

Prototypes as (Design) Tools for Behavioral and Organizational Change

A Design-Based Approach to Help Organizations Change Work Behaviors

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This article promotes the idea that prototyping, a method regularly employed in the design and development of products and services, is a powerful means to facilitate organizational development and change. The authors present three objectives related to prototyping that facilitate behavioral change within organizations. These objectives include building to think—creating tangible expressions of ideas enables organizational thinking to develop concretely through action; learning faster by failing early (and often)—making things tangible allows small, low-impact failures to occur early, resulting in faster organizational learning; giving permission to explore new behaviors—the presence of a prototype encourages new behaviors, relieving individuals of the responsibility to consciously change what they do. The significance of these objectives is illustrated through reference to client organizational change projects. The article concludes by reflecting on the value of applying this less analytical design-based approach to helping organizations transform the ways they work.

Keywords: *organizational change; rapid prototyping; design methods; experimentation*

We are grateful to many clients and colleagues for their participation in projects that have helped to generate the ideas and examples expressed here. And we wish to express thanks to our anonymous reviewers, especially one who truly went beyond the call of duty, for their challenging and helpful comments and guidance in the development of this article.

THE JOURNAL OF APPLIED BEHAVIORAL SCIENCE, Vol. 43 No. 1, March 2007 122-134

DOI: 10.1177/0021886306297722

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CHANGING ORGANIZATIONS, BY DESIGN¹

Increasingly, it is apparent that healthy organizations are those that can continually and flexibly respond to a world full of rapidly changing circumstances. That means not simply “reorganizing” to meet today’s challenges but rather fostering a culture within which people continually adapt solutions and respond creatively to new conditions and discoveries.

That idea—of adapting solutions and responding creatively—is design in its essence.

Our firm, IDEO,² is often asked to help client organizations with the development of this adaptive capability. Requests range from “help make our organization more innovative” to “help our organization equip itself to face an uncertain future.” In accommodating these requests, we frequently rely on the tools and methods our firm has developed over many years for the design of products, services, environments, and experience design to help us solve these organizational design challenges. (For an in-depth account of our firm’s philosophy and work practices, see Kelley, 2001.)

In our consulting practice, we refer to the application of design process to organizations as “transformation by design” because it employs the tools and methods of design to bring about organizational change. These tools and methods include, among others, observation of “users” (customers, employees, and other stakeholders) in everyday contexts of work, brainstorming to generate dozens or hundreds of potential solutions, and rapid prototyping of specific ideas to evolve and refine them, evaluate their potential, and introduce potential behavioral change to an organization in a nonthreatening, low-risk way. This article focuses on rapid prototyping, a core method in the design process and a tool we believe can play an especially valuable role in organizational change and development.

“RAPID PROTOTYPING” IN THE ORGANIZATIONAL DEVELOPMENT LITERATURE

As designers, we came to the practice of organizational change largely through the intuitive application of our design process to organizational development challenges variously brought to us by our clients. Recently, we have been made aware of an existing body of literature that sits at the intersection of design and organizational development and refers to prototyping as a tool for organizational change. Neely D. Gardner, for example, advocates for the use of prototypes to “test . . . assumptions before the change is implemented. This prototype should not be a simulation of the change but an actual implementation of the critical parts of this change” (Bruce &

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Wyman, 1998, p. 169). Similarly, Banathy (1996), in his volume on systems and organizational design, defines a change model that includes a “design experimentation and evaluation space” where through prototyping, alternative organizational design solutions are evaluated before a final design solution is reached (p. 73). Weick (2001) also describes a process he calls “self-design,” which “involves generating alternatives and testing them against the requirements and constraints perceived by people in the organization” (p. 410).

In spite of what appears to be a long tradition of “prototyping” as a means to bring about organizational change, we have not found many clients who are familiar with this approach. This leads us to believe that our design-based perspective on prototyping might provide valuable new insights into the successful application of this powerful methodology in organizational environments.

DESIGN APPROACHES TO PROTOTYPING

Prototyping is core to how designers do their work. It involves moving from the world of abstract ideas, analysis, theories, plans, and specifications to the world of concrete, tangible, and experiential things.

