Dialectic Volume III, Issue I: Research Paper

Design Thinking? Thank an Engineer.

STEVEN MCCARTHY[1]

1. Independent Scholar (University of Minnesota Professor Emeritus)

SUGGESTED CITATION: McCarthy, S. "Design Thinking? Thank an Engineer." *Dialectic*, 3.1 (2021): pgs. 39-57.

Published by the AIGA Design Educators Community (DEC) and Michigan Publishing.
DOI: http://doi.org/10.3998/dialectic.14932326.0003.102
STABLE URL: http://hdl.handle.net/2027/spo.14932326.0003.102

Abstract

The methodology of Design Thinking is pervasive across design disciplines, and to some degree business culture, with many crediting its origins to the Hasso Plattner Institute of Design—the "d.school"—at Stanford University. The d.school was preceded however by decades of curricular innovation, studio practice and research by faculty in Stanford's Department of Mechanical Engineering and Department of Art as they hosted the Joint [Graduate] Program in Design. Three engineering professors in particular developed concepts in "creative engineering," "visual thinking," and "conceptual blockbusting" that will be shown to be foundational to design thinking. Their ideas influenced Stanford design alumnus David Kelley whose company IDEO brought design thinking to corporations and institutions globally.

Design Thinking? Thank an Engineer.

STEVEN MCCARTHY

Introduction

"Design Thinking" has emerged over the past decade as the design discipline's major movement, the darling, to a degree, of education, corporations and various institutions. In design thinking's broad purview, lay people gain abilities in creativity, problem-solving, user-centeredness, the iterative process, feedback loops, prototyping and other aspects of thinking like designers. "*Design thinking* has become a familiar term to people who have never heard of the design discipline."[1] It is hoped—even promised by those most evangelical about the approach—that design thinking can tackle society's most intractable problems.

Design thinking is a concept whose origin story is largely associated with Stanford University's Hasso Plattner Institute of Design—the "d.school"—for emphasizing design's iterative process across academic disciplines. The d.school's founder is alumnus David Kelley, who also applied design thinking to the corporate world's challenges through his company IDEO, a global design powerhouse. Yet the d.school, an interdisciplinary collaborative workshop environment that does not grant degrees, began in 2005, almost fifty years after Stanford's Departments of Mechanical Engineering and Art created the Joint Program in Design graduate degree.[2]

The Joint Program in Design offered Master of Science degrees for those pursuing an emphasis in product design through mechanical engineering, while the Master of Fine Arts degree was for students creating graphic and visual designs through art. The Departments of Art and Computer Science also collaborated on short-lived program in digital typography during the 1980s;

1 Lloyd, P. "You make it and you try it out: Seeds of design discipline futures." Design Studies, vol. 65, https://doi.org/10.1016/j.destud.2019.10.008, 2019, p. 175.

2 McCarthy, S. "Design at Stanford: the D.school's Daddy" in REDES 2019, Research & Education in Design conference proceedings. London, UK: Taylor & Francis, 2020, 207–210. https://doi.org/10.1201/9781003046103

although graduating only five students, its impact was transformative—Adobe's seminal type designs were created by several Stanford alumni. [3]

This paper will reveal the origins of design thinking at Stanford, roots that have a direct connection to today's fascination with the movement. In particular, the ideas and philosophies of three mechanical engineering design professors will be analyzed and acknowledged as foundational. These are: John Arnold's innovative "creative engineering" curricula and symposia—the "root of design thinking" [4], Bob McKim's emphasis on imaginative "visual thinking," and Jim Adams' tools and techniques for achieving "conceptual blockbusting."

The latter two published books—McKim's *Experiences in Visual Thinking* (1972) and Adams' *Conceptual Blockbusting* (1974)—to further their ideas, and are summarized here. Arnold's writings from the late 1950s were gathered by scholar William Clancey and published posthumously as *Creative Engineering: Promoting Innovation by Thinking Differently* (2017). Consideration of these scholars' historical milieu—the 1950s, '60s and '70s—is necessary to contextualizing their intellectual contributions to the foundations of design thinking.

