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Communications of the Association for Information Systems

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Video Game Design in the MBA Curriculum: An Experiential Learning Approach for Teaching Design Thinking

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Abstract:

In the spirit of design thinking, we have developed a “hands-on” video game design workshop intended to be used for an MBA course on design thinking. This novel approach to teaching complex concepts and skills to business students has been received with enthusiasm, and it provides a unique and memorable experience for students to draw on as they encounter situations in which they will apply design thinking in the future. Additionally, student-produced games and student reflections on the workshops provide initial evidence of the value of teaching design thinking through this type of experiential method. In this article we review key design thinking concepts, report on our continuing efforts to incorporate these principles into video game design workshops in the MBA curriculum, and conclude with reflections on improvements for future iterations in hopes that these lesson plans will be shared and will add value to other institutions teaching design thinking. Workshop lesson plans and student projects can be found online at <http://www.kolobkreations.com/GDWweb/GDWHome.html>.

Keywords: design thinking, experiential learning, video game design, teaching methods

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Design ... is the core of all professional training; it is the principal mark that distinguishes the professions from the sciences. Schools of engineering, as well as schools of architecture, business, law, and medicine, are all centrally concerned with the process of design.

Herbert A. Simon, *Sciences of the Artificial*

Tell me, and I will forget. Show me, and I may remember. Involve me, and I will understand.

Confucius, 450 B.C.

I. INTRODUCTION

Design thinking is increasingly relevant to the managerial discourse (e.g., Austin and Devin, 2003; Boland and Collopy, 2004; Romme, 2003; Verganti, 2008), and is seen as a possible answer to many of the problems plaguing business schools [Dunne and Martin, 2006]. Thus, in recent years, a number of innovative business schools have been adding a design component to their managerial curriculum [Merritt and Lavelle, 2005; Nussbaum, 2005]. The Information Systems discipline is uniquely positioned to lead much of this design education since the discipline has a long history of design-related research [Gregor and Jones, 2007]. Further, modern design—whether it involves business processes, organizational structures, or artifacts—inevitably involves information flows [Berente et al., 2009] and has significant digital components [Yoo et al., 2008; Zammuto et al., 2007]. In this article, we address some of the key principles associated with a “design thinking” perspective and report on an ongoing teaching engagement where we use the context of video game design to address some of the challenges associated with teaching design thinking to MBA students.

“Design thinking” is a notoriously elusive perspective [Buchanan, 1992] that is often difficult to teach [Cross, 2001]. A continuing challenge in teaching design thinking involves the translation of generalized concepts to the practical skills that are applicable to diverse contexts, and which traditional lecture or business case pedagogical methods address inadequately [Avital, 2005]. One strategy to address this challenge is complement traditional methods by involving the students in some form of experiential learning [Kolb, 1984; Kolb et al., 2001], where they make meaning from direct experience and reflection on that experience.

In an effort to teach design thinking through an experiential learning exercise, we report on a series of video game design workshops that we have included as part of the Systems and Design Thinking course for MBA students. Through these workshops we are able to provide a hands-on design experience without over-reliance on a particular set of tools, methods, or goals. We argue that game-design offers a promising alternative to more typical design exercises. A number of modern object-oriented game design environments offer students the opportunity to create simple to moderately complex games in short order, with little training and without actually writing code. Further, games are fun and can appeal to a wide variety of users and contexts and are easy to relate to for the bulk of modern students. Also, these environments provide open-ended opportunities for design combinations while materially constraining the actions of the designers. Therefore, we believed that game design might prove a fruitful mechanism for design thinking pedagogy, and our continuing experimentation with this method seems to support this belief. Thus, in a unique twist, we have developed a workshop for business school students in which they build games rather than play them (as is often done in MBA classes, e.g., Proserpio and Gioia, 2007).

We begin by discussing the theoretical background of design thinking and our experiential approach. Following this, we describe the video game design workshop, including lesson plans and screenshots. We conclude with a discussion of outcomes and takeaways.

II. DESIGN THINKING

According to Michel and Cross [2007], the burgeoning design discipline accommodates three broad streams of inquiry. The first, “design science,” involves research into the theoretically motivated creation and testing of artifacts (consistent with Hevner et al., 2004; March and Smith, 1995). Cross indicates that the second stream of design inquiry is the “science of design,” which describes the use of scientific method (in March and Smith’s “natural science” tradition) for the study of design practice as the subject of research (i.e., the Gregor and Jones, 2007, “expanded view” of design research). The third stream, “design thinking,” involves guiding the reflective practice of acting designers (in the spirit of Donald Schön).

A common formulation of design thinking is rooted in Schön's [1983] concept of a "reflective practitioner." As reflective practitioners, designers interact with a situation and reflect on this interaction. Designers are acting when they generate "what if" designs, and continuously reflect on what they generate in relation to a specific situation. Through the designer's reflection, situations "back-talk" to a designer, which often results in shifts in the stances of the designers, as they learn more about the design situation [Schön, 1983]. This open, reflective, and tentative approach to creative activity characterizes what Boland and Collopy [2004] refer to as a "design attitude"—where designers explore new territory rather than deciding between existing alternatives. However articulated, design thinking, much like design activity itself, is not readily tractable and "eludes reduction" [Buchanan, 1992], and is often challenging to convey. Therefore, when looking to elicit an organized set of concepts relating to design thinking, one might look to the foundational design thinker, Herb Simon, for his treatment of design in the classic text, *The Sciences of the Artificial*.

Simon indicated that design involves "changing existing situations into preferred ones" [1996]. In addressing the way individuals go about designing, Simon [1996] indicated that design activity has four broad characteristics (see Table 1). First, design is generative, in that it involves the creation of novelty (i.e., the "artificial"), and thus requires the creation of new knowledge, or learning. Second, design is iterative, since each newly generated artifact is subjected to testing that thus informs subsequent design decisions. Third, these nested generate-test cycles occur in conjunction with representations and design artifacts themselves. Fourth, design activity is complex, as it inevitably, unpredictably leads down unanticipated paths. Designers simultaneously construct the problem space as they navigate the solution space. While there are a variety of formulations of design thinking principles, we have found that our framework based on Simon's original insights can accommodate most views of design thinking at a very high level. Next we will address each of these in turn.

