A generic model of design thinking:

Mini-case-based arguments

Under review by European Journal of Innovation Management

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Abstract

Purpose
Our generic model of design thinking builds on tractable, simple, mini-case based definitions of the elements of design thinking. Relationships between design thinking elements (two contextual and five processes) are described.

Methodology
Primarily case-based evidence, using abbreviated multiple mini-cases, drawing on historically prominent stories as well as the authors’ experiences in practice and academia. Selected academic literature is cited, but the focus is on building a model using real-world stories.

Findings
Our proposed generic model of design thinking has its basis in real-world stories and design education activities. Our plausible codification of design thinking practices holds potential for unpacking the answer to questions such as “what constitutes a high performance approach to design thinking?”

Research implications
Though a plausible generic model has been proposed, it awaits empirical confirmation, reflecting a major research opportunity. Also, a logic of design thinking issues and associated fixes is presently lacking. We open the door to further coherent exploration (theoretical and empirical) of the question “what organizational/team/individual settings are most suited to prosperous design thinking?”

Practical implications
We offer a set of simple, measurable elements of design thinking (2 context-related, five action-processes). We put these elements into a simple model of design thinking that illustrates the processes and sequences that comprise the interaction between design thinking elements. Managers looking to emulate this model of design thinking have potential to improve their organization’s innovative performance.

Originality/value
We offer an original articulation of a plausible, simple generic model of design thinking using real-world-based definitions.

Keywords: Design thinking, innovation, creativity, generic model.

Classification: Conceptual Paper/Case Study (has strong elements of both)
1. Introduction

Business managers’ interest in achieving successful innovation outcomes has never been greater. Innovation that successfully minimizes costs and increases profitability is highly valued. The nature of “proper” design process has, however, remained elusive. Innovation, design, and fomenting innovative processes inside firms are receiving substantial popular attention, much of it misdirected. Via multiple examples (largely from the realm of product design) we use several mini-cases to help us define elements of design thinking and propose an untested, but relevant framework for understanding "contemporary" design thinking (DT). Our proposed design-thinking dimensions are lacking in much of the popular and scientific literature: multidisciplinary teams, fluency, user-centered research, prototyping, critique, iteration, and form-giving.

Martin (2007) states “we are on the cusp of a design revolution in business, and as a result, today's business people don't need to understand designers better, they need to become designers.” Martin advocates the (trademarked) terms “integrative thinking” as a process to achieve superior “business design.” We applaud Martin’s basic thrust, and view it as broadly compatible with our own. Martin’s interest is somewhat more epistemological: he is concerned with state of knowledge of design in organizations. We propose a concrete design process model, a framework into which design thinking knowledge and increasing experience with DT processes may be embedded and enacted in organizations.

We offer some refinements to Martin’s approach by providing concrete, tractable definitions of our seven proposed design thinking dimensions. We unify these dimensions in a simple design thinking model illustrating how the dimensions interact. Our paper is primarily descriptive, and our evidence based on history and the authors’ anecdotal experiences consulting as well as working in both design and business schools. Our pre-formal work is provocative in
that it contains rich raw material for new testable hypotheses using real-world measures for testing and confirming (or refuting) parts of our model. We consciously attempt to define design thinking elements and the accompanying model in an empirically tractable manner to facilitate future research efforts.

This paper proceeds as follows: we next briefly discuss existing conceptions of design thinking and summarize cogent scholarly work in this area. We then offer an original definition of design thinking by specifying multiple dimensions comprising design thinking. We offer a preliminary model showing how these elements (optimally) interact. We conclude by offering our some thoughts on the issue of embedding design thinking practices in organizations, a task that comprises a major challenge for most organizations.