The Hasso Plattner Institute of Design at Stanford University—the "d.school"

Thanks in part to a gift of 35 million dollars by German industrialist Hasso Plattner, the Hasso Plattner Institute of Design at Stanford University—the "d.school"—exists as project-based connective tissue to students from all corners of campus. Students coalesce around topics, problems or opportunities in small, agile teams that are led by faculty facilitators. In this context, they are introduced to design thinking: empathetic need-finding, brain-storming and conceptualizing, deferring judgment, sketching and visualizing, the iterative process, prototyping, user testing, refining and being entrepreneurial. Some teams' projects advance to attracting start-up venture capital or to manufacturing and marketing to consumers.

The d.school began to codify its methods and make them available in open source formats in 2009. In one document, the "d.school bootcamp bootleg" [5]—so named after the d.school's introductory Design Thinking Bootcamp course—seven "d.mindsets" were listed:

- Focus on human values
- Show, don't tell

3 McCarthy, S. "Digital Typography at Stanford" in She Ji: The Journal of Design, Economics, and Innovation. Tongji University and Tongji University Press. Publishing services by Elsevier B.V., 2020, 546–560. https://authors.elsevier.com/sd/article/S240587262030068X

4 Xu, F., & Andersen, H. "Thinking about the Roots of Design Thinking" in 12th European Conference on Innovation and Entrepreneurship ECIE 2017. Reading, UK: Academic Conferences International Limited, 2017. pp. 662–668.

5 Stanford University d.school website, 2009. http://dschool.stanford.edu/wpcontent/uploads/2009/12/bootcampbootleg20091.pdf

- Create clarity from complexity
- Get experimental and experiential
- Be mindful of process
- Bias towards action
- Collaborate across boundaries

The document then provided five "modes," each with page-length definitions: empathize, define, ideate, prototype and test. A list of "methods" followed, which were a series of tactical approaches like brainstorming, point-of-view, composite character profile (more commonly referred to as "persona"), journey maps, interviews and more.

Use of the term "d.mindsets" brands the methods with the Stanford d.school's lowercase "d" for design. Lowercase type in this context likely means informal, welcoming, intellectually non-threatening and easily accessible to those without deep design, engineering or art backgrounds. "Mindset" also relates directly to cognition, to thinking. To "create clarity from complexity" might require deduction or synthesis. To "be mindful of process" invites the notion of meta-cognition—thinking about creative thinking, as Adams advocates in *Conceptual Blockbusting*. "Show, don't tell" emphasizes the visual and tangible over the oral—a central tenet of McKim's *Experiences in Visual Thinking*.

It is asserted by Kuang and Fabricant in their book *User Friendly* that the d.school's approach, "with a curriculum based on IDEO's methodologies,"[6] sprang largely from Kelley's successful business. Indeed, Kelley's initial curricular proposal for the d.school was written to his mechanical engineering colleague Rolf Faste, then the product design program chair, from his "dkelley@ideo.com" email address.[7] IDEO was preceded, however, by decades of Stanford design faculty who also considered the realm of human cognition and behavior in designing. In 2002, three years before the d.school's founding, it was acknowledged that "[IDEO's] growth and success did a great deal to confirm the viability of Professor Robert McKim's vision."[8]

These mechanical engineering professors primarily educated product designers (some of whom went on to design Apple's first Macintosh computer and mouse, among much else), while those studying visual design did their degrees through the Department of Art (one was the creator of the original Google logo, another an Oscar-winning film art director). Regardless, core faculty and courses were shared by the disciplines of engineering

6 Kuang, C. and Fabricant, R. User Friendly: How the Hidden Rules of Design Are Changing the Way We Live, Work, and Play. New York: MCD, Farrar, Straus and Giroux, 2019, p. 181.