Table 1: Dimensions of Design Thinking [Simon, 1996]

Dimensions	Related Themes	Sources
Generative	knowledge creation, learning, cross-community	Alexander, 1964; Avital and Te'eni, 2009; Boland Jr. and Tenkasi, 1995; Boland and Collopy, 2004
Iterative	generate-test cycles, abductive logic	Basili and Turner, 2005; Berente and Lytinen, 2007; Schön, 1983
Representational	design artifacts, models, object worlds	Bergman et al., 2007; Boland Jr. et al., 1994; Bucciarelli, 1994; Henderson, 1991; Rosenman and Gero, 1996; Schon, 1992
Complex	"wicked" problems, intractable	Buchanan, 1992; Checkland, 1981; Churchman, 1971; Yoo et al., 2006

Generative

The ultimate goal of any design activity involves the generation of novel objects or "forms" that fit within a particular context [Alexander, 1964]. Simon [1996] characterized the fundamental cognitive processes of design work as a form of heuristic search among alternatives in a problem space. Alternative solutions do not come ready-made to the designer, however, but must be generated. Then designers test potential solutions against a range of requirements and constraints. Since designers often generate multiple, temporary alternatives at any given time and then tentatively address each one as they learn about the environment, the generation of alternatives can have as much to do with learning about the problem itself as it does, necessarily, with satisfying the problem. Therefore, Simon's generative search process is less about seeking the solution to a problem at any point, than it is with "gathering information about a problem structure that will ultimately be valuable in discovering a problem solution" [1996]. Thus, together, the design object and its context form a "design world" that the designer is continuously creating [Schon, 1992]. In this sense, generated alternatives can be described as design hypotheses and reflect the "educated guess" of abductive reasoning [Pierce, 1992] which is central to the formulation of novelty. Such design hypotheses "form the backbone of design thinking" [Buchanan, 2001].

The generation of novel alternative courses of action is the key distinction between design and problem solving, and is the very foundation of a design attitude [Boland and Collopy, 2004], and generativity is a foundational concept across a variety of design-related disciplines [Avital and Te'eni, 2009]. Thus, while creativity and novelty are both critical to design activity, design is less of a single "flash of inspiration," but rather, a "careful, methodological generation of alternatives" [Cougar, 1995, p. 22].

When teaching design thinking, it is, therefore, critical to contextualize the creative aspects of idea generation within an overall design process—where the information gained from multiple alternatives inform the evolution of the design. The generative elements of a design process allow for the generation of design problems simultaneously

with their solutions. This learning does not flow from the generativity alone, however, as design alternative must be iteratively tested for the design process to proceed.

Iterative

The generation of design alternatives, for Simon, was inextricably linked with the testing of those alternatives in an ongoing series of “generate-test cycles.” As designers explore their design hypotheses and subject them to a wide range of tests involving requirements, constraints, assumptions, cognitive schema, or multiple perspectives, the design evolves. Each generate-test cycle can be thought of as a design iteration, which involves some form of repeated activity targeted toward bringing about some sort of convergence or closure [Berente and Lyytinen, 2007].

It is important to realize that the alternatives generated in a design process do not follow a predictable, linear pattern, but are nested within each other. Multiple alternatives may be explored simultaneously on different levels—for example, designers might test alternative decompositions of the problem from an architectural level, or they might generate multiple component designs within a given problem decomposition [Simon, 1996]. Throughout the design process, designers explore these alternatives through multiple series of continuous iteration. It is important to note, however, that there is no single thing that “is” the design, but that the evolving design becomes manifest through a variety of iterating [Berente and Lyytinen, 2007].

Representational

Designers leverage a variety of representations to extend their own cognition and reflect on design activity in relation to a particular context—in what can be described as a conversation with those representations [Schon, 1992]. Further, these representations are also used to facilitate design interaction between groups and communities [Rosenman and Gero, 1996; Simon, 1996]. Modern design is typically not the activity of a singular designer, but is a necessarily social experience [Bucciarelli, 1994] where diverse knowledge communities collaborate to create a design. Designers utilize a variety of representational artifacts to communicate across communities throughout the design process, but also to attend to different aspects of the evolving design [Boland Jr. et al., 1994]. Multiple representations, or “multiple models,” enable the visualization of a number of design alternatives from a variety of perspectives, and allow for iteration across these representations.

Simon conceives of design as a form of problem solving, and in dealing with complex phenomena, designers must construct representations of the problem space just as they must generate alternatives in the solution space [Simon, 1996]. As designers explore alternatives and iterate across representations, they learn about both the problem and the solution [Dorst and Cross, 2001], and the design space continuously evolves in an unpredictable manner as the design *emerges* over time. Thus, modern design is a complex activity.

Complex

Design involves solving problems, but the problems that designers solve are not analytical questions of optimality where the designer must use the appropriate analysis technique to solve a known problem. Rather, in all but the most trivial design tasks, designers deal with substantive, evolving questions with no definitive formulation and no final solution [Buchanan, 1992; Checkland, 1981]. Indeterminacy is the key characteristic of modern design activity [Buchanan, 1992], and whole designs emerge from a complex interplay of designers, representations, and iterations. While the complexity of design activity and resulting emergence cannot be denied, designers address this complexity through a variety of strategies, including the hierarchical decomposition of the design (e.g., Baldwin and Clark, 2000; Simon, 1996), through rich description of the design situation (e.g., Checkland, 1981), or through agile, iterative methodologies [Berente and Lyytinen, 2007].

Although “design thinking” is a contested concept, four aspects of design activity (generative, iterative, representational, and complex) are clearly fundamental to all contemporary design activities. It is questionable whether students can fully appreciate such elusive concepts without engaging in some form of design activity, thereby contextualizing these aspects of design in their own experience. To provide students with an opportunity to apply design thinking in practice, we developed a workshop based on the principles of experiential learning. Next we briefly introduce the concept of experiential learning and then describe the workshop.

III. EXPERIENTIAL LEARNING AND GAME DESIGN WORKSHOP

Based on the learning theories of Dewey, Piaget, Lewin, and others, experiential learning [Kolb, 1984; Kolb et al., 2001] is the process of making meaning from direct experience and reflection upon that experience. Contrary to the way experiential learning is often characterized, an experience alone does not constitute an experiential learning exercise, but this experience should be reflected on and conceptualized in abstract terms, and the experience itself should involve active experimentation and observation [Kolb and Kolb, 2005]. Thus, in order to faithfully identify a

pedagogical exercise as experiential learning, the activity must explicitly guide students in cycling through all four modes of such learning activity: (1) concrete experience, (2) abstract conceptualization, (3) active experimentation, and (4) reflective observation. Experiential learning involves the creation of knowledge through a tension between these four modes of activity and increases understanding and recall of new concepts [Kolb, 1984].

In an effort to provide an experiential learning experience, we developed a video game workshop to provide a lasting and concrete opportunity for students to personally explore and internalize the notion of design thinking. In particular, we developed the workshop to explicitly address the four modes of learning activity central to experiential learning:

1. *Concrete experience*—The exercise was designed to provide experiences in planning a design activity, working within a design team, and executing an initial and a derivative design task.
2. *Abstract conceptualization*—Before the workshop, the students were presented with the four dimensions of design thinking (generativity, iteration, representation, complexity); during the workshop the students were asked to actively think about how their actions reflected these four dimensions; and after the workshop students were asked to reflect on how the exercise illustrated these dimensions.
3. *Active experimentation*—Inherent in the design task is an extensive amount of trial-and-error learning. Further, preparatory sessions intentionally did not cover all the material the students would need in order to build their video games—thus, they were required to investigate and actively experiment with the tools to develop working games.
4. *Reflective observation*—We required each team of students to keep running notes to document their design process, and assigned each group a series of reflective questions to respond to after they had completed each of the two design projects; additionally we had a post-workshop discussion session to reflect on lessons learned.