2. Prior conceptions of design thinking

Our purpose here is not to trace the origins of the term design thinking, but to note that several prominent institutions have shaped what goes into current conceptions of design thinking. For example, taken from a design education view, MIT (Media Lab started in 1982), during the 1950s and 1960s was a hotbed of research on creativity and design thinking skills, though it was certainly not labeled as such at the time. - Stanford’s Product Design program, started in the early 60’s by John Arnold, himself from MIT, and Robert McKim, formalized the teaching of design thinking, called “product design” at the time, and created the first degree granting program in the US. Robert McKim’s dissatisfaction with the “designed to sell” design thinking typical of 1960s and 1970s mentality (he had worked on Madison Avenue at the prestigious design firm of Henry Dreyfuss) led him to develop an academic program that stressed creativity skills, a human-centered approach to engineering and design, and later, the importance of need
finding. His seminal book, Experiences in Visual Thinking (1980) was an early influential contributor to what constituted design thinking, with an emphasis on brainstorming and fluency in idea generation. David Kelley, a former graduate student at Stanford and a protégé of McKim in the 1970’s, founded IDEO (originally, Hovey-Kelley Design, then David Kelley Design), which became the world’s preeminent design (and now design thinking) consulting firm, and became a professor at Stanford. Recently, he is credited with coining the term “design thinking” and helping to found the “d.School” to teach design thinking in a multidisciplinary setting: The Hasso Plattner Institute of Design.

In the world of business education, the University of Toronto’s Rotman School is presently a fast-rising star; Rotman defines the state-of-the-art in non-design-focused education. The school heavily promotes the curricular role of “business design thinking,” as defined by Dean Roger Martin:

At the Joseph L. Rotman School of Management, we see great value in the designer's approach to solving problems – the integrative way of thinking and problem-solving that can be applied to all components of business. Great design is characterized by a deep understanding of the user, creative resolution of tensions, collaborative prototyping and continuous modification and enhancement of ideas and solutions. Great design is characterized by Integrative Thinking™. The application of these principles to business practices is what we call Business Design™ (Martin, 2007).

There is no main, agreed-upon seminal academic article that definitively defines design thinking. Dunne and Martin (2006), in an informal interview/discussion format, come closest to
doing what this paper sets out to do, but their idea of design thinking is presented with a more abstract and epistemological tone (e.g., see their Fig. 1, p. 518). Our approach is more concrete: we assert particular steps in a generic design thinking process, and develop our argument through a series of mini-case stories. Many useful ad hoc implementations of design thinking have occurred in the service, in particular, of design consultancy, but a standard set of agreed-upon terms with associated simple definitions has been elusive. We try to bring some sense of order to this fragmented world of design thinking by using historically important, but brief, mini-cases to illustrate points about each proposed element of a “generic” design thinking framework. Also of importance, we seek to offer definitions that are empirically tractable in order to facilitate the formulation and testing of hypotheses for verification or refutation of assertions regarding what comprises high performance design thinking.

A laudable, predominantly management-oriented, article by Shephard and Ahmed (2000) proposes a generic framework for new product development. Their framework focuses on the time to project completion (see their Sec. 3.2) as a primary outcome of interest, employing a useful if somewhat narrow economizing logic. While usefully describing two process elements (structured development processes and phase/review processes) and two organizational features (realization teams and review boards), they do not provide much detail as to how these elements interact to create or inhibit high performance innovation. Shephard and Ahmed’s work, though relevant for managers, uses the limited lens of management to specify their critical factors. We use a more appropriate, yet compatible, design-derived set of elements to specify a concrete set of organizational “context” features (multidisciplinary teams and individual/group fluency) as well as particular design thinking processes (research, prototyping, critique, iteration and form-giving). We usefully extend Shephard and Ahmed’s view of design thinking by proposing a
model that explicitly asserts additional important elements and the nature of the connections between elements.

More recently, Shani, Sena and Olin (2003) offer a useful framework for innovation processes that is tightly coupled to existing thinking regarding conventional managerial thinking and associated systems. The result, a highly specific complex set of relationships based on two case studies, may lack generality, but offers some interesting insights. Their resource-oriented reflections occur on a somewhat conceptual level and show how a firm’s capital-based factors drive thinking under a “design-based” (p. 140) approach to new product development. While broadly useful in describing how one might structure a firm’s various types of capital for innovation, their work stops short of facilitating the inquiry, “how should we organize a firm for high performance innovation?” Shani et al (2003) correctly assert a role for design thinking processes (p. 140, Fig. 1), but they do not define the processes involved in a concrete manner. Our paper fills this gap by focusing on the processes of new product development in a specific and compatible manner. We usefully extend Shani et al’s thinking by offering measurable definitions of elements of design thinking processes and asserting the nature of their interaction in a manner that is refutable by empirically-inclined scholars.

