Rapidly Exploring Application Design Through Speed Dating

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Abstract. While the user-centered design methods we bring from human-computer interaction to ubicomp help sketch ideas and refine prototypes, few tools or techniques help explore divergent design concepts, reflect on their merits, and come to a new understanding of design opportunities and ways to address them. We present Speed Dating, a design method for rapidly exploring application concepts and their interactions and contextual dimensions without requiring any technology implementation. Situated between sketching and prototyping, Speed Dating structures comparison of concepts, helping identify and understand contextual risk factors and develop approaches to address them. We illustrate how to use Speed Dating by applying it to our research on the smart home and dual-income families, and highlight our findings from using this method.

Keywords: Design methods, need validation, user enactments, Speed Dating Matrix, future breaching experiments, sketching, prototyping, reflection.

1 Introduction

For many years, design teams in the human-computer interaction (HCI) community have employed a user-centered design (UCD) approach to develop interactive products and services. In these traditional contexts, UCD provides many tools and techniques that help teams move from abstract concept to deployed system or artifact. As more and more researchers and developers begin to explore the possibilities of ubiquitous computing, they often adopt the tools and techniques inherited from UCD. Critical differences, however, differentiate ubicomp from these traditional contexts.

First, more than thirty years and millions of commercial products have produced mature design patterns [2] that provide design teams insight into how users might react to new products and interaction methods. Ubicomp, however lacks a similar commercial foundation while at the same time is tasked with breaking new ground in highly-contextualized, social environments. Second, the high cost of ubicomp development forces teams to quickly converge on a single concept to prototype, while the complex nature of the social environments in which ubicomp is typically deployed are best addressed by a flexible approach that compares many possible and diverse prototypes. Traditional UCD, however, offers no methods that directly support these critical differences, making it difficult and risky to directly apply them to ubicomp.

J. Krumm et al. (Eds.): UbiComp 2007, LNCS 4717, pp. 429–446, 2007.

UCD provides many sketching methods [5] that support generating ideas, and prototyping methods that help foreground usability [27] and support implementing an idea [5]. But few methods help design teams transition from ideation to iteration, to explore a diverse collection of early-stage concepts, to reflect on their merits [25], to check their assumptions of user behaviors and needs, and to reinterpret opportunity areas while evolving an understanding of users at the same time. Ultimately, progress in ubicomp is retarded because important contextual factors are not discovered until after a single system has been deployed.

To address this challenge, we introduce a new design method that we call Speed Dating. Like its romantic namesake[1], Speed Dating (SD) supports low-cost rapid comparison of design opportunities and situated applications by creating structured, bounded, serial engagements. SD helps teams contextualize multiple applications as well as critical aspects of individual applications, quickly foregrounding potential "showstopper" issues before any implementation. By structuring comparison, SD also injects time to reflect upon issues [25], practices and opportunity areas, helping teams to reform their hypotheses and produce more adept understanding both of user needs and ways to meet them. We used SD to explore over 100 design concepts, prototyping 27 application variations over the course of two weeks. SD helped us identify showstopper issues, and reflect that certain needs *not seen as critical* during our user research were actually much richer opportunity areas for technical interventions.

In this paper we describe how Speed Dating works and report on our experience using it to investigate the role a smart home should play in the lives of dual-income families, and report on the insights it provided. We situate SD within other design methods regularly used in HCI and ubicomp, and we provide a discussion of the strengths and weaknesses of our approach.

2 How to Use Speed Dating

As we move from ideation to iteration, designers necessarily narrow the solution space and compare design alternatives with the goal of identifying and refining a single system. During this narrowing, teams inevitably compare applications at two different levels. First, they compare broadly across many potential applications or design opportunities, and select a small subset of applications to iterate. Then they compare deeply within this smaller application subset, and examine various implementation strategies for each, before selecting a single system to implement. Instead of focusing on a small subset of prototypes using a single design method, Speed Dating structures multiple lightweight comparisons between widely-different application strategies, or multiple varieties of a single contextualized application. By exposing participants to varieties of interventions, the design team gains insight into the social and contextual factors that most strongly influence a situation, helping them understand more about their user needs in the face of this potential intervention. This comparison also helps designers revise their understanding of the needs they identified, ultimately helping to turn identified needs into opportunities, and defining new ways to meet those opportunities.

[1] Speed Dating is a technique to help busy single professionals meet many potential partners in a series of pre-screened, timed engagements. See http://en.wikipedia.org/wiki/Speed_dating.

Speed Dating consists of two main stages – *need validation* and *user enactments*. In need validation, teams first present a variety of paper storyboards to a set of target users to synchronize the design opportunities researchers found with the needs users perceive. These storyboards help designers prioritize user needs, more clearly map spaces for innovation, and use that focus to narrow the design space for potential applications. Teams then conduct user enactments, which evolved from the broad set of methods that make up experience prototyping [3]. Design teams create a matrix of critical design issues and write short dramatic scenarios that address the permutations of these issues. Researchers then ask participants to enact a specific role they regularly play (like mother or father) as they walk through the scenarios, within an inexpensive, low-fidelity simulation of the target environment. The following sections describe how to perform each part of Speed Dating using illustrative examples.