The video game design workshop was developed specifically to enable students to fundamentally relate to the concepts of design thinking through an experiential learning exercise. The next section describes the workshop activities in detail.

IV. DESIGN THINKING IN VIDEO GAME DESIGN—WORKSHOP DESCRIPTION

The video game design workshop is designed to provide a unique, hands-on activity for MBAs to learn design thinking through immersive experience. As of the writing of this article, the workshop has been administered on three different occasions. Each version of the workshop has undergone some structural changes to the length, frequency, and content distribution of sessions. During our pilot we offered four one hour sessions. Then, on the next iteration, we added one more day for student presentations and reflections. During our most recent iteration of this workshop, we have reduced it to three days in class, but we have also required pre-work (going through a pdf tutorial), then provided most of the instruction on Day 1, and then only a few minutes of instruction on Day 2. However, during this iteration, the students were expected to do a significant amount of the work away from the in-class workshop. In this section we outline only the most recent version of the workshop, as we believe this workshop is continuously improving, and thus the most recent version will be most beneficial to report.

Students involved in the workshop engaged in the following activities: (1) attended a pre-workshop lecture on the concept of design thinking; (2) completed a tutorial walkthrough on game design using the game development tool; (3) attended the first day of the workshop to be instructed on game design and the particulars of using the game development tool; (4) worked on the non-interactive elements of game design in between the first and second sessions; (5) attended a second session to receive final, and brief, instruction on the particulars of interactive elements; (6) worked on designing and developing their games in and out of the workshop (which consisted of one more day); and lastly, (7) submitted a final version of their game accompanied by a written reflection of the application and relevance of design thinking a couple days after the final session. Total time spent on the video game design module ends up being around ten days—from completing the tutorial to turning in a final product.

During the workshop, student groups were self-formed, but facilitator approved—facilitators must make sure that at least one person in the group is fairly comfortable with the game development tool. Each group consists of two to four students. Over the course of the three workshops, we have administered, we have had ninety students participate, comprising twenty-seven groups. For the most part, the students have been excited at the prospects of designing video games—something usually none of them have previously done or even imagined possible before participating in this workshop. Prior to actually building any video games, we required the student teams to map out who their customers were and what their customers' requirements might be, and then design on paper, and in concept, a product (video game) that would satisfy these requirements.

The tool we have used to design the games in this workshop is Game Maker 8 (GM8).¹ GM8 is a drag and drop game development environment that does not require developers to have any prior knowledge of programming in order to develop their own games. GM8 does not require any scripts or code to be written by the developer, though that option does exist for the more advanced users. Fully functioning games of all genres can be developed using GM8. Packaging of the end product results in a simple executable file that can be run on any computer operating system.² A screenshot of GM8 project window is shown in Figure 1.

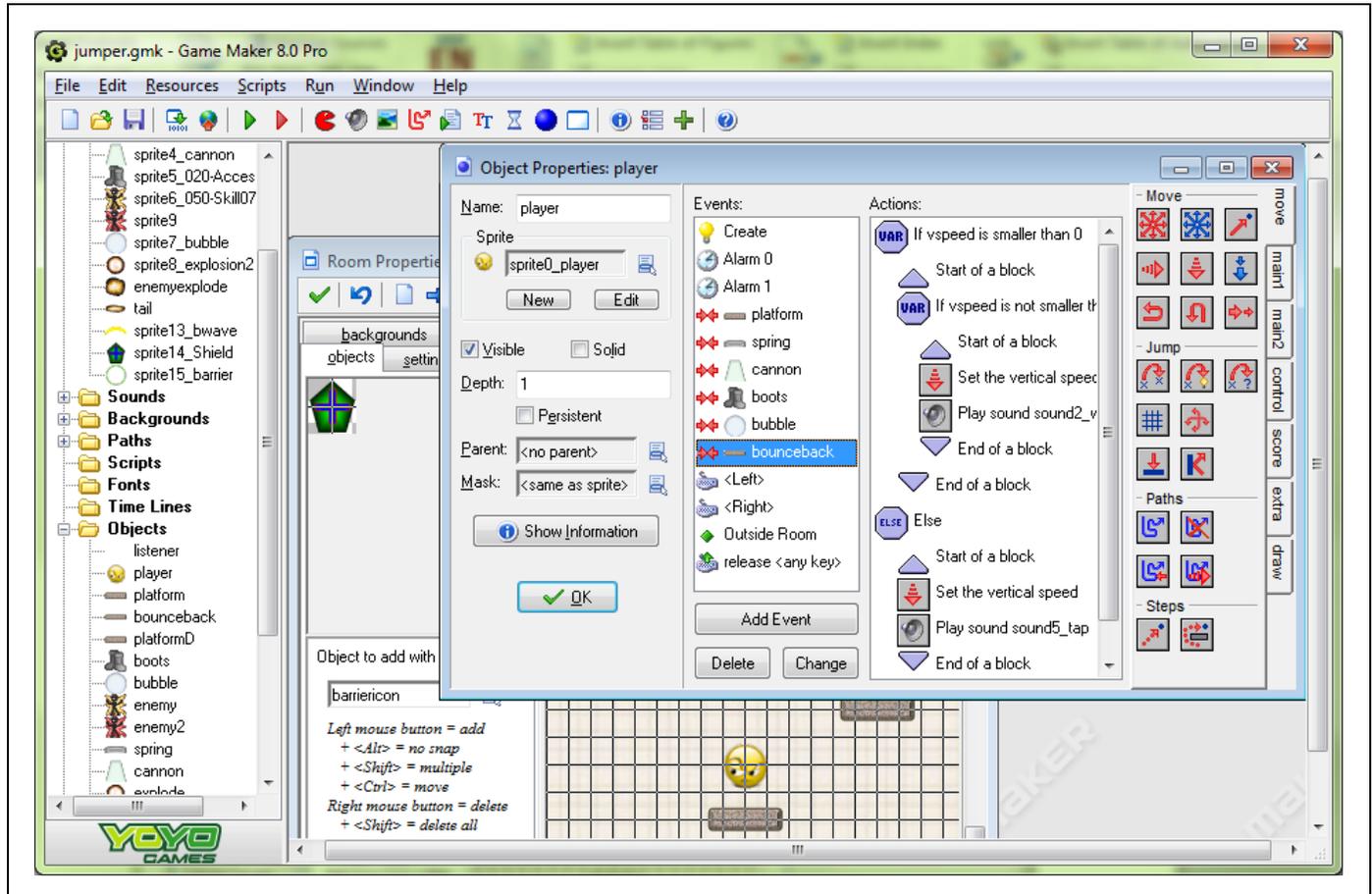


Figure 1. Game Maker 8 Project Window

Despite the user-friendliness of GM8, we did not expect our students to develop games of a high caliber for two reasons: first, limitations on time—students were given only a few days to develop games; and second, the relevant experience of the teams with regards to game development was minimal or nonexistent—none of the students had ever used GM8 prior to the workshop.