“Prototypes” are representations of design ideas created before final artifacts exist. In some industries or companies, the term *prototype* is reserved for highly resolved and close-to-launch versions that in essence “stand for” a final product or offering. In our use of the term, and more typically within the design profession, prototypes can be usefully thought of as “learning tools” and consequently may exist at any level of resolution—from very rough to highly refined—and may be used at any stage in the design process to explore, evolve, and/or communicate ideas.

Design has a rich tradition of employing prototypes of various kinds to explore and communicate evolving ideas and potential solutions. For example, Houde and Hill (1997) discuss various functions for prototypes as being essentially about the “role” that artifacts will play, their “look and feel,” and how they will be implemented. Prototypes range from low-fidelity sketches and cardboard cutouts (Wong, 1992) to high-fidelity different kind of models at various levels, all designed to explore and communicate propositions about the design and its context by allowing people to establish an experiential, sensory relationship with ideas about products, services, spaces, processes, and so on.

For IDEO, prototyping was originally established as a key activity in product design and engineering development, in contrast with the specification-oriented approaches that were more common in that industry. Rather than starting out with detailed analysis of technical and user requirements and development of specifications, a typical process at IDEO involves developing, at quite an early stage in the process, a wide range of low-fidelity prototypes from which to learn. With prototypes made from inexpensive and accessible materials—such as paper or card, foam-core, or wood models—we can explore many different possibilities with respect to physical form, human interactions, and how mechanical elements might work. Through trial and error we evolve and refine ideas to gradually integrate multiple

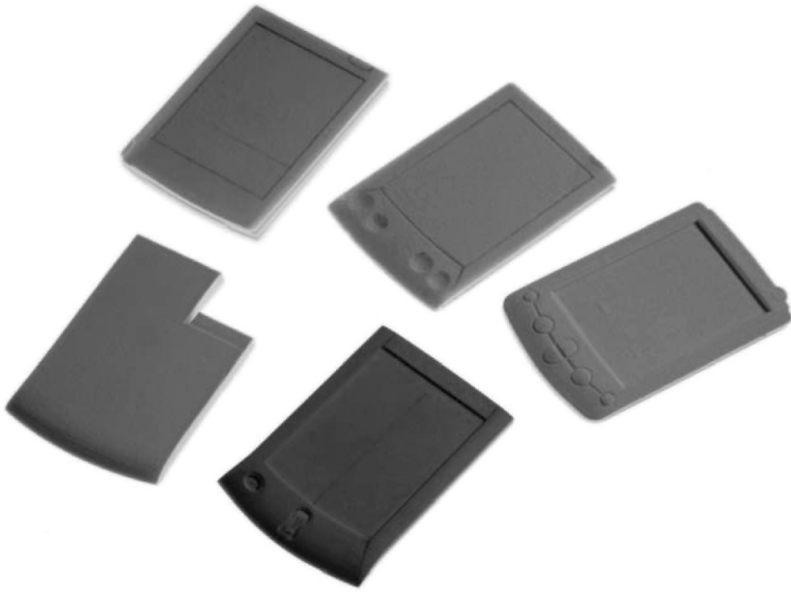


FIGURE 1: Physical Prototypes to Explore Various Aspects of the Palm V Hand-Held Device

elements of the design, answering multiple detailed questions through rounds of successively higher-fidelity prototypes (Figure 1).

Over time, we have evolved this approach and drawn on many other prototyping traditions within human-centered design and the design of interactive systems. For example, designers and researchers have explored the value of various forms of prototype, including matters such as different levels of fidelity (Vertelney & Curtis, 1990; Wong, 1992), prototypes for different audiences (Erikson, 1995; Wagner, 1990), and models for use in the context of participatory design (Ehn & Kyng, 1991; Muller, 1992).

Several groups of designers and researchers, perhaps most notably at Apple Computer, Xerox Parc, and Interval Research, have been active in pushing the boundaries of prototyping beyond the range of traditional methods (Burns, Dishman, Johnson, & Verplank, 1995; Burns, Dishman, Verplank, & Lassiter, 1997), especially around ways of exploring behavior with new technologies. As the reach of design has moved beyond the design of products to the design of interactive systems, and even to elements of service design, many of these newer prototyping methods, such as those that involve role-playing and scene enactment, are becoming more deeply embedded in design practice (Buchenau & Fulton Suri, 2000). Furthermore, prototyping as a design practice is now promoted within the business community as a key element for encouraging innovation in companies (Leonard & Rayport, 1997; Schrage, 1999).