2.1 Need Validation Helps Focus on Broad Opportunity Areas

Need validation has evolved from the concept validation method invented by the myInfo team at Philips Research [31] and through our repeated application [10][17][19]. The myInfo team recognized that when interactive products were designed that met needs researchers *observed* in users, but that the users did not *perceive* in themselves, that users had trouble recognizing the value of the innovation. Concept validation was invented to discover where observed and perceived needs align in order to better guide technical innovation. Need validation intends to synchronize this alignment, helping teams focus technical innovation on areas where users both have a need and are aware of that need. We intentionally renamed this method because we find that even experienced designers find themselves focus on validating individual concepts rather than on discovering the overlap between observed and perceived needs.

Need validation asks target users to react to concepts represented as paper storyboards. Since a more complete discussion of paper scenarios is available [6][29], we focus on the steps of need validation, what distinguishes it from storyboards, and how the data generated feeds into a new understanding of design opportunities.

1. Focus concepts on user needs. Teams generate and cluster concepts around the needs identified in fieldwork. Since generating concepts can reveal new needs, teams revisit key user research findings repeatedly. Teams then identify needs for which no concepts exist and generate concepts until all needs have been addressed with several concepts. Teams prioritize a critical subset of needs and then select and/or hybridize concepts in order to have a small set that match the prioritized needs.

Rather than have participants speculate on the social mores of imagined future situations and how technology could modify them – which often challenges users – Speed Dating instead deliberately focuses on creating scenarios that fall on both sides of boundaries the design team has speculated on. After Garfinkel [11], we call these *future breaching experiments*. In previous use of concept validation [10][17][19] we have found that presenting users with scenarios that push social boundaries helps to uncover where these boundaries actually lie.

2. *Develop Materials.* Teams produce storyboards that document how each need arises in daily life, and how the concept intervenes to improve the quality of life. Scenarios focus on situations where it is easy for participants to imagine themselves.

Storyboards show people in specific contexts interacting with the proposed system; however, the storyboards should downplay specific technical solutions that distract users from the focus on the need and unintentionally dominate conversations. In addition to the storyboard, the team authors a *lead question* to direct conversation towards the underlying need documented in the scenario.

3. *Conduct Session*. Teams conduct sessions with small groups of target users, presenting boards serially and following each with a lead question. Conversation should focus on the need – what triggers it and how important it is to address. If participants focus on the technology, the conversation is redirected back to needs.

4. *Debrief + Reflect.* The design team discusses reactions to concepts, prioritizing needs that appear strongly in both user research and validation sessions. This discussion should not focus on the details of the existing scenarios, but instead help to reveal new design opportunities. The places where perceived needs do not perfectly align with observed needs become opportunities for invention.

Need validation is not intended to be a Darwinian fitness comparison. Many techniques already support the ranking of existing ideas. Instead, design teams should reflect on their misunderstanding(s), and redefine both what they see as user needs and how to meet them. Doing this across many storyboards produces insight both within and across opportunity areas. Teams gain additional clarity not in confirming the merits of any single idea but through the comparison of many ideas [27].

Need Validation in Action. In our work on supporting the activity management of dual-income families we used affinity diagrams to group more than 100 concepts [19] produced through a process of brainstorming, bodystorming [3], and a review of our fieldwork [9]. These clustered into 21 categories. We then created scenarios for each category that described a need found in our fieldwork and a technical intervention that addressed the need. In order to increase the empathic connection between participants and our scenarios we developed a fictional, persona-like family consisting of two parents and two children – Johnny, 13 and Annie, 7 – in many enrichment activities. We conducted a series of 2-hour sessions with dual-income parents, where we presented our storyboards.

The "Safety Net" storyboard provides a good example of how to address challenges of presenting ubicomp scenarios (see Figure 1). This scenario focuses on the anxiety parents experience about forgetting or not being able to pick up their children. In this scenario, Dad is stranded and cannot pick up his daughter. The storyboard shows that the smart home arranges to have her picked up. With respect to reducing discussion about the underlying technology, in this scenario we show only a mobile phone in Dad's hand. The storyboard does not address how the smart home reasons about the situation, or how it selects and communicates with neighbors. Instead, the entire communication process is reduced to concentric circles. With respect to social boundaries, the smart home potentially oversteps its bounds by communicating directly with people outside of the family, asking them for favors.

To form the basis for more objective comparison between opportunities, we asked participants to rank our depictions of their needs, and the potential interventions depicted. Our top-ranked storyboard depicted the "Snack Day at School" opportunity