Although our expectations were low in regard to the team projects, we were surprised by the quality and completeness of several projects. Team members immersed themselves in designing these games and found it difficult to stop when time ran out during the in-class sessions. The majority continued their designing and building for several hours even after the workshop sessions ended each day. More importantly, the lessons learned from these projects seem to have hit home with each of the students. We hold a post-workshop wrap-up session to get feedback from the students and to ascertain what lessons they had learned. Classes inevitably reported enjoying the experience, and many students indicated that the relevance of the activities to design thinking helped them better understand these concepts and would forever give them a simple example to draw upon when faced with future design situations. From a more objective perspective, the games themselves, as well as the post-workshop reflections, provide evidence that design thinking was employed and internalized (to a degree) by many of the students.

¹ For more information visit: <http://www.yoyogames.com/gamemaker/>.

² The newest version of Game Maker (GM8) generates a Mac compatible .app file.

Pre-Workshop Preparations

In preparation for the workshop the facilitator needs to ensure students download and install the Game Maker software. Game Maker 8 has a free and fully functioning demo version that limits only the most advanced functionality. The facilitator should also provide students a downloadable package of game design resources (sprites, sounds, and example games and non-interactive games, etc.) so that they may follow along with in-class instruction.

All students participating in the workshop should complete the beginner's game design tutorial available from <http://www.yoyogames.com/downloads/tutorials/first.zip>. This tutorial is a very simple, step-by-step guide to using GM8 to develop a basic game. Students who complete this tutorial will find it much easier to follow along with the facilitator during the first day of the workshop. Completing this tutorial will take most students between twenty and forty minutes to complete.

Lastly, we have found that grounding the students in the concepts of design thinking through a lecture or lecture segment, helps reinforce the principles of design thinking as students work through the game design experience. As we outline the workshop below, it will be good for the reader to keep in mind the four dimensions of design thinking [Simon, 1996] as previously summarized in Table 1:

1. Generative—new learning, knowledge, and ideas
2. Iterative—cyclic process of design—test—redesign
3. Representational—results of design thinking represented by actual artifact or product
4. Complex—wicked, unstructured problems

Workshop In-Class Sessions

We use this section to outline each portion of the workshop.

Day 1

The goal of Day 1 is to familiarize the students with the software, programming terms and logic (though no actual coding will take place), and prepare them to be able to develop games of their own design. This goal is achieved by conducting an in-class exercise, during which at least one student from each group follows along. The end product of the in-class exercise is a game without interactive elements.

Begin the session by introducing game design³—what is game design and what is involved in game design. Explain why game design is being taught in a business class and what the relevance is to design thinking. Next, ensure everyone has prepared for the workshop by downloading and installing GM8 and the resources package. Next, explain that there are many different kinds of game-making applications and tools (optionally show a list of game makers that can be found on Wikipedia under “List of Game Engines”) and explain why you will be using the one you are using.⁴ Lastly, show some examples of non-interactive games and games that can be made by novices. These examples should be included in the resources package they downloaded (others can also be found at www.yoyogames.com).

The remainder of the session should be devoted to developing—as a class—a non-interactive game, by demonstrating and explaining the following concepts, which are also briefly covered in the pre-workshop tutorial they should have already completed:

1. Sprites and image capturing/editing
2. Objects and instances
3. Object Behavior
4. Rooms
5. Movement
6. Collisions (object interaction)

³ We have found that jumping straight into game design, without providing a good explanation of the relevance of the topic, and good motivation for participating, undermines the entire process. Thus, be thorough in motivating and explaining why you are doing game design in a business course.

⁴ Other tools may be used, other than GM8; however, we believe that for the audience intended, GM8 is the easiest to learn and most comprehensive tool currently available.

7. Variables (keep simple)
8. Conditional statements
9. Packaging of the game

As each new concept is introduced and demonstrated, ensure that at least one student from each group follows along. Encourage students who are mastering the skills more quickly than others to explore for themselves while the others catch up. GM8 allows a test run to be performed at any time. Test often. This will allow students to see the results of their work quickly and will also reveal errors early in development. It is very rare for things to go right the first time around. Thus, iteration is a key component of game design. Covering the concepts listed should result in a fully functioning non-interactive game. This non-interactive game is the representation of your design thinking. Wrap up the session by reemphasizing the importance of iteration and trial and error in design thinking.

A screenshot of the resulting non-interactive game is shown in Figure 2. In this non-interactive game, the red balls grow and shrink as they move about the screen at random speeds and directions, and bounce off the walls. Occasionally a ball will spawn a new ball (akin to cell division). Students are encouraged to spend time outside of the workshop to play with and edit the non-interactive game they made during Day 1.

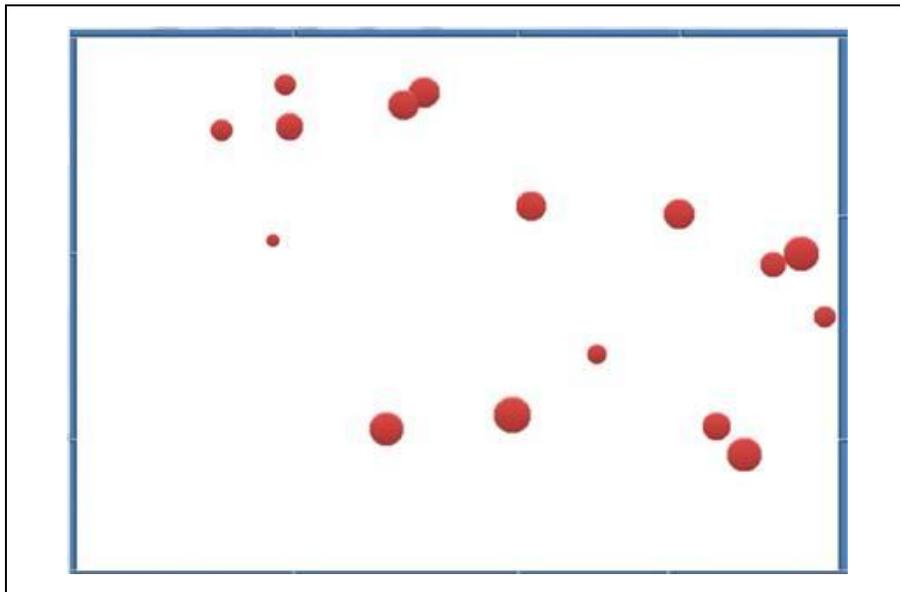


Figure 2. Screenshot of In-Class Exercise (Non-Interactive Game)

Day 2

The goal of Day 2 is to wrap up instruction on game development by discussing the interactive elements of game design (user input, score, etc...), and then to have the students develop an on-paper design of a video game—including details about the customer segments being served,⁵ the customer requirements,⁶ and the particulars of the game that will satisfy those requirements. This effort in creatively generating, and pursuing their own ideas is a manifestation of the generative dimension of design thinking. By requiring the students to come up with their own customers and requirements and their own solutions for those requirements, the students engage in unstructured problem solving. Game design, like most good product design, tackles wicked problems in which the problem space and solution space develop and are defined together and over time. Throughout the design process, teams are encouraged to keep notes about their work.⁷ As students write down their activities, they quickly come to realize the vital role trial and error and iteration play in design activities.

