8

Visual Research Methods in the Design Process

Prasad Boradkar

INTRODUCTION

Design, like the arts, is often regarded as a visual discipline. The design disciplines have, throughout their histories, actively engaged visual methods of problem-solving. Architecture, industrial design, graphic design and interior design – some of the core design disciplines – clearly employ a variety of visual techniques in their standard praxis. The creation of aesthetically appealing artifacts is often described as one of design's primary goals and, therefore, the research that is conducted in the design disciplines includes several visual methods. These typically include photography, videography, sketching, diagramming, storyboarding, model-making, prototyping, and so on. A variety of visual practices exist as a central component of all phases of design methodology, from the early research in understanding user needs and leading up to the final implementation or manufacturing. In fact, one may say that design as a discipline has been obsessed with the visual ever since its inception. However, the growing use of ethnography in design (mostly observations, interviews, surveys, etc.) might, in some ways, signal somewhat of a turn away from the visual. In the world of product design, a project that focuses primarily on designing an object's shape or form is often referred to as 'styling,' and some designers are offended to be referred to as stylists. They believe that their work extends beyond the visual. Designers are embracing the notion that their task is to solve people's real needs, not merely create beautiful artifacts. Therefore, while there may be a growing recognition and acceptance of visual research methods in the social sciences, design research, over the past few years, seems to be trying to get beyond the visual.

Understanding design

What is design? This question is continually asked by scholars within the design community, and the answers vary widely, in part due to the relative youth of the design disciplines. In addition, as it evolves, design takes on new meanings, adopts new methodologies, addresses a broader range of

Scholar	Definition
Herbert A. Simon	Devising courses of action aimed at changing existing situations into preferred ones
J. Christopher Jones	Initiating change in manmade things
L. Bruce Archer	Collected experience of the material culture, and the collected body of experience, skill and understanding embodied in the arts of planning, inventing, making and doing
Christopher Alexander	The process of inventing physical things which display new physical order, organization, form, in response to function
Horst Rittel	Structuring argumentation to solve "wicked" problems
Donald Schon	A reflective conversation with the materials of a design situation
Pelle Ehn	A democratic and participatory process
Jens Rasmussen/Kim Vicente	Creating complex sociotechnical systems that help workers adapt to the changing and uncertain demands of their job
Richard Buchanan	The conception and planning of the artificial
Gui Bonsiepe	Design is concrete invention to develop and produce artifacts

Figure 8.1 Diversity in definitions of design, an updated version of the diagram from Atwood et al. (2002)

problems, and redefines its scope, making it challenging to find a singular definition. A comparative study by Atwood et al. (2002) demonstrates some of the semantic diversity visible in the various definitions of design (Figure 8.1).

The authors explain that this list is by no means exhaustive; the individual definitions represent a small sample extracted from seminal definitions that scholars have formulated over time. Some common threads do emerge from this diversity. It is clear, for instance, that all design is a form of planning and problem-solving for the future. The employment of such terms as 'action,' 'change,' 'inventing' and 'creating' in these definitions establishes design as a generative process of transformation that leads to tangible outcomes. If the goal of design, as Max Bill of the Hochschule für Gestaltung in Ulm once explained, is 'to participate in the making of a new culture – from spoon to city' (Lindinger, 1991: 10), its scope is vast and the diversity in definitions is only to be expected.

DESIGN'S (SUB)DISCIPLINES

The wide variety of (sub)disciplines, such as architecture, industrial design, graphic design, interior design, fashion design, interaction design, and so on, included under the label of design, only complicate the task of creating singular definitions further. The divisions among the various forms of design practice serve a critical role. The design and manufacturing of products present challenges that are far different from those faced by an architect who is called on to oversee the design and construction of a building.

The designs of objects, graphics, websites, buildings, etc., require a related yet distinct set of skills and tools, and therefore each of these disciplines defines its task on its own terms. The Industrial Designers Society of America (IDSA), for instance, defines industrial design as 'the professional service of creating and developing concepts and specifications that optimize the function, value and appearance of products and systems for the mutual benefit of both user and manufacturer' (IDSA.org, 2009). The American Institute of Graphic Arts (AIGA) defines graphic design as 'a creative process that combines art and technology to communicate ideas. The designer works with a variety of communication tools in order to convey a message from a client to a particular audience. The main tools are image and typography' (AIGA.org, 2010). And, according to the American Institute of Architects, 'architecture is the imaginative blend of art and science in the design of environments for people' (AIA.org, 2010). While there are clear differences among the disciplines of industrial design, graphic design and architecture, the inclusion of such terms as 'appearance' and 'art' in their definitions make it clear that the visual plays an important role in all forms of design. And, therefore, visual methods of research play an equally critical role. This chapter focuses on some of the visual research methods used in industrial design in the development of new products.

DESIGN AS ART AND/OR SCIENCE

The fundamental goal of the design of a product, room, poster or building is the creation of a tangible artifact for a client and/or a consumer. In this process, design has to engage the professions of engineering and business, as the goods produced have to be manufactured and they have to be sold. In addition, they have to be appealing to the buyer. This form of appeal includes beauty, utility, safety, accessibility, affordability, sustainability, durability, identity, brand recognition, emotional connection, symbolic meaning, etc. Of all these qualities, beauty and utility have garnered the most attention through design's history; *form* and *function* are regarded as the two primary concerns of the designer. Things have to look good and they have to work well. If designers are expected to create artifacts that are beautiful and functional, they have to be trained artistically and they need to understand the principles of engineering. It is therefore no surprise that design has been described at times as a form of art and at times as science. However, both these characterizations have been rejected by design scholars. 'The concept that design is closely related to the world of art is deep-rooted. But opposing this widely shared opinion is the fact that design is design and not art' (Bonsiepe and Cullars, 1991: 20). Further along in the same essay, Bonsiepe and Cullars note that 'there can be a scientific component to design discourse, but design by its very constitution is not science' (21). There is recognition that design is both, and cannot be strictly defined as one or the other. 'It is misleading to divide human actions into "art", "science", or "technology", for the artist has something of the scientist in him, and the engineer of both, and the very meaning of these terms varies with time so that analysis can easily degenerate into semantics' (Smith, 1970: 493). Design is inherently interdisciplinary; it is the discipline which straddles craft and science, creativity and commerce, the humanities and the social sciences, art and engineering. Design is generative and analytical; it demands creative thinking and critical problem solving. If such is the task of design, its practice necessitates the practitioner to draw upon the type of knowledge that resides in disparate disciplines, and requires a type of thinking that is flexible enough to fluctuate between divergent and convergent modes – divergent thinking for the creative and brainstorming tasks, convergent thinking for the analytical tasks.