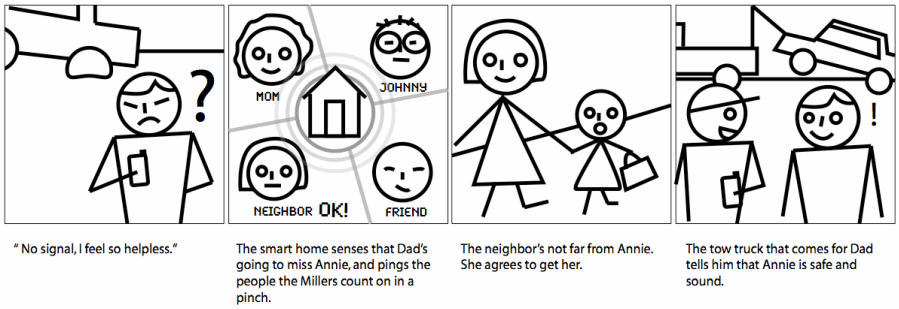

Fig. 1. "Safety Net" storyboard: dad is stranded and cannot pick up his daughter

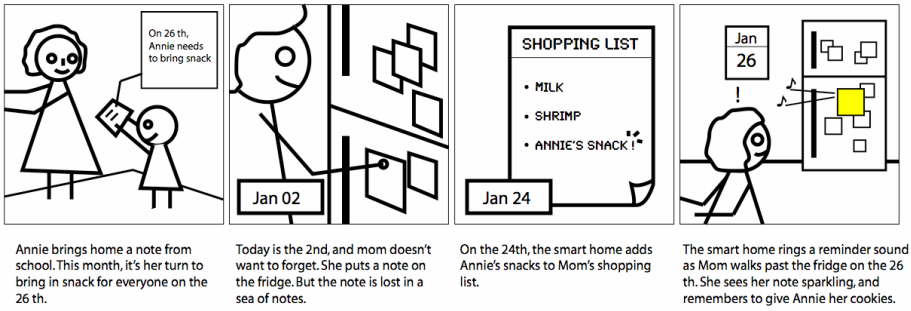

Fig. 2. Parents strongly identified with the "Snack Day at School" concept

(Figure 2). The scenario depicts days when parents need to provide a snack for their child's class. Parents reacted strongly to the story of this responsibility, which because of its infrequency, falls outside of the daily routine, increasing the chances for breakdowns. One mother commented, "It is very hard to keep track of future events and their impact." A father shared that failure has very high costs in disappointing his children; "It's devastating to the kids when we forget."

2.2 User Enactments Concretize Abstract Contextual Risk Factors

Storyboards help design teams identify the overlap between observed needs and perceived needs, and through that experience, redefine the opportunities for technical interventions. User enactments, in which subjects serially-enact invented scenes, build on this outcome, helping teams explore a critical set of design issues within the earlier-identified subset of opportunity areas, and provide further structure to reflect on their both their understanding of the opportunity and a strategy to address it.

To begin, researchers place the design issues (or problem dimensions they wish to explore) on the axes of a Speed Dating Matrix, articulating points of interest along those dimensions (see Table 1). Matrix cells are populated with fictional scenes that address the intersection of issues described by column and row labels. The team constructs a simulated physical location in which to situate the enactments, and adds whatever low-fidelity props and prototypes the enactment requires. The team then

asks participants to enact a familiar role and walk through a subset of the scenarios. Like experience prototyping [3], by engaging users as they carry out tasks, enactments bypass opinions based on the imagined fiction of storyboards and instead activate response to real-time engagements.

User enactments provide a structure to explore social mores surrounding situations that stretch our understanding of user needs in two ways. First, they provide a setting for users to experience future breaching experiments. And second, by combining wide exploration via multiple structured engagements, user enactments provide a broad perspective to analyze the impact of risk factors.

User enactments in action. Our fieldwork and storyboard sessions identified three principal dimensions of family activity management to explore: activity lifecycle, activity type, and system proactivity.

Family needs vary as activities evolve through their lifecycle. The first day of hockey practice presents different needs from the middle of the season, when families have established successful routines. Days when kids forget their skates and force deviations from a routine also present very different needs. Different activities also provide families with varied needs. The first day of school suggests a more permanent schedule change and ritual shopping, while soccer practice requires more episodic requirements and special equipment. We selected the type of activity as an axis to vary (*e.g.*, soccer, ballet, school). System proactivity is also an important dimension to explore. By proactivity we mean the degree of initiative that an intelligent system might take based on its understanding of the needs of the family. We recognize that different levels of proactivity might be appropriate for different kinds of activities or different kinds of needs, among other factors.

Many other issues rounded out our list of dimensions: location within the home (*e.g.*, kitchen, living room, bedroom), time of day (morning rush, evening rush, evening chill), type of chore (making lunch, picking up clothes), could all influence how a family might perceive the benefits of a particular technology. Using our top 3 as row and column labels, we created a 3x3x3 Speed Dating Matrix (Table 1).

From matrix cells to user enactments. In conducting our own user enactments, we again leveraged a fictional family and asked participants to enact the role of the mom or dad. Sixteen individual dual-income parents participated. Each parent "play acted" 9 user enactments over the course of two hours. Parents walked through three scenes for each activity (Soccer, Ballet, School) with different combinations of proactivity and at different points in the lifecycle for each. In all, each user enactment was performed by at least 5 participants.

We asked parents to walk through simulated daily routines (*e.g.*, dressing and feeding children), and each user enactment required them to complete additional tasks. The Soccer (activity) Beginning (lifecycle) enactments, for example, situate parents before soccer season begins, and asks them to arrange a carpool. The smart home either: (1) entirely automates the setup (High Proactive); (2) polls candidate driver families and informs parents who might be available, automatically confirming with the family of their choice (Medium Proactive); or (3) simply informs the family who might be available. To simulate extreme time pressure we asked participants to

Table 1. A compact representation of our Speed Dating Matrix for kids' activities. Concept dimensions form the row and column labels. Cells outline the content of user enactments, which juxtapose specified risk factors with social situations defined in the table structure. SH here refers to the "smart home." An extra row is added to explain deviation circumstances.