Over time, these ideas have evolved to form a prototyping philosophy that permeates IDEO's design practice in all spheres (Kelley, 2001) and most recently in applying design and prototyping methods in organizational change programs.

Because they are born out of the same prototyping philosophy, the prototypes that IDEO now uses to help us design and refine organizational processes, services, and infrastructure elements have, not surprisingly, many qualities similar to those that we might create for products or interactive systems. They are tangible, created so that everyone can grasp the idea. They start out as rough as possible so that we speed up learning, reduce the cost of failure, and avoid emotional attachment. They seek to answer one or two questions at a time rather than to address the entire system. They are codesigned by multiple stakeholders and thus quickly create a shared understanding. Building prototypes helps a group to move beyond talking and thinking about a problem to actually making progress toward action. Perhaps most important, they are real and physical—that is, they assume some material manifestation. For example, if we are attempting to prototype something as seemingly intangible as a new process, we might write down the different process steps on paper and spread them throughout a room so that we can literally “see” the steps in physical space. We might then have two people act out the steps in the process (using rough approximations of roles, tools, physical space, and other artifacts required in the process) while an additional person serves as “director” and occasionally “stops action” to ask questions of the participants to evolve or refine the process in action.

In applying this philosophy of prototyping to organizations, IDEO’s approach shares some characteristics with the traditions of participatory design (see Bate & Robert, this issue). The most significant difference is in its objectives: The value of prototyping in participatory design is largely in making ideas explicit and directly engaging stakeholders, particularly users and others who will be impacted, in the development of effective design solutions (Holtzblatt & Jones, 1993; Muller, 1993). The emphasis is primarily on the design outcome. Sometimes, particularly in Scandinavia, participatory design practices are valued also for the personally enriching nature of the democratization of work design, as a process involving people in decision making about their work environment (Bodker, Ehn, Kammersgaard, Kyng, & Sundblad, 1987; Ehn, 1992). The design and prototyping approach that we describe in this article also supports these outcomes, but our emphasis is primarily on change in individual work behavior, organizational capability building, and cultural change as objectives and benefits of prototyping.

HOW DOES PROTOTYPING SUPPORT ORGANIZATIONAL CHANGE?

Human behaviors are intricately tied to the contexts in which they are played out. We have found that to change behavior, it helps to begin by changing context. And the quickest way to change context is to change it physically. This is why prototyping—rapid and evident change in the artifacts that make up context—is so useful.

Next, we describe three objectives of prototyping and share stories from our work to illustrate how prototypes can help speed the development of a new idea and encourage behavioral change within an organization. Although the stories we have chosen all come from the health care sector, this same approach has been successfully applied to organizations and challenges as diverse as Native American tribal

leadership, cross-enterprise supply chain design, the entertainment industry, and molecule development in the biotech industry. Indeed, we have yet to encounter an industry sector where the approach has not been welcomed as a refreshing new approach to facilitating organizational change.

HELPING ORGANIZATIONS LEARN HOW TO PROTOTYPE

Although no two client engagements are identical, the way we introduce organizations to the practice of prototyping as a mechanism for change follows a fairly standard path. We typically begin with a multiday event in which we coach a multi-functional design team through all steps of the design process with the purpose of generating ideas that support specific organizational goals (i.e., improving customer satisfaction, decreasing time to market of a new product, etc.). This process is comprised of collecting data about customer and employee behaviors, sharing findings to reveal areas of opportunity, translating brainstorm ideas into rapid prototypes, and coming up with experiment plans for how to introduce these new prototypes into the actual context of work. At the end of this initial stage of the process, the client design teams have developed a shared understanding of the organizational challenges and opportunities, generated hundreds of ideas about how to face the challenges and leverage opportunities, and designed a series of experiments to introduce their ideas into the organization.

In a next stage, we support teams as they bring their experiments “into the field” to refine them over time. Participants do this by introducing prototypes to multiple stakeholders to assess the ideas in the context of work. Ideas get refined based on stakeholder feedback and what is learned by interacting with the prototype in the real world context of work. Ideas with promise get further spread through the introduction of more experiments.

