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DESIGN THINKING AND THE HYPE CYCLE IN MANAGEMENT EDUCATION AND IN ENGINEERING EDUCATION

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1. Introduction

As a paradigm, Design Thinking (DT) has been steadily penetrating various domains across many disciplines. While it has garnered considerable enthusiasm in the popular press and in academic essays touting its effectiveness, it is not clear whether it will develop into a field of its own or drop off the radar as so many fads have done before. One could perhaps posit DT as old wine in a new bottle or even new wine in an old bottle. The basis for this argument stems from the logic of Design itself, exemplified by Simon [1988] when he states that, while natural sciences are concerned with how things *are*, design is concerned with how things *ought to be*. From an intuitive perspective, one could easily see that the design of "how things could be" is deeply connected to the engineering disciplines with or without user-input (a cornerstone in DT). It follows, then, that DT may not be an entirely new field as it is often purported to be. DT, as we know it today, does have effective and even new elements that have contributed to its recent rise in popularity reducing the danger of it being dismissed as more public relations "hype" than substance. DT is much less obvious as an essential element of management and business, but interest in it has been rising in the past few years both due to intense promotion in a few professional outlets such as Harvard Business Review, Wall Street Journal etc., but also in academia such as a call for business schools to embrace DT [Glen et al. 2014].

This paper examines the rise of Design Thinking in engineering and engineering education, and in business and management education; juxtaposing this rise against legitimate rising concerns of whether or not this is a realistic rise as opposed to a passing fad. We frame the increase of interest in Design Thinking against its historic evolution and adoption and against a populistic technological framework known as the "Gartner Hype Curve [Gartner Inc. 2015]."

This paper does not attempt to review the Gartner Hype Curve nor endorse it but rather uses it, as is, to discuss and debate the Design Thinking phenomenon. While the authors are aware that the Gartner Hype curve is not a scientifically validated tool *per se*. It does serve as a reasonable framework with which to discuss the development of a phenomenon, technological or otherwise, and it is used by many business leaders as a well-established tool to predict industry trends and make investment decicions since 1995 [Linden and Fenn 2003]. Additionally, limited academic review of a tool does not in itself render a tool ineffective or useless until proven otherwise. For example, O'Leary [2008] used the Gartner hype cycle to analyse research research issues and opportunities in information systems.

Our preliminary evidence, including a literature review of the phenomenon and trend searches, suggests that Design Thinking is still in a "Takeoff Phase" and has not yet reached a "Plateau of Stability" which ensures that the paradigm stays around well after the disillusionment phase of most fads. The paper

concludes with recommendations that can aid the transition of DT into a mature cross-discipline paradigm and avoid the pitfalls that tend to befall most fads by ensuring that projects go past the ideation and prototype stage to the production of a finished artefact.

1.1 Importance of the topic

Design thinking as a paradigm has been steadily penetrating various domains across many disciplines [Lockwood 2009]. Although it has garnered considerable enthusiasm in the popular press and in academic essays touting its effectiveness, it is not clear whether it will develop into a field of its own or drop off the radar as so many fads have before it. The authors of this paper are both active proponents of Design Thinking because they see that it has the potential to integrate several disparate ways of knowing and thinking to create interesting solutions at multiple levels using skills and knowledge from across many academic and professional disciplines. At the same time, they are concerned that it has not developed a sufficiently strong body of evidence to be considered an independent area of academic scholarship, even though it provides designers with a useful body of practical tools. The authors are concerned that Design Thinking could be falling into that category and suggest ways for the field to avoid the pitfalls that accompany fads.

To be viewed as a genuine innovation, this paper will argue that the proponents of design thinking in engineering and business must ensure that they move it toward the "Plateau of Productivity [Gartner Inc. 2015]" through projects that complete the design process to full implementation and positive social impact.

1.2 The growth of design thinking as a field leads to questions

While the preliminary evidence discussed in this paper suggests that Design Thinking may have some of the charactaristics of a fad, we do not see this as a weakness, but rather as a call for better scholarship to provide stronger evidence of when it is most effective and when it is not. The frame of reference that we use as backdrop of our postulations is the Gartner Hype Curve – a framework developed by The Gartner Group [Gartner Inc. 2015] to determine when something is a fad or not and where the fad might might be heading, i.e. at what stage of development is it in. As of August 2015, they have analyzed over 150 different fields using the five stage model shown in Figure 1, below [Gartner Inc. 2015].

The Hype cycle illustrated in Figure 1 has five parts:

Technology Trigger: A potential technology breakthrough kicks things off. Early proof-of-concept stories and media interest trigger significant publicity. Often no usable products exist and commercial viability is unproven.

Peak of Inflated Expectations: Early publicity produces a number of success stories — often accompanied by scores of failures. Some companies take action; many do not.

Trough of Disillusionment: Interest wanes as experiments and implementations fail to deliver. Producers of the technology shake out or fail. Investments continue only if the surviving providers improve their products to the satisfaction of early adopters.

Slope of Enlightenment: More instances of how the technology can benefit the enterprise start to crystallize and become more widely understood. Second- and third-generation products appear from technology providers. More enterprises fund pilots; conservative companies remain cautious.

Plateau of Productivity: Mainstream adoption starts to take off. Criteria for assessing provider viability are more clearly defined. The technology's broad market applicability and relevance are clearly paying off [Gartner Inc. 2015].

