Is Design Thinking the New Liberal Arts of Education?

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Executive Summary. Design Thinking is frequently identified as an engaging process and methodical framework for approaching complex, multidisciplinary problems in ways that consistently result in solutions that are successful and often creative in unpredictable ways. It originated decades ago in the field of product design, but in recent years it has proven effective in a much broader context, including transformation of corporate cultures at PepsiCo and Samsung, establishment of new public school systems in Peru, and improving access to economic resources in Mongolia, transportation in India, and community building in low-income neighborhoods in the U.S.[3] Earlier this year, its importance in higher education was signaled by an article in the Chronicle of Higher Education raising the question of whether Design Thinking is "*the new liberal arts*."[4] This places Design Thinking on an equal footing with "*critical thinking*" as a desirable outcome for all educated people. This paper attempts to provide an introduction to Design Thinking and its role in the education of every graduate at Olin College of Engineering. We make the case that Design Thinking, in addition to its usefulness in developing answers to problems, is a power tool for student empowerment and potentially transformational in its ability to inspire intrinsic motivation, entrepreneurial mindset and commitment to making a positive difference in the world.[5]

Introduction. Engineering is, by nature, about solving problems and designing new things. The difference between science and engineering is often described by the nature of the questions that are asked: scientists ask "why" as they attempt to understand the world, while engineers ask "why not" as they attempt to change it and create what has never been. The process of creating what has never been is the essence of the process of design in engineering.

Of course, this differentiation between science and engineering is rather over simplified. In order to solve problems and create new things, it is also necessary to understand the world, so science and engineering are symbiotic twins. The differentiation between the two may be most clear in the pedagogical approaches used to teach the different ways of thinking in an engineering curriculum. Most of the engineering curriculum is devoted to "analysis" which amounts to starting with a known device or system and applying natural laws and mathematics to predict the behavior or performance of the system. However, for that part of the curriculum that is devoted to the principles of design, the process works in reverse. That is, the challenge is to start with a description of the desired behavior or performance and work backwards to "design" the device or system that will produce these outcomes. The differences may be visualized by the diagram in Figure 1.

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[3] Miller, Peter N., *Is 'Design Thinking' the New Liberal Arts?,* The Chronicle Review, **Chronicle of Higher Education**, March 26, 2015.
[4] Ibid.
[5] Kelley, Tom, and Kelley, David, Creative Confidence: Unleashing the Creative Potential Within Us All, Crown Business, 2013.

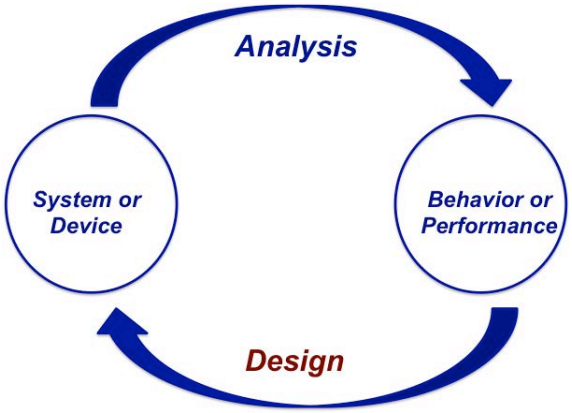

Figure 1 – Thinking processes for analysis and design are reversed

The reverse process of design is much less straightforward than analysis, and usually involves iterative progression through stages, including "problem finding," in which diagnostic conversations are used to take a fresh look at a challenge and make sure that all unconventional options are considered; configuration or concept development, in which promising architectures of potential solutions are identified; and detail or parameter optimization, in which the features of a solution (size and geometry of components, materials used, etc.) are adjusted to improve performance of a chosen configuration.