PROTOTYPING OBJECTIVES

As previously discussed, prototyping plays many important roles in the development of a new product, service, environment, or experience. In the realm of organizational change, prototyping helps with three primary objectives:

1. Building to think—rather than discussing, analyzing, or hypothesizing in abstract terms before acting, creating tangible expressions of ideas early enables organizational thinking to develop concretely through action.
2. Learning faster by failing early (and often)—making things tangible allows many small, low-impact failures to occur early, resulting in faster learning about what does and does not work and why.
3. Giving permission to explore new behaviors—the tangible presence of a new thing, the prototype, itself encourages new behaviors, relieving individuals of the responsibility to consciously change what they do.

Each of these objectives is discussed next with examples taken from our consulting work.

Objective 1: Building to Think

In school, we are taught to plan before we execute. We are encouraged to describe what we want to do before we do it. Prototypes allow us to develop ideas in a different way—by thinking with our hands. We may not have an idea completely developed, but the act of building it—putting our idea into a concrete format—allows us to push our thinking forward.

One cancer center we worked with asked us how we could help staff come up with innovative ways to provide a better experience for chemotherapy patients. A group of care providers and administrators participated in a multiday workshop to help them envision what it would be like to work in a truly patient-centered care environment. During the workshop, participants generated a large number of ideas about how to improve the patient experience at their cancer center. Toward the end of the workshop, small teams of 3 to 4 were asked to take an idea they were interested in, build an inexpensive prototype of it, and begin to test it with patients to evolve the concept (a process not dissimilar to the one Bate & Robert, 2007, describe for head and neck cancer patients but in line with its focus on action rather than analysis, with considerably less diagnosis and data collection at the “front end”).

One team’s initial idea was to create a binder for patients to collect useful information over time. As they began to imagine how the binder might be used and what specific information it might contain, the questions it raised for the team began to multiply: For example, who needed what information? Was a binder the right format to contain and access the information? Would patients remember to bring the binder with them to their appointments?

Overwhelmed with the number of unanswered questions, the design team decided to create a survey to ask patients the answer to the many questions they had generated. However, in the course of creating the survey, they generated another set of questions to be answered: What number of patients would represent an adequate sample size? What questions should they ask patients? How many surveys would they need? Would the data tell them what to do next?

Having reached a state of near paralysis (and 3 precious weeks into the 4 weeks we had allotted to prototyping!), we advised the team to abandon further research and to begin building something that could help them advance their thinking, even if they had not figured out exactly what. The team came up with the idea to build an “interactive device” that would help them discover what information patients would find most valuable. On the interface of this device would be an initial list of topics—their best guess as to the top 10 things about which patients would desire further information. We quickly built the device out of a piece of plain white paper with a dozen different colored post-it notes stuck to one side. On each post-it note was a topic, such as “the treatment process,” “waiting,” “parking,” “my test results,” and so on. We left a few post-it notes blank so that additional unanticipated patient questions/information could be captured. We then went with the design team to a waiting room to show their prototype to patients to get some feedback.

Through the act of building a rough prototype, the team was able to make immediate, dramatic progress. Rather than spend additional time trying to decide what to

create, they created something that represented their “best guess” as the starting point for the discussion. When they showed their prototype to patients and family members, they quickly discovered that customers’ needs were quite broad—too broad in fact to create a tool that would meet everyone’s needs. What they also discovered is that more valuable than the specific information being provided to patients was the personalized attention the patients were receiving by engaging with the prototype. Based on this early response to their initial prototype, the design team decided to abandon the idea of a binder altogether and instead morphed their idea into a series of “conversation cards” with which to initiate conversation with patients and family members. Patients in the waiting area were invited to look through the cards and choose a topic of most interest or concern to them at that time. The cards helped facilitate interaction between patients and care providers—it was easy to begin a conversation by the “invitation” provided by the cards. Through conversation (prompted by the cards), the staff were now able to answer questions of immediate relevance to patients or point the way to additional resources.

These conversation cards are now in widespread use. Their introduction as a prototype spawned the creation of a new protocol at the clinic: Each floor manager now spends 2 hours per week in the waiting area with the cards, moving from patient to patient to have conversations. Although met with some resistance by some staff members who were not part of the initial design team, the floor managers now report that the 2 hours a week they spend engaging patients are among the most rewarding time they spend at work. Had the team continued to approach this effort with their heads rather than their hands, we believe they would not likely have come up with such an ingenious solution to meeting patient needs.