	Proactive	**Soccer**	**Ballet**	**School**
Begin	**High**	SH auto arranges carpool, interrupts to inform parent	SH auto adds lessons to calendar, interrupts to highlight conflict with doctor + reschedules	SH purchases supplies online, and prompts for optional items
	Medium	SH finds carpool availability, interrupts to inform parent	SH prompts to add to lessons to calendar, then highlights conflict and prompts to reschedule	SH auto adds supplies to shopping list and prompts to schedule shopping
	Low	SH informs parent when on phone with friend they could be driver	SH highlights schedule conflict when lessons are added manually	Constant ambient reminder via embedded picture frame
Routine	**High**	SH interrupts parent to inform that shin guards are not in bag	SH tells parent "you must" pick up your daughter from ballet	SH passes task from spouse to make lunch
	Medium	SH highlights bag as parent passes, indicating missing shin guards	SH tells parent "you should" pick up your daughter from ballet	SH adds lunch task to to-do list
	Low	Constant ambient reminder via embedded picture frame	SH asks parent to pick up daughter from ballet as favor to other parent	Constant ambient reminder via embedded picture frame
Deviate		What: Last-minute meeting and parent can't drive to soccer	What: Mom's away, and Dad needs a reminder of what to bring and when	What: Parents need to bring cookies for a school play in 2 weeks
	High	SH arranges new ride home for kid and informs parent	SH rearranges schedule and provides list of needed items	SH auto adds items to shopping list, auto schedules shopping
	Medium	SH asks friends for favor and relays their reply	SH suggests new schedule and suggests list of needed items	SH auto adds items to shopping list and prompts to schedule
	Low	SH asks friends for availability	Constant ambient reminder via embedded picture frame	SH prompts to add items to shopping list

complete these tasks within a short time window. When actual routines deviated from scripted scenes, parents were afforded an opportunity to draw on their real experiences and engage with the scenario.

Speed Dating advocates highly-disposable creations to support these user enactments. We simulated our smart house (Figure 3) out of 6'x4' white foam-core, drew appliances on a wall of a whiteboard, and filled the environment with enough physical trappings to suggest a home: magazines on a den table, coffee pot on the kitchen table, and a laundry basket partially blocks a hallway. After each enactment we probed participant reactions, digging past observed behavior towards its root cause. We conducted semi-structured interviews after participants completed 3 enactments for each activity (exploring one dimension fully), and a more elaborate interview after completing all 9 enactments.

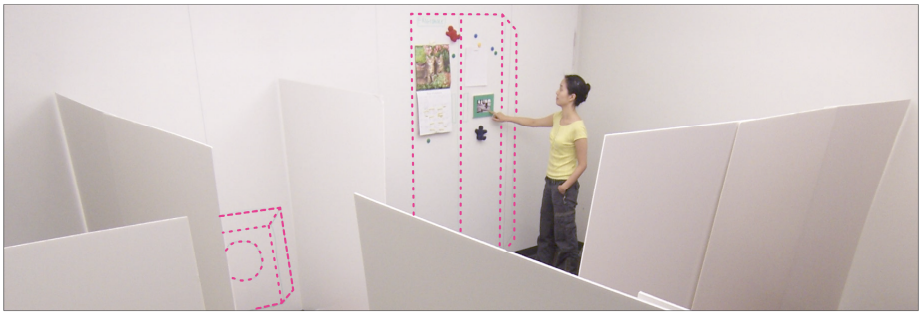

Fig. 3. Our simulated smart home for Speed Dating. Foam core walls organize the "smart home" prototype into rooms. The refrigerator and washer-dryer are drawn on a wall of whiteboard (emphasis added for photo). A confederate is shown interacting with the fridge.

3 Insights Provided by Speed Dating

Speed Dating evolved our understanding of both the needs of dual-income families and how smart homes might help them in important ways. First, SD helped us identify that supporting kids' activities presents a major opportunity for ubicomp to positively influence home life. Next, Speed Dating helped us explore the many ways in which we might choose to support kids' activities. The wide and structured exploration provided when looking across need validation and user enactments helped us re-learn the kind of support that families really need, and has pushed our work in unexpected directions. We describe two of these directions.

First, Speed Dating evolved our perspective of how to address the opportunity of managing kids' activities. It helped us realize that the work surrounding kids' activities actually sits within the much larger, principal task of the home – raising kids. Though our early applications focused largely on kids' activities, SD revealed that applications cannot decouple support for kids' activities from the fundamental act of parenting. In other words, parenting and kids' activities are contextually bound, and applications expecting to focus on one necessarily will need to be aware of the other in order to deliver appropriate assistance.

Second, Speed Dating helped us realize that we could not support communication to facilitate the work of the home without considering communication's other roles. It revealed that communication plays an important social role when it occurs between members of different households, and that it can play a more utilitarian role when it occurs between members of the same household. Any application that supports communication within and between homes, will have to balance a desire for utilitarianism with the need for maintaining social protocol. In this section, we discuss these issues in greater detail.