DESIGN'S RELATIONSHIP TO THE VISUAL

Designers working within corporations or as consultants are often called upon to update the appearance of products through manipulation of form, color, material and textures. While design practice includes much more, projects that involve mostly aesthetic modification of products are not unusual. And while designers take the task of beautification as an important responsibility, pure styling is also sometimes perceived as superficial ornamentation and therefore has negative connotative meanings. 'Designers of all stripes regularly lament that they are seen by the rest of the world as stylists – pseudo-professionals brought in to smooth the edges, improve the palette and make the medicine go down more easily' (Lunenfeld, 2003: 11). The industrial design profession often bristles at this word and is unhappy when its work is described as mere modification of product form for market differentiation and increased profits. In design practice today, there is increasing attention being given to ethnographic research, human-centered methods and sustainability. This testifies to the gradual shift in design's image – within and outside the profession – from a style-driven occupation to an empathic, problem-solving practice.

Design's relationship to the visual is evident in common language too – the word design is often used to refer to style. Design, in noun form, can mean spatial arrangement, compositional layout or pattern (as in the design of a room or quilt or other material artifact). In addition, articles about design in the popular press often tend to emphasize the visual, stylistic and sensual qualities of products. After all, the most visible aspect of all design work is appearance. Over the last decade, however, there has been a perceptible shift in how design is 'read' and therefore written about by journalists, critics and business writers. Design has been steadily gaining recognition as a key activity in processes of innovation, and offers tangible and intangible benefits to all stakeholder, including the users, manufacturers, society and the environment.

DESIGN RESEARCH

The classical definition of design research is traced to Bruce Archer, who presented it at a conference of the Design Research Society in 1980. According to Archer, 'design research is systematic inquiry whose goal is knowledge of, or in, the embodiment of configuration, composition, structure, purpose, value, and meaning in man-made things and systems' (Bayazit, 2004: 16). This definition is expansive enough to sweep up a broad range of investigations surrounding design's process and its end product. Since Archer, a variety of scholars have produced articles and books on design research (Downton, 2003; Laurel, 2003; Cross, 2007; Ralf, 2007), several design research conferences have been organized, and in 1966, the professional organization called the Design Research Society was formed. Bayazit lists five major concerns of design research as they apply to design methodology and design science:

1. Design research is concerned with the physical embodiment of man-made things, how these things perform their jobs, and how they work.
2. Design research is concerned with construction as a human activity, how designers work, how they think, and how they carry out design activity.
3. Design research is concerned with what is achieved at the end of a purposeful design activity, how an artificial thing appears, and what it means.
4. Design research is concerned with the embodiment of configurations.
5. Design research is a systematic search and acquisition of knowledge related to design and design activity (Bayazit, 2004: 16).

It is clear from the list above that design research deals primarily with the analysis of

human-made artifacts as well as understanding the process of doing design. And there are several reasons why visual methods play a critical role in design research:

1 The artifacts of human design have a visible presence in the world, and designers pay careful attention to the visual quality of things. In other words, designing aesthetic appeal into things is an important component of the design process, and therefore visual techniques are central to design activity.
2 Giving shape to things involves the processes of sketching, computer visualization, illustration, model-making, etc., and all these methods are forms of doing research. All of them involve the use of images.
3 The utilization of ethnographic methods to discover consumer needs and to document how consumers use products is now standard practice in design. The use of photography and videography is central to this practice.

Figure 8.2 shows the research methodology for a product development project that includes primary research for understanding user needs and secondary research for technology and market research. Such visual tools are often used in planning research projects in design.

FORMS OF VISUAL RESEARCH IN THE DESIGN PROCESS

Throughout the process of new product development, designers use a variety of visual and tactile means of doing research. There are several methodologies that outline the process of design and innovation. Figure 8.3 is a generic process of innovation as explained in the Harvard Business Essentials book *Managing Creativity and Innovation* (Luecke, 2003). With some variation, all generic processes of innovation and new product development include the phases of research, analysis, ideation, idea selection and implementation.

Corporations involved in new product development routinely customize this process