Objective 2: Learning Faster by Failing Early (and Often)

A common belief is that failure is both costly and embarrassing and therefore best avoided. Yet, we know that failure is often a powerful way to learn. Within our work culture at IDEO we have found that prototypes help to create a “safe space” for failure and therefore free people up to make discoveries and to learn more quickly. In client organizations, we also work hard to help create this tolerance for failure, not catastrophic failure but a series of “micro-failures” that help move an idea forward more quickly.

At first blush, this rule of prototyping seems illogical. Surely the best way to reduce risk is to make sure to get it right the first time. However, if we acknowledge that (a) failure produces powerful learning for an organization and (b) seldom is the first solution to a problem the best one, then it stands that one can help an organization reduce risk by lowering the cost of learning. That is why we advise clients to think of the absolute cheapest and quickest way to test an idea before developing it further.

An example of this type of micro-failure comes from a program we carried out with a health care organization where frontline staff and administrators were charged with developing closer relationships with patients. One idea that came up was the idea that patients in the waiting area would like to know the names and faces of staff

members who were treating them. We encouraged them to quickly create a “face board” (consisting of hand-labeled photos of willing staff members taken with a Polaroid camera, mounted on a piece of foam-core board) and to hang this board in the waiting area to test their idea. After a week of observing how patients responded to the face board, they concluded that it was not actually helping them achieve their goal of developing closer relationships with patients.

When staff asked patients about their lack of interest in the board, patients told them that it was easy enough to discover the names of the people who took care of them (after all, everyone wore a name tag and introduced themselves to patients before treatment) and that furthermore, they did not want or need to know the names of providers who did not deal directly with them. One patient offhandedly suggested that what would be nice would be a way to learn more about the care providers they already knew.

Based on this early feedback, the staff took down the face board and brainstormed ways that patients could get to know them better. They came up with the idea of creating a photo album that would sit in the waiting area and would contain pictures of staff members with their families or engaged in hobbies or other activities. The design team asked interested staff members to contribute photos and text to create the album. This revised version of their idea was met with big success: Our clients reported that patients truly enjoyed seeing “another side” of their care providers. (Eventually, the album morphed into a large bulletin board, where staff competed with one another to see who could create the most interesting or amusing profiles of themselves.)

The moral of this story is that the early failure was not a failure at all—the first prototype enabled the staff to engage in a dialogue with their patients, and it helped to reveal (and meet) their patients’ needs in a way that a survey or interview could never have done. The “quick and dirty” nature of the prototype meant that no one was truly invested in the idea, thus making it easier to move on to a better idea. Had we invested more significantly in the idea, the organization would probably have viewed its failure as shameful. Instead, the early failure was viewed positively because it allowed the design team to learn more quickly about their patient needs and move on to a better idea with a minimum of investment.

Objective 3: Giving Permission to Explore New Behaviors

Behavioral change is difficult to achieve, in part because so much in our environment triggers established patterns of behavior. For example, our everyday dinner table configuration reinforces how family members relate to one another at mealtime and even how we consume our food. A meeting agenda reinforces the way in which a workgroup conducts its business. Prototypes provide a way to break established patterns: By introducing a “foreign” object into a familiar context, we create a level of consciousness about our behavior that then gives people the option of either following or not following the normal patterns. Tangible, visible representations of new behaviors serve as both encouragement to behave in new ways and as ongoing prompts or reminders of the new behaviors.

In that sense, prototypes actually give people permission to behave differently. People who might otherwise be hesitant to change behavior can use the prototype as their “excuse” to behave differently. In this sense, we think of prototypes as “transitional objects,” that is, objects that support a change from a current behavior to a new behavior.

A particularly rich example of how a prototype can change behavior comes from a project we did with postpartum nurses (involved in postnatal health for babies and their mothers) to improve their communication with other nurses, patients, and physicians. The prototype in question was a postpartum checklist that was placed in patient rooms to facilitate communication at shift change. In this hospital, shift change had typically taken place in the nurse’s lounge, with the outgoing nurse giving a series of quick patient reports and the incoming nurse taking notes. Needless to say, these exchanges were not only time-consuming (they required up to 45 minutes per pair of nurses), they were quite ineffectual because details about patient care were frequently omitted by the outgoing nurse or forgotten by the incoming nurse. In addition, it was impractical for patients, doctors, or family members to be made a part of the conversation, leading to further communication breakdowns.