3. Definitions: Elements of design thinking

Design thinking requires the following elements to be successful: (1) multi-disciplinary teams; (2) fluency; (3) experience-based, user-centered research; (4) prototyping; (5) iteration; (6) critique; and (7) form-giving. Below, we define each dimension, and briefly mention an example either from a firm or management education/academia.
3.1 Multidisciplinary Teams

While there is nothing particularly new about using multidisciplinary teams to tackle innovation, DT employs a rarefied definition of multidisciplinary teams. Multidisciplinary teams are necessary precursors to design thinking—they are part of organizational context, and design thinking processes may not occur in their absence. In firms, multidisciplinary teams are composed, as the name suggests, of diverse personnel from various functional areas, including, for example, marketing, finance, manufacturing, technical support, suppliers, complementors, and customers. In management education, diversity is achieved by organizing classes into groups of multidisciplinary student-teams when possible—this technique is particularly well-suited to MBA and executive education programs. In firms, a “matrix” organization structure is one example of the creation of multidisciplinary teams. Diversity, however, is not the unique defining characteristic of multidisciplinary teams. Examples of truly design thinking-oriented multidisciplinary teams in firms are somewhat rare, but they exist in academia. Accordingly, our example in this section is drawn from experiences at Stanford. At the Stanford “d.school” teams are organized around a concept called “radical collaboration.” These teams have some unusual characteristics, the most important being that they are not organized around a single leader. Radical collaboration means that team leadership is frequently passed back and forth, and team members have an explicit task of “making the (present) leader look good.” One analogy often used to teach teams this behavior is that of a jazz ensemble. A jazz group is expected to be comfortable with the notion of passing a solo back and forth among players, within the structure of a song.

3.2 Fluency
Merriam-Webster (2007) defines fluency as “…capable of moving with ease and grace… 2 a: capable of using a language easily and accurately…” Though often overlooked by others, multidisciplinary teams require fluency for design thinking to function. Fluency, like multidisciplinary teams, is a necessary precursor to design thinking. It is a part of the existing organizational context, without which, design thinking processes may not take place. We define fluency as the ability (1) to translate effectively between various rarefied technical vocabularies, (2) to move effortlessly between problem solving methodologies, and (3) to value others’ outcome expectations. As an example in the realm of problem-solving methodology, consider brainstorming. Fluency is critical for effective brainstorming. Brainstorming is not possible if teams fail to resolve issues arising from members’ divergent understanding of the meaning of important terms of art.

Practically, fluency requires that people suspend judgment and generate many ideas, both good and bad. Fluency is the deeply embedded understanding of the requirements of a process coupled with substantial experience in implementing the (brainstorming) process. An analogy to fluency in language would be a strong awareness of the syntax of a language—how words fit together in the writing process. In addition to syntax, however, vocabulary fluency is also important.

Without mutual vocabulary fluency, multidisciplinary teams run into other critical team dynamics issues; sometimes they fail to function at all. The conditions for failure often include semantic gaps (in the meaning of common terms of art) between teams that are overly large, and remedial efforts may incur costs but lack results. For instance, a technical vocabulary, which is highly efficient at encoding complex, discipline-specific knowledge, becomes a significant barrier to communication in a multidisciplinary team where many members do not know “the
code” (Heiman and Nickerson, 2004). Team members may need to be taught to speak in plain English, without jargon, or other team members must undergo costly training to comprehend the jargon. Although we have focused mostly on vocabulary fluency, fluency in process is also important. For example, a common understanding between team members regarding the rules of brainstorming, as well as some experience with the technique are essential for positive brainstorming outcomes. In contrast to vocabulary fluency, process fluency is about team members possessing similar (preferably high) levels of understanding regarding setup, rules and actions in the design thinking process.

Finally, divergent outcome expectations are often an issue in team dynamics. Business training conditions team members to expect tangible outcomes in terms of, for example, profits, plan execution milestones, scheduled reviews, and/or market share. Training in design thinking, however, conditions team members to place a high value on process outcomes. Process outcomes that designers expect, such as productive brainstorming sessions, creative synergy between participants, and concentricity of vision, are frequently dismissed as unimportant or unquantifiable by some team members. A dismissive attitude about a valued or potentially valued outcome, from any team member, indicates a lack of respect for and ability to move between disciplines, and is often the undoing of multidisciplinary teams. An important part of fluency is mutual respect for and openness to others’ discipline-based work cultures, techniques and performance measures.