7 Kelley, D. "Kelley–Faste email" in Faste papers. Privately held, January 10, 2002.

8 Pang, A. S.-K. "Mighty Mouse" in Stanford magazine, Palo Alto: Stanford University, March/April 2002, p. 56.

and art with the understanding that a balance between objectivity and subjectivity, rationality and intuition, and function and expression would lead to better designs.

The Hasso Plattner Institute of Design at Stanford University is the result of an evolution that began in the late 1950s and continues today.

John Arnold and Creative Engineering

To bolster the engineering leg of design studies at Stanford, the University hired Massachusetts Institute of Technology associate professor John Edward Arnold in 1957 with joint appointments in Mechanical Engineering and the Graduate School of Business. Arnold had distinguished himself as an innovative teacher at MIT with his focus on "creative engineering," a blend of psychology, business, science fiction, invention and synthesis. To many in the discipline of engineering at that time, his methods were unorthodox, even radical—yet Stanford offered Arnold a receptive environment. Arnold was brought in as a full professor, "a promotion he had been denied at MIT."[9]

One novel approach to teaching engineering that Arnold used at MIT, but not at Stanford, was his Arcturus IV project. To challenge his students, he created a fictitious environment on a planet that was populated by creatures covered with "feathery type fur"[10] who had long, three-fingered arms, three eyes (one eye employed X-ray vision) and who breathed methane gas. Complete with project briefs printed on designed letterhead of the "Massachusetts Intergalactic Traders, Inc." and other fictitious entities, Arnold created a world that his students could not take for granted. This was "an acclaimed but highly idiosyncratic teaching methodology intended to jolt his students out of their routinized, formula-based problem solving habits."[11]

"Question, Observe, Associate, Predict" was the sequence advocated by Arnold to achieve creative engineering. The phrase was lettered on the wall behind him in a photograph published in an article titled The Course Where Students Lose Earthly Shackles in *Life* magazine on May 16, 1955.[12] The other prop was an open wooden crate labeled "Arcturus IV" with a three-fingered limb sticking out! Arnold's leveraging of irreverence, publicity and contrarianism made him popular, to the chagrin of some MIT colleagues.

Because of his experience at MIT and his mid-career seniority, Arnold assumed a leadership role in design at Stanford. He began developing design courses for the Department of Mechanical Engineering and

9 Clancey, W. "Introduction" in Creative Engineering: Promoting Innovation by Thinking Differently edited by William J. Clancey. https://www.inist.org/library/1959.John%20E%20Arnold.Creative%20Engineering.pdf, 2016, p. 24.

10 Arnold, J. "What is Creativity" manuscript (1959) in Creative Engineering: Promoting Innovation by Thinking Differently edited by William J. Clancey. https://www.inist.org/library/1959.John%20E%20Arnold.Creative%20Engineering.pdf, 2016, p. 8.

11 Katz, B. Make it New: The History of Silicon Valley Design. Cambridge, MA: The MIT Press. 2015, p. 119.

12 Hunt, M. "The Course Where Students Lose Earthly Shackles" in Life. New York: Time, Inc. May 16, 1955. pp. 186–190.

he continued to offer the summer seminar that he started at MIT titled "Creative Engineering." This seminar brought seminal thinkers from different disciplines together and advanced Arnold's own ideas about creative engineering—"One of the aims of Creative Engineering is to bring about a union between the physical sciences, social sciences and the arts." [13]

In a statement that sounds prescient of Stanford's current emphasis on "design thinking," Arnold wrote in 1959: "In order to be creative, mastery in use of the process is more important than the type of problems that you work on." [14] William Clancey, a Stanford-trained computer scientist and former NASA researcher who presently lives in John Arnold's former house in Portola Valley, California wrote: "He formed basic questions about society, problems, engineering, and thinking. He predicted that a new pedagogy could develop a new capacity to innovate, such that thinking differently about the world, materials, and methods could lead to breakthrough solutions to large-scale practical problems." [15]