3.1 Need Validation and Kids' Activities

Several storyboards presented parents with scenes depicting recurring deviations from routines and the need for parental role shift, two problems that our fieldwork brought

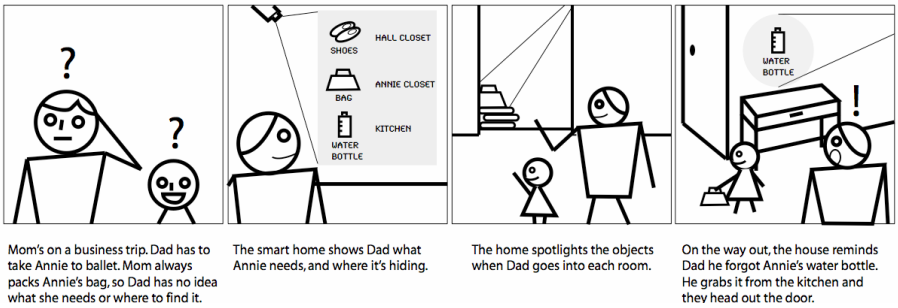

Fig. 4. Parents strongly favored this storyboard, validating our observation of the need to support the process of remembering activity-related objects. Testing in context also revealed that this service directly competes with kids learning responsibility.

to light many times. One storyboard depicting "Where are the Ballet Shoes" (Figure 4) explores both of these issues through a particularly stressful example of kids' activity management. When Mom, who normally manages the responsibilities surrounding ballet lessons, is away on business, Dad assumes Mom's responsibilities. Dad has no idea what gear his Daughter needs or where they put these things in their house. One mother observed, "My husband would love this. He never knows how to dress our daughter." The storyboard also helped elaborate the consequences of failure to meet even these seemingly simple needs. One father described that "it's very stressful for me. I feel like I failed as a parent when I forget what my kids need.

A tension emerges between efficiency and parenting. While storyboards such as this showed much potential in supporting kids' activities, other storyboards brought to light critical considerations that would impact *how* a smart home might support these activities. During fieldwork, many parents frustratingly described the stress of the morning rush. Part of that morning stress involved parents having to constantly persuade or nag younger kids to get them to comply with the parents' wishes. In "Annie Dresses Herself" (see Figure 6), the smart home limits Annie's TV consumption, and then helps her pick clothes on her own.

Though designed to help Annie feel more independent, and offload some of the morning struggle onto the smart home, the storyboard also revealed contextual factors: some more complex and subtle dimensions of the morning struggle that were less visible during our earlier fieldwork. For example, one mother asked "What's the parents' job, and what's the house's job? Is Annie going to listen to her Mom, or to the house?" This concept surfaced the fact that while dressing children creates stress for parents, it also creates opportunities for parents to feel like good parents, and to teach their kids skills and independence, and provides moments for meaningful interaction. Through concepts like this, we recognized that we should focus our attention on how to support the work of parenting, but also saw early evidence that we had to be careful not to reduce opportunities for meaningful interaction that occur through that work.

Fig. 5. Parents reported that dressing younger children often injected stress into the morning. To alleviate stress and encourage independence, the smart home helps the daughter choose her own clothes. Parents resisted this system, suggesting that, while challenging, dressing children also forms a pleasurable part of their morning and helps them feel like good parents.

3.2 User Enactments and Contextual Factors in Parenting

Through the use of user enactments, we were able to witness richer evidence of the contextual factors found in need validation. Here, we describe three factors relating to our emerging view of the complexity between kids' activities and parenting.

Parents want support focusing on the big picture. One future breaching experiment explored potential emotional support from the smart home. The smart home interrupts a busy parent during the dinnertime rush, and presents them with a naked compliment, "You're very very busy. But no matter how busy you are, you always do everything you have to." We expected distracted parents to dismiss this empty sentiment. But interestingly, over three quarters of parents responded positively, saying "thank you." Half stopped their activity to express an almost shocked gratitude.

We do not interpret this to mean that smart homes should literally emotionally serve their occupants. Instead, in looking to understand an emotional connection with a home, our future breaching experiment actually uncovered a much deeper emotional need between the occupants of the home. Parents were so starving for attention and gratitude from their children and each other, that they accepted a compliment from a computer system that could hardly grasp the truth of the statement or invest in it with any real emotional significance.

Supporting activity means being a parent. As part of the user enactments, fictional Son Johnny keeps all his soccer gear in a dedicated bag to avoid having to remember each needed item individually. Johnny's strategy breaks down whenever an item is separated from the bag. Muddy cleats that stay outside or a clean uniform in the dryer breaks this system down. These kinds of breakdowns can impact both kids, who need the gear to participate, and parents, who feel the stress when their kids can't participate in their activities, and sometimes rescue them with emergency deliveries.

The Soccer Routine Enactment explores an opportunity to avoid this potential disaster. As a parent passes a dryer containing a forgotten uniform, the smart home tells the parent about the dryer contents. Interestingly, parents strongly objected to

this system. One father said that this felt "weird that the smart home is telling me something that I don't have to do. It should be telling Johnny directly." Another even said "I don't want to do it for Johnny." Even though the application supports an observed and validated need, and if used could help avoid a potentially stressful situation, parents instead describe that the needs of parenting supercede our earlier identified need to avoid the stress surrounding the potential breakdown.