There are three main topics that will be covered on Day 2: (1) Interaction: games allow player input through the mouse or keyboard or other peripheral devices; (2) Goals: games have specific goals for players to work toward; (3) Interactive entertainment: games are intended to be fun, engaging, and have an appropriate level of challenge or

⁵ For example, a customer could be boys from seven to ten years of age.

⁶ For example, requirements could include an easy to use interface, humorous content, engaging and appropriate challenge, and cartoon-like graphics.

⁷ These notes include things like what they want to accomplish (on a small scale, like a bit of object behavior), what things they tried to do to meet those goals, whether what they tried worked, and what they ended up doing in the end to satisfy that requirement.

difficulty. The remainder of the session is devoted to adding these elements to the non-interactive game from Day 1 in order to turn that non-interactive game into a fully functioning game. With the students, build a game from the Day 1 non-interactive game by demonstrating and explaining the following concepts:

1. Keyboard input
2. Mouse input
3. Scoring (optionally demonstrate health and lives)
4. Drawing (dynamic sprites, such as life icons, or dynamic text, such as a timer or money)
5. Sounds (music and sound effects)

The end result of this session will be a fully functioning game with goals, score, challenge, input, sounds, fun, etc. Throughout the exercise, make frequent mention of keeping in mind the customer and requirements. Also, depending on the savvy-ness of the facilitator, allow students to suggest or even dictate how the game play ought to run. For example, allow them to suggest what the goals are, how scoring should be calculated, what constitutes winning or losing, etc. This will allow students to engage in generative thinking and show the students that iteration, through trial and error, is involved in every step of the design process, and that there is always a way to build what you design—perhaps not the exact way you intended (because the problem space and solution space are evolving), but built nonetheless. A screenshot of the resulting game is shown in Figure 3. In this game the paranoid virus, controlled by the mouse, must avoid the red blood cells as long as possible; the longer the player can evade collision with a red blood cell, the greater the player's score.

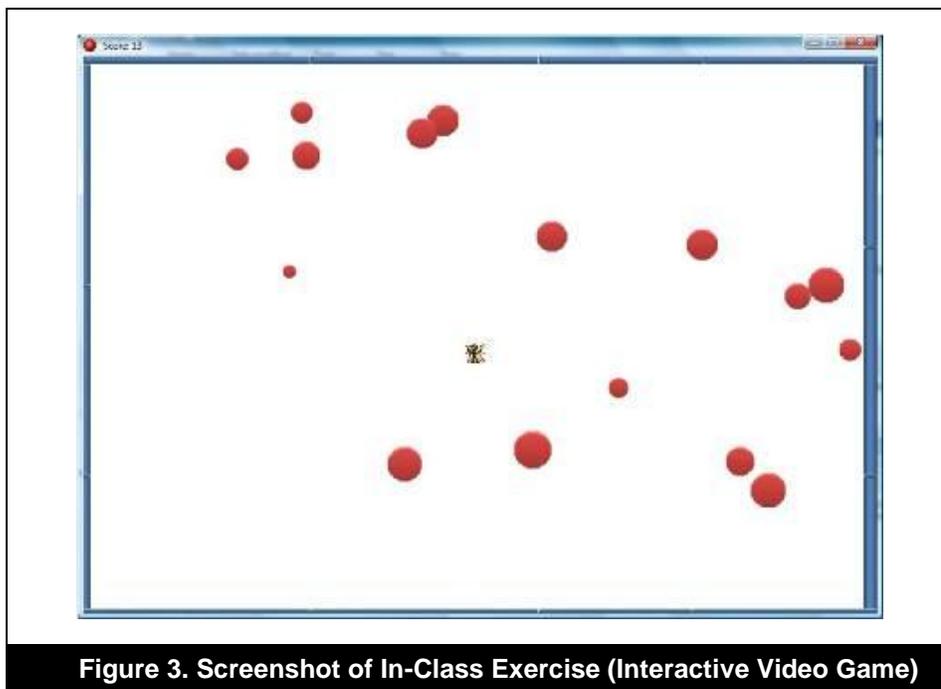


Figure 3. Screenshot of In-Class Exercise (Interactive Video Game)

Day 3

The goal of Day 3 is simply to provide need-based consulting for student teams as they begin to develop their video game in GM8. Much of the consulting at this point is helping the students decide on what is feasible, given their experience and time constraints. Several teams will also need more mechanical assistance—not being sufficiently familiar with GM8, they will need to be pointed in the right direction when they have a requirement, but are not sure what resources are available to them.

Student teams will finish the game design project on their own time and with occasional assistance from the facilitator as needed. All games should be completed and submitted within the next few days. Along with the games, teams should submit written reflections on the workshop, discussing how design thinking is relevant to video game design, and how they applied the concepts of design thinking during their development of a video game. These reflections provide a second source of evidence (aside from the game itself) for discovering the richness of design thinking that occurs during the workshop. These outcomes of the workshop will be explored next in the discussion section.

V. OUTCOMES

The results of the workshops continue to exceed our expectations, and student reactions to the workshops are generally positive and enthusiastic. Our expectations going into each of these workshops have been optimistically low; our time frame is always shorter than we would like, and our students are mostly inexperienced in the realm of game design and programming in general. Despite these limitations, the student teams continue to exceed our expectations in terms of the quality and completeness of the products they submit.

Granted, there is some variance in both the quality and completeness of the products, and not all exceed our expectations; however, many do. For example, one of the non-interactive games submitted by a group in our pilot workshop used object paths, on-the-fly sprite morphing, and frame by frame sprite animation; however, none of these concepts were demonstrated in class. Another team developed a game that had the quality of a commercial NES (Nintendo Entertainment System—the original Nintendo gaming console) product, with clean graphics and animation, and fun game play. These team games can be viewed online at <http://www.kolobkreations.com/GDWweb/Day4.html>.⁸

In this workshop, even though students all used GM8 to compile and organize their projects, they also drew from a number of other applications of their choice (such as the Web, illustration software, image and audio editors, etc.) to design the final product they had in mind. Aside from learning the basic constraints of GM8, the thrust of the students' energies were toward actually designing and building their ideas. In other words, the workshop was not focused on tools, methodology, or specific outcomes; it was an open-ended set of design activities in which students could design conceptually, and then physically, whatever product they felt would meet the requirements expected by the customers they envisioned.

The remainder of this section is divided into two broad topics. The first describes the outcomes of the workshop, with regard to design thinking. The second summarizes the lessons we have learned from conducting these workshops. It is probable that the effort to measure design thinking through student reflections may be problematic for some readers, and we address the idea of measuring design thinking in Appendix 1.