Creative Engineering: Promoting Innovation by Thinking Differently, Arnold's theories as compiled and edited by Clancey, reveals Arnold's definition of the creative process, which consisted of four criteria: [16]

- The creative result must be a superior combination, and not merely differentiation for its own sake.
- The result must be tangible and have material properties, and not simply be a concept.
- It should be future-oriented and useful to society, functional rather than recreational.
- And it should have a value in which the sum is greater than the total of the parts, or synergy through a multiplicative effect.

John Arnold's Creative Engineering seminar of 1958 featured, by invitation, a promising young engineering design instructor: Robert "Bob" McKim. A year later McKim presented a paper at the seminar titled "Designing for the Whole Man." In it, he criticized "the utter lack of human value in much contemporary architecture and product design." [17] McKim emphasized that humans' physical, intellectual and emotional needs must be considered by designers and that these needs exist in the context of natural and cultural environments. He also blasted the automobile industry in particular for the "reams of market research

13 Arnold, J. "What is Creativity" manuscript (1959) in Creative Engineering: Promoting Innovation by Thinking Differently edited by William J. Clancey. https://www.inist.org/library/1959.John%20E%20Arnold.Creative%20Engineering.pdf, 2016, p. 67.

14 Arnold, J. "What is Creativity" p. 77.

15 Clancey, W. "Introduction" in Creative Engineering: Promoting Innovation by Thinking Differently edited by William J. Clancey. https://www.inist.org/library/1959.John%20E%20Arnold.Creative%20Engineering.pdf, 2016, p. 22.

16 Wikipedia. https://en.wikipedia.org/wiki/John_E._Arnold, 2018.

17 McKim, R. "Designing for the Whole Man" in Creative Engineering: Promoting Innovation by Thinking Differently edited by William J. Clancey. https://www.inist.org/library/1959.John%20E%20Arnold.Creative%20Engineering.pdf, 2016, p. 198.

statistics"[18] that they used to justify surface styling over user comfort and safety.

McKim took over leadership of the product design program in 1963 after John Arnold died of a heart attack at age 50 near Venice, Italy while on sabbatical leave. McKim evolved Arnold's creative engineering concept into his own theories about visual thinking.

Bob McKim and Visual Thinking

McKim published his book *Experiences in Visual Thinking* in 1972, a couple of years after developing the mechanical engineering course ME 101 Visual Thinking. The course, and the Stanford product design curriculum in general, provided McKim with an active laboratory of students to test his ideas. And the favor was returned—*Experiences in Visual Thinking* became recommended reading of Stanford engineering and art design students, perhaps the bible of the program. "McKim epically advances a Visual Thinking curriculum,"[19] according to scholars in the article "Theoretical Foundations of Design Thinking Part II: Robert H. McKim's Need-Based Design Theory."

In 1968, the term "visual thinking" was initially used in the description of McKim's mechanical engineering course Rapid Visualization. A year later, ME 102 Visual Thinking was offered for the first time, and in 1970 the course number was changed to ME 101—its current designation 50 years later—and it was co-taught with professor Jim Adams. ME 101 Visual Thinking has since achieved legendary status as the design program's gateway course. It is "one of the oldest courses on campus and is also a requirement for every mechanical engineering major."[20]

McKim's *Experiences in Visual Thinking* is an academically rigorous book that draws from the fields of psychology, neurology, semantics, art and perception. He cites some of that generation's major thinkers such as psychologist Abraham Maslow, physician and author Edward de Bono and art theorist Rudolf Arnheim, acknowledging the latter's influential 1969 book, *Visual Thinking*. In McKim's acknowledgments section, he said, "My greatest debt is to the late Professor John E. Arnold, who not only suggested that I develop a visual-thinking course at Stanford ... but also influenced me by his pioneering efforts to educate productive thinking."[21]