Speed Dating illustrated that a smart home cannot simply view its mission as one to prevent errors. Errors form part of the critical pedagogical mission of parents to raise kids who understand the consequences of their actions. And to raise kids to be responsible, successful adults, parents do not want to prevent their kids from making every mistake, or doing any work. In fact, doing work and making mistakes are important parts of being a child. The smart home has to approach support for these situations not just as failures but as important didactic opportunities.

Other user enactments went on to add further layers of nuance to this contextual risk factor. For example, parents strongly favored having the smart home tell them to deliver their daughter's forgotten lunch to school, as part of the School Routine Enactment. Through this comparison, we see the same didactic needs of parenting now strongly interacting with parents' desire to protect their child. A forgotten uniform presents modest consequences when compared to a hungry child. One parent noted, "Vital stuff. No problem. Without lunch...kids don't eat. It's reassuring. I wouldn't be as worried and stressful knowing somebody is watching."

Essentially, user enactments foregrounded contextual factors that the storyboard under-emphasized, forcing us to redefine our understanding of what we saw as similar situations, and by extension, applications we could design to address them, and ultimately helped to expand our understanding of the role of the smart home. Where we could have interpreted parents' responses to the earlier "Ballet Shoes" storyboard to mean that we should build applications that support "gathering items for activities," the first user enactments actually demonstrate that unconditionally supporting this need interferes with another equally compelling need to teach responsibility to children. But, by comparing the results from these user enactments to the user enactment on lunch delivery (School-Routine), we realized that this particular issue of parenting was much more nuanced than we first expected. Without user enactments and without the structured comparison that they offer, these nuances would not have been evident. We discuss the implications of this finding in Section 4.

3.3 User Enactments and Contextual Factors in Communication

Communication proved to be another contextual risk factor that offered a layer of nuance affecting application development. Parents were very uncomfortable when automated support messages from the smart home sought help outside the family. In contrast, parents tolerated the efficiency of extremely abrupt, bordering on rude communication from the smart home when seen as coming from their spouse.

Parents resist support for external communication. In the Soccer Deviation Enactment, a last-minute meeting traps a participant at work unable to complete her responsibility to transport her Son to his impending soccer game. With her husband also unavailable, the smart home: (High Proactive) automatically arranges a new ride;

(Medium Proactive) communicates directly with candidate drivers on parents' behalf; or (Low Proactive) presents mom with a list of candidate drivers and availability.

Despite the stress and work dictated by the situation, and the convenience automated support could provide, many parents placed social factors above convenience. "I would want to talk to the parents [asked] and see how they feel. I would have to connect and talk to people. I want there to be a person behind the name and to make sure they'd be comfortable when my kids are involved." Parents described that automated communication simply smothers critical highly-social characteristics of human expression. One parent notes, "I would never say no to my friends without personal contact." Automation would smother explanation or opportunities for coercion. "I would want to know why [he said no]. I might try to push if he could go," says one mother.

Efficiency predominates discussion of internal coordination. Coordination within the home reflects a different standard for utility than external coordination. Here, the primacy of efficiency prevails. In the School Routine Enactment, a parent is asked to negotiate with their spouse about who will pick up their daughter. The smart home either: (1) assigns the task to them; (2) passes them the task from their spouse; or (3) relays them a voice message from the spouse.

Parents realized that they appreciated the expediency afforded by the smart home, and gave little consideration to the same requisite subtlety they rallied for when communicating outside the home. One father prefers automatic coordination when in his busy office environment. "I don't like to be called at work during the day. It's better to be like a quick message. It normally takes a lot to get somebody on the phone but this is more thoughtless." Some parents wanted even more automation: one wants "[the] smart home to make the call on my behalf. It's better for the system to automatically tell me to pick up [my daughter] so I don't have to make a call. I would feel comfortable with smart home automatically determining who has more time."

User enactments redefine communication opportunity areas. Fieldwork and need validation both provided evidence that kids' activities impose heavy communication costs on families. But user enactments showed us that families feel uncomfortable mapping the binary nature of automated communication with the social factors embedded in human contact, and that the work saved would not outweigh the potential risks of handling social needs without their requisite subtlety. In this way, user enactments helped us refocus our efforts on the work of supporting communication within the home.

4 Moving from Ideation to Iteration

In the previous sections, we have described the method of Speed Dating, illustrated how we applied it to our research on smart homes and dual-income families, and highlighted key results from its application. Here, we contextualize Speed Dating within the available set of user-centered and participatory design tools and techniques.

Design ideation and iteration have been the focus of ongoing invention and discourse in the HCI community, resolving two principal forces at work – sketching

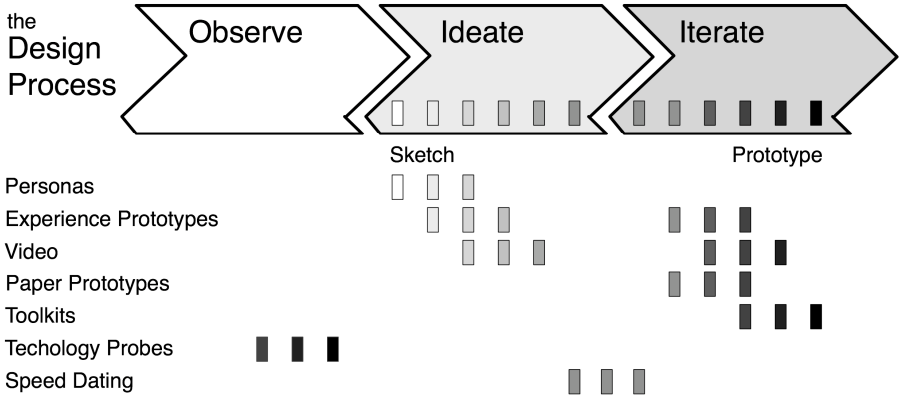

Fig. 6. Sketching and prototyping form a continuum that spans the design process. Lightweight sketching techniques support ideation, helping explore multiple concepts early in the design process. Prototyping , however, more directly supports iteration of a specific idea.