According to Linden and Fenn [2003], "The Hype Curve characterizes the typical progression of an emerging technology from overenthusiasm through a period of disillusionment to an eventual understanding of the technology's relevance and role in a market or domain." They add that "The first part of the hype curve is driven by vacuous hype — mainly by the media, which speculates on the technology's prospects. The second part of the hype curve primarily is driven by performance gains and adoption growth." Hype can be both positive and negative (Figure 1) and, as per Gartner's recommendations, the curve suggests that one should neither "buy-in/join-in" just because of positive hype, nor "opt-out/miss-out" just because of negative hype.

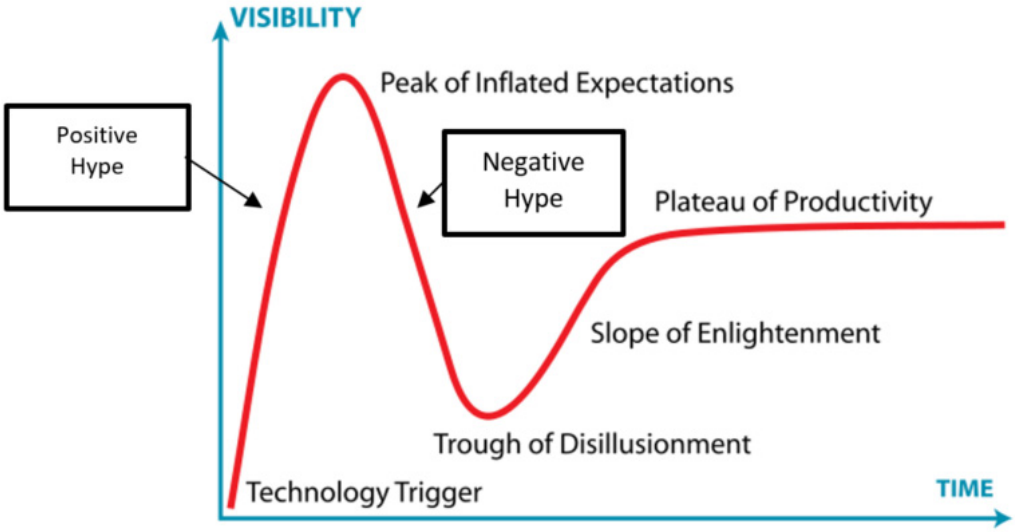

Figure 1. Hype Cycle [http://digitaltechdiary.com/wp-content/uploads/2015/08/gartner-hype-cycle.png]

While it is clear that the five stages described for the Hype curve are technology oriented, the curve in itself is as applicable to concepts as it is to technology as the implicit information we are trying to derive here is that most discoveries do not behave as expected, i.e. a new thing typically tends to become useful only after the publicity and/or hype around it fades. Does that mean that all hype is bad? Probably not, as hype brings awareness and, in the technology space, much needed investment. However, if there is much hype at the early phases of a phenomenon and/or technology and it doesn't then live upto its hype, it is then likely to be abandoned. It is with this backdrop that we posit our inquiry into Design Thinking with the following two questions. The first question this paper addresses is:

- How is design thinking being implemented in engineering education and in business education?

This question will be addressed by reviewing Design Thinking Literature from engineering and business sources and will primarily be addressed in Section 2. This question however, leads to the next and perhaps even more pertinent question:

- Where does Design Thinking currently lie on the Hype Curve with regards to engineering and business education? Will it grow in importance and value and mature from fad to best practice or fade under the weight of hyperbolic expectations?

This question will be addressed by evaluating both evidence from the literature and preliminary evidence from Google Scholar and other sources and a logical treatise on the subject and will be discussed in Section 3.

2. Design thinking in engineering and business education

If recent coverage of popular media and also the academic literature is to be taken as a yard stick, one can easily claim that interest in Design Thinking is growing both in engineering and business domains. The sections below investigate DT's growth in engineering and engineering education, management and management education, and ends with where they sit on the Hype Cycle.

2.1 Design thinking in engineering and engineering education

In engineering education, Design has been proposed as an integral part of engineering education since the late 1980s [Simon 1988]. It may be important to stress here the difference between the natural science disciplines where the emphasis is on how things "are and work", and the engineering sciences where the emphasis is how to make artifacts with desired properties and in doing so design them accordingly [Simon 1988].

The development or rather evolution of design in engineering schools is very well covered by Dym et al. [2005]; who not only discuss the historical development but also highlight the crucial interplay of divergent and convergent thinking approaches which can be understood as another pillar of the design thinking process. Where convergent approaches are probably more oriented towards the sciences due to their core element being the pinning-down of "facts" (converging to verifiable truths], divergent thinking is viewed as its mirror-opposite where the core element is discovery of multiple unknown possible answers [Dym et al. 2005] without verifiability of the answers being a major concern. While engineers could probably be seen as those most comfortable with convergent thinking, Vincenti [1990] has argued that the act of questioning and thinking is also the same process that engineers adopt thus confirming Simon's observations that classic Engineering education does have elements of Design thinking already embedded in their origin.
So, how close or far is Design Thinking Education from current Engineering practices? Let us look at several examples taught in engineering schools today including Stanford's model, CDIO, and Problem Based Learning.