Design Thinking Outcomes

The main goal of the workshop was not to teach video game design, but to provide future managers with an experiential lesson in design thinking. According to Boland and Collopy [2004, p. 202] design thinking is particularly important to managers:

Unlike those [professionals] found in the physical disciplines, managers' constraints are a dynamic unfolding discovery. Managers cannot always know at the outset of a project those constraints that will be the project's undoing; sometimes constraints develop as a project progresses.

Many of the student teams reported this kind of dynamic problem solving—they discovered that, as they worked, their “best-laid plans” often go awry and require quick thinking and ingenuity to stay on track. We collected written reflections from each student group in order to assess their general feelings about the workshop, their application of design thinking, and their suggestions for improving future workshops. Next we use several illustrative quotes for each dimension of design thinking to capture the overall sentiments conveyed in written student reflections.

Generative

Designing and developing video games is necessarily generative in nature. Students must consider alternate perspectives and solutions, and they engage in improvisation, “bricolage,” and “satisficing” to balance constraints and resources with goals. The generative principle of design thinking is evident in the following quotes selected from the written reflections of the students.

We started to use the resource available to us, which is Internet [sic]. Therefore we searched a lot of game websites to see what kinds of games are popular and simple, and finally a story about Spongebob stealing sandwiches came out! After we figured out a prototype, we met several challenges and we solved them.

When we were facing the problems, we always believed that there might always be an alternative explanation, and by using careful judgment or judicious evaluation any problem could be solved.

Although not initially obvious, it became apparent that for a comprehensive, successful game design, our group would need to approach the game's general algorithm as well as its construction and problems along the way from a variety of angles in order to fully integrate all aspects of the game.

We had to generate a new solution, rather than choose from a set of pre-existing solutions. By designing our own game, we were making an entirely new solution, which has never been used before.

Iterative

As with other design activities, designing video games is an iterative process. An object is given additional behavior, or an object is added to an existing system of objects, and each change to the game requires a test cycle. Often each change must undergo multiple test/generate cycles in order to accomplish a successful change to the game. Students were able to do this easily using GM8, which allows test runs of the developing game at any point. The following student quotes selected from the written reflections evidence this activity and the students' understanding of how critical iteration is in design.

Once we put something into the game we had to validate whether it really worked the way we intended it. And if it didn't work, we tried to come up with a different solution that still fit into our concept and met the needs of the target group. We went through a number of iterations to get there.

The success of the design project depends on the designer's ability to interpret the feedbacks (test runs) and make necessary adjustments to the game design. The design process follows Plan-Do-Check-Act cycle, which turns out to be very effective.

I would like to think I used an evolutionary prototype methodology during development, but at times it felt more like build-and-fix.

We experienced several tasks of trial and error and for each time we attempted to input a new programming step, most of the times we had to go back to the drawing board to fix, update or correct an issue to cause the game to function as designed.

Representational

Much of the representation that takes place in game design occurs during the many iterative generate/test cycles. Students design a certain representation of a solution (a working version of a semi-constructed video game—a prototype), and then they test that representation against their expectations. If the representation meets their expectations, then they move on to a new problem/solution space; if not, then they iterate. Representations provide form to concepts. These more “tangible” representations fill in the gaps inherent in conceptual understandings, and “inspire” or “spark” additional design ideas—sometimes unintentionally. For example, if a prototype doesn't work as expected, but still works (i.e., doesn't crash) it may be considered an alternative solution, rather than a failure. Thus representations can alter intended solutions and the problem and the solution develop together [Buchanan, 1992; Checkland, 1981; Churchman, 1971; Yoo et al., 2006]. In addition to the quotes provided in the iteration section above, we add one, which is more specifically about representation.

What we learned is the value of prototyping. You can really come up with an entire game in your head or on paper, but then when you start experimenting, you come up with different solutions and this might ultimately change the game entirely.

Complex

Students are given very liberal instructions regarding the game they are to develop. They are instructed to come up with their own customers who have their own requirements. Thus the “problem” is almost completely unstructured. There is no “right” answer or correct configuration or design. Each team is responsible for designing a solution to a problem that evolves as they learn their own capabilities and the possibilities available to them. The result is a set of completely unique video games—each game a solution to a problem unique to each team. The beauty of the complexity of video game design is that even if two identical solutions (in form) were created, the underlying mechanics and the method used to produce the solutions would likely be largely distinct, since there are an unlimited number of ways to achieve the same end. The following quotes bear witness to the complexity of video game design and the understanding students gained from engaging in it.

Translating our ideas into realistic actions often meant finding solutions that were workable, not optimal.

We had to push ourselves to think outside of the box and come up with solutions that, although we had no idea how to program, we knew were possible.

First of all, I was able to appreciate that, from using a few basic principles and rules, relatively elaborate systems could be constructed. This is an important concept, because often when we deal with complex problems that seem overwhelming, the best approach is often to break them down into individual components and reconstruct the situation.

We determined what our ideas were, then had to determine a course of how to get where we wanted to go with defined steps along the way. (For example, we want the game to do “action X” but right now, the way it's programmed, it will do action “Y.”) What steps do we need to change this, and, if we make one change, how does this adjustment affect all of the other parts of the game?

Potential Counter-Evidence

The written reflections of the students are not all perfect examples of an ideal design thinking experience, or of a successful workshop. Some participants, over the course of the three workshops, have expressed uncertainty in the relevance of video game design, and of its benefits. Other students seem to have developed a misinformed understanding of design thinking. For example, one team's reflective paper mentions its critical reliance on design thinking, but then goes into an extensive, and mostly irrelevant, explanation of how the team used "design thinking." Thus, perhaps the concept still had not yet sunk in for this team. In an effort to provide full disclosure, we include the most salient of these counter-evidence comments here.

This first quote demonstrates that at least one student did not understand that design thinking actually encourages thinking outside of defined boundaries—in this case, the capabilities of GM8.

Since we had limited resources that we were bounded by, we had to use Design Thinking and design our game with the actions that Gamemaker 8 had pre-programmed in.

The student quoted next evidently misunderstood the "sufficient vs. optimal" argument of design thinking.

I learned that there are multiple ways to do the same task or function, but finding the best way is the key.

The next quotes indicate that the students did not feel that the workshop was an effective method of learning. These two quotes are from the first workshop we held, and no similar comments have been expressed in subsequent versions of this workshop. We hope this is evidence that the workshop has improved as we have continued to redesign it.

I think that it is an interesting and innovative way. But the way we have learnt it here is not sufficient to have any impact in developing the skill.

I guess I'm not really clear on what I was supposed to learn. I am not really trying to become a computer programmer, although I realize that was probably not the objective of this exercise. In some respects, I was reminded of the original "Karate Kid" movie from the 1980's. After Ralph Macchio's characters spends days painting the fence and waxing the cars, he grows extremely frustrated until he realizes the benefit of what his labor was. In this case, I guess I am still waiting for that magic moment.

Facilitating Takeaways

In addition to written reflections, we have solicited verbal feedback in workshop debriefs. Students have made several constructive suggestions, which we consolidate and describe here, leaving some quotes intact. We break up this feedback into things that worked well and things that should be rethought for future implementations of this workshop.