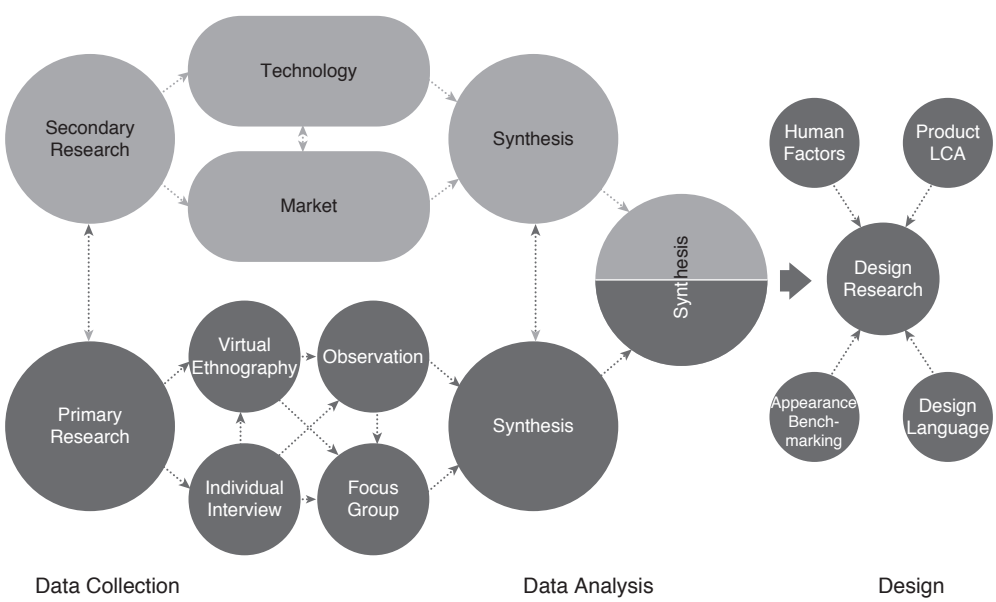

Figure 8.2 Research methodology for a product development project known as the In-Class Communicator, a product that assists students with low vision in the activity of note-taking in the classroom. (illustration by Liqing Zhou.)

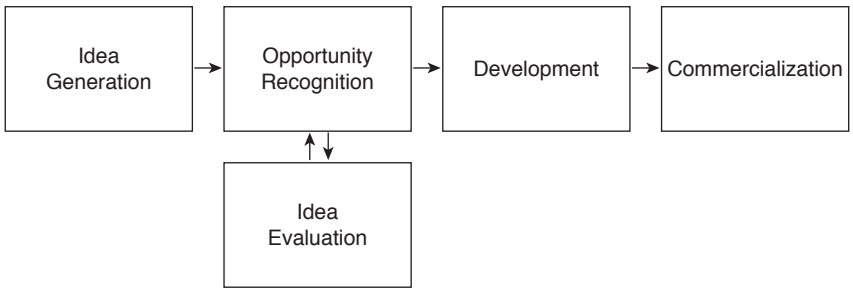

Figure 8.3 'The Innovation Process' by Luecke, R. (2003), from the Harvard Business Essentials book *Managing Creativity and Innovation*, pp. xi

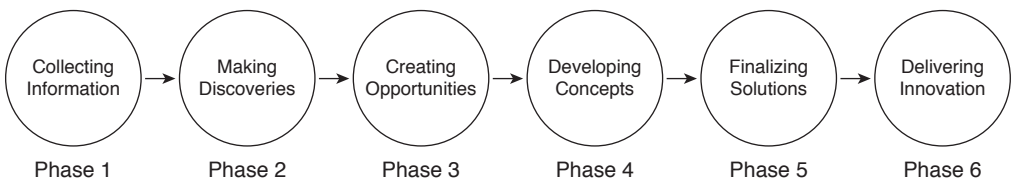

Figure 8.4 The process of new product design and development

to suit the unique characteristics of their institution. The *PDMA Handbook of New Product Development* (Kahn, 2005) lists a variety of these industry-specific variations. The process illustrated in Figure 8.4 is one variation that is employed by transdisciplinary new product development teams of design, business and engineering students at Arizona State University, in a program called InnovationSpace. Students in this program learn how to develop new product-service systems that address significant social problems while minimizing impacts on the environment. Examples include medication management devices for older adults, reading aids for people who are blind and visually impaired, renewable energy systems for people living off the electrical grid, and so on. The process involves a series of steps that include research, analysis, ideation, development, refinement and delivery (Boradkar, 2010). Each phase calls for a set of visual methods of research and problem-solving. For instance, the earlier phases involve primary and secondary data collection as well as analysis, and therefore photography, videography and diagramming are the key visual tools used. During the ideation and development phase, designers tend to use the visual skills of drawing, sketching and digital renderings as well as computer modeling. And, finally, in the refinement and delivery phases, prototyping and presentations play a key role. The following explanations of the phases of new product development include descriptions of some of the visual research tools used.

Phase 1 – Collecting information

The process of design starts with collecting information about consumers, the market, potential technologies, related social issues and environmental conditions. The goal of Phase 1 is to understand the needs and desires of the people for whom the product is being designed, the constraints and possibilities presented by technology and engineering, competition in the marketplace

with other industries, social trends that will affect and be affected by the new design, and environmental conditions that have to be considered to make the product sustainable. The activities include comprehensive primary and secondary research such as literature reviews, interviews with experts and users as well as ethnographic observations.

As designers and design researchers collect information in Phase 1, they typically use photography as well as videography to document users' behaviors, lifestyles and daily activities. In situations where the project involves the redesign of an existing product, the goal is to capture visual data that can help document how people operate existing products and discover means by which to make them better. Design researchers routinely conduct observations and interviews with users and collect images and audio to serve as raw data to be analyzed in Phase 2 of the design process. The other information collected at this stage may include images of competitors' products, market research reports and technology briefs that help map out the context within which the new designs are meant to operate.

The complexity of the project often determines the type of data collected and the methods used. For instance, large urban design projects might require a large team of researchers, several citizen participants and a wide range of tools. Figure 8.5 is a photograph of a low-income neighborhood in Phoenix, Arizona, where a team of graduate students in architecture and industrial design – called Studio 1:1 – used interviews, observations and other ethnographic methods in order to understand the context and develop solutions that appropriately addressed

Figure 8.5 Photograph of a low-income neighborhood in Phoenix, Arizona (photograph by Studio 1:1)

the needs of the community. Several such photographs served as initial data in mapping the neighborhood visually.

Phase 2 – Making discoveries

The objective of Phase 2 of the design process is to analyze the data gathered in Phase 1 with the hope of discovering unique insights that can help the designers in fashioning the new product or service. A variety of analysis tools are typically deployed to derive insights about the context within which the new product will exist. A comprehensive research report typically emerges at the end of this phase that catalogs key research insights concerning the user, market, technology, society and the environment. At this stage, quantitative and qualitative data are represented through such visual means as bi-axial diagrams, illustrations, charts, timelines, etc. The visuals serve to convert complex textual or statistical data into more accessible information.