2.1.1 The Stanford d-School design thinking process

The Design Thinking process for which the Stanford d-School is famous is closely related to the methods advocated by the IDEO design studio. The five steps of their process can be summarized as follows:

- Empathize: See the problem from the user's experience
- Define: Use the "Five Why's" to define the problem, then the success criteria
- Ideate: Brainstorm multiple solutions to meet the defined goals
- Prototype: Build prototype(s) of the solution as fast as possible
- Test: Measure the impact of your solutions, then iterate

As is clear from this widely adopted model, its emphasis is on the user, which DT practitioners also refer to as "human-centeredness" as opposed to "technological-centeredness"- the latter oft the domain of engineering schools. The Stanford Design School (d-School) argues that DT reaches the "sweet spot" of innovation by focusing on human values, technological feasibility and business viability, which by its very nature demands a systems approach to thinking that can only be provided by interdisciplinarity. As the d-school itself states:
This process—which has been called design thinking—draws on methods from engineering and design, and combines them with ideas from the arts, tools from the social sciences, and insights from the business world[Hasso Plattner Institute of Design, 2016a].
Design Thinking is, therefore, an interdisciplinary concept and it should be taught and learned as such [Cary 2013]. While the d-school is indeed the torch-bearer in the educational implementation of design thinking, it is also a unique case that is not easily replicable. Interestingly enough Utley [2014], an educator from the the d-school, argues that it was never meant to be a replicative model but a flexible and adaptable one:
"We teach it (DT) as "a process" at the d.school because it's a useful scaffold to structure an experience for the purpose of learning. Shared language and a shared approach give us an opportunity to focus on how we're doing something rather than what we're doing. But the process we use for teaching isn't meant to be replicated and repeated verbatim in perpetuity. It should flex and adapt and be changed by adept design thinkers with an understanding of the organization, who are capable of acting on instincts in accordance with the underlying principles of human-centered design. The key is cultivating the people capable of acting with agency and creative confidence, not perpetuating an inflexible stage-gate process." [Utley 2014].
Continuing with our theme of drawing parallels on prevalence of the design thinking process, we would now like to look at a couple of other engineering education relevant pedagogical methodologies that also incorporate elements of Design thinking already in their process.

2.1.2 The Conceiving, Designing, Implementing, Operating (CDIO) framework

One of them is called the CDIO method - an innovative educational framework that provides students with an education stressing engineering fundamentals set in the context of **C**onceiving — **D**esigning

— **I**mplementing — **O**perating (CDIO) real-world systems and products [Crawley et al. 2008]. An initiative stemming from MIT in 1997 with the goal of shortening the student gap between academia and industry, the model complements traditional pedagogy with hands-on process learning through actual system and product development. Students thus learn to "Conceive-Design-Implement-Operate" an idea to action within this framework. A cursory look at the CDIO framework may suggest similarities with DT but they are weak ones. The model is still very solution-focussed contra to the problem-focus in DT, which is not to say that they are not complementary. A study from Singapore showed the positive result, gauged by student learning and motivation, of integrating the first two phases of DT (Conceive and Design) into the CDIO framework [Fai 2011]. Conceive and Design are also the two phases that are probably the most abstract and thus, for engineering students, require more guided intervention from the educators.

Author 2 is an educator at the Engineering and Science faculty and has been using Design Thinking in his teaching since 2013. However, personal experience has also indicated that he has had to tailor DT towards engineering and the natural sciences in two different ways where the overlap is largest in the CD steps but not in the IO steps. He was drawn to DT due to its relative simplicity in eliciting student response and ownership in the projects that they came up with as opposed to industry-driven or instructor-driven problem formulations. Here the strength of DT integration in engineering and science eduation (STEM) clearly stood out. However, such cases of design integration are still only a handful in the Engineering world [Takemata et al. 2012], though the call for integration of DT within engineering pedagogy is increasing [Abdulla and Shayan 2013].

2.1.3 Problem Based Learning (PBL) model

The problem-based learning approach or Project Based Learning (PBL) originated at Aalborg University, Denmark as an experiment [Kjærsdam and Enemark 1994], [Luxhøsj and Hansen 1996]. The definition that Aalborg University uses is "Problem-Oriented, Project-organized learning." The official description of the PBL approach is as follows:

"Once you have formed a project group, you need to define a problem together that you want to examine. The problem forms the basis of your project and you are to a great extent responsible for defining this yourselves within a set, though often very broad, theme frame."

The students work together in groups which then choose a problem setting, analyse the problem, provide a "problem statement," and conduct an analysis of "how to solve the problem." The whole process including analysis, activities and reflections are documented in a project approach. Multidisciplinary team work is thus a given in this model and the project work can be divided into two main themes that seem very similar to the divergent-convergent thinking interplay [Dym et al. 2005]:

- Design-oriented – dealing with "*know how.*"
- Project-oriented – dealing with "know why."

2.1.4 Comparison with Design Thinking

How do both of theaforementioned models compare to the Design Thinking process?

While there are not that many studies that have empirically tested for benefits of Design thinking in education, if one were to trace back historical developments of the design thinking process and accept that these methods have been built on the work done by CDIO and PBL approaches, one can see a significant body of evidence behind these methods and by that measure extrapolate some of the findings to also be applicable to design thinking as it is practiced today.