What Worked Well

One thing that has worked very well is having a traveling consultant assist student groups on an as-needed basis. Students often struggle with some of the more technical aspects of game development. Having a consultant who knows the GM8 environment available in the classroom allows students to think big—not limited to their skill with GM8. Depending on the size of the class, having two consultants might work even better. There is a balance that must be kept between encouraging student exploration and experimentation (by not relying on the consultant), and removing trivial, yet insurmountable technical roadblocks.

Having students do a pre-workshop tutorial (implemented in our most recent version of this workshop) was a definite improvement over previous workshops. Previously, some students had struggled with navigating the interface, which made for rather slow progress during class. Additionally, having each student follow along during the instructive portion of the workshop, rather than having just one person per team follow along, completely derailed our efforts in previous versions of this workshop. Having just one person follow along from each team made the instructive portion much more productive and smooth.

The workshop, as a whole, has worked very well for the students. Students find it to be fun, practical, useful, and memorable, as evidenced by the following quotes:

We think that playing with the logic and the design aspects of thinking, determining who the target customer is and what makes them react to the different aspects of the game would be very useful in a strategy or marketing function. In general, to lead or manage, one has to know what motivates and stimulates people. Designing a game gives one insight into these very important aspects of leadership.



This exercise has taught us how to systematically approach a task that we have no experience or training on. Game design forced us to think logically about the task and develop a solution with the tools available, similar to any problem or task that we would encounter in our professions.

I think game design definitely has a place in the MBA curriculum—it is one of the most interesting and intriguing development processes I have learned thus far.

I think this was a good experience and because it was so unique I will be able to draw upon this experience and use the lessons I learned in my workplace and with my coworkers.

What Needs to Be Rethought

The feedback was not all positive, and we have not had flawless implementations of this workshop. Certain aspects certainly need rethinking. For example, nearly everyone has suggested that we need more time for the workshop (the suggestions range from two weeks to an entire semester). We are pleased that students would like to spend even more time on this activity, but we have found it difficult to justify spending more than ten days (only three class sessions) on this topic in a course that must cover several other topics. One possible solution to this issue is to make the video game design an end-of-semester project, blocking off two to three weeks for the workshop.

A couple students also suggested that we should focus more on video game design, rather than video game building. Due to the limited time we have for this workshop, much of the time during the workshop is focused on *how* to build a video game using GM8, rather than the design concepts that go into designing a video game. Perhaps a way to address this is to have a couple classes prior to the workshop devoted to conceptual game design, including exercises and deliverables of design plans.⁸

Additionally, we feel it may be beneficial to offer some instruction on file sizes and formats. Many of the final products were large and slow because students had included full versions of their favorite soundtracks and hadn't compressed large images they used for sprites.

Lastly, one student expressed that the link between business and game design is missing. Admittedly, this link was least explained during the second implementation of this workshop (which is when we received this comment), but the most recent workshop included a thorough explanation of relevance.

However, I am still struggling making the connection between the game design workshop and a business organization. I am not sure how to take this experience and apply it in the workplace to either better my management skills or solve problems at work. I could be missing the obvious connection, but, by participating in this event, it has not come to me yet.

VI. CONCLUSION

Since the turn of the millennium, business schools have employed the use of “business games” and simulations to help teach students marketing, strategy, collaboration, and other useful real-world skills in a risk-free and quasi-experiential environment. Yet, in each such simulation, the desired outcomes are implied by the assumptions embedded in the system. The goal, in effect, is not to design something innovative, but to solve the problem as presented in the simulation. Thus it becomes a course in learning how the simulated environment operates. In the teaching of design thinking concepts, it is critical that students not be hampered by over-concentration on the tools that enable the design activity, the methodology, nor any single design outcome (such as aesthetics, usability, etc.). A course focused on tools, methodology, and specific outcomes might take away from an open-ended designing approach and would likely inadvertently draw the bulk of attention on those tools, methodology, or particular outcomes rather than emphasizing general design principles.

In the video game design workshop we offered, students *build* games rather than play them. Designing games, rather than playing business simulations, has some distinct advantages. Game design affords the opportunity to learn how to build, define, and work within defined contexts. Additionally, game design teaches students not only how to be good problem solvers, but how to be good solution creators, and that there's always a way to design their own solution. Game design teaches that there are always other means to reach the same ends. We are not restricted to the set of choices we have before us; we can develop or design our own set of choices [Boland and Collopy, 2004].

Design thinking is a vital skill for managers in modern, dynamic organizations. However, teaching design thinking to MBAs through traditional methods is difficult. Two common problems face all pedagogical subjects; namely, (1)

⁸ An excellent resource for this kind of an activity can be found at <http://www.yoyogames.com/downloads/tutorials/goodgame.zip>.

finding an engaging mode of teaching and (2) facilitating greater retention of learning. How can we teach in a way that is interesting to students and in a way that leaves a lasting impression? Design thinking is not immune to these common problems, and, being somewhat complex and debated even among scholars, design thinking is perhaps even more susceptible. Through a design–thinking workshop on video game design, students can engage in experiential learning as they immerse themselves in actively designing solutions to the problems they define. We posit that this kind of learning provides a more concrete experience on which students can draw as they will be required to design in the future. The workshop is not complete, but rather, a work-in-progress (in the spirit of a design attitude!). Future implementations of this workshop will help us refine the process and develop a consistently effective set of lesson plans which may be shared with other institutions in order to aid in the dissemination of design thinking.

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1. These links existed as of the date of publication but are not guaranteed to be working thereafter.
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APPENDIX 1: MEASURING DESIGN THINKING

We have not explicitly measured design thinking. The intent of this article is simply to provide a new and innovative way to approach the teaching of design thinking in the classroom. However, we feel that the issue of measuring design-thinking-related outcomes is an important one, and should be given further thought. Thus, we use this section to discuss the potential to measure design thinking. It is important to keep in mind that the main goal of this article does not involve measurement of design thinking, but we put forth the following as a starting point for those who wish to explore such measures more fully.

