface is based on Kristen's successful experience, while offering options such as the exchange of rough ideas for more developed, designer-contributed sections, to aid less confident users, such as Emma.

Given that many people find quality words difficult to relate to once more concrete decisions are framed, it would be recommended that the user sort them first as a way of providing a broad framing. Concept "cards" would represent ideas at different scales and would be provided in random order to encourage gut reaction sorting over analytical comparisons. This would allow the user to quickly filter a large number of options to a manageable set for investigation. The "I don't know" category could be retained and used later, and iterative use of the interface, with different family members, would insure that a larger set of ideas is ultimately considered in depth.

To encourage Kristen's approach to build a model of decision dependencies, the user may be encouraged to categorize concepts (e.g. primary, secondary, activity), order decisions, link concepts, and subsume perceived duplicates (e.g. place to eat breakfast and kitchen table) into compound concepts. This process of initial decision-making may be enough for individuals who are highly phobic of spatial representations; they could then link concepts to examples they have selected in image sorting (e.g. Zach's #13), issues they have identified in mental maps (e.g. "clutter is significant", "I need more counters"), or steps within scenarios, as described below.

For those who feel comfortable with constructing rough spatial ideas, they could use placeable representations of the primary, then secondary, concepts, as anchors and rough sketch or assemble partial ideas for relating elements. When the user indicates he is stymied or uncertain, the system could first prompt with activity concepts from his selected set (e.g. place for mail) to encourage elaboration. The user can

indicate sections that represent important ideas (such as Emma's work area between prep sink and cooktop), and depending on the system, might request larger units (developed by designers) that represent the combination of elements (e.g. island and counter configurations that feature work space between prep sink and cooktop).

Once the user indicates a mostly complete unit (a room) has been generated, the system can encourage the application of his saved sets of scenario cards (tool 4) to look for missing elements (e.g. need place to store extra food), provide argumentation for the inclusion of elements or the positioning of elements (i.e. this is good for this reason), or to identify conflicts (i.e. I don't know how to meet this step). The user can also go back to the words, applying them to sections or subsections of the sketch, as a way of describing and validating her work. The same techniques for evaluation and confirmation could also be used in evaluating later-stage designs supplied by experts or expert systems.

4) Scenarios in Time and Space

Architects typically believe that a homeowner's current space and experiences will limit their ability to imagine new possibilities. This concern seemed to be born out during the study sessions when several times participants seemed to confuse their current situation and projected situation, and realized that their spatial-based ideas looked a lot like their familiar contexts.

Part of the issue seems to be a lack of fluency in spatial components and metaphors, such that generation and creativity is painstaking. On the other hand, participants again and again demonstrated a strong ability to tell stories, to describe their experiences in time, to think in terms of staging, and to imagine connections between people, as they play out different roles (e.g. doing homework, cooking, talking with the cook) in a spatial context. Tom referred to this as sight lines and voice lines:

> It's sight lines, being able to talk, voice lines, back and forth, so other people are not in the way as you are cooking, but you are still part of the conversation when you are in the kitchen, and you are aware of what's going on outside their work, things are happening, it's easy to say, "oh can I help you with something" or "did you hear this story."

Zach used a similar process to determine his "alternate functions" room connections, which supported situations where a formal party might occur or everyday

scenarios where family members wanted and needed to be in contact with each other. Patricia and Zach recommended a "simulate and test" procedure that inspired the development of scenario cards, and Kristen used these cards first to create two distinct visions of home use, based on her current situation and her projected future, and then to evaluate her spatial-based ideas, concluding that they better matched her current scenario ("informal"), and maybe that was as it should be. A clear division between how it is and how it might be seems to be easier to accomplish through scenario.

The scenario cards represent a structured way to elicit a story, using pre-developed actions that can be personalized by being reordered, edited, qualified, or selectively replaced. System developers can take on the task of supplying possible actions and linking them to decisions or critics, in a similar way to how question responses have been linked to intention rules in Fischer, Nakakoji, et al. (1995). Fischer et al. have also pursued options to have users contribute their own intention linking rules (e.g. large family requires large dishwasher). One could imagine that in addition to expression of rules, homeowners could link steps (e.g. the guests arrive) with images of aesthetics, spatially expressed ideas, critics that seem to adhere to the scenario expectation, or fully fleshed solutions.

Story-style actions offer benefits over questions, as they encourage the users to situate themselves within the problem context, offer both small scale and large scale revision possibilities, and focus on activities, that can be tied to space and behaviors (because a solution could be accomplished by changes to either or both). As Kristen said in talking about the scenario exercise,

> [Kristen:] …it was interesting to think about my activities in the kitchen, like what I do, what space I use, how that changes in different situations, and so it was very useful in thinking of, oh, if I could do my ideal kitchen, this is what I would want, because this is how I would use it in different times of the day or different situations, so it made me think of things I wouldn't have thought of.

If a user wants to add a step or a qualification to a step, it may not be something that could directly be linked with features that are brought out in automated design generation, particularly if the user doesn't take the time to link the step to other established ideas, but even if the addition did not have a particular interpretable

meaning to the system, it could continue to be employed by the user to explore issues of adjacency, connection, and integration.

Suzanne Hatfield, a precocious high school student from the area, interned for me for a week, directly following the interviews, and kindly helped me by going through the scenario card exercise, dividing the cards up by time or stage (vertical axis) and dedicated spaces (horizontal axis), and sketching connections, of walking paths (blue), sight paths (red), and sound paths (green). She did this for the dinner party scenario, and one scenario of her own generation, of an everyday family meal.

Figure 68. Suzanne arranged the scenario cards on the glass table, with the vertical axis representing time (before meal, preparation, eating, cleanup) and the horizontal axis representing dedicated spaces (storage, food processing, eating, socializing, unassigned). She drew connections between cards in blue (walking paths), red (sight paths), and green (sound paths). Photos were taken from above and collaged together.

Suzanne pursued both tasks of sorting and filtering the cards and drawing the connections with confidence. Neither requires one to think in purely spatial terms. Instead, she brought to mind a story of how her family experiences the events, thinking through each step as it applies to their own routines and personal styles. Although each person may visualize the steps playing out in space, most likely in their current or past homes, they do not have to be tied to a particular home layout. I suggested to Suzanne that she divide up the cards into regions that have a functional significance "food processing," but that don't necessarily have to map one-to-one to a stereotyped

room space. It is also possible to start with each step occupying it's own space, although it gets somewhat unwieldy to draw, pulling each out on the horizontal axis. She ordered them on the vertical axis event segment (e.g. "cleanup"), thinking through where overlaps might occur. For each section of time, she drew out where there needed to be visual connections, walking connections, and sound connections, sometimes reflexively to the same region (e.g. for family members to see each other while they eat), and other times across regions (e.g. for family members having to do cleanup to have a view to the more still active eating and socializing area). It was also possible for Suzanne to specify times when sight, sound, or access should be blocked, though she didn't personally find a need to do so.

Figure 69. Two options for a step in a dinner scenario.

In my concept of a tool based on this low-fidelity prototype, homeowners would follow a similar process of first defining a set of steps, envisioned in their current home, for scenarios which are significant to them (e.g. throwing a party, night-time routine, working-at-home). For any given scenario, they will be encouraged to pay attention to points of indecision (e.g. sometimes I want guests to be with me, sometimes I'll want them in another room) and varied projective time scales (right now, when my children are teenagers, when my parents move in with us). The interface may store several versions of each scenario, representing different family member's beliefs, different conditions, and different proposed strategies. Homeowners may then select steps from a scenario set they have developed that they believe are more highly situated, affected by the space in which they are staged (e.g. guests socialize with cook may be seen as more affected by home layout than cook prepares grocery list). They may arrange these steps, or their associated visual representations, to define visual, sound, voice, quick access, and traffic connections (or disconnections), step by step, as they imagine activities that are occurring simultaneously at each moment in time (e.g. the guests are chatting with a family member while the cook is setting the table, the parents are washing up dishes on a weekday night, while children are doing their homework), as envisioned in Figure 70.

An aggregate view of connections between defined spaces can help determine divisions, adjacencies, and level of openness (Figure 71). Regions that have several quick access connections, and no disconnections, could easily be subsumed into the same room. Regions that have several visual connections, and no disconnections, could be in the same room, or be part of an open plan. Regions that have several disconnections, such as sound (e.g. I don't want to hear the TV when I'm cooking), might best be separated by solid or partial divisions, but if quick access is still required, room adjacency may be recommended. Where conflicts occur, the users could have the options of prioritizing (e.g. increased social time with guests is more important than hiding the mess; the time that sound needs to be blocked is relatively minimal), going back to consider other scenarios

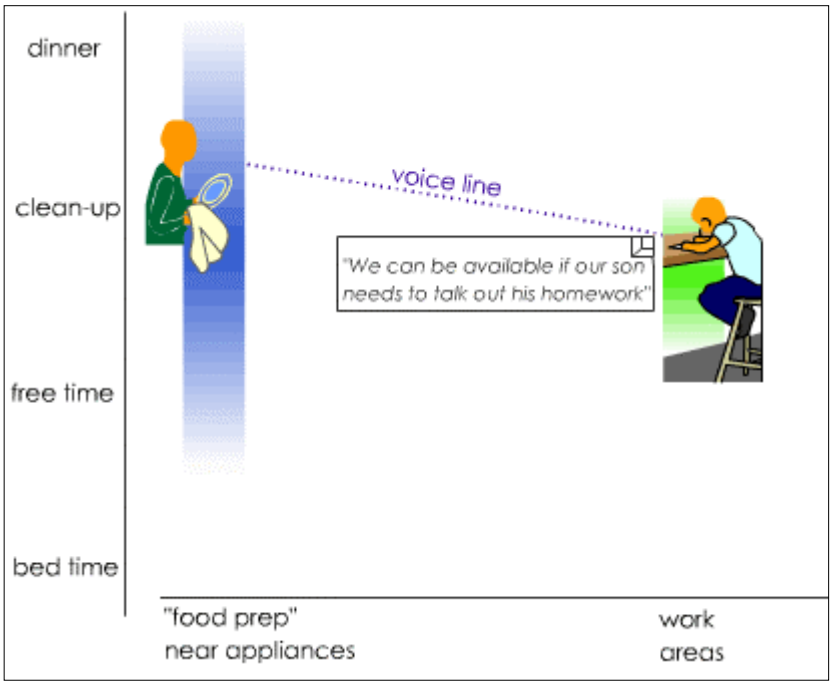


Figure 70. Conceptualization of an interface for identifying overlaps in activities in time and space and setting desired sight, sound, and access connections between them.