and prototyping (see Figure 6). At the beginning of the design process, teams create a large number of ideas through processes that we describe, after Buxton, as sketching – any process where the output is quick, timely, inexpensive, disposable, plentiful and ambiguous [5]. Sketching helps designers explore rather than confirm [27].

UCD provides many tools and techniques to help design teams sketch ideas across various media. Paper naturally supports abundant sketching of interface elements, scenarios [6] that depict users or personas [8] interacting with technology in a context. Informance (informative performance) [4] techniques like experience prototyping [3] use the contextually-rich felt experience of role play to inspire design ideation. Video also capably supports sketching concepts [30].

UCD also provides a rich tradition of tools and techniques that support prototyping. Prototypes use paper [24][26] or video [20] to quickly discover "showstopper" issues [27] before making too large an investment in a single direction, Higher-fidelity prototypes can rely on sophisticated toolkits to simulate functioning screens [18], physical tools [14], or aspects of user experience [15], and helps teams find the "right design" [5] to accomplish a decided-upon direction.

Lower-cost prototypes have more flexible uses. For example, they can function as ethnographic stimuli. When users discovered new purposes for technology probes [16], the researchers gained new insight into user needs and goals. These robust prototypes function more like a single engagement than SD's many short flirtations. Other prototypes are more exploratory. Simulating a distributed information system with paper [7], a sound transcription system by following users [21], or telephone interviews to simulate activity recognition [23], "Wizard of Oz" simulations [12] help teams provide low-cost exploration of ideas.

But even where prototypes help teams explore ideas, there is a need for tools and techniques to support the transition between sketching and prototyping. Speed Dating could provide for this need in two important ways. First, earlier techniques focus on the simulation of single systems, while evidence from both early-stage sketches [27] and deployed systems [1][28] shows that multiple systems provide more perspective into both the value of an idea and the user reaction to it. Sketching functions best

when alternative visions encourage designers to explore, compare, understand and evaluate an opportunity space and gain insight into the space through that reflection [25]. Speed Dating helps lower the cost of simulation enabling teams to compare multiple application instances, and provides a structure to explore those multiple versions. And second, earlier techniques were applied in areas where there was a fundamental understanding of the role a particular service would play, and often the design of their devices and interactions could follow well-formed cultural conventions. Speed Dating would help in domains that lack similar conventions, where teams might have trouble choosing between them, and are unaware of how users might react to mores surrounding the technology.

Participatory Design [22] approaches many of these same issues, asking users to participate in the design process from start to end. Instead of focusing on what is wrong with a proposed solution, techniques like user sketches [27] encourage users to reflect on what they want, helping designs co-evolve with the opportunity [13]. Our research with busy dual-income families limited our exposure to families' time, so we focused on a more user-centered approach.

5 Discussion

In the previous section, we placed Speed Dating in the larger context of an overall design process. Here, we discuss benefits of the method including: its focus on sampling actual user experiences, its usefulness in identifying important contextual risk factors early in the process, and how structured examination of applications reveals larger themes across those applications. We discuss each point in turn.

Speed Dating samples user experience, not opinion. We gained valuable insights about our concepts without putting subjects into a position that ubicomp research often places them in, when asking them what they would do or how would they respond to some future technology without contextualization. Speed Dating was able to expose their real current needs in context of this imagined future technology, but did not place the burden on the imagination of the user.

Speed Dating surfaces insights early in the research process. It would not have represented a departure from standard practices to deploy an application after our fieldwork and need validation. We could easily have invested heavily in an application that could have delivered some benefits to families, but as Speed Dating showed, would have simply overlooked parents' larger needs to teach their kids responsibility. A field study of such an application could have revealed this insight. But instead, Speed Dating brought this important contextual factor forward before investing in any implementation. Moving forward with this knowledge, we argue that Speed Dating will make it more likely that the applications we build will both target the correct needs and be designed in a way that is respectful towards the important contextual factors that it helps identify.

Future breaches force reevaluation of invalid hypotheses. One future breaching experiment showed us that everyday stress often leaves parents starving for gratitude. Interestingly, this enactment was included largely to disconfirm a desire for emotional

connection with a smart home. Instead, the situation destabilized our understanding of parents' needs, and how a smart home might meet them. We do not interpret this literally as evidence that a smart home should provide emotional support. Instead, we were forced to go back and reinterpret some core parent needs and how they affect fundamental application goals. Knowing that parents are filled with so much need to do damage control, a smart home could potentially help parents focus not on the day-to-day chores, but instead on the larger perspective of raising successful kids, and the activities that help them support that larger goal.