The above two dimensions, fluency and multidisciplinary teams, are necessary pre-conditions for an organization wishing to engage in design thinking. Promoting fluent multidisciplinary teams is not easy—this organizational context rarely arises naturally in firms. We turn again to a brief example from academia.² One proven method to promote fluency
among non-designers at Stanford’s d.school places trained designers (often graduate students) into roles that function as the “glue” binding multidisciplinary teams together. This is especially impactful for teams where the outcomes required are not obviously “design” outcomes, but rather a new business process or a service. Designers are often called upon for their visual skills and creative mindset. They help teams visualize early ideas, help with brainstorming and other creative processes, and work as translators between various vocabulary-specific groups.

3.3 User-Centered Research Focused On Experience.

Research is the first step in the design thinking process. Design thinking begins with focused observation. Ethnographic research tools are employed and users are studied in their home or working environments. Latent needs, discovered through these study techniques, become the basis of the insights that inform the entire design process. Latent needs can only be discovered through a combination of observation and inquiry, and must be observed at the site of the activity or service being designed. Our experiences strongly suggest that asking users “what they want” or “what they need,” in an artificial setting (e.g., via mall intercepts, surveys, web questionnaires) frequently fails to provide the right kind of data for critical down-stream design thinking activities. The user-centric approach differs substantially from the bulk of market research in that the insights sought are not about understanding what “average” users will buy. Design thinking focuses explicitly on discovering and understanding what evokes feelings of joy and satisfaction in users.

In design thinking, user groups often sample extreme or leading edge users and populations that do not use the product or service but may be potential users since they have similar or parallel needs. This type of user-centered research does not attempt to look at the
mainstream markets nor does it expect to generate an “average user” profile. As such, it differs from the traditional user research methods of focus groups and surveys. User-centric research generates data of a different quality: data with increased emotional nuance. Developing, analyzing and interpreting a “nuanced dataset” and preserving related insights and innovations through subsequent design thinking stages reflects successful design thinking--findings from nuanced data are strongly reflected in the final product, service or experience.

Disney is one of the most successful firms when it comes to understanding users through research. Having the most popular amusement park concession in the world helps Disney by giving them natural “labs” in which to observe and interact with customers. One dramatic, recent example of Disney’s insight into their users via nuanced research is the rise of so-called V.I.P. tickets, which cost more than regular tickets, but allow holders to “jump” to the front of lines at the parks’ many attractions. Disney, in the late 1980s and early 1990s observed that an increasing fraction of many visitors’ time in their parks was occupied in lines. Naturalistic observation suggested (correctly) that people did not enjoy spending large amounts of their time in long lines. For Disney, long lines take away from time people can spend in shops and eating, two major in-park revenue sources. The essential insight, however, is the former observation: long lines and corresponding wait-times evoke a lack of joy in users. By creating V.I.P. passes, in addition to adding significantly to admission ticket earnings, Disney removed from long lines the people who can most afford to buy souvenirs and eat at the best (most profitable for Disney) restaurants in their park. Without close-observation via sociological/anthropological user-centered research, these insights would never have been available to Disney. By understanding nuances of the rich data from in-park observation in great detail, as well as data regarding
spending patterns inside the parks, Disney was able to correctly design, price and market the V.I.P. tickets (which have been hugely successful).

### 3.4 Prototyping

A prototype is any object or simulation that can evoke feedback from the target user group and buy-in from the sponsoring organization. When we talk of prototyping in terms of design thinking, it is important to stress that we are not talking about highly refined engineering models or prototypes designed to validate a final idea. We are talking specifically about prototypes that are used to evoke and explore a problem. Prototypes are often crude, no more than paper models, simple spreadsheet simulations, or hand drawn storyboards of a potential new product/service/experience. They are observed and tried by target users, refined, and built again and again, each iteration used to obtain feedback on one aspect of the design. A partial prototype is often made to test one aspect of the product or service; only rarely is a prototype “complete” under this view of design thinking. It is critical that prototypes are experienced by users and the multidisciplinary team. Prototypes are additionally used at multiple levels of a client/user organization to solicit comments and buy-in.