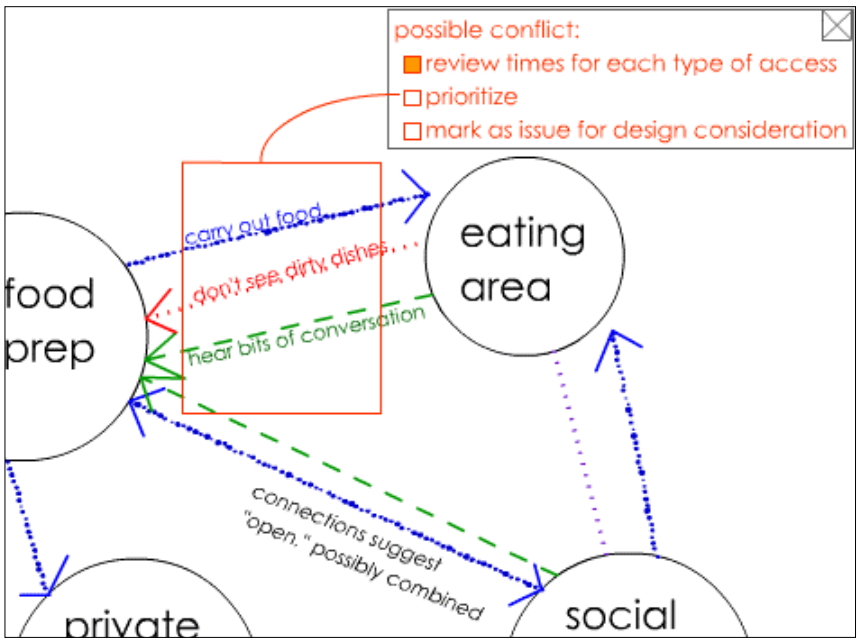


Figure 71. Conceptualization of an interface for examining aggregate connections between dedicated spaces, with options available to address conflicts.

that play out across space (e.g. a party *and* a holiday dinner *and* the breakfast routine) to accumulate more evidence, or going forward with the conflict, letting experts or expert systems look for a best match (e.g. slide-away partitions).

Pre-design to Design

The use of each tool may transition to an intermediary decision stage, where homeowners explicitly decide how what they've learned about themselves should inspire initial design solutions. The order that decisions are presented may be dictated by which issues and ideas are identified through the use of the pre-design tools, assuming that homeowners will want to engage first with that which they have expressed an interest in and an understanding of. The in-context questions lead naturally into decision-style questions, with choices about a future home correlated with the more concrete awareness-type questions that have been answered within the current home. The field kit may help to identify a path of decision-making, for example by most frequently used elements or spaces, as well as identify issues or decisions that the data can elucidate, such as openness between rooms or relative placement of elements. Work with the reflective and constructive interfaces may produce concrete decisions (via the concepts), partial spatial-based ideas (via the concepts and components), selected aesthetics styles (via the image sorting), and issues of interest connected with decisions (via each of the interfaces). Finally, the scenario time-space tool can contribute both specific decisions based on individual steps (e.g. inclusion of a secondary refrigerator) or conflict identification, and sometimes resolution, for room segregation, adjacency, and level of openness.

Each tool may also provide more implicit evidence it has collected about the user that can be matched with design-linking rules (e.g. "preference for these images implies preference for style xyz") or with data about other users or designers (e.g. "this person is like…") that have been used to train design-selection algorithms. Although these approaches imply a level of automation, which may seem mysterious to the user, they could alternatively be employed to mirror back preferences ("you may like…") or solutions that could concentrate the user's more explicit investigations or trigger investigation ("why did it think I would like that?"), if coupled with a reasonable method to trace the system's assumptions or experiment with changes to input. Williams (2003, forthcoming) has proposed critics for the design stage that use machine learning to

represent professional designers' tacitly held expertise; these critics are trained through ratings on examples to respond to new designs in a consistent way. Similar machine learning techniques may be used to represent a user's perspective, not just for component placement in plan view, but also for responses to images, or elements within images, and selections among qualities and concepts. These critics could represent a more dynamic externalization of the user's preferences and values, and even if significantly error-prone, could inspire investigation and conversation. Family members might each develop their own "critics" and apply them to each other's selections, as a potentially less confrontational way to compare and contrast perspectives (one could always argue that the critic wasn't really representative).

Application to Customized Apartments in Development Housing

Customization made possible through component architecture and a technologically-mediated system of design tools will likely be realized first, on a significant scale, in leased or owned units within multi-family residential developments (Chien & Shih, 2000; Larson, 2002; Lawrence, 2003). These apartments will be marketed to clients who otherwise would have had limited opportunities for a customized home. Although constrained to the design of the interior space and using a restricted palette of developer provided options, customization could apply to inclusion and placement of wall and storage components, placement and selection of kitchen and bath layouts, appliances, interior finishes, lighting, furnishings, entertainment systems, and information systems, representing hundreds of individual decisions.

The developer may see value in offering customization, but will tend to limit options if the process of decision-making requires extensive guidance, inspires problematic alterations late in construction, or fails to satisfy the inhabitants on completion. As exemplified by Neil's experience, described in chapter 3, while customization has the potential of producing a better match and giving the homeowner a sense of empowerment, its failed execution can leave clients more disappointed than if they had simply purchased a generic, pre-built home. So there is risk in offering customization, without addressing how the client will achieve meaningful personalization.

Figure 72 Custom apartment plan by Kent Larson (2003), two-bedroom layout, large kitchen with "parlor" sliding doors between spaces.

Figure 73 Custom apartment plan by Kent Larson (2003), enclosed kitchen with open dining and living space, office that converts to guest room, and make up desk in master suite

In initial efforts, developers may choose to offer a few pre-designed base plans, representing variations in layout, number and type of rooms, and degree of openness or segregation, that are functional and anticipate a range of broad lifestyles (singletons versus families). The initial paring down of plans may come from simple constraints that homeowners can provide without extended reflection, such as budget range and needed number of bedrooms. From there, homeowners would need to determine which individual customizations they would request to make their apartment personal.

Based on the interviews, I would expect that a homeowner's typical response to this task would be to research all options, begin making decisions as dictated by the construction deadlines, and reach a point of decision burn-out, with whatever is remaining kept as default. Homeowners will have difficulty with the combination of elements and may tend to gravitate to plans that seem familiar, either because they are similar to their current space or to a stereotyped idea of the home, and therefore seem more meaningful. Relatively late in the process, family members may suddenly express dissatisfaction with elements and request fragmented alterations in an attempt to have a better sense of control over the process.

The challenge here is to make the most of constrained customization, while managing a large number of chained decisions. A straight presentation of options will require the homeowners to mentally compare, filter, and combine. They may draw on provided expertise or recommendations, but fail to make personal connections, if design decisions are kept separate from their interior models, experiences, and preferences. Tools for pre-design should help them break down the task, determine a path of decision-making, express a combined family aesthetic, organize decisions around goals, and situate themselves within the design. To achieve these actions, the homeowners need to appropriate a model of the design process, uncover issues that are meaningful and important, identify and elaborate personal aesthetics, understand how and when design impacts behaviors and life patterns, and see themselves in relationship with their home environment. Fortunately, they have the resources, in their current environments and in their personal models and responses, to make these connections with design, provided they are placed in a position of participation, reflection, and investigation.

The tools I have proposed can be applied to the more constrained problem of custom apartment design, with example applications as follows:

1. Questions-in-Context:

   This tool could be particularly helpful for determining a path of decisions that is neither overwhelming, nor arbitrary, prioritizing decisions for which the homeowners will have easily recalled referents from recent experience. Homeowners may answer activity or location-triggered questions about the physical and psychological experience of their current space, determining the attributes that matter to them for features such as flooring (e.g. "do you like to walk in bare feet?") and storage (e.g. "does segmented storage help keep you organized?"). Skipped questions or questions that are not triggered by activities from the week can be de-prioritized, filtering decisions to be relevant to the homeowners' particular lifestyle and interests. The process should remind them that their current home is a resource and help them uncover evidence of their preferences and needs. Rather than answering how they feel they "should," or with unchecked acceptance (i.e. anything is good), they can observe their perceptual responses and reason about relevant resources and behaviors.

2. Field Investigation Kit:

A straightforward use of this tool would be to determine which rooms, appliances, and other items are used with such frequency that additional decision-time and budget should be devoted to them. For a custom apartment, devoting significant space to a particular room may require adjustments to others, so determining where family members will likely spend their time will be important. Data patterns may also be transplanted to the new plan, as a hypothesis of projected use. Particular investigations could include room scheduling (e.g. if the family currently has two bathrooms and is considering one, to what extent will schedules have to be adjusted?) and concurrent activities (e.g. at the times we like to work, are other family members nearby, watching TV? Is a closed-off work area needed?). Homeowners can begin to map activities to new locations (e.g. reading in the formal living room in our current home can be done in the study in the new apartment), to get a better sense of how they will adjust to what may often be a more compact space.

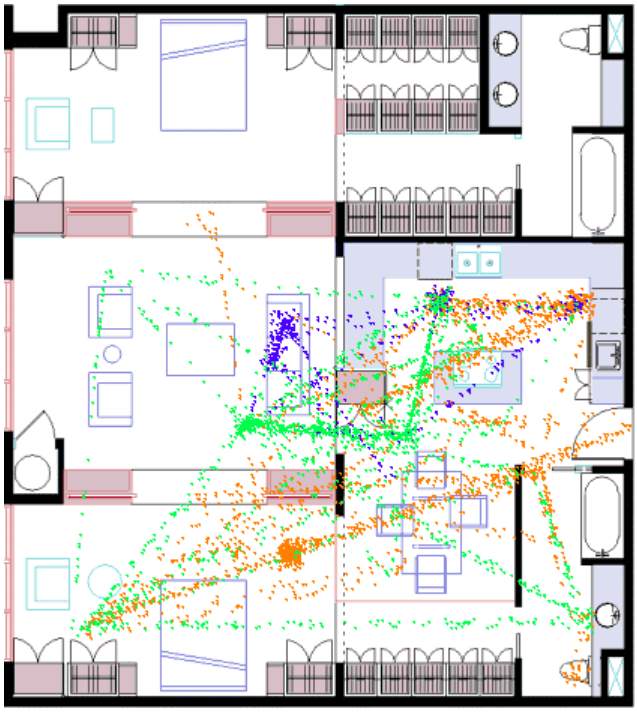


Figure 74. The evening activity pattern of Susan's family, transplanted to an apartment plan.