Even CDIO and PBL seem to have overlaps with the only major difference being that PBL has emerged from rethinking the learning process whereas CDIO was developed by rethinking the outcomes [Edström and Kolmos 2014].

Let us go back to the definition of DT as put forward by Dym [2005]:

Design Thinking reflects the complex processes of inquiry and learning that designers perform in a systems context, making decision as they proceed, often working collaboratively on teams in a social process, and "speaking" several languages with each other (and to themselves).

Based on this definition, Design Thinking can thus be claimed to be a natural evolution that has stemmed from the pre-existence of earlier models such as the CDIO and PBL with the latter being quite evidence-

based. PBL is also older than CDIO and DT itself and also indicates that they are all maybe not mutually exclusive but complementary as also said by Edstrom and Kolmos [2014]. Design thinking advocates are also realizing that it has to be very context based and that it has to allow for the flexibility that the CDIO model has to better fit various conditions. Some efforts are underway in this direction as Thoring and Mueller's [2011] conference presentation on an iterative application of Design Thinking shows.

2.2 Design thinking in business and business education literature

The current state of the literature of Design Thinking in business and in business schools suggests that DT could lose traction just as its proponents are gearing up to promote it as a useful and valuable innovation at their universities.

Author 1 was drawn to Design Thinking because it allowed him to integrate several key learning outcomes in a single activity with a concrete outcome, not because it has any particular merit one way or another as a stand alone topic of scholarly research. The IDEO model [Kelley 2013] and its offshoots [Liedtka 2000], [Liedtka and Ogilvie 2011], [Liedtka et al. 2014] provide a structure for problems solving, creativity, empathy, oral communications (through pitches) and usability through design projects that can be tangible or intangible that can engage students in several activities that demonstrate and enhance the four skills that Colby et al. [2011] define as essential for liberal education: Analytical Thinking, Multiple Framing, The Reflective Exploration of Meaning, and Practical Reasoning.

Johansson-Sköldberg, Woodilla, and Çetinkay [2013] note multiple ways the terms Design Thinking has been used in the literature. The first view is based on the professional practice of designers such as engineers and architects. The second view is based on uses of design outside the usual context by people other than those trained in design, such as managers and social entrepreneurs.

2.2.1 Designerly Thinking

Within the first stream, Johannsson-Skodlberg, et al., found literature about design as the creation of artifacts, reflexive practice, problem solving activity, a way of reasoning and making sense, and creation of meaning [p. 124].

1. Design and designerly thinking as the creation of artefacts: Johannsson-Skodlberg, et al, link this discourse on design to the work of Simon [1988], who saw design as a cognitive process. They argue that Simon did not exclude the field of engineering from his discussion but he did exclude natural science, social science, and the humanities. The focus in this part of the stream is on creative thinking that results in an artefact. If, however, you include fine arts in the definition of the humanities, then the study of how artists create music, visual media, or performance would have to be included in this stream.
2. Design and designerly thinking as a reflexive practice: Johannsson-Skodlberg, et al, link this discourse on design to the work of Schön [1984]. In Schön's view, it was not the cognitive process that was of interest, it is the designer's reflection on the artefact that lead to its improvement and an increased level of mastery for the designer that matter most.
3. Design and designerly thinking as a problem –solving. Johannsson-Skodlberg, et al, link this discourse on design to the work of Buchanan [1992], who applied design concepts to the Wicked Problems defined by Rittel and Webber [1973]. Buchanan began to focus attention on the need for designers to understand problems in context, especially through the eyes of users.
4. Design and designerly thinking as a way of reasoning/making sense of things: Johannsson-Skodlberg, et al link this discourse on design to the work of Cross [1982] and of Lawson [1980]. While Cross uses ethnographic research to observe what designers actually do, Lawson uses models for research in psychology to propose improved design processes.
5. Design and designerly thinking as creation of meaning: Johannsson-Skodlberg, et al, link this discourse on design to the work of Krippendorff [2005]. Krippendorff argues that meaning, not the creation of artefacts, is at the core of the design process. How users interact with an artefact is as important to the discourse as the artefact or the designers intention in creating it.

While it is beyond the scope of this article to fully review these discourses, they are repeated here to show the diversity of the discourse and the ways in which scholars who study the process of design across a variety of domains, including business and economics.

2.2.2 Design Thinking in management

Switching to the management literature in particular, Johannsson-Skodlberg, et al. found that the evidence in the professional management literature is anecdotal and focused almost exclusively on success stories. Within the management literature on Design Thinking belonging to the management stream, Johannsson-Skodlberg, et al., found three subareas of discourse [p. 128]:

1. Design Thinking as a way of working with design and innovation:
2. Design Thinking as an approach to solving indeterminate organizational problems:
3. Design Thinking as an extension of management theory

While adding a diverse mix of observations to the stream, Johansson-Skodlberg, et al., did not find a strong set of theories developing around design thinking but saw those as possible outcomes of future work.

2.2.3 Where are we now?

While new literature continues to be generated that could be categorized in the eight domains within these two streams, no new work has appeared that brings solid empirical evidence in confirmation or disconfirmation of hypotheses based on prior literature. Perhaps some doctoral dissertations now in progress will break this logjam. Management educators can find plenty of competing models of DT and that is probably a good thing because, as Buchanan pointed out, context matters, as does the meaning people attach to the artefacts being designed, whether they are tangible products or organizational processes and procedures. Educators need solid tools, not hype, to develop their students' design skills and the research tools they need for scholarship of discovery about the processes designers use in the business context.