For instance, Figure 8.6 shows consumer preference for transportation in urban environments in the form of a three-dimensional diagram that also shows interrelationships. Similarly, Figure 8.7 shows a hierarchy of transportation needs of the key stakeholders (commuters, businesses, the municipality and society at large) in an urban environment. These diagrams illustrate that visual information can help in not only representation of data but also in its comprehension.

Figure 8.8 is an illustration of some of the data gathered by the team members of Studio 1:1 regarding automobile traffic, aircraft flight patterns, noise levels and the routine, everyday activities of the people living in Memorial Towers, a non-assisted senior apartment living complex in Phoenix, Arizona. The researchers discovered that many of the older adults living there had redesigned their environments and repurposed the facilities to suit their needs. For instance, many had placed potted plants so they had visual access to greenery, many were using the large open parking space for exercise and using underutilized spaces as gardens. The illustration shows view angles, walking/exercise paths and the gardens. Such visual representations are critical in bringing research insights to life for the design team.

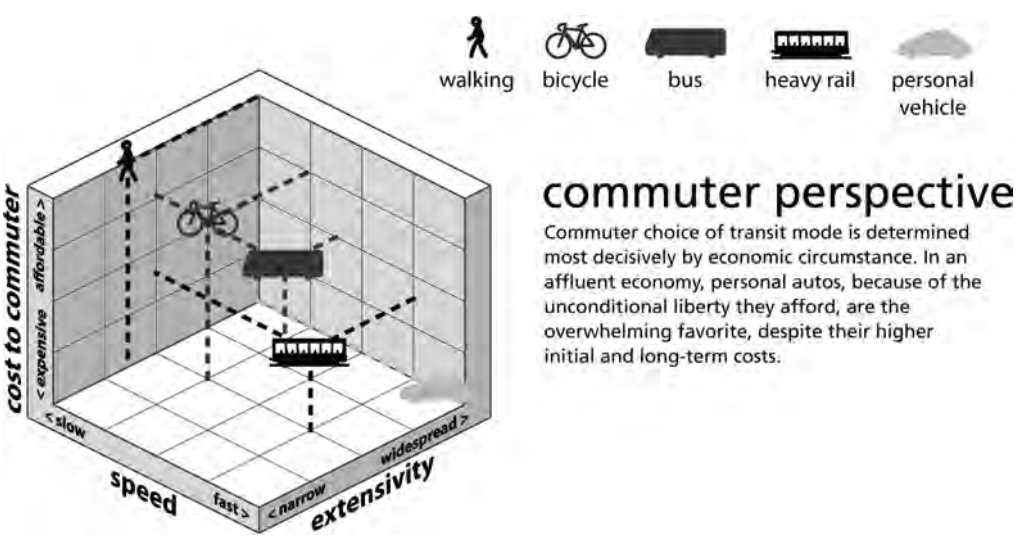

Figure 8.6 Transportation Needs Assessment Diagram for Multiple Stakeholders (Illustration by Katherine Randall and Luke Morey)

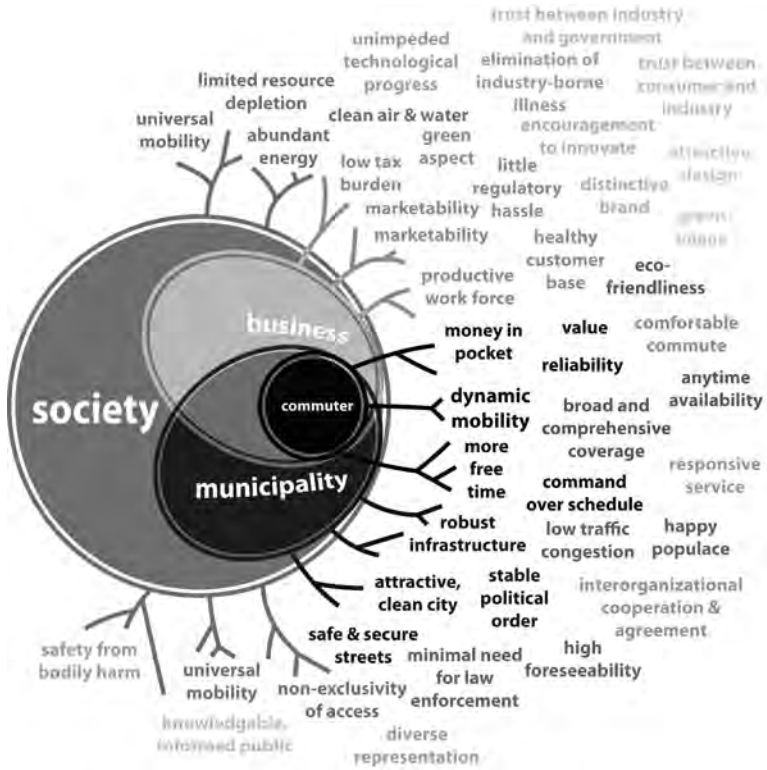

Figure 8.7 Product Benchmarking for A New Braille Reading Device (Illustration by Qian Yang)

Similar illustrations are often created for market and engineering analyses as well. Figure 8.9 shows an example of product benchmarking – a visual tool that is often used to map industry competitors. In this case, the benchmarking shows a variety of portable and desktop devices that use display and software-based technologies to assist people who are blind. The diagram presents the unique insight that there might be a market opportunity for portable display-related technologies, as there are very few competitors in that space.

Phase 3 – Creating opportunities

During Phase 3, the product development team starts generating ideas for how the problems identified during research can be tackled through the design of new products, brands and services. Also referred to as ideation, this phase involves brainstorming and other creative problem-solving exercises aimed at generating as many ideas as possible. These solutions are typically visualized through product sketches, digital renderings, and quick models. Figure 8.10 and 8.11 are examples of sketches developed for a product that assists students who are partially blind with the process of taking notes during a lecture in a classroom. These sketches provide information about the form, shape, color, texture and materials that could be used in the design of the new assistive device.