3. Reflective and Constructive Interfaces:

The visual integration of dozens of options, including surfaces, detailing, lighting, and structural elements, is difficult for homeowners, and typically may be done in a piecemeal fashion, using visual images simply as a way of specifying "this is what I want" without reflection or experimentation. The more involved process of image sorting can help family members define an

abstracted personal aesthetic (e.g. open, warm colors), while determining specific conditions (e.g. must have light) and compromises (e.g. minimalist okay, if there are places to add personal items) that can help them cope with the more restricted options of a custom apartment. They may even begin with a general set of images that don't necessarily represent options they will have; in this more open process, they can develop a set of criteria that may help them evaluate and create with a more limited palette, without worrying too soon about what can and can't be done. As they begin to identify a more directed aesthetic, images that include available surface and detailing options or that represent examples of other custom apartments in the development may be introduced. A final interface may present the visualized combination of options identified through sorting for final modifications.

Mental maps could help identify salient structures and options within the home, and identify issues of concern that could be specifically met with the new apartment. When presented with a plan view, or even a 3D rendering, it's difficult to identify what will have more "perceptual weight," directing the homeowners response due to physical or symbolic presence. Homeowners armed with an awareness of how their mental representation of their home may differ from the straight reality can be more focused on both salient and defining ("this has to be here or it's not my home") features.

The partial idea expression interface provides the opportunity to address a large number of decisions quickly, through sorting and structuring concepts, the most concrete of which could apply to actual options within the apartment, such as "walk-in closet" and "sub zero" refrigerator. Some concepts, along with the quality words and activity cards may continue to be unconstrained, encouraging broad framing and reinterpretation (How can "spacious" be applied to a more compact apartment? Is there a way to accomplish the perception of raised ceilings?). While homeowners would likely become frustrated with sketching or assembling the entire apartment, they could be invited to express partial relationships with wall, storage, and furnishing components, elaborated with placement of people, activities, and portable objects, for focused areas, such as a socializing area, eating area, or work area.

An expert or expert system can try to build on or match some of these ideas to actual plans. The homeowners can also be encouraged to use techniques for "making sense" of their partial ideas to evaluation of complete designs.

4. Scenarios in Time and Space:

While the positioning of some rooms may be constrained in the plan, for example the kitchen and bathrooms may be anchored to a wet wall, the division of the remaining space, with wall and storage components, may be the most powerful, and challenging, opportunity for customization in an apartment space. This tool should help homeowners make decisions about divisions, adjacency, and openness without having to deal directly with spatial components. Instead, they would work with the staging of scenarios, both representing current and projected patterns; in a sense, focusing on the interiors and transitions, rather than the boundaries and connecting space. Material generated from the first two tools may also benefit the homeowners here. Questions answered with the questions-in-context tool, such as "can you hear the TV in the other room?" may prime homeowners to be thinking about visual, sound, and physical connections. Sensor data may provide evidence of concurrent activities and traffic patterns. The scenario sets themselves should help situate the homeowners in the design, making it less about the space, and more about what will happen there.

If a more traditional approach is applied, combining an analytical decision-making process, better matched for discrete consumer decisions, with gut reactions driven by unexamined ideas of home and self-image, it's highly possible that the result wouldn't be cohesive or represent strong personal goals. A pre-design process of the type I propose would instead suggest a mindset of laying down hypotheses, investigating, elaborating, compromising, and prioritizing to focus decision-making around actual experiences and beliefs. Such a process will likely require a more extended period of preparation, will challenge the homeowner to be reflective and expressive, which may be unfamiliar or uncomfortable, particularly in working with other family members, and will not always result in simple answers. Success doesn't require the perfect apartment or customization on every possible element. If my assertions are

correct, use of pre-design tools should be associated with differences in how homeowners describe and perceive their home (as belonging to them), homeowners' comfortable level with sharing and showing their homes (as representing them), and homeowners' willingness to continue to reflect on their relationship with their home environment and experiment with modifications to their space and routines.

Next Steps

This work is largely about how to understand, reinforce, and build on the aspects of design that are personal. Consistent with this theme, I have chosen to use the first person in the writing of this text, acknowledging that it has foremost been a personal journey for me, learning from homeowners about how to explore and engage with design. I hope this makes the text more readable, while reminding that any "side effects or distortions" are in my interpretation.

This research derives its benefit from reflecting the thought processes and experiences of actual homeowners, trying to make sense of their connection with design. The judgment about the success of the approaches they tried must necessarily take into account their existing abilities to appropriate and reflect. The homeowners represented here are uniformly well educated, financially secure, and self-selected as individuals eager to learn more about and contribute to design. Rather than find methods that changed them, I may have found methods that resonate with the way they change themselves. Whether such methods can also assist homeowners who are less equipped to approach design, due to lack of familiarity or confidence, should be a source of future investigation.

Several of the difficult requirements of design were underrepresented within my study. Although the individual participants were able to comment on what they would do to come to compromise with partners or family members, only one couple actually participated together, a pair of individuals who seemed well matched in temperament and perspective. Whether externalizing different perspectives using materials and approaches such as the image sorting, in-context questions, wish lists, and collage, can give each member a sufficiently involved role and help with conflict identification and resolution, needs to be studied with multiple couples and larger families (including children and teens) whose members relate to each other in different ways.

To take homeowners from an open-ended, creative and reflective process, all the way to decisions based on highly constrained options, as represented by the custom apartment example above, is a more involved problem than could be adequately addressed here. Future work should ideally be coupled with early efforts at providing options for homeowners; how do they find meaning in limited options and accept the many cycles of prioritization that will help the accept a more constrained solution? As recommended above, the homeowners' perception of their resulting apartment should be juxtaposed with use of traditional approaches versus the kinds of tools and process that I have proposed.

Most work on design tools has focused on developing computational intelligence. Fischer (1998) and Nakakoji (1993) have started to link the use of these smart tools with the actual human design processes that need to occur. While a major goal of my work has been to elevate the personal knowledge that homeowners already have and acknowledge the importance of design appropriation, I fully expect that homeowners at some point would need to draw directly on expert advice to produce workable designs. As Bonnardel and Sumner (1996) noted, novices often tend to be overly compliant with expert rules, burying their own ability to evaluate and create. A more complete test of whether homeowners are "primed" for design after going through a stage of pre-design, would be if they continued to play an active role when given expert advice, questioning rules, developing their own evaluation techniques, refining proposed designs.

I would like to see how these approaches map to other domains, including those that have acted as sources of inspiration, such as workplace design and healthcare; even something like wedding planning, which has similar challenges of achieving varied personal goals within budget constraints and in the face of a multitude of options, would be an interesting comparison.

The work here with having homeowners reflect on data about their home activity patterns is really in a pilot stage, and I hope will lead to more in depth investigations of how to involve participants in interpreting everyday activities, from a research perspective, and how to involve home inhabitants in planning their own interventions, whether spatial or behavioral, from an applied perspective. Much work needs to be done to find ways to present data that is meaningful, that is recognizable,

and yet that encourages further investigation. Directed research may try to determine how homeowners can identify (or fail to identify) their own data, get homeowners to express and test their own hypotheses, and over a longer period, focus on how homeowners may change their behavior or environments in response to their new level of awareness.

The Product of a Custom Home Design Process

In their famous study of personal control, Langer and Rodin (1976) implemented two experimental conditions on separate floors of a nursing home. On one floor, residents were told that the staff wanted to make their lives fuller and to do so would provide them with a nice environment, give them plants that would be taken care of for them, and schedule them to attend weekly movie nights. The residents of the other floor were told that they had the responsibility for making decisions and caring for themselves. Part of the message they heard included:

> You should be deciding how you want your room arranged – whether you want it to be as it is or whether you want the staff to help you rearrange the furniture… It's your responsibility to make your complaints known to us, to tell us what you would like to change, to tell us what you would like. (p. 194)

The results were striking: the residents in the responsibility condition reported being happier, were observed to be more alert, healthy, and involved by staff members blind to the experimental conditions, and 18 months later, actually had a lower *death rate* than the comparison group (Rodin & Langer, 1977).

What is central to the theoretical traditions of reflective practice, constructionism, and participatory design, and that is consistent with what Langer (1997) calls "mindfulness," is the belief that the practitioner, the learner, the client, the person, is best served by being intimate with her own thought processes, behaviors, and environments, and confident that she can exert influence over her own life through experimentation and participation. What begins with being active in making decisions about custom design, can continue in the design of one's own intervention strategies and reflection about living patterns - and the important piece of this is not the personalized, high-tech home, but the involved inhabitants.

If a million more homes are custom built that ordinarily would have followed the decades-old blueprints for suburban development, it may be that they are no different from what we have seen before, not in any significant way, from a design perspective. It is no secret that people seek out the familiar, especially in areas that have so much to do with feeling safe and nurtured, and maybe the average, for whom so many houses have already been built, is not that different from most of us after all. This may be the case, and though it would surprise me, it wouldn't change my belief that *personal,* homeowner-driven custom design, for all its challenges and obstacles, is a worthwhile goal - because the one million homes might be no different, but the one million homeowners would be.

Appendix A: Pre-design Exercises

Exercises follow a basic format, which includes a main task, extensions to the task, and options to construct more elaborate artifacts or share work with friends or other participants. Most exercises also have a preparation section. Each of the major sections is described below:

- Preparation
  a. Articulate expectations about the exercise.
     - e.g. what will be pictured in most images of kitchens, what kinds of questions will be asked in the questionnaires
  b. Make initial decisions about how to approach the exercise or generate basic content for the task
     - e.g. select a title to build a scenario around

- Basic task – generate and structure content (quickly) to have material on which to act and with which to communicate.