Measuring Design Thinking from a Workshop

The primary way we attempted to gage the impact of the workshops was through student reflections. This reflection is a key element to any experiential learning exercise [Kolb and Kolb, 2005], and it is also essential for reflective design practice [Schön, 1983]. Through these reflections, we have some evidence that the workshops potentially aid the students in understanding the principles of design thinking. It is important to note, however, that students were guided to specifically attend to the four design-thinking principles we were looking to instill. These four principles represented "abstract conceptualization," which, along with concrete experience, experimentation, and reflection, together comprise an experiential-learning exercise. Therefore, although the reflections were used to gage the success of the workshop, these reflections were first and foremost an essential component of the workshop—a component that could really bring multiple lessons together in a course on design thinking. This is an important point, because the game design workshop is not intended to supplant other forms of pedagogy, but rather to complement them.⁹

However, one should look to the information within these reflections—or any other assessment of design thinking in a classroom setting—with caution. Design thinking cannot be learned solely through the transmission of codified knowledge, but necessarily involves a tacit understanding of design practice [Wong and Radcliffe, 2000]. Experiential learning exercises are intended to attend to tacit knowledge building through behavior, experience, and reflection [Kolb and Kolb, 2005]. Tacit knowledge does not "test" well through codified, standardized testing instruments typically applied in a classroom. Rather, tacit knowledge can be made explicit only through reflection and sharing [Kolb and Kolb, 2005, p. 200]. We have attempted to capture the outcomes of this experiential exercise by having students write down their reflections on the workshop and by soliciting feedback in workshop debriefs. However, Sternberg and Horvath [1999] warn that the success of programs intent on developing tacit knowledge should not be assessed by measuring insight gained or learning reported by the participants, since individuals often report high scores on insight and learning, regardless of actual program impact. Thus, while reflections or self-reported learning are part of the experiential learning process, it may make sense to measure outcomes associated with design thinking workshop by asking questions about the process and about what the participants might do differently if required to do a similar task, and then inferring that some internalization may be taking place. For example, the instructor might ask questions like the following:

- About how many prototypes (working versions of the game) did you test out before settling on a final version? (perhaps suggest brackets of 0–5, 6–10, 11–15, 16+)
 - If you were asked to design and build a video game again, do you think you would use more or fewer prototypes? Why?
- Did your team tend to iterate through build/test cycles frequently (for minor changes) or only for major changes?
 - If you were asked to design and build a video game again, would you change this behavior? How?
- Did the nature of your goal (video game) change over time, or did you stick with the original plan? Please explain how it changed, if it changed.
 - If you were asked to design and build a video game again, would you be more or less flexible regarding change? Why?
- Did you use resources not given you by the workshop facilitator? Which ones?
 - If you were asked to design and build a video game again, would you expand or contract your boundaries of "acceptable" resources? Why?

While these questions may provide insight into the level of learning from a workshop or temporary program, it is important to distinguish such measures from measuring design thinking "in the wild"—in organizational settings. In organizational settings we feel that measures of the degree of design thinking could be quite beneficial.

⁹ Therefore, we argue that attempting to measure which approach "better" teaches design thinking may be misplaced.

Measuring Design Thinking in Organizations

Design thinking is still evolving as a field of study with few proposed methods of formal measurement and certainly no established standard. One instrument that captures the way the literature tends to think of design thinking (albeit in a more thorough fashion than most) is Michlewski [2008], who develops a framework for guiding future work in exploring design attitude. Through a content analysis of interviews with professional designers, Michlewski developed these five categories of design attitude:

1. Consolidating multidimensional meanings
 - a. Reconciling contradictory commercial objectives
 - b. Bridging approaches, swinging between synthesizing and analyzing
 - c. Consolidating multiple languages and media
2. Creating, bringing to life
 - a. Creative manifesting
 - b. Rapid prototyping
 - c. Working with tangibles
3. Embracing discontinuity and open-endedness
 - a. Allowing oneself not to be “in control”
 - b. Linear process, detailed planning vs. “let’s see how it goes”
 - c. Freedom to think and behave differently
4. Engaging polysensorial aesthetics
 - a. Visual discourse, visual thinking, creative dialogue
 - b. Aesthetics, beauty, taste
 - c. Intuition, instinct, tacit knowledge
5. Engaging personal and commercial empathy
 - a. Concentrating on people, human-centeredness
 - b. Transparency of communication
 - c. Sense of commercial purpose
 - d. Authenticity, playfulness

Through this analysis, Michlewski provides guidance for an in-depth assessment of dispositional elements of an individual that focus on the “attitude” of a designer. We argue that many elements of this attitude can be applied to the culture of an organization or team. Based on many of the concepts identified by Michlewski, and through our continued work with design thinking and our reading of the literature, we argue that there are three broad concepts associated with design thinking: design practice, design attitude, and design ability.

Design practice involves the process for practical and creative resolution of problems or issues with the intent to improve on the way things currently are. It is the essential ability to combine empathy, creativity, and rationality to meet user needs and drive business success [Simon, 1996]. *Design attitude* is an entrepreneurial spirit—approaching each new problem with a desire to do something different and better than before—and a desire and willingness to experiment with resources [Boland and Collopy, 2004]; in essence, treating problem solving as a quest rather than a quiz. *Design ability* is being able to resolve ill-defined problems, adopt solution-focused cognitive strategies, employ abductive or appositional thinking, and utilize nonverbal/graphical media [Cross, 1990]. Given these definitions and our understanding of extant research, and in adapting many of Michlewski’s observations, we suggest the following scales as a starting point when attempting to measure these important elements of design thinking.

Design Practice

Please rate the following statements as they characterize your organization’s/team’s approach to problem solving: (Likert scale from strongly agree to strongly disagree)

Iterative:

- Our organization/team solves problems with a great deal of trial and error experimentation.
- Our organization/team prototypes new concepts to a great extent.
- Our organization/team is heavily focused on solving problems correctly “the first time.” (reversed)

Generative:

- Our organization/team consistently generates novel products and/or processes.
- Our organization/team typically “reinvents the wheel” when solving problems.
- Our organization/team specializes in implementing standardized solutions efficiently and effectively. (reversed)

Representational

- Our organization/team regularly employs graphical representations such as models and sketches.
- Our organization/team applies many different types of representations to capture new ideas.
- Our organization/team *primarily* uses word processors and slide presentations to convey ideas. (reversed)

Complex

- Our organization/team is continually questioning established directions.
- Our organization/team readily adapts to new situations.
- Our organization/team converges quickly on goals then works to attain them. (reversed)

Design Attitude

Please rate the degree to which you agree with the following items with regards to your organization's/team's approach to managing (1 = Strongly Disagree, 5 = Strongly Agree):

- Our organization/team is comfortable with indeterminacy.
- Our organization/team can be described as "people-centric."
- Our organization/team rewards creativity.
- Our organization/team is playful.
- Members of our organization/team are free to think differently.
- Our organization/team engages in detailed planning processes and then sticks to the plan. (reversed)
- Our organization/team always aspires to complete control of new situations. (reversed)
- Our organization/team discourages risk taking. (reversed)

Design Ability

Please rate the degree to which you agree with the following items as they characterize your organization/team (1 = Strongly Disagree, 5 = Strongly Agree):

- Our organization/team is comprised of experienced designers.
- Our organization/team has a strong track record of innovation.
- Our organization/team has experience in consistently generating new ideas.
- Our organization/team has a history of successfully deploying new products and services.
- Our organization/team is technically competent.
- We have a variety of skills and expertise in our organization/team.
- Members of our organization/team have received training in creative disciplines (such as engineering, art, or architecture).
- Members of our organization/team have received training in graphical modeling software.
- Our organization/team has a great deal of knowledge diversity (i.e., people with different disciplinary training).
- Our organization/team has a great deal of cultural diversity (i.e., socio-economic, national, etc.)

ABOUT THE AUTHORS

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