Figure 8.12 illustrates the visual and tactile rough models that are constructed during

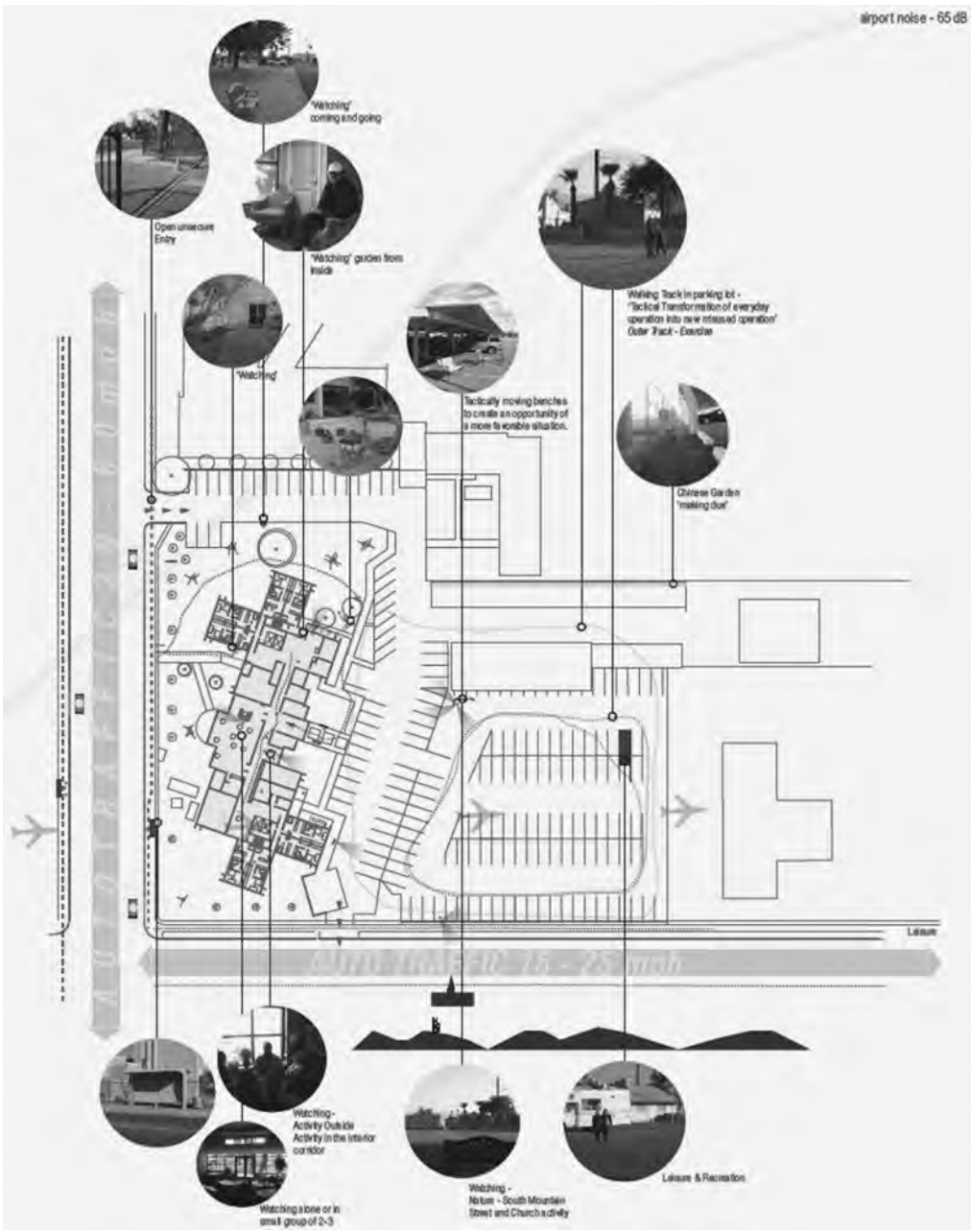

Figure 8.8 Diagram of Memorial Towers, a senior apartment complex showing patterns of use and behavior (Illustration by Studio 1:1)

Figure 8.9 Product benchmarking for a new Braille reading device (illustration by Qian Yang)

Phase 3 as a means to develop a three-dimensional understanding of the product's form, scale, size, shape and feel. While the two-dimensional sketches provide an early visualization of what the product might look like, the three-dimensional models provide a higher level of fidelity and tactile representation of form.

Phase 4 – Developing concepts

The aim of Phase 4, the process of developing a single concept in further detail, is to start making critical decisions to resolve all issues relating to the proposed product design concept. The activities in this phase include making strategic decisions about how this product can be designed, branded, engineered and sold. The visual materials developed in Phase 3 are developed further and additional sketches and models are created to start the process of finalizing the design. During this phase, many of the decisions about the aesthetic development are made and the final product starts taking form. The sketches created in Phase 3 are embellished with further detail and rapid prototyping machines are often utilized to build three-dimensional models.

One of the fundamental goals of design research is to inspire designers and make them truly understand the lives for the people for whom they are creating design solutions. Research has to instigate empathy. Studio environments where creative design work often happens are visually active spaces replete with photographs, diagrams, sketches and models to serve as inspirations. The visual energy plays a critical in helping designers translate research insights into tangible solutions. Figure 8.13 shows one such example of a research and design environment.