3. Design Thinking and the Hype Cycle

As noted earlier, the authors are concerned that Design Thinking will stall out as a fad rather than becoming a valued innovation. In 2001, Birnbaum published a study of seven fads in management education that did not survive the test of time. These included the Planning Programming Budgeting System, Management by Objectives, zero-base budgeting, strategic planning, benchmarking, Total Quality Management, and Business Process Reengineering. We might add Emotional Intelligence [Goleman 1998], Systems Thinking [Senge 2006], and several other attractive approaches [Sherman 2003]. By 2010, when the time the first author became aware of Design Thinking as an approach at a professional development workshop Callopy [2009], [Cooper 2010] was already sounding the alarm that Design Thinking could lose its appeal the way Systems Thinking had done.

The Hype Cycle is one way of evalaluating the degree to which Design Thinking has the characteristics of a short term fad. The Hype Cycle is different from innovation, however, because it suggests that some technologies never really provide value. They get a lot attention but do not really stick. This is where we approach our main question – where we try to ascertain where on the hype curve can Design Thinking be placed currently. Is Design Thinking destined to be a valued paradigm or a short-lived phenomenon that made a lot of noise but failed to make a lasting impact and create a legacy? The following section will take a look at the preliminary evidence as we try to ascertain this from multiple sources including the above literature scan within business and management education.

In their 2013 review of the literature, Johansson-Skoldberg and colleagues examined several hundred books, articles, and web sites on design thinking in management and business published between 1969 and 2010. Their plot of the results by year (Figure 2) suggested to them that the peak in popular interest had already been reached in 2009 [Johansson-sköldberg and Woodilla 2013]. To test that conclusion, however, we would need to extend their literature review through 2015.

The above approach indicates a rise of Design thinking "speak" in a published medium though the number of academic articles is more modest than the more populist medium which accounts for approximately 75% of the coverage of total publications. What is also more interesting is the trend is not sustained but lowers considerably in 2010 and especially that of popular media – reaffirming a common trend in such channels that are always on the lookout for "the next best thing." Reassuringly though the academic study into DT remained steady though 4-5 publications is by no means an

indication of the academic lens falling on Design Thinking. Cautious of reading too much into such secondary data, we thus looked elsewhere for "trends" that may reveal more light into our query.

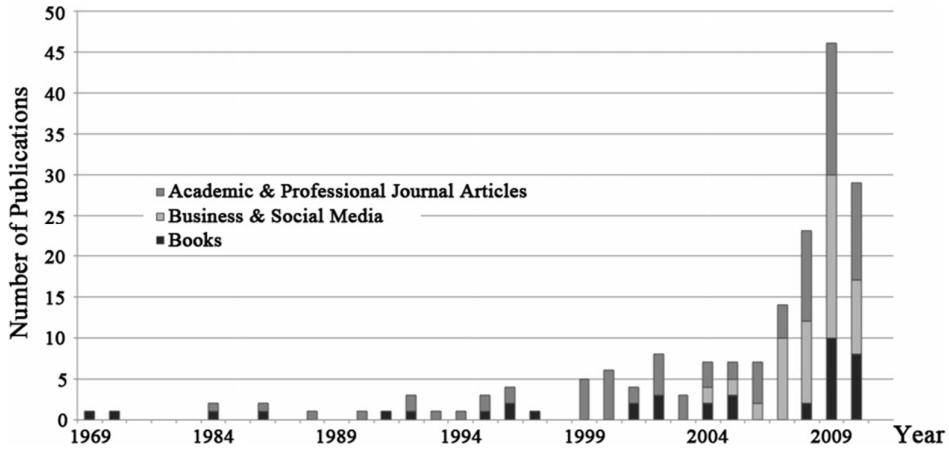

Figure 2. Timeline of Design Thinking publications by type [Johansson-sköldberg and Woodilla 2013]

3.1 Sample 1 searches

Determining Design Thinking's placement on the Hype Cycle can be done in a preliminary way thorugh assessment of content through assessment of the quantity of coverage. We realize that this is not a true meta-analysis, but that was beyond the scope of this essay.

One way of measuring its impact as a trend is through Google searches. The first sample was generated using the Google Trends tool. Google Trends is a method for using Big Data to investigate population trends [Nuti et al. 2014]. The authors followed the eight steps Nuti et al. recommend when using Google Trends. Quotation marks were used around the terms "Design Thinking" and "User-Focused Design." No other versions of these terms were used in the search as it was beyond the scope of this exploratory investigation. Figure 3 shows the relative strength of Design Thinking as a search term compared to another recent trend; Gamification [term chosen as a control due to its known placement on the Gartner Hype Curve on the Peak of inflated expectations in 2013 and moving towards the trough of disillusionment more recently in 2015; and User-Focused Design. The users chose "User-Focused Design" because it represented an earlier iteration of DT. Figure 3 illustrates that Design Thinking is not a new term, despite its current popularity or its existence on the Internet (as queried by Google searches) since 2004.