- Extensions
  a. Analyze and re-generate content based on different representations: using a different symbol system, descriptive structure, or unit of analysis
     - e.g. divide sketch into work areas, represent dynamic characteristics like traffic paths, use "bubbles" and connecting lines to represent adjacencies; instead of using narrative prose, trying a narrative list for scenario building
  b. Analyze and re-generate content based on different perspectives: separate out and externalize "hidden players" – "resale", "the past", "the future", "my spouse."
     - e.g. sort images according to "what my parents would have chosen"
  c. Identify criteria for evaluation by adding constraints or labeling categories

- Construction – shift the audience (from self/expert to another homeowner) and develop materials that can educate or serve as tools for other people, and by doing so, become designers of the exercise itself
  - e.g. create a tour or category that illustrates a concept for another person; devise scenarios that other homeowners should consider; create a symbol toolkit for assembling a kitchen diagram

- Sharing
  a. Separate, model, and compare perspectives between friends or family members
  b. Share content as examples for other homeowners ("this is my perspective," "this is what I created") or their process method for other homeowners ("this is how I did it").

1. QUESTIONNAIRES

Fill out traditional needs assessment questionnaires – by answering questions, form a description of what you need and value

preparation: Before you look at the supplied questionnaires, try listing the type of questions you expect to be on the checklists.

basic task: Select and complete one or more questionnaires

extensions:

- Using the supplied question envelopes, tape questions around your kitchen at the designated locations. As you use your kitchen over the next few days, try jotting down answers to questions posted where you are working.
- Write down a questionnaire code and question number (Y3) to identify questions that
    - are unexpected or thought-provoking
    - that you don't know how to answer
    - that you think you may not answer accurately (maybe not what you really do or what you really need)
    - that are ambiguous or context dependent (you might have different answers depending on what time of year you are referencing, what time of day, who's using the kitchen, why you are using the kitchen, etc.)
    - would be answered differently by different members of your family
    - you think you may answer differently in five years, in ten years

construction: Create your own questionnaire, selecting questions from the questionnaires and/or adding your own. If you were helping another person to design his or her kitchen, what questions would you ask? Think about ordering and grouping.

- Where would you want to start?
- Which questions naturally lead into others?
- Which questions restrict or affect other questions?
- Should questions be grouped? Should some be optional?

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sharing:

- If you are doing this exercise with a friend or family member, try answering as the other person and comparing responses.

- Trade questionnaire responses with another participant – are any of their answers surprising?

- Provide your constructed questionnaire to another participant – do you have any ideas for them about their new kitchen based on their responses? Did they answer any questions in a way you didn't anticipate?

background:[18] Questionnaires and checklists are omnipresent in home design books (e.g. The Complete Guide to Kitchen Design with Cooking in Mind, Silvers,1994) and web sites (e.g. AARP Universal Home, http://www.aarp.org/universalhome/) and represent the common conceptualization of the dialogue between client and design professional. Their structured and text-based qualities have made them the first choice of many design software programs (e.g. Duarte, 2001; Ma, 2002; Nakakoji, 1993). As discussed in chapter 2, Negroponte (1975) noted that though they are ostensibly user-centric, questionnaires can be overly controlling. As questionnaire content and frameworks can be quite different, three questionnaires were provided to participants, from Home Depot (http://designcenter.homedepot.com:8001/), the popular design book Kitchens That Work (Edic & Edic, 1997), and the more philosophical design book The Place of Houses (Moore, Allen, & Lyndon, 1974).

[18] The *background* section was not included in the instructions sent to participants.

2. IMAGE SORTING

Sort images of kitchens into categories – by categorizing examples, understand your preferences.

preparation: Jot down some notes about what you expect to see in photos of kitchens. What will be common? What might be missed? What will attract you?

basic task: Sort images into "I like/I don't like." Each image has a number on the back – every time you sort the images, list the categories and jot down the numbers in order to record your groupings. (e.g. "I like" : 7, 9, 2, 1; "I don't like": 3, 6, 13)

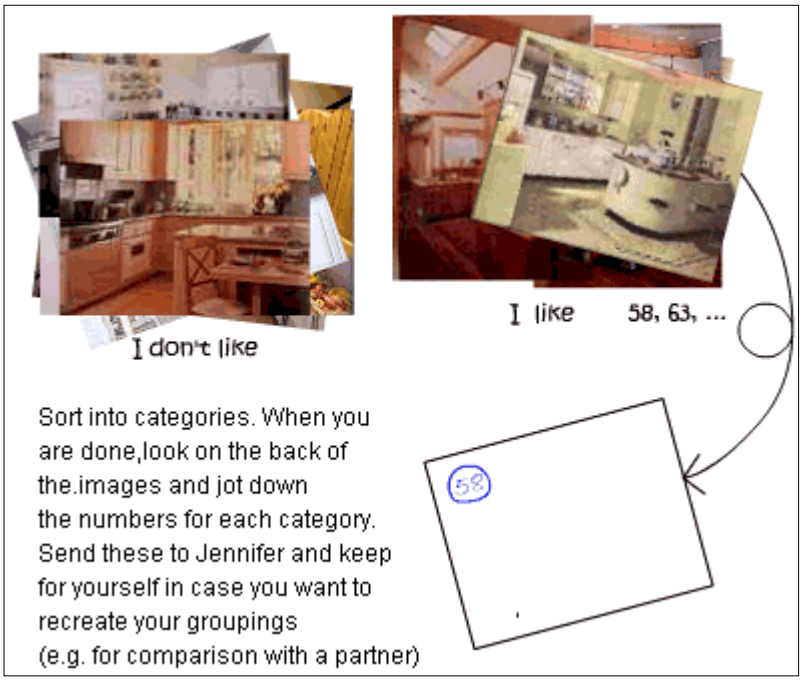

Figure 75.

extensions:

- Sort images into
  - "my parents would have chosen"
  - "a typical American family would like"
  - "I would have liked 10 years ago"
  - like aesthetic categories (can name or simply group), e.g. "traditional," "modern" or just "all these kitchens fit into the same aesthetic category"
  - like budget categories (economical, average, high-end, luxury)
  - like functional categories (kitchens that are good for x), e.g. "these kitchens are good for party preparation", "these kitchens are good for people who like to cook"
  - (additional categories? contribute one!)

- Select a few images that you find provocative or appealing and staple or paperclip each to a blank piece of paper. You can draw directly on the image and jot down notes on the attached page. Circle elements that stand out and affect your judgment about the image. Consider:
  - What are the safe decisions represented in this image?
  - Is there anything that is "unsafe" from a resale perspective?
  - Why was this image photographed in this way? What is it meant to suggest?
  - What did you notice only on closer inspection?
  - Are there qualities or elements that you recognize from your own kitchen? From your childhood kitchen?
  - Are there qualities or elements that are common in most of the images?

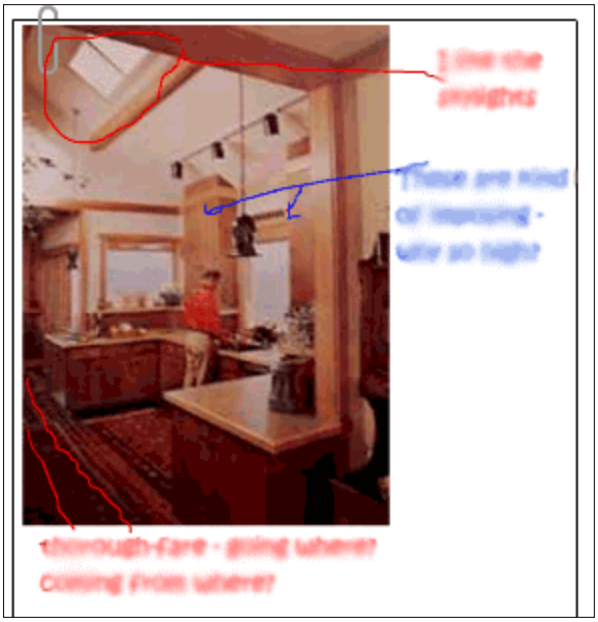

Figure 76.

construction: Create a "tour" through these images. For a tour, think about a topic you would like to introduce – a particular aesthetic look, a type of decision to be made, or something other people might like to know about the kind of kitchens that are available – and select and sequence images, adding captions if desired.

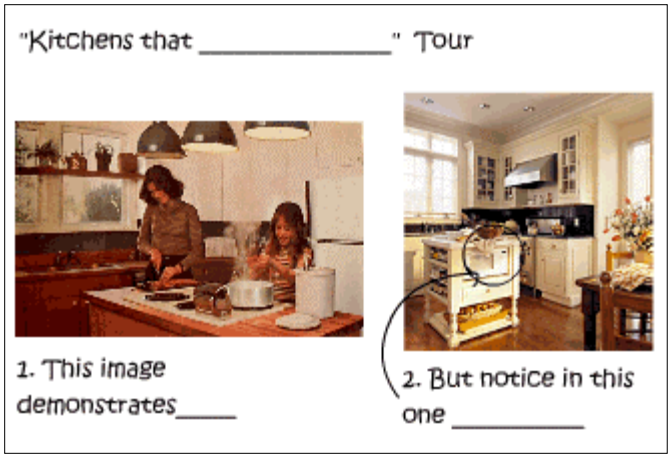

Figure 77.

sharing: Try sorting images according to how you think your friend or family member would respond, then compare results. Offer to share some of your groupings with other participants (e.g. do others share your belief about what the typical American family would like?)

background: This exercise is inspired by the collecting clippings procedure that many design books advocate and that was prominent in the homeowner interviews (see chapter 3).

3. REFLECTION

Reflect on what meaning the kitchen has for you, examining your possessions, recalling childhood memories, and recognizing cultural assumptions.

basic task: (adapted from Clare Cooper Marcus's House As Mirror of Self) Find a quiet place to work and have paper and felt pens or crayons ready. Take a few deep breaths and close your eyes. When you are relaxed, open your eyes and put down a symbol of what your home or kitchen means to you. Start with whatever core image comes to mind. Put this in the center of the page, and then continue with whatever other images, colors, shapes, or words emerge.

Notice if any other homes or dwellings flash through your mind as you do this – a grandparent's house, your friends' home, a home from a favorite movie. Note which room or image or word seemed to trigger that memory.

Be aware of any sensations in your body as you do this. Are you conscious of any feelings of warmth or sadness, any sensation of relaxation or tension?