It was through trying to address these communication issues that the design team came up with the idea of a board that would serve to prompt nurses to cover all the relevant issues at shift change. They decided that such a board would need to be placed in each patient’s room (Figure 2).

Upon placing early prototypes of the board in the postpartum patients’ rooms, the design team discovered some interesting behavior changes occurring. First, because shift change conversations were now happening in the patient room (in the presence of the patient), the patient became “invited” into the conversations and frequently asked questions or made comments. (This later influenced the design of the postpartum checklist so that the patient could read the board from her bed.) Second, the list of activities leading up to the patient’s discharge (these included things like a hearing test for the baby, car seat installation instructions, etc.) prompted patients and family members to proactively inquire about the care plan (“You mean I have to buy a car seat before we can leave the hospital?”). Third, the checklist gave nurses permission to ask questions of doctors about the plan of care or prompt the doctors to complete an activity. Similarly, the board gave doctors permission to confirm with nurses or patients any of the activities that had taken place, helping them to look more informed. (“I see your baby had her hearing test today. How did that go?”)

The placement of a simple prototype provided all of the different stakeholders with a powerful behavioral change mechanism, one that prompted and gave permission for them to engage in new patterns of behavior. Because it was introduced as an unfinished prototype (and not as a *fait accompli*), care providers and customers were given permission to improve it and to adapt it to their local context. Attempts to create these behavioral changes either by mandate or by training would not, we believe, have succeeded as quickly as the introduction of the prototype allowed.



FIGURE 2: Postpartum Checklist

IMPLICATIONS

Our discovery that prototypes are highly effective tools for organizational change has led us to the realization that just as important as the prototypes themselves are the activities and attitudes involved in the process of creating, testing, and refining them. We have learned that by adopting a process that involves prototyping, organizations commit their people's precious time and energy more effectively and more constructively. Time and energy that would be more usually spent discussing and planning, gathering and analyzing reams of information, trying to express and accommodate multiple stakeholders' often conflicting points of view, and making frustratingly imperceptible progress is instead employed in the creative, collaborative, and rewarding pursuit of learning together in forward-thinking and constructive activities. In its essence as a design synthesis tool, prototyping represents commitment to a new future. In contrast, prolonged analysis of existing or historical practices (implicit in many of the articles in this issue), even though undertaken with the goal of future change, inevitably feels rearward facing. By enabling people to give life to their early and unrefined ideas using this particular design method, we encourage them to engage others in collaboratively creating their future. The visible changes brought about by prototyping represent indications of progress and even when they result in small failures, are inherently motivating. Prototyping allows teams to make small easily reversible changes before everything is fully resolved and

to learn quickly by making recoverable errors of small scale. This is in contrast to typical patterns encountered in planned change programs where teams may become paralyzed by an either/both desire to think through a watertight plan before taking action and fear of making mistakes in implementing the plan. Not only does prototyping change the conversation, it changes behavior. Furthermore, we have learned that when organizations see one or two successful process changes emerge through prototyping, prototyping itself becomes an ongoing expectation and mode of behavior. We believe there is no more powerful way to help organizations transform the way they work.

NOTES

1. For a recent overview of the field of "transformation design," see Burns, Cottam, Vanstone, and Winhall (2006). For a description of IDEO's particular version of this work, see Coughlan and Prokopoff (2004).

2. IDEO is a design firm headquartered in Palo Alto, California. The firm employs approximately 500 people from a wide range of disciplines including industrial design, interaction design, human factors, mechanical engineering, and storytelling. Our programs range from traditional product and service development to brand strategy to organizational transformation.