Figure 3 shows that the growth in Gamification as a search term started later than that for Design Thinking, but appears to have already peaked by 2014. It is thus no co-incidence that the Gartner group also decided that the peak of hype for Gamification was in 2013 and they additionally predicted in 2012 that 80 percent of all gamification initiatives would fail, primarily due to poor design. Searchers for User Centered Design were already falling when Google began collecting data in 2004 and as of 2015 appear to be in a steady state. The results in Figure 3 suggest that Design Thinking was nearly non-existent as a search term prior to 2008 and has yet to reach a plateau or peak.

Sample 2 used the same three search terms but in Google Scholar instead of Google Trends. The searches were conducted on 7 March 2016. Quotation marks were used for the terms "Design Thinking" and "User-Centered Design." The boxes for Include Patents and Include Citations were unchecked. The search for each term was repeated for each year from 2004 to 2015 using the custom dates search box. It should be noted that Google Scholar searches do not yield the exact same number of results each time they are run. The results on 7 March 2016 varied slightly from the results of October 2015.

Figure 4 shows how the same three topics have fared over the last ten years by number publications listed. The number of publications about a topic gives a different view of its popularity compared to the number of searches. It appears that search popularity lags publication popularity, which is not surprising.

By this measure, User-Centered Design appears to have had more academic interest than Design Thinking initially but is now beginning to lag. The number of articles on Gamification appears as noise before 2011 about the time it begins gathering momentum as a research subject. The number of articles on Design Thinking lags the number of articles on User-Centered Design until 2012 when User-Centered Design peaked. Design Thinking continues to have more articles in the database than User-Centered Design, although the rate of increase is not as high between 2014 and 2015. By comparison, Gamification continues to look strong as a subject.

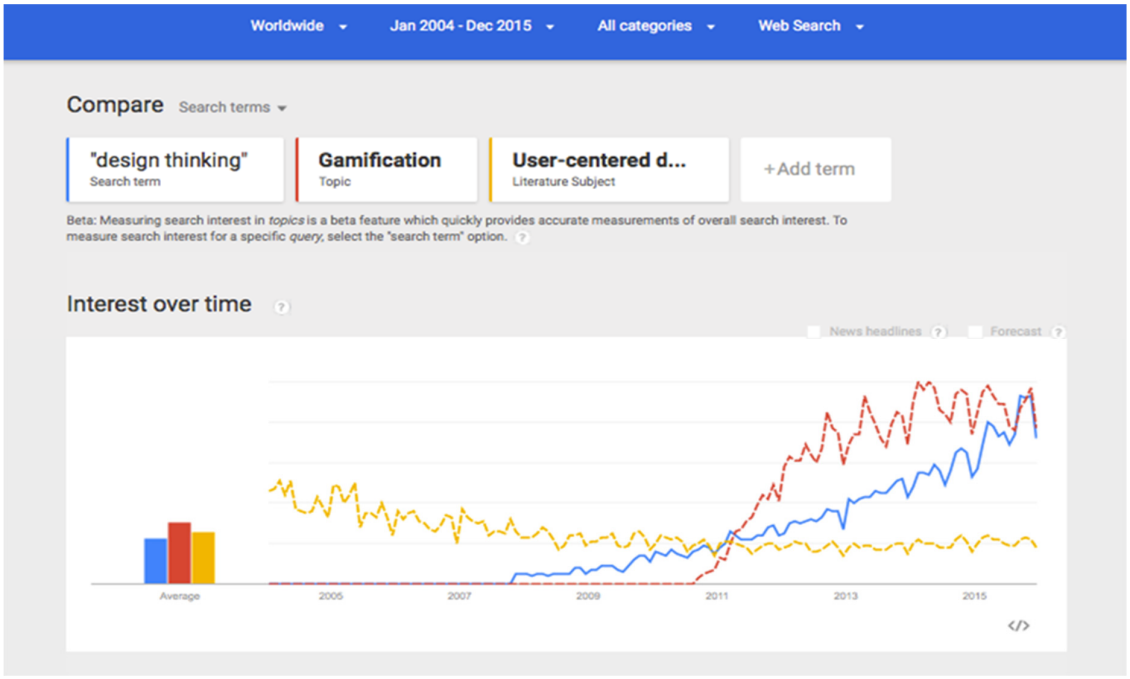

Figure 3. Google search trends for Design Thinking, gamificaiton, and user centered design

The results in Google Scholar suggest that the peak in search results for Design thinking was not reached in 2015. User-centered design appears to be nearing a plateau while Gamificaiton is still on the increase.

3.2 Where on the Hype curve will we place Design Thinking?

Determining whether something is a hype or not is no easy task and especially not when there seems to be literature (both popular and academic) that would argue for both sides (such is the fandom around this phenomenon). Also, the analysis of trends in the preceding sections are by no means a comprehensive empirical study, but that was also not the aim of this study which was primarily to ascertain whether or not there is hype around Design Thinking. We must also reiterate here, that we are not interested in adding Design thinking into the Hype curve just out of a trivial pursuit or out of simple academic curiosity. This is due to our genuine concern for the field and its promise that we feel this is a relevant and timely exercise.