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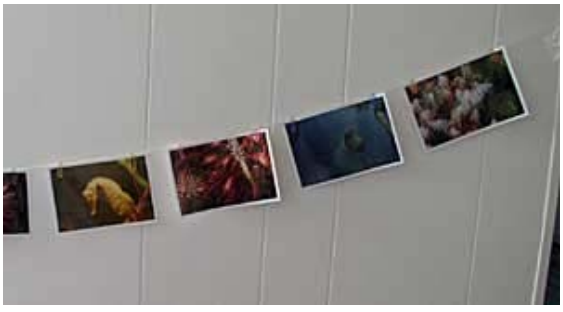
extensions:

- Write a description of your kitchen for someone who has never seen it.
- What are your favorite objects in your home? You may want to photograph them, print the photographs, and annotate them. What do you like about them? What do they say about you?



- Do a quick inventory of your kitchen and group items into categories. What do these items tell you about the kind of cooking you do?
- What was it like in your childhood kitchen? What smells, sounds, and sensations do you remember? If possible, try to find some photos of your childhood (or grandparent's) home and kitchen and write down stories that you remember (create a "genealogy of family places"). Call your parents or siblings and ask them what they remember about your childhood kitchen. How is your current

kitchen like your childhood kitchen? How would you want your new kitchen to be like your childhood kitchen?

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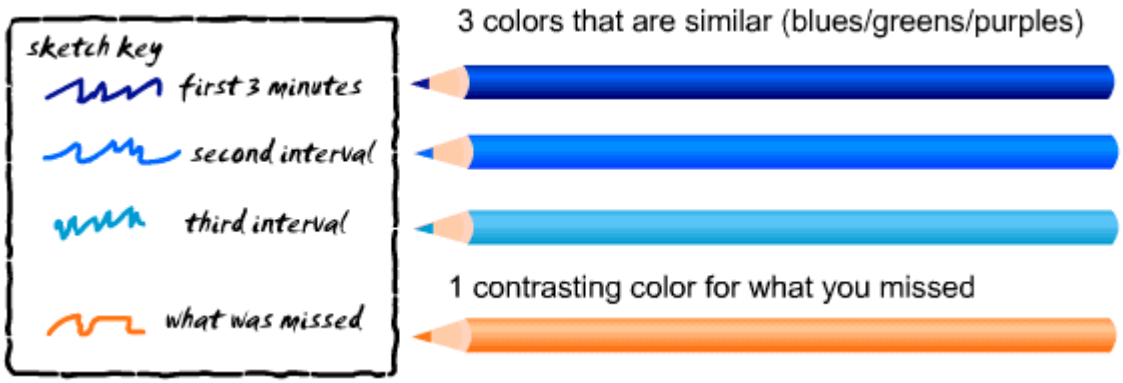
sharing: As suggested above, if you feel comfortable doing so, you may want to ask parents or siblings to give you their recollections of your childhood home. Are there particular routines that the family had? Family dinners, baking cookies? Can they remember a particular event that took place in the kitchen? If you are working with a spouse or partner, compare your idea of home and the kitchen, are there significant differences? What words do you each use to describe a kitchen? Share your kitchen description (extensions above) with another participant – can they visualize your kitchen?

background*:* The main procedure for this exercise is based on one offered by Clare Cooper Marcus in her book, House as Mirror of Self (1995). Cooper Marcus employs reflection on the home as part of a therapeutic process. The symbolic significance of possessions, particularly as they reflect projections of personal identity, have been further studied by Csikszentmihalyi and Rochberg-Halton through interviews with 80 families, described in The Meaning of Things: Domestic Symbols and the Self (1981). Akiko Busch (1999) and Witold Rybczynski (1987) both write about the cultural and personal significance of the home and the concept of "comfort." Teens have used virtual representations of homes and objects to express issues of personal and cultural identity in the digital community, Zora (Bers, 2001).

4. SKETCHING

Sketch in plan (bird's eye) view to understand the relationships in your current kitchen and envision ideas for your new kitchen.

preparation: Without first examining your kitchen, sit in another room and sketch what your kitchen looks like. It's generally easier to do this from a bird's eye view (looking from above). Don't worry about exact measurements. To keep track of the order that you add details, use the colored pencils provided. Have a timer or watch sitting nearby and work in 3-minute intervals. For the first 3 minutes, use one color, then change colors for the second 3 minutes and the third 3 minutes. Then go look at your kitchen and look for elements that you may have missed. Add these in with the 4th colored pencil. On your sketch, please include a "key" indicating which color you used for each interval.



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basic task: Look at your sketch representation of your current kitchen and label what you

- Like and don't like
- Want to keep and want to change

Now try to sketch your new kitchen, either by modifying your current plan or starting from scratch. Try not to worry about issues of scale or precision – your sketch can be quite rough.

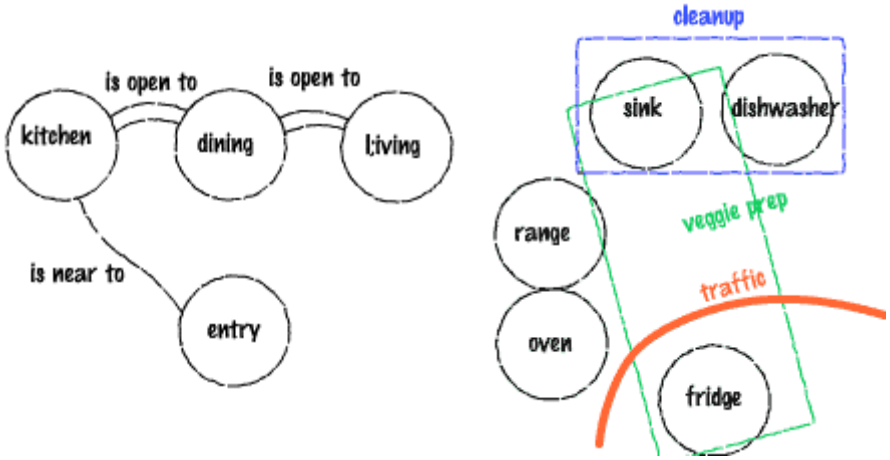
extensions:

- If you didn't originally, add adjacent rooms, a path to the grill, a path to the trash, a path to the garage.

- If you didn't originally, add in "traffic paths" in your current plan and your new kitchen plan - Where do people enter the kitchen? Exit the kitchen? What path do they take to walk through it? Do you need separate paths for different tasks – "just walking through," "getting a snack from the fridge," etc.?

- If you didn't originally, divide your current plan and your new kitchen plan according to work areas. What areas are used for cleaning dishes? What areas are used for basic meal preparation? Baking? Socializing? Leaving messages/communicating?

- If you found the sketching frustrating, try it using a different kind of representation. For example, label circles as rooms (living room, dining room, kitchen, etc.) and connect them with lines to indicate adjacencies (does the kitchen connect to the dining room?); use a similar approach to sketch relationships between appliances or work areas (cleaning, baking, cooking, messages) in the kitchen.



construction: Propose elements for a 'cut-out' kit for kitchen assembly. In addition to appliances, counters, and cabinets, are there other objects that should be included? How do you represent dynamic qualities like traffic or work patterns? Other qualities or elements? What instructions would you include?

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sharing: Ask another family member to sketch the kitchen as you did in the preparation section. What did he or she remember that you did not? What did he or she draw first? What seemed to be the most important component of his or her sketch? Share your new kitchen sketch with another participant for comment. Recommend your cut-outs for a 'kitchen assembly and sketching kit.'

background: Sketch-style representations are well established in the formal field of architecture and therefore are a mainstay of home design. The idea of interpreting "mental maps" for significance of how a space is used and perceived was memorably explored in Kevin Lynch's Image of the City (1960).

5. SCENARIO BUILDING

Describe what you do now and what you think you will do in the future for the provided scenarios.

preparation: Determine which of the following scenarios look interesting and jot down a few of your own:

- Your friends come over for an informal dinner.
- Your weekday morning ritual.
- You bring in groceries.
- The holiday that is most important or most elaborate at your house.
- You get up in the middle of the night for a glass of water.
- An older relative (with limited mobility) wants to help with a family dinner.
- The size of your family changes (you get married/have children/have children move out/have parents come to live with you).
- You want to make your diet healthier.

basic task: Select a few scenarios and describe 1) what you do now (or would do now if the scenario arose) 2) how you want the scenario to be in the future. You might want to think of these descriptions as "stories" about you and your family. While you are creating them, walk through the steps and consider the context, the people, the objects, the events, and the sensations. For example, for the "your weekday morning ritual", consider questions like: Where do you go in your kitchen? What do you have ready? What helps you wake up? How do you keep track of the time? Who else is in the kitchen with you? Do you leave messages for yourself? Other family members? How is your morning ritual linked to other events (getting dressed, shopping, dinner)? How do you clean up? When do you feel awkward? When do you feel supported?

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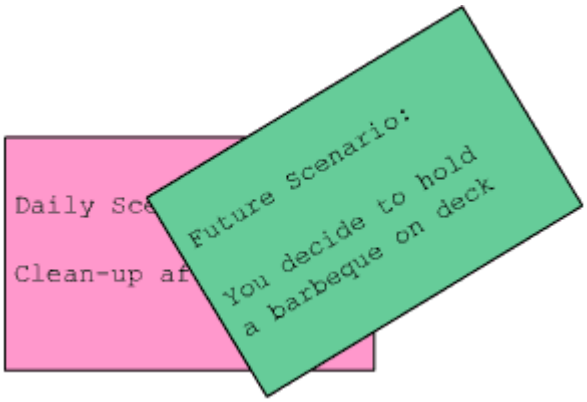
extensions: If you feel uncomfortable with describing or "story telling" the scenario, you might want to try creating a ten-point description. Here is an example of how two different people might describe how they like to experience a bath (from The Place of Houses (Moore, Allen, & Lyndon, 1974, p. 262), also see pages that came in packet):

1. sweep into the bath 2. be undressed 3. seek shelter from view 4. but be with another 5. be indoors, but at the edge of a terrain 6. be in a large space 7. be in a bright and open space with afternoon sun 8. be served by a giant tub surrounded by warm walls of wood 9. be tuned in to the sounds of others 10. and be hot	1. squeeze into a tub 2. be undressed 3. seek shelter from view 4. be alone 5. be indoors 6. be in a small space 7. be in a sheltered space 8. be served by a bathtub free of objects 9. be quiet 10. and be hot

The authors suggest making lists for each member of the house for each action of the day and joining them together, removing redundancies and resolving conflicts. You may want to try this approach for the above scenarios.



construction: Devise scenarios, depicting the present or future, that other homeowners should consider.