The widespread use of prototypes in design is well-documented in a recent book, *Designing Interactions*, by Bill Moggridge (2006). A host of examples are documented by Moggridge; we cite two. The idea for the original Palm Pilot was captured by Jeff Hawkins one evening at home in a crude wood and paper prototype. While the fidelity of this prototype was low (it barely resembled the finished final product), it was essential to capturing one critical element of the design: that it fit in a pocket. This became one of the four “rules” of the Palm Pilot design philosophy and the wood prototype became the means of communicating this
essential element to investors, the design team, and potential customers. (Moggridge, 2006, Ch. 3).

Moggridge also documents one of the most important prototypes of early computing history, the original prototype of what became a ubiquitous pointing device, the mouse. Doug Englebart, a researcher at SRI, was working on the problem of pointing to things on a CRT (a 12” round CRT, circa 1964). He had previously noted in his design notebook (another common “prototyping” venue for designers) the tendency of a wheel to rotate around one axis and to slide evenly on its orthogonal axis. He quickly prototyped a device that had two wheels, mounted at right angles, that could move over a surface and give a direct X/Y coordinate readout of its motion. This early mouse was made from wood (again, a common quick prototyping material) with wheels from another device, and spare electronics from Englebart’s lab. The prototype of the first mechanical mouse pre-dated the original Apple mouse by almost 20 years, and demonstrated the fundamental principals, if not the actual materials, of all mechanical mice that followed (Moggridge, 2006, Ch. 1).

The following example, based on one of the authors’ industry experiences, further demonstrates prototyping process in the development of a superior product. At Apple during 1993, the author was the project manager of a design team that developed the first-ever portable computer with a built-in track pad (the Apple Powerbook 500). The challenge/problem facing Apple was to improve on its novel, award winning design of a “trackball in the palm rest” configuration for laptops, first introduced by Apple in 1991. By 1993, given the computing power available from increases in system performance, the team decided to start with a clean sheet of paper and re-think the input device with respect to the tradeoffs between size, weight, power consumption, and pointing efficacy.
The team decided to use prototyping for exploring and developing the design. Multiple classes of solutions were explored, including a smaller track ball in the palm rest, a small trackball located near the screen (a solution Compaq later implemented), a sliding/spinning pointer located in the keyboard’s space bar (an invention from an outside source) and a thin pad that sensed the position of a fingertip for pointing that the Apple Advanced Technology Group had developed.

Apple built many crude prototypes to test the standard human factors issues of pointing accuracy and to understand the ergonomics of the hand position and the resulting wrist strain. All prototypes were incomplete physical models. In addition, multiple full-scale, complete models of various laptops were constructed; these looked real but did not function. These non-working physical models were used to evaluate the industrial design captured by each of the different devices.

Some prototypes were shown to potential users for a reaction, some were used to build a consensus inside the Company for the radical new “look.” Mechanical volume studies were done, typically very crude (using a cardboard-like, foam-cored flat material with paper cladding known as “Fome-Core™”), a few mechanically accurate, and some virtual, using Apple’s CAD (Computer Aided Design) system. Each prototype helped evaluate one aspect of a possible solution. Eventually the design team converged on a “radical” solution—the trackpad—and built a final complete engineering/aesthetic model using authentic materials (form-giving). This device became one of major innovations in the Apple Powerbook 500 series which went on to be the best selling Apple laptop of that decade. Trackpads are now standard fare in notebook computers, but sans this exceptional prototyping process, the “radical” solution of a no-moving-
parts device versus the traditional opto-mechanical mouse/trackball solution might never have surfaced.

### 3.5 Iteration

Iteration, an element central to design thinking, is the most efficient process for stimulating high quality design innovation. Iteration implies that the idea of “fail early and fail often” is a goal to be sought, not a pitfall to avoid. In order to encourage iteration, teams often use techniques like brainstorming and rapid prototyping to stimulate new approaches to problems. Teams are encouraged to “start-over, often.” Rather than treat iteration as an arrow in a diagram, we consider iteration to be an integral process step owing to the involvement of managerial choice: deciding whether/how to revise and refine a crude initial design via successive prototypes is a critical dimension of design thinking. As an example from industrial product design, consider the need to transport radioactive materials for patient implantation around a busy hospital (this cancer therapy is called brachytherapy and involves temporary implantation of powerful radioactive isotopes into the patient to kill tumors). One of the authors worked at a firm developing such a product. The (radioactive) item to be carried was at the end of a flexible rod, up to 18” long. The radiation was intense, so a lot of lead was needed—the transporter weighed over 100 pounds. A series of rough, fast prototypes led to a design that was near impossible to tip over, a key product feature. Early prototypes were concerned mainly with balancing weight to avoid tip-over. Successive prototypes additionally addressed issues such as steering, braking, isotope handling, waste storage, and cleaning. Multiple iterations allowed our team to solve a series of small problems as we gradually focused increasingly on successive issues. The product was a success in the marketplace and highly profitable for the firm.
One contribution in this paper is the “promotion” of iteration to a step in an overall design thinking process. The decision must be made to engage in the next iteration or not, a critical managerial choice. We thus include iteration in our design process as a discrete step. The development of a radically new cordless nail gun by a consulting firm is an example of using iteration explicitly to improve product development. For the following case-story, the client name and circumstances have been change to protect the proprietary nature of trade secrets.