Experiences in Visual Thinking has five chapters: Background, Preparations, Seeing, Imagining and Idea-sketching, with each chapter having multiple sub-sections. McKim began by discussing thinking itself, establishing

18 McKim, R. "Designing for the Whole Man" p. 202.

19 von Thienen, J. P. A., Clancey, W. and Meinel, C. "Theoretical Foundations of Design Thinking. Part II: Robert H. McKim's Need-Based Design Theory" in Design Thinking Research: Looking Further: Design Thinking Beyond Solution-Fixation, Cham, Switzerland: Springer International Publishing, 2019, p. 18.

20 Toh, E. "ME101 addresses student concerns about workload, not work space" in The Stanford Daily, 2015. http://www.stanforddaily.com/2015/08/17/me101-addresses-student-concerns-about-workload-not-work-space

21 McKim, R. Experiences in Visual Thinking. Pacific Grove, California: Brooks/Cole Publishing. 1972, p. vii.

its pervasive and integrative qualities. He asserted that people are always thinking, that thinking is physical not just mental, and that thinking involves feelings. "As the mind-body dichotomy is false, so is the one that separates thinking from feeling. The character of your thinking is always colored and directed by your emotions and motivations." [22]

To achieve productive thinking—the type that leads to creative actions—McKim offered three foundational conditions: people need a challenge or impetus, people need information, and people need flexibility. This last condition must be applied to thinking's levels, operations and vehicles. Levels are defined as conscious, subconscious and unconscious mental states; operations refers to the cognitive approaches of analysis, synthesis, induction and deduction; and vehicles are thinking conveyances like languages, emotions and sensory imagery. McKim concluded his ideas on thinking by stating that learning to think visually is an experiential endeavor that resides in each individual, and that it can best be attained through considered reflection and introspection.

McKim went on to describe and show the interacting nature of seeing, drawing and imagining. On graphic ideation versus graphic communication, he emphasized the differences:

"Because thinking flows quickly, graphic ideation is usually free-hand, impressionistic and rapid. Because communication to others demands clarity, graphic communication is necessarily more formal, explicit, and time-consuming. Education that stresses graphic communication and fails to consider graphic ideation can unwittingly hamper visual thinking." [23]

Experiences in Visual Thinking has many visual examples, and some teach the reader through heuristics, or learning by doing. Visual tests and puzzles challenge the reader to engage directly with the material, such as discerning patterns, noticing closure, sorting and categorizing, and exercising short-term memory. McKim makes Gestalt theory accessible and evident.

In the book's section on ambidextrous thinking, McKim avoided assigning too much importance to binary notions of symbolic right- and left-handedness, and to strict divisions between the brain's hemispheres. McKim advocated for "internal transfers" [24] between so-called rational and intuitive brain halves, and for building bridges "to integrate the artist and scientist within each one of us." [25] Later in *Experiences in Visual Thinking* McKim was critical of elementary and secondary education's over-emphasis

22 McKim, R. Experiences in Visual Thinking. p. 2.

23 McKim, R. Experiences in Visual Thinking. Pacific Grove, California: Brooks/Cole Publishing. 1972, p. 10.

24 McKim, R. Experiences in Visual Thinking. p. 24.

25 Ibid.

on reading, writing and arithmetic, because neglecting drawing and other visual expressions creates "massive visual atrophy."[26]

To prepare for effective visual thinking, McKim recommended obtaining various drawing tools and supplies, plus a camera and an image projector. He acknowledged the eventual role of graphic computers. He also thought it beneficial to put oneself into a state of "relaxed attention"[27]—this could include meditation, stretching, massage and deep breathing.