Where did the term "Design Thinking" come from? More than a half century ago, while teaching design principles to engineering students at Stanford University, Professor David Kelley (founder of IDEO and of the Hasso Plattner Institute of Design—better known as the "d.school") noticed that the principles he taught were often misunderstood and under-valued. "Design" is often regarded as an art subject, and while the principles of design are central to many forms of art, they are equally important to such endeavors as the design of cellphones and spacecraft. In addition, he noticed that his engineering students complained that developing an expertise in complex systems design was not recognized in industry as well as specific content knowledge in sub-disciplines, such as electrical engineering or mechanical engineering. Students with those more narrow and traditional interests seemed to get better starting jobs in industry. His students felt that after mastering the principles of design, they were not "experts" at anything that was valued. In response to these challenges, Kelley explained that his students were experts in a new way of "thinking" not in a technical discipline. He called this Design Thinking, and it caught on. Design Thinking is a framework for thinking about complex, multidisciplinary problems that applies to just about anything. It is not confined to an art medium or to any technology.[6]

As an originator of Design Thinking, David Kelley has a wealth of experience in both applying it in his company, IDEO—which is world famous for its success in developing "first to the world" solutions to product design challenges (such as the mouse for personal computers), and in the establishment of the Hasso Plattner Institute of Design—or "d.school"—at Stanford university. He points out that Design Thinking is important, but it isn't the only or most important way of thinking about complex problems. All successful design solutions reside at the intersection of a Venn Diagram that involves three independent considerations (see Figure 2). These three involve feasibility, because nothing exists in the real world that isn't consistent with what we know about the laws of nature. In addition, every solution must also be viable, in that it must have a cost of production and maintenance that is competitive with alternatives. The ways of approaching problems from these two well-developed domains are taught in depth in engineering schools (feasibility) and business schools (viability).

[6] David Kelley, Stanford University, personal conversation, October 2015.

However, there is a third independent requirement for successful solutions that involves desirability. Desirability is the quality of being desired, embraced and accepted by the people who must use and implement the solution. Thinking first about this aspect of the solution is central to Design Thinking and is often over-looked and under-valued in the overall design process. Obviously, the feasibility and viability centric thinking that is widely taught in engineering and business schools respectively continues to be extremely important, but without this third dimension of desirability to the people involved, they are not capable of providing the best—and sometimes the only—successful solution to a complex problem.

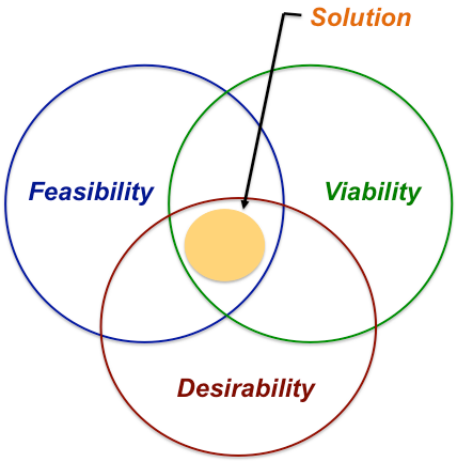

Figure 2 – Independent Ways of Thinking About Complex Problems

The types of solutions that emerge from "engineering thinking" usually involve a new technology (e.g., the internet, electric car, software, etc.) while the types of solutions that emerge from "business thinking" usually involve a new financial model (e.g., the credit card, iTunes, etc.). But the types of solutions that emerge from "Design Thinking" (or desirability) involve more human motivation and psychology, such a Facebook—where the driver is the fundamental need to tell your personal story to a group of friends you care about.

What is the basic method of Design Thinking? The basic approach to developing a solution through Design Thinking begins with people and "problem finding." Beginning in the "desirability" circle, you need to understand the context and the culture of the people who will be most affected by the solution. This begins by deliberately suspending any preconceived notion of either the problem to be solved or the options that might be applied as solutions. The design team begins with direct observations of the people and circumstances to be addressed, developing qualitative data, listening for narratives and developing empathy for the people most involved. This clearly takes time and special skill, and implicitly involves an understanding of values. This is necessary to diagnose the "true" problem, which often is not the problem that others have assumed. Next, the design team ideates through brainstorming that is not constrained by preconceived options, and this leads to prototyping of simple solutions that are tested for quality of outcomes. Only through testing can original ideas be evaluated. Several iterations of prototyped solutions then result in a more refined solution that can be optimized for implementation. A two-minute video from Stanford's d.school provides a quick overview of this process and is informative for anyone who has never heard of Design Thinking: https://www.youtube.com/watch?v=a7sEoEvT8l8.