The ABC Tool Company approached the design consultancy to design a new nail gun. (Nail guns are traditionally used by professional carpenters as a replacement for manual hammers and are powered by compressed air delivered by hoses—they represent a huge leap forward in productivity over manual hammers). Unlike existing nail guns, the ABC gun was not to be powered by a hose-based external compressed air source, hence the term “cordless.” The design specification from the client noted that a competitor’s product, which had dominated this category for 15 years, was coming “off-patent,” an opportunity which provided the impetus for the project. The specification also noted that the client had previously launched a similar product that had failed to achieve market acceptance. Both used a propane-like gas cartridge to provide nail-driving power. The design consultancy team began the project by taking apart both the competitor and client products and understanding their design principals. A new prototype was built that met the specification by mimicking the design of the competitive product. The client was satisfied with the result. During the brainstorming phase, however, it was noticed that this gas-powered system was similar to a traditional internal combustion engine, albeit with only one cylinder. Recent advances in electronic ignition and combustion dynamics suggested a more powerful “engine” was possible along with commensurately enhanced performance of the nail gun. A series of rapid iterations in the project plan was undertaken. This allowed the team to
quickly prototype a microprocessor-controlled ignition and an advanced compression cylinder. The results were impressive: a doubling of the output power in a reduced gun size. The client was impressed—a smaller, lighter gun that delivered more nail-driving power offered an immediate competitive advantage. One more iteration was suggested, an improvement to the nail feed mechanism to increase the speed of the gun. (This was initially unplanned but the client quickly agreed.) This iteration proved successful and the design was turned over to the client for manufacturing. Several patents applications were filed to protect the product innovations.

The temptation to stop at the first successful result was strong for both the client and the design team. It was only because iteration is strongly embedded as part of the team’s design process that the design team pushed beyond their first success and continued to innovate. The client, seeing how much of an impact iteration had on the quality of one emergent solution, was willing to authorize more iterations. Our example supports the assertion that to decide to iterate (or not) reflects an important (often repeatedly encountered) managerial choice. This managerial choice is also (regrettably frequently) driven by the constraint of time: “iterate until there is no more time left to iterate.”

3.7 Critique

Unless the critique process is embedded in design thinking, the “fail early, fail often” dictum and the iterative process described above results in an endless loop. This is why design (and most of art since the Renaissance) has been taught using a critique process. Designers have become quite comfortable with this approach, but outsiders routinely fear it. The critique process involves selecting discrete moments in an interactive design process for an in-depth dialog about the concepts and design “so far.” James Elkins, in his book “Why Art Cannot be Taught”
describes one common form of critique this way; “(it is) the ancient art of dialectic: you ask (a question), you think about the reply, you ask again, you rephrase the question, you go on pushing and inquiring, without changing the subject.” (Elkins, 2001, p. 170, emphasis added). This technique is often aggressively applied in design, art, and architecture schools and it is not uncommon for some first year students, unaccustomed to the technique, to experience emotional distress when critiqued.

A critique is distinct from a milestone review (also known in project management parlance as a phase review, toll gate, project checkpoint, etc.). A good milestone review is primarily a decision-making event. Facts and figures are weighed to assess the project’s progress and its likelihood of success. In contrast, a good critique is primarily an opportunity to vet a concept; to examine, through questioning, paths not taken, alternatives unexplored, and the quality of the design synthesis. Opportunities for improvement and refinement abound when critique is properly executed. Applying milestone-like criteria to a critique risks losing the value of the dialectical process and potentially impairs the transfer of insights between various parts of the design thinking process.