REFERENCES

- Banathy, B. (1996). *Designing social systems in a changing world*. New York: Plenum.
- Bate, S. P., & Robert, G. (2007). Towards more user-centric OD: Lessons from the field of experience-based design and a case study. *The Journal of Applied Behavioral Science*, 43, 41-66.
- Bodker, S., Ehn, P., Kammersgaard, J., Kyng, M., & Sundblad, Y. (1987). A UTOPIAN experience: On design of powerful computer-based tools for skilled graphic workers. In G. Bjerknes, P. Ehn, & M. Kyng (Eds.), *Computers and democracy—A Scandinavian challenge* (pp. 251-278). Aldershot, UK: Avebury.
- Bruce, R., & Wyman, S. (1998). *Changing organizations: Practicing action, training, and research*. Thousand Oaks, CA: Sage.
- Buchenau, M., & Fulton Suri, J. (2000). Experience prototyping. In *Proceedings of Design of Interactive Systems 2000* (pp. 424-433). New York: ACM Press.
- Burns, C., Cottam, H., Vanstone, C., & Winhall, J. (2006). *Transformation design* (Red Paper 02). London: Design Council.
- Burns, C., Dishman, E., Johnson, B., & Verplank, B. (1995, August). "Informance": *Min(d)ing future contexts for scenario-based interaction design*. Paper presented at BayCHI meeting, Palo Alto, CA.
- Burns, C., Dishman, E., Verplank, B., & Lassiter, B. (1997, November). *Actors, hair-dos and videotape: Informance design*. Paper presented at Presence Forum, Royal College of Art, London.
- Coughlan, P., & Prokopoff, I. (2004). Managing change, by design. In R. Boland & F. Collopy (Eds.), *Managing as designing* (pp. 188-192). Stanford, CA: Stanford Business Books.
- Ehn, P. (1992). Scandinavian design: On participation and skill. In P. Adler & T. Winograd (Eds.), *Usability: Turning technologies into tools* (pp. 96-132). New York: Oxford University Press.
- Ehn, P., & Kyng, M. (1991). Cardboard computers: Mocking-it-up or hands-on the future. In J. Greenbaum & M. Kyng (Eds.), *Design at work: Cooperative design of computer systems* (pp. 169-195). Hillsdale, NJ: Lawrence Erlbaum.
- Erikson, T. (1995). Notes on design practice: Stories and prototypes as catalysts for communication. In J. Carroll (Ed.), *Envisioning technology: The scenario as a framework for the system development life-cycle* (pp. 37-58). New York: John Wiley.

- Holtzblatt, K., & Jones, S. (1993). Contextual inquiry: A participatory technique for systems design. In D. Schuler & A. Namioka (Eds.), *Participatory design: Principles and practices* (pp. 177-210). Hillsdale, NJ: Lawrence Erlbaum.
- Houde, S., & Hill, C. (1997). What do prototypes prototype? In M. Helander, T. Landauer, & P. Prabhu (Eds.), *Handbook of human-computer interaction* (2nd ed., pp. 367-381). Amsterdam: Elsevier Science.
- Kelley, T. (2001). *The art of innovation: Lessons in creativity from IDEO, America's leading design firm*. New York: Currency Doubleday.
- Leonard, D., & Rayport, J. (1997). Spark innovation through empathic design. *Harvard Business Review*, 75(6), 102-113.
- Muller, M. (1992). Retrospective on a year of participatory design using the PICTIVE technique. In *Proceedings of CHI '92* (pp. 455-462). New York: ACM Press.
- Muller, M. (1993). PICTIVE: Democratizing the dynamics of the design session. In D. Schuler & A. Namioka (Eds.), *Participatory design: Principles and practices* (pp. 211-237). Hillsdale, NJ: Lawrence Erlbaum.
- Schrage, M. (1999). *Serious play: How the world's best companies simulate to innovate*. Boston: Harvard Business School Press.
- Vertelney, L., & Curtis, G. (1990, April). *Storyboards and sketch prototypes for rapid interface visualization*. Paper presented at CHI 1990, Seattle, WA.
- Wagner, A. (1990). Prototyping: A day in the life of an interface designer. In B. Laurel (Ed.), *The art of human computer interface design* (pp. 79-84). Reading, MA: Addison-Wesley.
- Weick, K. (2001). *Making sense of the organization*. Cambridge, MA: Blackwell.
- Wong, Y. (1992). Rough and ready prototypes: Lessons from graphic design. In *Posters and short talks of the 1992 SIGCHI conference on human factors in computing systems* (pp. 83-84). New York: ACM Press.