How does Olin College implement Design Thinking? We see engaging creatively as a fundamental way of understanding and being in the world and a vital aspect of a holistic and fulfilling education. To this end, one of the streams within the Olin curriculum is a sequence of six courses across all four years emphasizing Design Thinking, which all students experience

independent of their degree program or discipline. This is unlike almost any traditional engineering program. Because the Olin curriculum is organized into streams, the design stream flows alongside and interacts with the other streams that make up a modern education, supporting and empowering learning and personal growth over time for students. Olin students also take design courses specific to their area of study by the way, meaning they usually take 8 to 10 design courses in total, far more than a typical engineering program.

The design stream topics span value creation activities all the way from the fuzzy front end of opportunity identification and problem framing through detailed design to end of life and closed-loop systems. Olin students are not just challenged to apply their area of expertise to "design it right," which is a narrow subset of these activities. They also take ownership of figuring out how to "do the right thing," to add value to people's lives in meaningful and appropriate ways. Students in traditional programs often take almost exclusively discipline specific, design-it-right engineering courses, which can have the effect of commodifying the engineer's role in society, i.e., engineers only participate when one needs something "engineered" and not in the full creation process, in choices that shape society.

The design stream seeks to impart general process and methodological approaches to design practice, and just as important, to enable a change in beliefs and behaviors around personally acting creatively for students. In line with the Olin "do learn" pedagogy, the design stream learning environment is highly experiential, one in which students are encouraged to learn from their experiences through reflection and abstraction. These experiences come primarily in the form of individual and team projects that immerse students in authentic challenges structured to be intrinsically motivating and emotionally real. Infused throughout these experiences is the sense that we are here to make the world a better place. Students come away with considerable tacit design knowledge and a substantial capacity to "do" and a feeling that they "can do" purposefully. This curriculum takes place primarily in design studios, shops, project areas, lunch rooms and even hallways, in a way that is more familiar to art and industrial design schools than engineering ones.

What are the effects of a Design Thinking curriculum on students? Most students educated in conventional schools today expect to be “taught” by an expert “professor” through a course that is well structured (lectures, homework, exams, etc.) so they feel “guided” through the learning process. The expectations set by many years of learning in this mode can lead to a sense of insecurity and confusion when a project using Design Thinking is first encountered. Design Thinking requires students to take charge of their own learning with minimal instructions. This sudden shift in responsibility for learning from the professor to the student can feel radical and less rigorous at first.[7] However, once the students realize that they really have the freedom to shape their learning experience and make real decisions, they usually respond well to the new experience, even though it often actually results in significantly more work and less certainty about the technical content knowledge gained. However, the Design Thinking process aims at developing another kind of “social/emotional learning” that enables collaboration with others, independent judgment and mastery of an important project—skills that arguably are at least as important as technical content today.[8]

Design Thinking requires an immersion experience and guided mastery of the process by a design mentor. In the best case, a series of successful solutions developed by multidisciplinary collaborative teams using Design Thinking that consistently exceed a student’s expectations produces a deep and lasting change within the student. In particular, this can lead to a change in identity, a very emotional transformation where students realize and believe that they are truly capable of creating important things. Most people in surveys give themselves low marks (<25%)

[7] Goldberg, David, and Somerville, Mark. (2014). A Whole New Engineer: The Coming Revolution in Engineering Education, ThreeJoy Associates.