Figure 8.14 shows an illustration of the development of a design language. A design

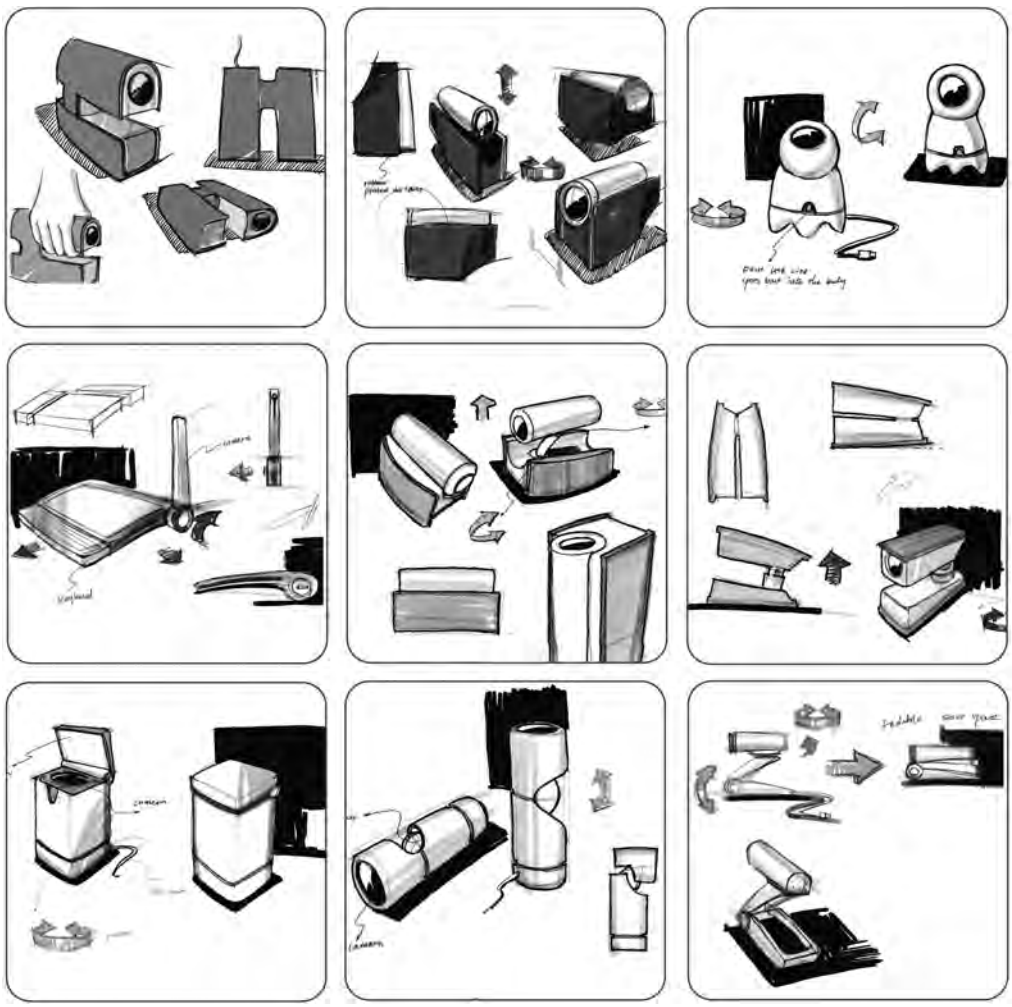

Figure 8.10 Product sketches for the In-Class Communicator, a product that assists students with low vision in the activity of note-taking in the classroom (sketches by Liqing Zhou)

language (also referred to as the aesthetic language) helps the designers define the kinds of forms, colors, shapes and details that will best suit the context and the needs of the consumers. For instance, in Figure 8.11, for the design of a Braille reading device, the designer has identified 'simplified, rounded, organic and smooth' forms as appropriate for the user group, which in this case is people who are totally blind. Similarly, 'obvious contour lines' have been included in the design language as critical for the users to be able to maneuver the product and find the buttons through tactile means.

Phase 5 – Finalizing solutions

The purpose of Phase 5 is to finalize the design and engineering for the product, along with the graphic language and marketing materials. In this phase, designers create final digital illustrations (also referred to as renderings) and appearance models that

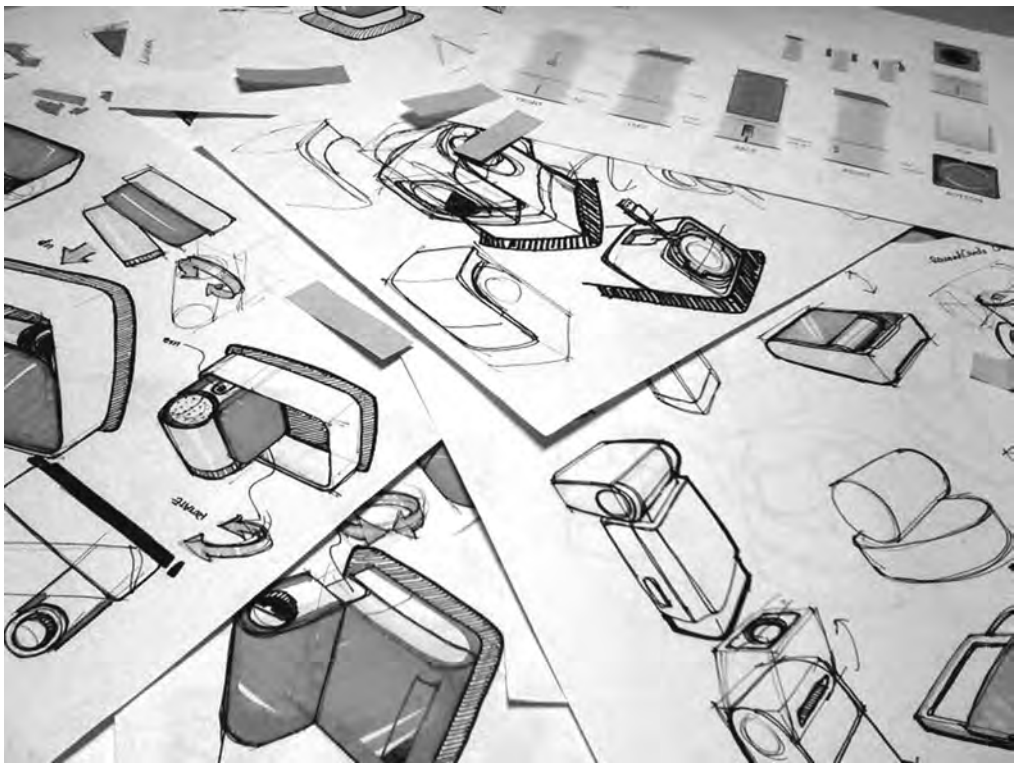

Figure 8.11 Product sketches for the In-Class Communicator, a product that assists students with low vision in the activity of note-taking in the classroom (sketches by Liqing Zhou)

demonstrate the product appearance. In additional to design drawings, at this stage, detailed and accurate engineering drawings and functional prototypes are also prepared to finalize the solution.