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sharing: Compare scenarios with a friend or family member – if they share your home with you, were there discrepancies in the accounts of what currently goes on? Do your "future scenarios" mesh? Share your devised scenarios for other homeowners.

background: The use of scenario construction is more common in commercial building design, and advocated in How Buildings Learn (Brand, 1994). Moore, Allen, and Lyndon recommended an interesting scenario-list approach for each activity in the home and each member of the family in The Place of Houses (1974), which was also provided as part of this exercise's instructions.

6. STORYTELLING

Tell a story about people who live in a kitchen depicted in the supplied photos.

preparation: Select an image from the image sorting task or the study web site and jot down elements that you first notice – the style, the objects on the counters, etc. Try to associate these elements with qualities (convenient, elegant, child-friendly), and group the qualities into possible lifestyles.

Figure 78.

basic task: Write a short story about the people who live here. You might want the story to be descriptive of them or their current situation (do the photographs tell a story about a moment in time?), to tell a sample "day-in-the-life," or to look at how their lives play out over several years (perhaps from the perspective of what the kitchen sees). What do they value? How do they use their kitchen?

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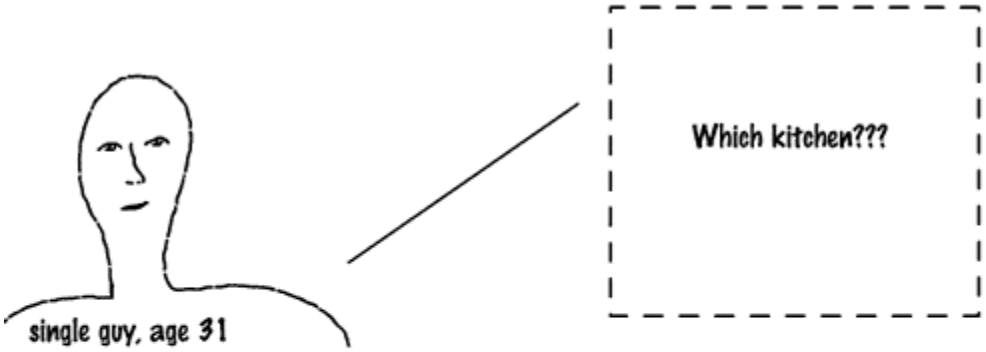
extensions:

- Try telling a story about a family who feels out of place or is inconvenienced in this kitchen – which family made a mistake with this kitchen? (it's helpful here to think about "war stories" you've heard from friends and family)
- If you feel uncomfortable with straight story-telling, try combining words and images (that you clip from magazines or find on the Internet). Try creating the action lists described in exercise 5.
- Create a typical dinner menu that has been prepared in this kitchen (what gets cooked here?)
- Try the reverse – collect images of kitchens (from magazines or borrow some from the image sorting exercise) and/or sketch a kitchen for a prototype family that you first describe (e.g. single man living in his first house who loves the outdoors…)



single guy, age 31
loves to cook
likes to make dinner for friends
forgetful when it comes to repairs
wishes he could be outdoors
is a public school teacher
loves the movie The Matrix

construction: "Create" some prototype families by describing them with words or images (objects they own, clothes they wear, food they eat, etc.) and select some kitchen images that might match up with the families – have a friend try the game of matching the family to the kitchen.

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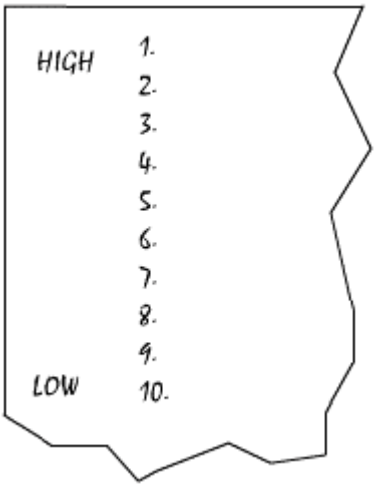
sharing: Have a friend or family write their own story – how do your two fictional families, evoked by the same kitchen, compare? What elements in the images resulted in the shared qualities between stories? What elements in the images were ambiguous, resulting in differences in the stories? Share your stories with other participants. Share your prototype family-kitchen matching game with the other participants.

background: The focus of this exercise is on what a living space projects about the inhabitants, the flip-side of exercise #3. Storytelling has been described as an example-based reasoning and learning approach by Jordan (1989), in her studies of indigenous midwives. Telling stories about people other than oneself by interpreting their living space is familiar to anyone who played dolls as a child or The Sims (creator Will Wright, software distributor Maxis) as a teen or adult. As exemplified in the interviews, adults also engage in this kind of story-telling home evaluation of friends' homes, particularly when engaged in their own home design project.

7. WISH LISTS

Create a wish list for your new kitchen; recreate it when you are given new constraints or opportunities.

preparation: Identify 20 elements or features that you might like to have in your new kitchen and write them down on a piece of paper, in no particular order. Circle 10 that you want for your wish list. List the numbers 1 through 10, on a separate piece of paper, leaving the slots next to the numbers open for your circled elements.



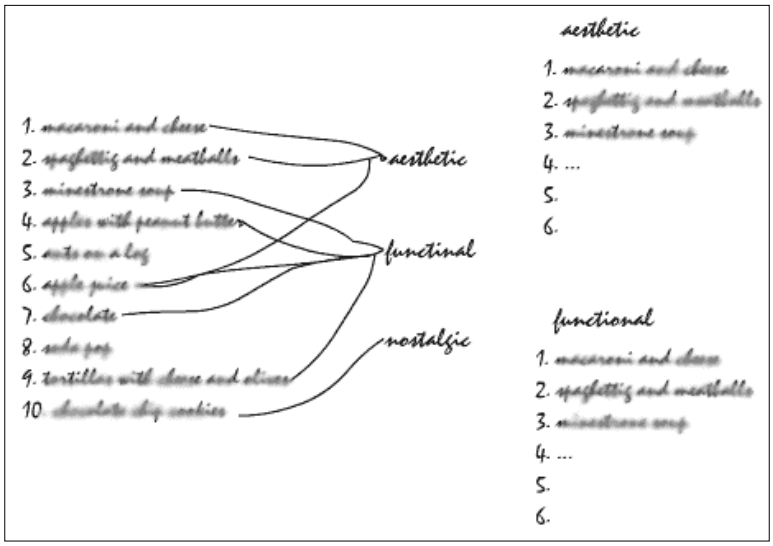
basic task: Create your wish list, with ordered items from highest priority (1) to lowest (10).

extensions: Evaluate and rebuild your original list for each extension.

- Assign one $ to *odd* numbered items and $$ to *even* numbered items. Imagine that your budget will permit no more than 10 "$"s. Rebuild your list within this constraint, removing items so that your total will be within budget.
- #3 on your list is unavailable/not possible –is there something (or several somethings) you could replace it with to achieve the same effect or function?
- Consider one of the following scenarios (that does not represent your current situation). Which items on your list would still apply? Would anything have to be removed?
  - An older adult (parent, grandparent) comes to live with you
  - A new child becomes part of the household
  - You have to economize on space
  - You can spend significantly less/more time cooking
  - TV/Movies/Video-phone can be projected anywhere, including on the surfaces of your kitchen
  - You will probably have to sell the home within 5 years/you will live here for the next 15 years

- Evaluate the type of elements on your list - are they qualities? Specific product choices? Materials? Functional spaces?
  Identify 2 to 3 categories by which you can divide your list, such as
  - qualities / features / layout elements
  - functional / aesthetic / nostalgic
  - needs / wants
  - for resale / for the family / for me
  - Others?

  You may even want to include a category that no items on your list match. If you could now have 5-10 elements in each category, what would you add? Complete the new lists.



construction: Create "event cards," ways of assigning "costs," and ways of evaluating the success of a wish list.

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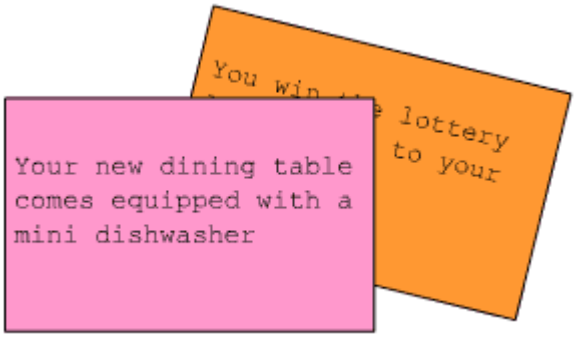
sharing: Compare your initial list with your spouse or partner's list, then join them into a combined list of 10 items. Share your event cards, cost assignments, and evaluation rules with other participants.



background: Homeowners often independently think to do this, though sometimes at a more general level than specified in the exercise. The requirement to recreate the list under new conditions mirrors a common practice in design games (Habraken, 1988) and is reminiscent of event-based board games.

8. PHOTOGRAPHIC INQUIRY

Use images to describe a day in the life of your kitchen and pinpoint issues or ideas that you want to explore.

preparation: Photograph your kitchen. A recommended approach in work observation studies is to first photograph significant objects or elements. Then "zoom out" to photograph the surrounding context of those elements. Finally, photograph boundaries of the area. You can also try creating a "panoramic effect" by photographing the kitchen so that the photos will join up in a line (see the supplied photos for exercise #6).

Figure 79.

If you are using a digital camera, print the photos and lay them out on a table. If you are using photos you already taken of the kitchen, paperclip them to a sheet of paper. You may want to use a felt pen for the annotation, so your marks will stand out from the photo.

basic task: Individually annotate the photos, circling elements and writing notes in the margins.

- What do you like? What don't you like?
- What do want to keep? What do want to change?
- What is "safe"? What is "unsafe"?

---

extensions/construction:

- "day in the life of" – create a photo journal of activities in your kitchen, print, and add captions

Figure 80.

- Create a guide to/tour of your current kitchen – imagine that you are giving a tour to dinner guests or creating a guide for someone else to use your kitchen. Using photographs, point out what your audience should notice, paying attention to the sequence of your tour/guide. Examine the tour - what are you highlighting? What are you leaving out? What kind of tour would you like to give of your new kitchen?

---

sharing: Have another family member annotate the photos, using a different colored pen. Share your tour or guide with other participants.

background: This exercise invites the participant to use their current space as a resource for thinking about design, is inspired by the visual anthropology tradition (Collier & Collier, 1986), and work by Frost (2001), described in chapter 5.