The authors’ teaching experiences have shown us that business students are often not at all comfortable with the open ended and subjective approach of critique. Business professors tend not to use critique because they are not trained in this dialectic technique. The case study method often employed in business schools, via a Socratic pedagogy, has aspects in common with critique in design thinking, notably constructive reflections on the quality of solutions to problems. Once students realize this, they become more comfortable with the process and critiques proceed smoothly. Team teaching and/or juried design reviews are particularly effective ways to implement a critique process in an educational setting owing to the multiplicity of
critical perspectives available to the student. Similarly, team members in firms often dread or shun juried or multi-party reviews of projects, as each perceives the possibility of a shadow cast on individual careers. Studious, multi-party critique is a valuable, yet somewhat rare phenomenon in most firms. Critique is an essential dimension in the design thinking process.

3.7 Form-giving

It is common that the final output of a design-driven process, (affecting product, service or experience) often falls far short of the designers’ and customer’s expectations. Something has been lost. Organizations often fail to capitalize and deliver on design thinking because they skip the crucial step of form-giving. Form-giving is the final phase of the design thinking process and involves a succession of increasingly feature/functionality integrated models that result in at least one final product in its most refined form. Form-giving is frequently incorrectly perceived as a synonym for prototyping. Note that a “final” prototype is very different from the output of form-giving. Prototypes are necessarily incomplete and rough, whereas the final result of form-giving is necessarily complete and detailed. In form-giving, the organization must embed (1) the underlying findings of the original user research (the nuanced dataset), and (2) the many cycles of prototyping and iteration into the object or service—difficult tasks. The goal of form-giving is to evoke delight and satisfaction in users, and to legitimize the underlying innovations discovered in the course of user-centered research. Successful form-giving fulfills the hopes and aspirations of the user--emotional connections to the product or service are constructed and understood by the multi-disciplinary team—the product is ready for users. Form-giving, as they say at Apple, creates “objects of desire;” a dedication to the refinement and total, uncompromised instantiation of the final form is necessary. The famous Mies van der Rohe
quote “God is in the details” is nowhere more relevant than for the form-giving dimension of design thinking. (van der Rohe, 1959).

A useful example of form-giving (from the software world) comes from Moggridge (2006). Game designer Will Wright is one of the most successful game designers of all time--his “Sims” games have sold over 8 million copies (Moggridge, 2006, Ch. 5). He credits his success to a deep understanding of game player psychology and careful attention to the details of the simulation. In the book’s interview, Wright describes three things that make his simulation games successful; creating a sense of community, a five second feedback loop for interactions, and consistent and realistic “failure states” for each character action. These observations about good games and game players constitute Wright’s “nuanced dataset.” Wright’s care in making sure each element of his simulation games are crafted to support these observations is a good example of form-giving and “attention to consequent details.”

The seven dimensions of design thinking outlined above fit together as shown in Figure 1. For design thinking to permeate an organization, an environment different from the traditional work or educational environment is essential. We have isolated two organizational-context dimensions necessary for a rich design thinking environment, without which design thinking processes are impaired at best, or impossible: multidisciplinary teams and group/individual fluency. Within this organizational context, high performance design and innovation outcomes occur when a multidisciplinary, fluent team engages in design thinking process by explicitly working with five dimensions of design thinking action: user centered research, prototyping, iteration, critique, and form-giving.
Following appropriate user-centered, experience-based research, the rapid cycling of prototyping, critique and iteration become central to the design thinking process. Iteration is identified as a distinct process intentionally; the goal is to prompt the statement “now we will iterate” so that the team is not tempted to accept early problem solutions. Similarly, experienced design thinking teams know when to ask “Is this the last iteration? Should we stop now?” Finally, iterations are by nature rapidly executed, with a sense of urgency driven by the team’s, genuine desire to understand the basis of user satisfaction and joy. The number of iterations is undetermined, though, as noted, in our professional experience in highly creative environments, iteration always continues until the allotted time runs out. Iteration drives the prototype-critique-iterate cycle, but iteration may also sometimes lead back to user-centered research—gaps in knowledge of user requirements must be addressed if present (the dotted arrow in Figure 1).