[8] Bandura, Albert. (1986). Social Foundations of Thought and Action: A Social Cognitive Theory, Englewood Cliffs, NJ: Prentice Hall.

for creativity. But experience in the process of Design Thinking can change that. David Kelley believes everyone is inherently creative and capable of being a designer; everyone can enhance their creative potential and master the art of design by experience.[9]

According to Kelley, the major impediment to creativity is fear of being judged. The fear of failure appears to be involved in a high percentage of cases where students feel unable or incompetent in taking the initiative to create solutions to practical problems. One useful analogy is that of learning to juggle. Apparently, people who attempt to juggle for the first time almost always struggle with dropping the balls frequently. Fear of dropping a ball apparently plays a major role in this inability to keep track of the balls in the air. But when acceptance of dropping balls is explicit—at least during an initial training period—it is frequently much easier to learn. There is an important psychological "unlocking" of the creative process that results when fear is released. Much has been written about this in other fields, including improvisation in music.[10]

Kelley reports that, in the d.school, a relatively high percentage of students eventually progress to a point where they achieve a kind of "epiphany" in their lives where they realize that they are really capable of being creative in important ways. This transformation is the basis for a heightened sense of empowerment or "can-do" attitude, lending confidence to taking initiative and creating an entrepreneurial mindset. The formal psychological term for this state of mind is "agency" (or empowerment) and a heightened level of "self-efficacy."[11] We also find other outcomes, such as students developing a deep commitment to authentically engaging and understanding people in their efforts and defending "the right thing to do" in a principled way.

Unfortunately, it seems that learning at this social and emotional level requires an immersive experience. It cannot be learned alone while reading a book or watching a video. This presents obvious problems in scaling up this self-efficacy effect through traditional educational programs. Experiential learning appears to be required to break through the barrier to success here.

Interest in applying Design Thinking more broadly across higher education and other domains. Since this transformation to self-efficacy is beneficial both for the students involved and for society, the interest in spreading Design Thinking methodology throughout other disciplines is growing. Recently, President John Hennessey of Stanford University asked David Kelley to try to find a way to make it possible for all Stanford graduates to develop a competency in Design Thinking. Toward this goal, Stanford has created two new classes: "Designing Your Life," which aims to help upperclassmen think about the decisions that will shape their lives after graduating, and "Designing Your Stanford," which applies Design Thinking to help first- and second-year students make the best choices about courses, majors, and extracurricular activities. Both are popular.[3]

Other universities are also considering expanding the use of Design Thinking principles across the curriculum. For example, Boston College also received advice to use Design Thinking in a pervasive way.[12]

In a series of more recent articles, the Harvard Business Review documents the growing influence of Design Thinking in business and society. In one article, they point out that new products and systems frequently struggle to gain acceptance, in both industry and society. However, when the introduction of the new product or system is treated as a design challenge that engages many stakeholders, the results can be transformative. For example, when Intercorp

[9] Kelley, David, personal communication, October 2015.
[10] Zagorski, Nick, *Music on the Mind*, **Hopkins Medicine**, Spring/Summer 2008.
[11] Bandura, Albert (1997). Self-Efficacy: The Exercise of Control. NY: W.H. Freeman.
[12] Berrett, Dan, *Boston College, to Refresh Its Aging Curriculum, Turns to Design Thinking*, **Chronicle of Higher Education**, April 6, 2015.

Group in Peru took that approach, it won acceptance for a new technology-enabled school concept in which the teacher facilitates learning rather than serves as the sole lesson provider.[13]

In addition, corporations and professional services firms are working to create design-centric cultures. This is increasingly accomplished by the use of the principles of Design Thinking spread from the product design function to the whole organization in order to improve the integration of new technologies into the workplace.[14]

Design Thinking is credited with playing a transformative role in some major technology corporations, such as Samsung.[15] Samsung Electronics knew that in order to become a top brand, it needed a design-focused culture that would support world-class innovation. But designers faced constant challenges stemming from the company's efficiency-focused management practices, which were deep-rooted. Managers who were invested in the status quo had to be persuaded to buy in to idealized visions of the future. So, the company built a corps of designers with a capacity for strategic thinking and tenacity that enabled them to overcome resistance by deploying the same tools—empathy, visualization, and market experimentation—that they use in pursuing product innovation.