9. FIELD EXPERIMENT

Collect and reflect on simple sensor data and time-lapse images of your kitchen activities.

preparation: Email Jennifer to let her know you may want to try this exercise.

What kind of "experiments" would you want to run in your kitchen? Would answering the questions below help you understand what kind of kitchen you need? Can you think of additional questions that could be investigated using simple sensors, time-lapse photography, and experience sampling?

- Are there places of the kitchen that are overused?
- Are there places of the kitchen that are underused?
- Do you tend to work left-to-right or right-to-left?
- Do you tend to move around your kitchen in a clockwise or counter-clockwise direction?
- How often are you multi-tasking?
- How often is more than one person using the kitchen?
- How often is the kitchen being used for non-food processing tasks?
- What are the times of heaviest use in your kitchen?
- Are there some decisions, about what you want to see, hear, feel, that can best be answered in context?

basic task:

- **Simple Sensors**: Have investigators place simple sensors in your home kitchen. The sensors are small and can be placed in cabinets and appliances. When a cabinet with a sensor is opened/closed or a switch turned on/off, the time of the event will be recorded. After a several day period, the data will be retrieved by the investigators and visually displayed for your reflection.
- **Time-lapse photography**: If you are comfortable, we can place a "web-cam" style camera in your kitchen that can capture “time-lapse” images of the activity there. The images would be stored on your computer. Investigators would help group and display the images, as well as help make connections with the sensor data (based on timestamp).

- **Experience sampling**: Using a PDA (portable "pocket-size" computer) that we will loan you, answer questions about the way you experience space and what you would want for a new kitchen, in the context of cooking. The PDA will periodically remind you to answer questions relevant to where you are.

Throughout this process, you are free to ask that data be disposed prior to or following evaluation. You may also ask to see the raw data or images before the investigators do. Imagery that may identify you or family members will be digitally blurred for data storage.

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extensions: After this reflection, you may want to make suggestions about placement of the sensors, the nature of the sensors, and the display of the data, repeat collection and reflection may be possible, if scheduling permits. You may also want to come back to House_n to try the collage exercise, based on any new understandings of your space.

background: Background for this exercise is provided in chapter 5.

10. DESIGN YOUR OWN EXERCISE

Design your own exercise for needs assessment and preparation for home design.

Do you have an idea for an exercise that is not represented here? Would you like to combine elements of exercises to create something new?

To design these exercises, I drew on multiple sources:

- Interviews with homeowners (collecting clippings, working on sketches with architects)
- Advice from home design books (questionnaires, wish lists)
- Techniques for work environment design (scenarios, mental maps, time-motion analysis)
- Other examples of adult learning such as for healthcare (storytelling)
- Ethnographic techniques (photographic inquiry, reflection)

How do you go about understanding yourself and your environment? How do you learn to filter information, make decisions, and visualize alternatives? Think about what would works for you and how to capture it an exercise. Describe it or create it!

Appendix B: Experience Sampling Questions

1) Is this a good time for design questions?
    a) Yes (go to #2)
    b) No

2) Where are you?
    a) Major appliance (go to #3)
    b) Counter
    c) Storage area
    d) Eating area
    e) Other area (go to #4)

3) Which appliance?
    a) Sink/dishwasher
    b) Refrigerator
    c) Cooktop/range
    d) Oven/microwave
    e) Other

4) Which area?
    a) Family/living room
    b) Laundry
    c) Bedroom/Bathroom
    d) Other

5) Your main current task would best be described as
    a) Cooking or food prep
    b) Eating or snacking
    c) Top cleaning
    d) Deep cleaning
    e) Organizing or planning
    f) Other

6) Are you currently multitasking?
    a) Yes, but only on food prep tasks
    b) Yes, I'm mixing food prep tasks with other chores
    c) Yes, I'm doing multiple non-food prep tasks
    d) No, I'm working on one main task

7) Is there enough interaction with family?
    a) Yes
    b) No
    c) Doesn't apply

8) Do you have enough privacy?
    a) Yes
    b) No
    c) Doesn't apply

9) Is there too much noise?
    a) Yes
    b) No
    c) Doesn't apply

10) Why are you doing your current task?
    a) It's comforting or nostalgic
    b) I've been putting it off, and it has to be done
    c) To make other tasks easier
    d) Just general maintenance
    e) I'm experimenting
    f) Other

11) Do you feel organized?
    a) Yes
    b) No
    c) Doesn't apply

12) Are you in a rush?
    a) Yes
    b) No
    c) Doesn't apply

13) Could you use more space for what you are doing?
    a) Yes
    b) No
    c) Doesn't apply

14) What kind of view do you have from here?
    a) Not relevant
    b) Backyard
    c) Activities in the kitchen
    d) TV
    e) Family or friends in adjacent rooms
    f) Color, texture or surfaces
    g) The view is not important

15) Can you see the kitchen from here?
    a) Not relevant
    b) No, I don't want to see the mess
    c) Yes, I want the cook to have visual contact with people/activities here
    d) Yes, I want people here to be able to watch the cooking
    e) Yes, I want the cook to be able to do work here while monitoring cooking/baking

16) Can you quickly reach the kitchen from here?
    a) Not relevant
    b) Yes, to make it more convenient
    c) Yes, to enable multitasking
    d) Yes, to support social activities
    e) No, it would negatively impact the use of this area
    f) No, there's little or no need

17) Can you monitor the range from nearby areas?
    a) Not relevant
    b) Yes, just in case I am called away
    c) No, I never leave the kitchen while something is cooking
    d) No, I'm afraid it would encourage unsafe behavior

18) Can you hear the dishwasher when it is running?
    a) Not relevant
    b) Yes, it disrupts dinner or after-dinner conversation
    c) Yes, but I don't mind it
    d) No, we all go to other parts of the house
    e) No, it's quiet
    f) No dishwasher!

19) Could you hear talk from the family room?
    a) Not relevant
    b) Yes, it makes me feel involved
    c) Yes, and it distracts me
    d) No, and I feel excluded
    e) No, I'm protected from that distraction

20) Could you hear talk from the eating area?
    a) Not relevant
    b) Yes, it makes me feel involved
    c) Yes, it helps me coordinate serving meals
    d) Yes, and it distracts me
    e) No, and I feel excluded
    f) No, I'm protected from that distraction

21) Could you hear talk from where guests would be?
    a) Not relevant
    b) Yes, it makes me feel involved
    c) Yes, and it distracts me
    d) No, and I feel excluded
    e) No, I'm protected from that distraction

22) Have you had to improvise where you do work?
    a) Not relevant
    b) Yes, it was inconvenient
    c) Yes, but it was okay
    d) No

23) Do sounds from nearby rooms distract you?
    a) Not relevant
    b) Yes, from the TV
    c) Yes, music
    d) Yes, from other appliances
    e) Yes, conversations
    f) No, I don't hear anything
    g) No, I don't mind what I hear

24) Do you often leave your work area?
    a) Not relevant
    b) Yes, to the TV
    c) Yes, to talk with family/guests
    d) Yes, to get ingredients/equipment
    e) Yes, to simultaneously do non-cooking tasks
    f) No

25) Can you smell the aroma of food as it is prepared?
    a) Not relevant
    b) No, and I wish I could
    c) No, but it's not important
    d) Yes, but it is often off-putting
    e) Yes, and it adds to the experience

26) Has someone recently gotten in your way?
    a) Not relevant
    b) Yes, they were getting a snack/drink
    c) Yes, they were working on the meal
    d) Yes, they were talking with me
    e) Yes, they were trying to get to another room
    f) No

27) Is your main working area -
    a) Not relevant
    b) Cramped
    c) Too spread out
    d) Disorganized
    e) Just right

28) Do you often have to return to the same place?
    a) Not relevant
    b) Yes, some of my work areas need to be better distributed
    c) Yes, I need to better distribute equipment and utensils
    d) Yes, but I don't think it can be helped
    e) No

29) Do you have enough space for ingredients?
    a) Not relevant
    b) Yes, but I can't get everything out at once
    c) Yes, there's plenty of space
    d) No, but I don't leave ingredients out for long
    e) No, I would like more space for meal pre-planning

30) Do you often have to clear off space as you work?
    a) Not relevant
    b) Yes, and it's annoying
    c) Yes, and it keeps me organized
    d) No

31) Could you easily wipe your counter clean?
    a) Not relevant
    b) No, the surface makes it difficult
    c) No, it would take some work to re-arrange for cleaning
    d) Yes

32) Could you (chop, knead) directly on the counter?
    a) Not relevant
    b) No, but that would be convenient
    c) I wouldn't want to do so
    d) Yes, I could

33) Could you place a hot pan directly on the counter?
    a) Not relevant
    b) No, but that's okay
    c) No, and it might be a concern
    d) Maybe
    e) Yes

34) Is your counter surface visually appealing?
    a) Not relevant
    b) Yes, I like the colors
    c) Yes, I like the texture
    d) Yes, I like the pattern
    e) Yes, I like the shine
    f) No

35) Is anything in the way between appliances?
    a) Not relevant
    b) Yes, the island, counter, or table
    c) Yes, another cook
    d) Yes, other people in the kitchen
    e) No

36) Could you accommodate another cook?
    a) Not relevant
    b) No, we would bump into each other
    c) Yes, but it might be awkward
    d) Yes, there's plenty of room

37) Could another dish be prepared simultaneously?
    a) Not relevant
    b) No, there's not enough space
    c) No, the main appliances are in use
    d) Yes, but it would take some juggling
    e) Yes, it would be fine

38) How do you feel about how your kitchen looks?
    a) Not relevant
    b) I like the colors and patterns
    c) I like the textures
    d) I like shine / lack of shine
    e) I like the lighting
    f) I like the lines and shapes
    g) I don't like anything

39) Are odors and heat being adequately exhausted?
    a) Not relevant
    b) No, it's a little smoky
    c) No, the odors are too much
    d) Yes, everything seems fine

40) Can you clearly see what you are doing?
    a) Not relevant
    b) No, at times I have to strain
    c) Yes

41) Are the colors of food and tools sufficiently vivid?
    a) Not relevant
    b) No
    c) Yes

42) Are there any sources of glare?
    a) Not relevant
    b) Yes, the counters
    c) Yes, the floors
    d) Yes, from the windows
    e) No

43) Do you see any significant shadows?
    a) Not relevant
    b) Yes, on work surfaces
    c) Yes, near storage areas
    d) No

44) Is the lighting visually interesting?
    a) Not relevant
    b) Yes, it adds to the aesthetic appeal
    c) No, it has a cold or artificial feel
    d) No, pretty standard, but that's okay
    e) How can light be interesting?