Larger themes emerge and revise design strategy. It is important to distinguish the Speed Dating Matrix from the structured comparisons used in controlled experiments. A controlled experiment manipulates single dimensions while at the same time strictly controlling all other potential variables, enabling researchers to make a measured statement of causality with respect to an explicit hypothesis. Instead of precise control, the Speed Dating Matrix facilitates *exploration*. Speed Dating is not designed for, and cannot provide, experimental discrimination or predictive power. Instead, looking across grid cells, researchers should observe that larger and potentially-unexpected themes emerge. This variety of themes then allows researchers to iteratively refine how they interpret the original design opportunity.

Our early research, for example, interpreted kids' activity-related failures as stressful problems to be solved by delivering the right information at the right time. But user enactments showed us that, while stressful, these problems are literally necessary parts of raising responsible kids. A smart home that removed these didactic opportunities in the name of "fixing problems" would also interfere with an important aspect of parental responsibility, and by showing an insensitivity to an important aspect of family life, risk rejection by parents.

This added nuance presents important implications as we move forward with our current research agenda, and shows how careful exploration of contextual risk factors can help effectively reformulate application design, opening previously overlooked opportunities. Instead of delivering information to parents to help them *prevent mistakes* their kids might make, we could instead create systems that give parents a choice about when to get involved, and that gives kids the tools to learn good decision-making without replacing their existing responsibilities. This would mean creating moments for kids to learn responsibility, and to involve parents in that dialog.

Exploring what we believed was a firm understanding of a single need instead exploded a different need. Instead of learning that parents want an emotional connection with their smart home, we looked back at our fieldwork and storyboards and found much evidence that parents are focused on the day-to-day activities. This evidence forced us to go back and reinterpret what we see as parents' core needs. We used this information to reinterpret one of our fundamental goals, and we now see that one of the potential role of the smart home could potentially be to help parents focus not on the day-to-day chores that they so easily fall into, but on the larger perspective that they want to raise successful kids.

Whatever the experiment might suggest about a potential relationship between families and a smart home, it also revealed significant nuance to our understanding of the social needs of families. The stress of the everyday work to support activity often leaves parents starving for gratitude. The smart home cannot simply focus on making

the home more efficient by taking over appropriate parenting responsibilities. Instead, it should play an active role in helping parents feel like good parents.

Match design process to project needs and domain knowledge. We see Speed Dating as an opportunity to explore both a variety of approaches and new and undefined opportunities. Because Speed Dating helps foreground contextual factors, it seems appropriate to domains where models of users are less well-defined, or researchers suspect their understanding may contain assumptions they wish to explore. We chose to apply Speed Dating to domestic technology because while researchers have observed that the home will likely produce needs that differ from the workplace, few models have arisen that can demonstrate successful alternative models of applications for the home. By adding 2 weeks to a project timeline to perform Speed Dating, we argue that the risks are minimal in proportion to the rewards. Projects that utilize Speed Dating will likely require further prototyping to explore critical widget-level decisions. Though Speed Dating can help explore poorly-defined design spaces, foregrounding critical contextual factors, designers still face the question of how to implement the systems that it gives them the confidence to say are valuable, including interaction metaphors, timing, transitions and appropriate feedback levels.

Did Speed Dating provide insight about what specifically to design? SD, like all other design processes, can guarantee no output. The output rests most heavily with the creativity of the design team. It answered some but not all of our questions. For example, while it helped us see that the desired amount of proactivity interacts with other variables (*e.g.* location, activity), it did not tell identify an optimal proactivity level. And SD provided little insight toward some matrix dimensions, leaving us to wonder if the issues are less critical than imagined, or if SD did not reflect their actual importance. For example, by focusing more carefully on the fidelity of the services represented during SD, would SD be able to discern how proactive a system should be? In our future work, we plan to explore the kinds of questions for which SD can provide sufficient discrimination to deliver insight, and at what point issues are more appropriately addressed through prototyping.

6 Conclusion

The paper offers three contributions. First, we present Speed Dating, a method for helping researchers move in a structured manner from ideation to iteration as part of a larger design process. By combining need validation and user enactments, researchers can select concepts worth pursuing, explore dimensions of those concepts in a structured and low-cost manner, and reveal subtle contextual risk factors that can impact application success. By structuring exploration and foregrounding user needs, SD helps design teams reflect upon the opportunity for technical intervention, reinterpret their strategy. and create more appropriate and innovative solutions.

Second, we illustrate how to use Speed Dating by applying it to our research on the smart home and dual-income families. Third, we share our novel results from the application of Speed Dating to the smart home domain. Speed Dating enabled us to rapidly identify managing the stress of kids' activities as a key parental need, and to

rapidly identify contextual factors such as the interplay between kids' activities and parenting, and the dynamic role of communication within and between households.

To continue the romantic metaphor, Speed Dating is not about finding the best person, but through the process of comparing, learning what aspects of others are (in-) compatible with your likes and dislikes.

Acknowledgments. We thank the 52 families who have taken over 250 hours from their busy lives to inform and inspire our research, smart home summer class students Bryan Crowe, Elena Kim, Ben Koh, K.C. Oh and Ray Su who helped us invent and come to understand Speed Dating, and the myInfo [31] team at Philips Research.

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