PepsiCo's CEO Indira Nooyi used the principles of Design Thinking to transform the culture of the company in pervasive ways. In 2012, she brought in the company's first-ever chief design officer. Now, she says "design" has a voice in nearly all important decisions that the company makes, resulting in better product design and brand position and a rapid rise in stock value.[16]

How did Design Thinking spread and achieve such widespread influence? The influence of Design Thinking is clearly profound, spreading from product design to education to business and society in remarkable ways. Its rise has been rapid and its acceptance remarkable. However, it is very instructive to examine the way in which it achieved this influence.

The d.school at Stanford is, in many ways, the cradle of this movement. While affiliated with Stanford, it is an unusual organization. More than half of its academic offerings are "pop-up" courses, which do not count for course credit and for which its faculty members are not paid as "professors." Kelley explained that the academic process at Stanford (as in nearly all universities) requires all academic courses to pass through an approval process that involves conforming to university rules and regulations. For example, courses must be taught by professors who are recognized experts in their fields (which usually means they must have a PhD and a record of peer-reviewed publications). Courses must also conform to the academic calendar for start and end date, number of hours per week of contact with students, assessment procedures involving exams, etc. Kelley explained that by not offering formal "courses" that will count for degrees, the d.school obtains complete freedom to organize and present learning experiences at whatever time and in whatever format they feel is beneficial. They can experiment freely, and try new approaches without constraints. Thus, they operate largely as an "extra-curricular" opportunity for students from Engineering and any other discipline to come together and learn to collaborate in developing the solution to complex problems.

It is particularly noteworthy that the d.school did not publish a book with a title like "the d.school way" and sell it in order to efficiently spread the ideas they developed while simultaneously building their brand and revenue stream, as is more conventional. Neither did they make a

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[13] Brown, Tim, and Martin, Roger, *Design for Action: How to Use Design Thinking to Make Great Things Actually Happen*, **Harvard Business Review**, September 2015, 56-64.
[14] Kolko, Jon*, Design Thinking Comes of Age: The Approach, Once Used Primarily in Product Design, Is Now Infusing Corporate Culture*, **Harvard Business Review**, September 2015, 66-71.
[15] Yoo, Youngjin, and Kim, Kyungmook*, How Samsung Became a Design Powerhouse*, **Harvard Business Review**, September 2015, 72-78.
[16] Spotlight Interview: *How Indra Nooyi Turned Design Thinking Into Strategy—"a well-designed product is one you fall in love with."* **Harvard Business Review**, September 2015, 80-85.

MOOC and use video over the internet to deliberately spread their approach. (This is because it is not possible to learn Design Thinking from a book—it requires a guided immersive personal experience, according to Kelley.) In spite of this, few educational ideas or pedagogical approaches have had an impact that rivals Design Thinking.

So, how did these ideas spread? In talking with Kelley (and with our own faculty and students), it appears that the transformation in personal ability and self-efficacy that is common among students of all disciplines after mastering Design Thinking is so obvious and differentiating that these "graduates" go out into their world and "turn heads" with their new attitudes and abilities. They stand out among their peers. Others notice this and ask questions, seeking the source, and they learn about Design Thinking by the most powerful marketing device in existence: word of mouth from first hand observers and trusted acquaintances.

While this method of spreading influence has clearly been successful on a large scale in the case of Design Thinking, it presents a challenge from a conventional strategic planning perspective. If we attempt to engineer a predictable spread of ideas across an industry or society, we are drawn to concepts that involve strategic plans, metrics, brand management and marketing campaigns. But these approaches do not seem to be well suited to the spread of Design Thinking, perhaps because it depends on such a personal experience and transformation.

At Olin College, we seek to spread similar ideas across engineering education and the approach that has been most successful to date is similar to that of the d.school. The challenge remains for us to understand what, if anything, we might do to accelerate the spread of influence and to manage this process in ways that are more predictable and effective.