In the Seeing chapter, McKim addressed the sense of visual perception, point-of-view and stereotyped vision. He promoted both "free doodling" and "disciplined doodling," as forms of "seeing by drawing."[28] Using other senses to complement vision is also valid, he claimed—tactile, auditory, taste and olfactory sensations provide information that can then be visualized, perhaps through more gestural or expressive sketches. *Experiences in Visual Thinking* provides some typical drawing advice—about line, shape, value, perspective, proportion and foreshortening, for example—but as this was already well-furrowed ground, McKim focused less on technique and method, and more on why drawing is important to design.

Drawing makes the imagination manifest. Inside the mind's eye, whether through memory, stimulus, illusion, fantasy, reality or other cognitive structures, humans are free to imagine. McKim also included dreams and hallucinations as valid influences on the imagination, and stressed that "here-and-now sensory experience is essential to vital imagination."[29]

Idea-sketching, the final chapter in *Experiences in Visual Thinking*, takes theories of visual thinking, graphic imagery, seeing and imagining into a concrete realm. Sketching harnesses interior mental processes to tangible outcomes, making ideas into images, images that lead to products and other designs.

McKim explained his sequential Express-Test-Cycle iterative design process: ideas are expressed in tangible ways, then evaluated for feasibility, and finally cycled back through a feedback loop for revisions. The initial rounds of this process are divergent—exploratory and lateral, even wild and risky—while the later iterations begin to converge towards refined results. McKim emphasized quantity over quality in earlier rounds of ETC, and encouraged designers to maintain a process journal, or idea-log, "even by your bed, ready to record an insight gained by a dream."[30] The ETC acronym is also the abbreviation for *etcetera*, and McKim takes advantage of this to remind readers of the ongoing, iterative quality of Express-Test-Cycle.

26 Ibid.

27 McKim, R. Experiences in Visual Thinking. Pacific Grove, California: Brooks/Cole Publishing. 1972, p. 33.

28 Ibid.

29 Ibid.

30 McKim, R. Experiences in Visual Thinking. Pacific Grove, California: Brooks/Cole Publishing. 1972, p. 119.

Experiences in Visual Thinking ends on a highly visual note. The last thirty or so pages are packed with examples of sketches, renderings, doodles—the book depicts images by artist-engineer Leonardo di Vinci, film director Federico Fillini, architect Paolo Soleri, inventor Thomas Edison, artist Pablo Picasso, and industrialist Henry Ford, among many others. Two full spreads show the biomimicry drawings of Nancy Strube; her work scrolls into a cascade of contours, shapes, patterns and notes that reference apparel, or perhaps jewelry design, and presages today's interest in wearable technology. Simultaneously figurative, expressive and abstract, it is the work of an accomplished visual thinker, making Strube's work emblematic of McKim's philosophies.

As a design artifact itself, the paperback book has an approachable horizontal format and is graphically stylistic of the early nineteen-seventies. Its cover features a full-bleed black and white photograph of an enlarged human eye under the finely lined geometry of white concentric circles. The effect is both humanistic and scientific, natural and hallucinatory. *Experiences in Visual Thinking*'s title is set in lowercase Cooper Black, a chubby and friendly typeface that was popular in that era, and printed in a color similar to Dijon mustard. Inside the book, text is set in three columns per page in the ubiquitous sans serif font Helvetica, with Cooper Black headings and page numbers throughout. Images are plentiful.

McKim's tone is well-informed and encouraging. About *Experiences in Visual Thinking*, McKim's Department of Mechanical Engineering colleague Jim Adams wrote, "It is fun to read, and deceptively profound."[31]

Besides his work at Stanford, *Experiences in Visual Thinking* is Bob McKim's major contribution to design education. McKim co-founded the Joint Program in Design in 1958 with mechanical engineering colleague John Arnold and with art colleague Matt Kahn. He was a professor and advisor to David Kelley in the mid-1970s, and a major influence on Kelley personally and professionally. The design thinking movement—and indeed, Kelley himself—stands on the shoulders of McKim's research into, explanation of, and use of visual thinking.