The aforementioned trend searches converge on one key observation: that interest in Design Thinking is increasing across the board. Whether or not this is indicative of “hype” is another question in itself. Again, we would like to remind the reader that hype *per se* is not necessarily bad, needed even to both increase awareness, bring in early-adopters and financial support. The danger lies in two things – 1) overselling of “a” concept; and 2) the hype not living up to its expectation. Here we do brief literature review to find relevant studies and highlight quotes thereof before we stake our claim to insight.

For a summary of the success stories, see Glen, Suciu, and Baughn [2014]. Fewer reports about failed implementations can be found in the literature. This abundance of success stories and an apparent absence of failures is probably “the” strongest indicator for DT being at the Peak of the Hype Curve.

Where the Peak of Inflated Expectations is defined as a stage where "early publicity produces a number of success stories" often accompanied by scores of failures" (often under-reported).

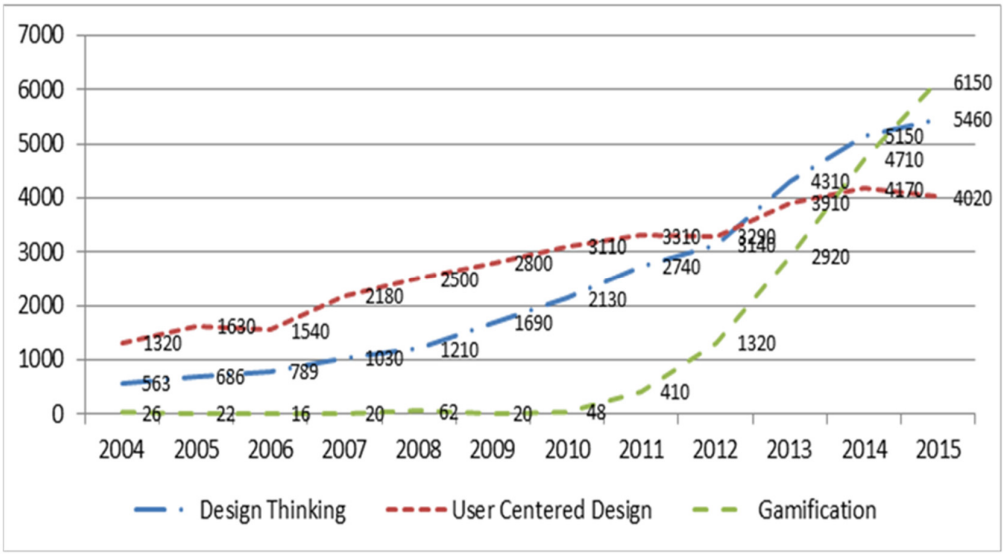

Figure 4. Number of search results per year for "Design Thinking", "User Centered Design," and "Gamification" in Google Scholar [http://scholar.google.com]

The authors did, however, find some (not many) strong critique in the Design Thinking literature that maybe could suggest that DT is in fact entering the trough of disillusionment. By 2013, Johansson-Sköldberg et al. had found a number of cracks in the armor of Design Thinking. The strongest critiques come from a former proponent of the DT paradigm, Nussbaum [2011]: "Design Thinking has given the design profession and society at large all the benefits it has to offer and is beginning to ossify and actually do harm." He argues instead for a new idea he calls Creative Intelligence. Unfortunately, to our eyes, his argument appears to be an attempt to start a new Hype Cycle. Walters, another thought leader, argues:
Design thinking neither negates nor replaces the need for smart designers doing the work that they've been doing forever. Packaging still needs to be thoughtfully created. Branding and marketing programs still need to be brilliantly executed. Products still need to be artfully designed to be appropriate for the modern world. When it comes to digital experiences, for instance, design is really the driving force that will determine whether a product lives or dies in the marketplace.
Design thinking is different. It captures many of the qualities that cause designers to choose to make a career in their field, yes. And designers can most certainly play a key part in facilitating and expediting it. But it's not a replacement for the important, difficult job of design that exists elsewhere in the organization [Walters 2011].
Probably, some of the strongest critique towards DT is coming from the Business field itself – a field that DT has approached in an attempt to find common ground, which in effect may have created an unintended repellent effect due to ideological or language divides. This is best explained by Rhinow and Meinel (of the Stanford d-School) in their empirical analysis of management perspectives towards Design thinking where they found that:
"Corporate managers explicitly expect Design Thinking to contribute to existing frameworks such as Lean in general and Scrum in particular. It can be assumed, that the success of Design Thinking in this corporation will therefore depend on its compatibility with those established frameworks. [Rhinow and Meinel 2014]"
Attempting to fit DT existing processes, and then finding that these were very different from each other would undoubtedly lead to disillusionment but that, in our opinion, is not the same as that of the trough of disllisuionment in the hype curve. Rather, we argue that they are the product of unaligned expectations (where DT is viewed as a magical elixir) which in turn are a result of the hype around the topic that feed