During this phase, storyboards outlining the process of installation, use and repair are also generated.

Phase 6 –Delivering innovation

The goal of this phase is to demonstrate the final product solution through appropriate materials to clients, investors or other experts. The activities include the development of text-based, visual and presentational media to communicate and promote the project to an audience.

The visual research tools used in the six phases of the new product design and development process outlined above are but some of the tools used by designers; new methods are routinely developed and disseminated.

CONCLUSION

The application of critical research methods in the disciplines of design is relatively new. Often accused of focusing too much attention on the visual aspects of artifacts, designers have adopted a variety of research methods into their profession to ensure that their practice is taken seriously. The growing recognition of design research and the widespread use of rapid ethnography in design are indicators of this shift. And while the visual continues to play a central role in all design praxis, tactile forms of research are

Figure 8.12 Rough conceptual models of the In-Class Communicator, a product that assists students with low vision in the activity of note-taking in the classroom (photographs and models by Liqing Zhou)

Figure 8.13 The Studio 1:1 creative environment (photograph by Studio 1:1)

Figure 8.14 Design language for a new Braille reading device (illustration by Qian Yang)

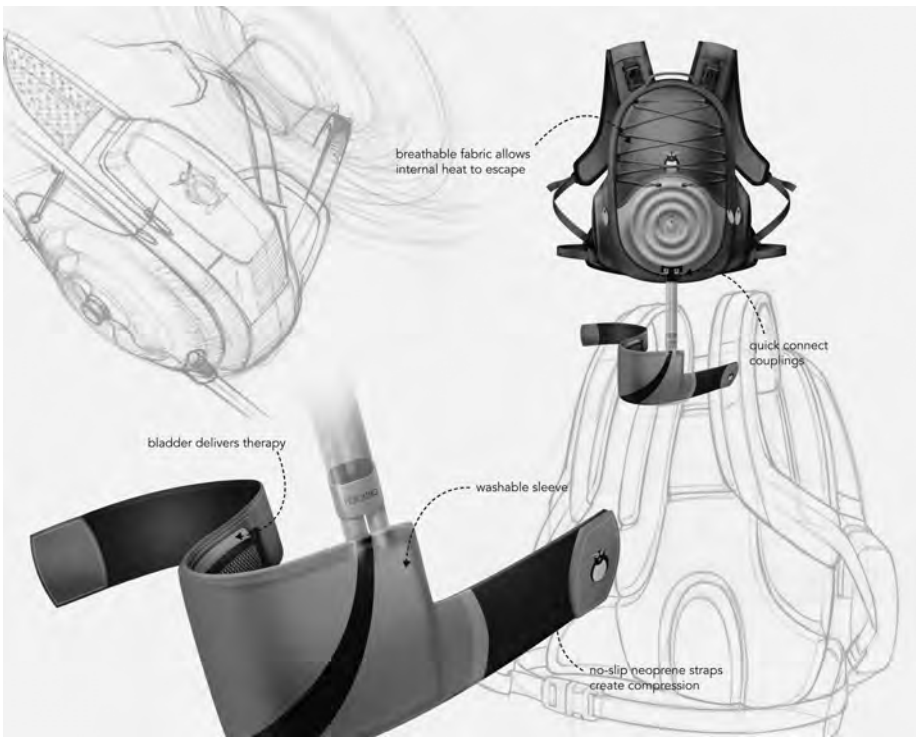

Figure 8.15 Final product rendering for a therapeutic backpack with hot–cold therapy (illustration by Matt Storey and Shelby Sandler; project sponsored by Dow Corning Corporation)

Figure 8.16 Final digital renderings of the In-Class Communicator, a product that assists students with low vision in the activity of note-taking in the classroom (illustration by Liqing Zhou)