Figure 1 also shows form-giving as the culmination of the design thinking process. Though it is beyond the scope of the present discussion, we note that each increasingly focused subsequent generation of design thinking might start with the results of a previous generation’s form-giving as part of its input and proceed to user-centered research and prototyping to begin the next-generational cycle of design thinking.

4. Design thinking: Lingering issues

This paper has briefly defined seven dimensions of design thinking and proposed a preliminary, generic model of how these dimensions interact. We have used a series of mini-cases/stories to help illustrate parts of the model. The model codifies admittedly widespread
practices that have been claimed as original, but more importantly used extensively by no less than the Bauhaus school of design thought, MIT, Stanford, and IDEO, among others. Our goal has not been to offer a definitive history of the origins of design thinking processes, but rather to articulate a generic model that essentially describes fundamental processes involved in design thinking in a useful manner. Our contribution is to make them explicit and clarify definitions where possible. Most organizations deliberately employing design thinking will likely have their own “flavor,” or approach relative to our stripped down generic model. This often includes re-labeling of terms to firm-specific cultures, increasing apparent fragmentation of design thinking.

Specifying a generic model is useful to some extent, but a consideration of potential impediments to high performance design thinking is lacking in our discussion. There exists a need to identify critical organizational impediments to productively engaging in the design thinking process. Why doesn’t design thinking come about naturally in organizations? Why is so little design thinking technique taught outside the rather vertical niches of engineering, product, and industrial design as well a marketing? This paper is a start in unpacking why fomenting and maintaining a culture that embraces, utilizes and benefits from design thinking is far from easy. Design thinking in both firms and educational institutions does not occur naturally, and a logic explaining why has yet to be meaningfully articulated.

5. Next steps: A “high performance” logic of design thinking

This paper has so far proposed a generic framework intendedly suitable for scholars, educators and managers interested in design thinking for their organizations. Our experience addressing design thinking issues both within business schools and in firms suggests that this is a rich arena for further study. Future research efforts might focus on empirically validating our
model by examining innovating firms and tracking the nature of their design thinking processes against their subsequent performance. While Figure 1 outlines a plausible design thinking context and process, it lacks empirical confirmation and prescriptive value regarding how best to implement design thinking throughout an organization: which processes for attacking problems using design thinking are most cost-efficient for particular problems? What is the best way to go about finding good problems to attack with design thinking processes that yield valuable solutions? Is there a logic of issues and fixes that helps us understand what constitutes a strategy for implementing high performance design thinking in organizations?

The main contributions of this paper include a useful set of simple, original, tractable definitions that break down design thinking into seven dimensions, two of which are organizational context-related and five of which comprise design thinking processes (actions). The specified dimensions must each be properly matched to situations by managers and team members wishing to promote productive design thinking outcomes. This may seem like a demanding, even rarefied, set of requirements, but we reiterate that design thinking is not easy, even for experienced practitioners. Inculcating an organization with the necessary values, environment, culture and processes is a substantial, even intimidating task. To facilitate this task, we have proposed a “generic” model of activities and precursor conditions within which design thinking might be expected to prosper. This opens the door on discussing design thinking using a set of commonly agreed-upon terms that may facilitate cross-discipline conversations. This model codifies much of current best practice in design thinking, but is routinely subject to substantial variation and even distortion beyond easy recognizability as organizations embrace different aspects and create variations driven by situation-specific factors (e.g., industrial, sociological) surrounding the problems to be attacked with design thinking. Our definitions and
supporting discussion offer practitioners and theorists from diverse traditions a chance to unify the conversation in a manner that creates opportunities for future concrete empirical exploration.
References


Figure 1: Seven Dimensions of Design Thinking—A Generic Model.
Notes

1 For clarity, Stanford’s d.school (http://www.stanford.edu/group/dschool/) is not an independent academic “college or school,” but rather the Hasso Plattner Institute of Design at Stanford.

2 Limited examples of fluency exist outside academia. One common method used by firms to access and spread creativity skills such as design thinking employs the hiring of consulting designers to facilitate the running of clients’ internal teams and augment the teams’ skills as needed with consultancy staff. Consulting firms experienced with this service include IDEO, Strategic Decisions Group, and D2M. The authors question the long-term impact of this approach for client firms.

3 The ABC Tool Company was subject to a merger during the project and the current status of the invention on the market is not known. The example nonetheless underscores the role of iteration as part of deliberate design thinking.