into these unrealistic expectations. This is probably best illustrated by the founder of Fahrenheit 112, Michael Payne when he states:
Design solutions for the user are still as unlikely to reach market as those created through any other method. Design thinking in the hands of brilliant designers does really good things but when it's air lifted into other contexts, it produces a lot of heartache [Payne 2011].
To end this section, we would also like to highlight a more recent article by the founder of IDEO (and his famous 2008 article in the HBR that probably catalysed the hype curve) Tim Brown when he took out another piece in HBR where he raised the issue of "the coming of age of DT" and the "loss of competitive advantage in an era where 'everyone' is using DT." He goes on to state that instead of jumping ship and hopping on to a new "fad" that could provide competitive advantage (like Nussbaum did in 2011), one should actually embrace the "mastery" of DT, implying that most, if not all, current adoptions are superficial or not done right [Brown 2015]. The article may lend itself to the claim that DT is in fact maybe climbing the slope of enlightenment, but yet we beg to differ – as a lack in mastery or poor implementation indicates a shallow understanding of the DT paradigm which in turn leads us to believe that this is so because we are still very much so in the peak of inflated expectations.
We conclude that DT is indeed still very much in the hype curve and in the region of the peak of inflated expectations. Why is this still a cause for alarm? DT has been around for close to a decade now and we have not yet heard or seen any failure stories. In addition, instead of moving towards a slope of enlightment where practitioners, educators and business leaders are able to openly discuss the advantages and contextualization traits within their organizations and academic institutions, we still seem to be struggling to gain mastery over the subject. If these are not signs of hype, we don't know what else is! However, as concerned proponents of a paradigm that holds promise, we would encourage in-depth participation, transparency and engagement of concerned stakholders. This would ensure that when we start to enter the inevitable trough of disillusionment (that is probably just round the corner), we would come out strong and be positioned towards a plateau of productivity that would and should set the stage of further growth and widespread, masterful adoption.
The remaining section will now discuss our conclusion in light of business and engineering education and offer recommendations for the same.

4. Discussion and recommendations for Design Thinking adoption in business and engineering education and the push towards the "plateau of productivity"

4.1 Discussion of results

Based on the preliminary results reported above, it is premature to report that Design Thinking is just a fad without deeper exploration of the academic and popular literature. Although the preliminary data is encouraging, the absence of empirical studies with statistical power on the effectiveness of Design Thinking in industry projects and in producing consistent learning outcomes in education is still a concern.

4.2 Recommendations

For engineering and business educators, avoiding the hype cycle will require a better understanding of what Design Thinking is and what it is not. It will require tailoring Design Thinking tools to specific projects rather than using the same process for every project. For example, Curedale [2013] lists over 150 different Design Thinking templates. It will require moving projects beyond the proposal stage to full implementation.
Such a result may not always be possible within a single term. It may not be as appropriate for undergraduates as it is for masters and doctoral candidates, but it is still worth pursuing. The National Aeronautics and Space Administration uses a nine level assessment scheme for determining how ready technology is for "launch." The levels are:

1. Basic principles observed and reported
2. Technology concept and/or application formulated
3. Analytical and experimental critical function and/or characteristic proof-ofconcept
4. Component and/or breadboard validation in laboratory environment

5. Component and/or breadboard validation in relevant environment
6. System/subsystem model or prototype demonstration in a relevant environment (ground or space)
7. System prototype demonstration in a space environment
8. Actual system completed and "flight qualified" through test and demonstration (ground or space)
9. Actual system "flight proven" through successful mission operations [Mankins 1995, p. 1]

Most university design projects stop at Level 2. A few move into 3 or 4. Unless they are commercialized through a patent and developed into a spin off business, none ever reach level 9.

To move beyond level 2 projects, educators should consider projects that engage students in projects that are bigger than a single product or process innovation. Social innovation and entrepreneurship are one way to engage students in deeper and longer-range projects. Sachs and Murphy [2013] argue that social entrepreneurship can help society overcome the shortcomings of greed based global capitalism. One method for engaging students in social entrepreneurship projects has been very successful: student case competitions such as the Hult Prize [Basaiawmoit and Wagner 2015], [Jenvey 2015]. The "Hult Prize" is one of the world's biggest Social Entrepreneurship challenges. It runs for a period of ten months where short-listed student teams have to leave their studies for two months to join an accelerator program (in the summer months). It had 4000 teams applying in 2012. In 2014, it had over 11,000 teams from across the globe. This, in itself, speaks highly about the engagement level of the students for SE challenges – as the students prioritize this over the holidays and alongside their studies. This level of engagement is probably not even seen in the best of the Design Schools [Tripathi and Chaturvedi 2014].

Although it establishes Design Thinking as a well-established paradigm with high levels of adoption, the evidence per se behind Design Thinking interventions and its effects is still lacking. At the outset, and given the history above, both from the overlapping business school perspective and engineering school perspective, one would imagine that Design Thinking would have been solving a lot of world problems. This, however, is not yet happening. The emergence of heavy critiques of Design Thinking rings some alarm bells as to whether Design Thinking as we now know it has probably deviated from its initial goals and/or is beset with a problem that seems to have adversely affected the PBL model – namely the "ritualization" of the "process," which makes people go through the motions without real involvement. Or is this the result of the "clash of ideals" that has happened with the demand of business for standardized processes and the yardstick of measure being those same pre-existing processes? Furthermore, following the footsteps of the iterative methodology that has shown promising results from the area of entrepreneurship education, we would also encourage the sharing of failure stories such as that found in Newstetter [2005].

Design Thinking proponents should perhaps learn from several other paradigms out there and instead of trying to establish itself as its own unique domain, integrate it into existing systems. Such a "systems" level integration victory would either raise Design Thinking as one of the greatest interventions developed by man or relegate it into the annals of history as yet another fad that impressed but failed to make a significant impact.

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