45) Do you squint or avoid the light?
    a) Not relevant
    b) Yes, it's too bright
    c) Yes, it has an artificial quality
    d) No

46) Are the lights easy to change?
    a) Not relevant
    b) No, and sometimes I delay changing them
    c) Not really, but it's not too bad
    d) Yes

47) Do you see kitchen items with personal meaning?
    a) Not relevant
    b) Yes, that remind me of childhood or family
    c) Yes, that remind of good food or good times
    d) Yes, that express who I am/we are
    e) No, I don't have room
    f) No, I hadn't thought of it
    g) No, I don't need that

48) Where do you put together your grocery list?
    a) Not relevant
    b) I don't have a specific place
    c) On a white/bulletin board
    d) On the refrigerator

49) Do you ever leave out empty cartons or bottles?
    a) Not relevant
    b) Yes, to remind myself to get more
    c) Yes, I take them to the trash/recyling in one trip
    d) Yes, I forget to throw them out

50) Does your space seem cluttered?
    a) Not relevant
    b) Yes, but I like it that way
    c) Yes, I wish that would change
    d) No

51) Any counter appliances not used in the last month?
    a) Not relevant
    b) Yes, and I wish they were put away
    c) Yes, but that's unusual
    d) Yes, but that's okay
    e) No

52) Is your storage for tools
    a) Not relevant
    b) Specialized - spaces fitted for certain items
    c) Flexible - spaces where almost anything could go
    d) Good for small items
    e) Good for large items

53) Is your storage for ingredients
    a) Not relevant
    b) Specialized - spaces fitted for certain items
    c) Flexible - spaces where almost anything could go
    d) Good for small items
    e) Good for large items

54) Do you see reminders of your childhood kitchen?
    a) Not relevant
    b) Yes, my childhood kitchen is deliberately evoked
    c) Yes, I have unintentionally replicated aspects of it
    d) No, but I would like that
    e) No, I don't want to replicate it in any way

55) What information sources do you use?
    a) Not relevant
    b) Cookbooks
    c) Magazines
    d) The Internet
    e) The phone - to call friends and family

56) What types of messages are left in the kitchen?
    a) Not relevant
    b) Grocery list
    c) Mail
    d) Phone messages
    e) Reminders
    f) Greetings to family members

57) Do you use the kitchen for non-food related activities?
    a) Not relevant
    b) Family interaction
    c) Planning
    d) Hobbies
    e) Other

58) What kind of traffic do you get?
    a) Not relevant
    b) Frequent through-traffic which is fine
    c) Frequent through-traffic which is disruptive
    d) Occasional snack/beverage runs which are fine
    e) Occasional snack/beverage runs which are disruptive
    f) Very little traffic which is nice
    g) Not enough traffic

59) Are there items on display?
    a) Not relevant
    b) Yes, I like the memories they evoke
    c) Yes, I like how they look
    d) No, that would just add clutter
    e) No, but I would like some

60) Is it easy to invite family members to participate?
    a) Not relevant
    b) Yes
    c) No, there is not enough room
    d) No, it is difficult to divide up tasks
    e) No, they find it difficult to reach/feel comfortable

61) Do you wish you had more space for?
    a) Not relevant
    b) Large items
    c) Odds and ends
    d) Common use items
    e) I have enough space

62) Do you feel comfortable experimenting?
    a) Not relevant
    b) No, I just want to get it done
    c) Not right now, but usually
    d) Yes

63) Do you dread the clean up?
    a) Not relevant
    b) Yes, it takes too much time
    c) Yes, it's tedious
    d) No, it's worth it

64) Would you be comfortable if friends were with you?
    a) Not relevant
    b) No, the kitchen is such a mess
    c) No, it would be distracting
    d) Yes, I would love the company
    e) Yes, I wouldn't mind

65) How well do you recall how to make this?
    a) Not relevant
    b) This is the first time I made it
    c) Not well, but it's been awhile
    d) Not well, I can't visualize it
    e) Pretty well

66) Do you feel ?
    a) Not relevant
    b) Cramped
    c) Bored
    d) Supported
    e) Comfortable

67) Are there cues that remind you what to do next?
    a) Not relevant
    b) Yes, because I purposely arrange my workspace
    c) Yes, but I'm not sure how to deliberately make that happen
    d) No, I'm making things up as I go along
    e) I don't know

68) Are you working at a comfortable height?
    a) Not relevant
    b) No, I'm bending over
    c) No, my arms are at an awkward angle
    d) Yes, it's fine

69) Are your feet comfortable?
    a) Not relevant
    b) Yes, they're fine
    c) No, the floor is too cold
    d) No, the floor is too hard
    e) No, the floor is not clean

70) Does your upper body feel crowded or cramped?
    a) Not relevant
    b) Yes, the upper cabinets bother me
    c) Yes, the exhaust bothers me
    d) Yes, there are too many objects placed up high
    e) No

71) Would you rather be sitting down?
    a) Not relevant
    b) Yes, that would be more comfortable
    c) No, I'm moving around a lot
    d) No, I like standing

72) Are you generally following the same path?
    a) Not relevant
    b) No, but I like taking different paths
    c) No, I frequently have to navigate around
    d) Yes, I think so

73) Are you at any risk of burning yourself?
    a) Not relevant
    b) Yes, occasionally I have to reach near the heat
    c) Yes, occasionally I almost knock something over
    d) No, I feel safe

74) Is there anything you sometimes collide with?
    a) Not relevant
    b) Yes, the edges of counters
    c) Yes, the corners of cabinets
    d) Yes, the exhaust
    e) Yes, appliance doors
    f) No, not anything I've noticed

75) Which direction do you move dishes to be cleaned?
    a) Not relevant
    b) Left-to-right, and it feels fine
    c) Left-to-right, and it seems wrong
    d) Right-to-left, and it feels fine
    e) Right-to-left, and it seems wrong

76) Do you have enough room for dirty dishes?
    a) Not relevant
    b) No, but it forces me to not let the dishes go
    c) No, and it is inconvenient
    d) Yes, but it's hard to keep it organized
    e) Yes, it's fine

77) Could you use another sink?
    a) Not relevant
    b) Yes, I could split up tasks among cooks more easily
    c) Yes, it would help me stay organized
    d) Yes, it would be more convenient
    e) No, everything is fine as it is

78) Are there shelves that are hard to reach?
    a) Not relevant
    b) Yes, I need to reorganize
    c) Yes, and it inhibits the kids from doing more in the kitchen
    d) Yes, and it's inconvenient for the shorter members of the household
    e) No, everything is fine

79) How frequently do you prepare quick meals?
    a) Not relevant
    b) Most days we eat carry-out, almost-ready-to-eat, or delivery
    c) Some days we eat quick meals
    d) We rarely eat quick meals
    e) We eat more quick meals than I would like

80) How frequently do you do involved cooking/baking?
    a) Not relevant
    b) Every week
    c) At least once a month
    d) Only on holidays

81) How would you describe your family's eating style?
    a) Not relevant
    b) Formal
    c) Informal
    d) On the go
    e) Social time

82) How should guests be involved in meal prep?
    a) Not relevant
    b) They should be enjoying themselves in another room
    c) They should feel comfortable talking to me while I work
    d) They should feel comfortable helping me serve
    e) They should feel comfortable joining in with the cooking
    f) They might help with the clean-up

83) Do you organize the kitchen to encourage behaviors?
    a) Not relevant
    b) Yes, to encourage self-service
    c) Yes, to encourage group preparation
    d) Yes, to encourage healthy eating
    e) Yes, to encourage experimentation

84) Do you have a place to put groceries?
    a) Not relevant
    b) Yes
    c) Not specifically, but I find a place
    d) No, but I wish I did
    e) No, but it's not important

85) How do you make decisions about what to eat?
    a) Not relevant
    b) We plan out meals
    c) We see what we have, then decide
    d) It varies

86) What can keep you entertained here?
    a) Not relevant
    b) TV
    c) Music
    d) Family interaction
    e) Computer access
    f) My own thoughts

Figure List

Chapter 1

Chapter 2

Chapter 3

Chapter 4

Figure 26. Several of Zach's question slips that he answered in the context of his kitchen.

Figure 27. Gwen's image tour for homeowners who live alone and like to entertain.

Figure 28. An image to which Gwen initial reacts negatively, improves on second-look. Image from Planning & Remodeling Kitchens, A Sunset Book, (1979). Ed. M.W. Zimmerman. Menlo Park: Lane Publishing Co., p. 51.

Figure 29. One of Kristen's scenarios, "my friends come over for an informal dinner."

Figure 30. On re-inspection, Barbara decided that she didn't like this image, noting that the open space had driven her initial response. Building Specialties Store Inc, Durango, CO (http://www.bsdurango.com/fireplaces.php, retrieved August, 2003)

Figure 31. Quality words included broad descriptive adjectives.

Figure 32. Concept cards represented kitchen design ideas at multiple scales and levels of abstraction, combining illustrations, simple labels, and associated vinyl pieces.

Figure 33. Glass table at House_n where participants worked on the collage exercise. Dry-erase markers, vinyl pieces (center), concept cards (top left), and quality words (top right) are also visible.

Figure 34. Examples of the added concepts include "mud room," "arched doorways," "a place for mail," "no thoroughfare," and "a place for guests."

Figure 35. An added vinyl piece, a toaster-oven, recommended by participants to give functional context to sketches

Figure 36. Scenario modified by Kristen; black ink signals an essential change, blue ink represents her current lifestyle, and red-pink ink represents her projected future lifestyle

Figure 37. Kristen divides up the quality words into two categories.

Figure 38. Kristen reasons about how to order decisions about her selected concept cards.

Figure 39. Kristen sketches an overview layout for the home before turning to the kitchen.

Figure 40. Kristen begins to prioritize what she wants in her kitchen.

Figure 41. Kristen focuses on orientation of elements within the island.

Figure 42. Kristen extends her counter to mirror the concept expressed in the "L-shaped" card.

Chapter 6

Appendix A[19]

[19] Pre-design exercises are displayed in the format they were given to participants; figure captions only appear on images with credits, cited above.

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