Jim Adams and Conceptual Blockbusting

Mechanical engineering professor James L. "Jim" Adams wrote *Conceptual Blockbusting* in 1974, two years after Bob McKim published *Experiences in Visual Thinking*. Subtitled "A Guide to Better Ideas," *Conceptual Blockbusting* is

31 Adams, J. L. Conceptual Blockbusting: A Guide to Better Ideas. San Francisco: W.H. Freeman, 1974, p. 152.

concerned with creativity, conceptual thinking, problem-solving, human cognition and behavior, and organizational structures that enable or impede innovation.

The first edition of the book has seven chapters: Introduction, Perceptual Blocks, Emotional Blocks, Cultural and Environmental Blocks, Intellectual and Expressive Blocks, Alternate Thinking Languages, and All Kinds of Blockbusters. The 1979 edition added Groups and Organizations. The book contains numerous exercises and problems, which Adams encourages the reader to complete to make it "much more meaningful and much more likely to influence your thinking..." [32] Adams spends the first two-thirds of the book on the "mental walls" [33] between people and ideas, and the final third on possible techniques for overcoming conceptual blocks.

The book's tone is anecdotal, and is rich with stories, cases, and rhetorical questions. A little disconcertingly, Adams speaks in first person, first person plural, second person and third person plural voices throughout *Conceptual Blockbusting*. Illustrations are plentiful, but lack captions—the pictures are referred to in the text.

In the chapter Perceptual Blocks, Adams discusses short and long-term memory, sensory input and stereotyping. Seven pages are devoted to the classic visual/spatial challenge of drawing as few straight lines as possible to connect a three-by-three grid of nine dots. When players think outside of the box that is the grid itself, myriad unorthodox solutions are possible. Adams even allows readers to tear a page out of *Conceptual Blockbusting* in order to attempt the "fiendish solution by Rodney W. Supple," [34] (who was in Adams' 1955 Caltech graduating class and is one of Adams' oldest friends) which requires folding the grid paper prior to connecting the dots.

The Emotional Blocks chapter begins with a party game called "Barnyard"—the game concept is credited to Bob McKim, Adams' Stanford colleague—in which participants make farm animal noises. The ensuing cacophony leads people to experience "feeling like an ass," [35] a common emotional block that prohibits creativity. Adams goes on to explain psychologist Sigmund Freud's concept of the id, ego and superego and their effect on human inhibitions. Discussion of risk-taking, consequences, and idea judgment versus idea generation follows. Adams cites the lack of incubation time ("sleeping on an idea") as a key limiter to allowing the unconscious to contribute to better ideas. Readers will not find a deep dive into human emotions. What are the roles, a curious reader might wonder—in the realms of creativity

32 Adams, J. L. Conceptual Blockbusting: A Guide to Better Ideas. San Francisco: W.H. Freeman, 1974, p. 3.

33 Adams, J. L. Conceptual Blockbusting. p. 11.

34 Adams, J. L. Conceptual Blockbusting. p. 26.

35 Adams, J. L. Conceptual Blockbusting: A Guide to Better Ideas. San Francisco: W.H. Freeman, 1974, p. 11.

and ideation—of envy, greed, pride, elation, relief, love or contempt, among many others?

Urinating into a vertical pipe to elevate a ping pong ball is one of the examples Adams gives of a clever solution to a posed problem in the chapter Cultural and Environmental Blocks. Both elegant and mildly disgusting, it illustrates how taboos prevent people from being creative when social pressures exist. (This "ball in the pipe problem" block was also metioned—although with a crystal pitcher of ice water instead of urine—in the 1955 *Life* magazine article about John Arnold.) Adams defines other cultural blocks by the misguided notions that "fantasy and reflections are a waste of time, lazy, even crazy,"[36] that reason is preferable to intuition, that playing is solely for children, that tradition is better than change, and that "any problem can be solved by scientific thinking and lots of money."[37] Of environmental blocks, Adams cites physical structures like room temperatures and windows, distractions like ringing phones, and social structures like an autocratic boss or unsupportive work environment.