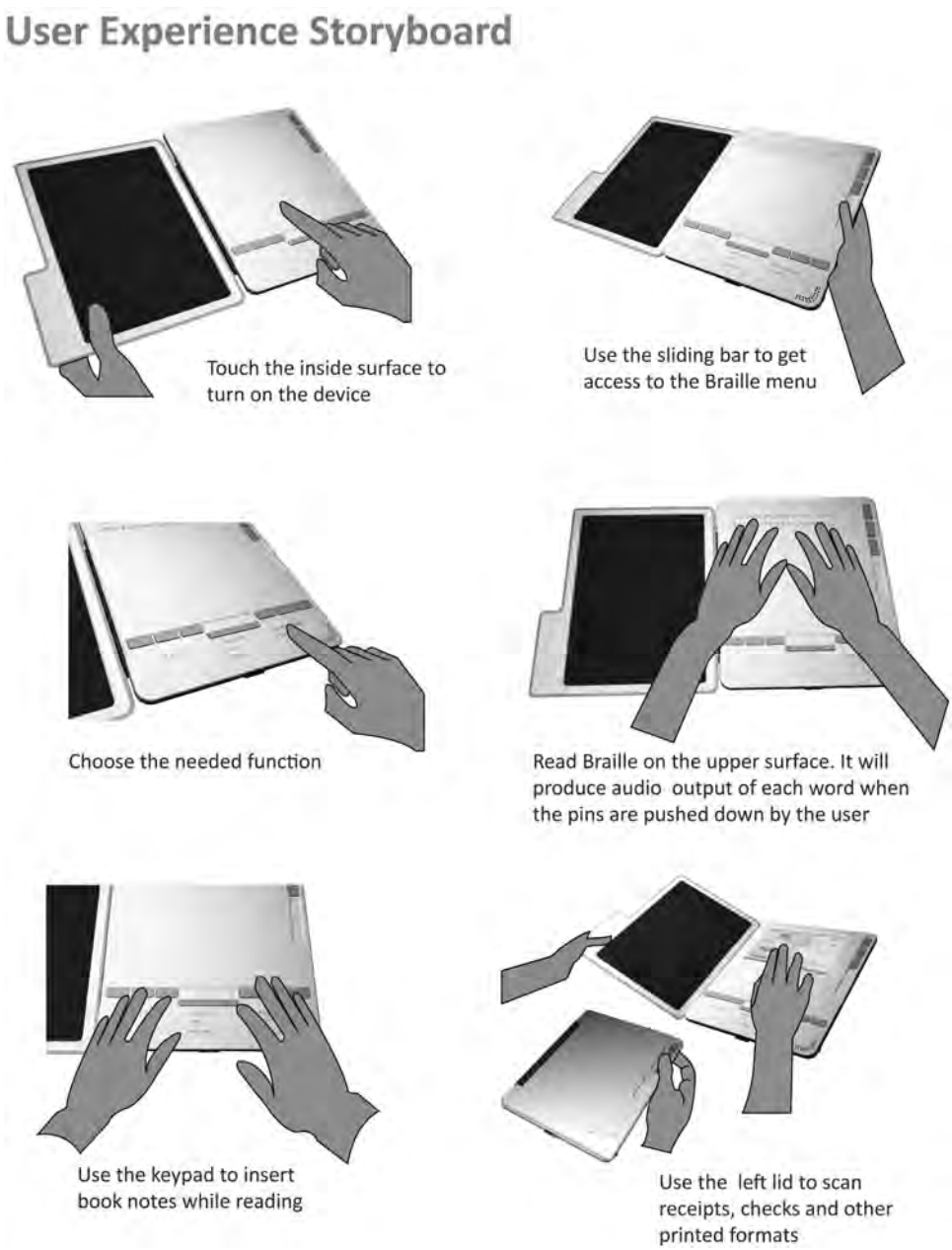

Figure 8.17 User experience storyboard for a new Braille reading device (illustration by Qian Yang)

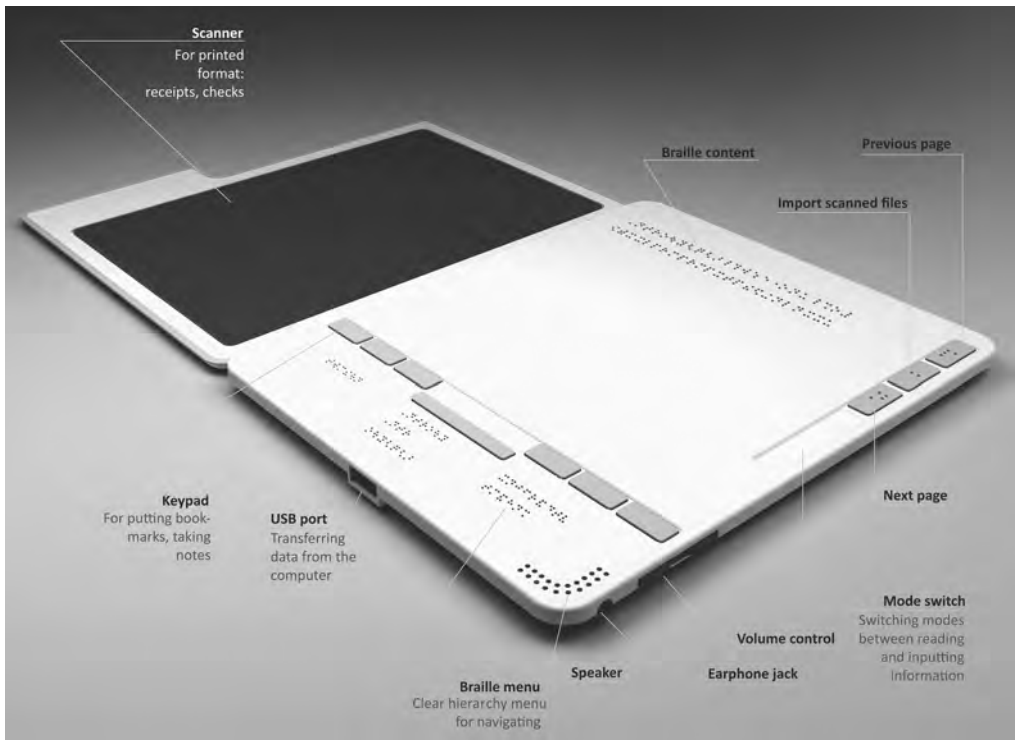

Figure 8.18 Final digital rendering for a new Braille reading device (illustration by Qian Yang)

equally important too. Whereas photographs, videos, sketches and renderings are valid forms of visual research, prototyping and model-making step beyond the visual into the tactile realm. It is also important to note a key distinction between the visual data used in design research and that used in social science and humanities research. Much of the photography and videography employed in design and other forms of research attempt to capture the world as truthfully and objectively as it appears. Many of the visual and tactile methods used in design rely on image creation rather than image capture. The sketches and renderings developed by designers are not representations of the world outside but visualizations of ideas that are yet to take physical form. 'Design research is inherently paradoxical: it is both imaginative and empirical' (Johnson, 2007: 39). Visual research changes roles gradually through the design process. Photographs and videos of users that are taken early in the design process represent the empirical nature of visual research, while the sketches and models that are created later emerge from the imagination. Visual research in design can therefore serve two roles – it can help us in making sense of the material world in which we live and also help us in understanding the creative process of design thinking.

ACKNOWLEDGMENTS

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