The Intellectual and Expressive Blocks chapter covers the role of language in solving problems, including mathematics, visualization and words. Issues of appropriateness, skill, literacy and fluency, precision, communications media and technology impact how language can be beneficial to creative thinking and problem solving. Lacking these qualities, and lacking complete or correct information, blocks the ability of the person to conceptualize.

Alternate Thinking Languages builds on the previous chapter. Linguistics and mathematical formula are given their due, with Adams then expounding on the "languages of the senses."[38] He gives an overt nod to McKim's book *Experiences in Visual Thinking*, especially when discussing visual imagery: perceptual, mental and images rendered graphically.

In the chapter All Kinds of Blockbusters, Adams asserts that conceptual "blocks exist because of the achievement-oriented, competitive, and compulsive nature of Western man."[39] He laments this archetype's lack of a "questioning attitude"[40] and goes on to promote the quality of "constructive discontent,"[41] a term from book *The Universal Traveler: A Soft-Systems Guide to Creativity, Problem-Solving, and the Process of Reaching Goals*. (A decade later David Kelley used *The Universal Traveler* as a text in his Stanford course ME 115, Human Values in Design.)

Adams advocates for word lists as a means to help break conceptual blocks: lists of attributes, lists of things that bug people, and finally, check lists.

36 Adams, J. L. Conceptual Blockbusting. p. 53.

37 Ibid.

38 Adams, J. L. Conceptual Blockbusting: A Guide to Better Ideas. San Francisco: W.H. Freeman, 1974, p. 88.

39 Adams, J. L. Conceptual Blockbusting. p. 103.

40 Adams, J. L. Conceptual Blockbusting. p. 104.

41 Adams, J. L. Conceptual Blockbusting. p. 105.

Regarding this latter item, Adams credits Stanford mechanical engineering professor John Arnold, co-founder of Stanford's design program, with using check lists to good effect. The chapter evolves into discussion of Synectics, the organizational tool for encouraging creativity through analogy and metaphor, and ends with mention of psychologist Abraham Maslow's concept of "self-actualizing creativeness." [42]

The final chapter of *Conceptual Blockbusting*, Groups and Organizations, begins by explaining why affiliation is a strong social pressure in group settings—seeking to belong while also demonstrating constructive discontent is a challenging personal position. The exertion of ego and authority can also undermine group dynamics, especially if the goal is creativity. Adams reminds readers that deferring judgment is crucial to successful group brainstorming sessions. He goes into greater detail with the Synectics method, which attempts to structure brainstorming sessions into a more purposeful exercise.

Adams ends with an acknowledgment that large organizations have bureaucracies that often suppress creativity and problem solving. Hierarchy and control mechanisms dominate many corporations and institutions. "The natural tendency of organizations to routinize, decrease uncertainty, increase predictability, and centralize functions and controls is certainly at odds with creativity, and conceptual blocks can abound." [43] The solution to this is that some large organizations have given special independence to "skunk works" or other creative spin-offs.

Lastly, a Reader's Guide offers additional books for further information on creativity, psychology and conceptualization. Adams offers a disclaimer in the afterword: "[*Conceptual Blockbusting*] contains a good bit of conjecture and many value judgments which the reader must sort through and accept or discard depending on whether he is convinced or not (and probably on whether or not the reader's own opinions and values are reinforced)." [44]
A gesture drawing of a figure—perhaps a self-portrait—accompanies Jim Adams' biography on the last page of *Conceptual Blockbusting*.

Despite its many images and visual puzzles, the book's design is very conventional, suited more for a paperback novel than a book about conceptual blockbusting. Thin margins, awkwardly spaced text type, and a pedestrian layout indicate that *Conceptual Blockbusting*'s publisher ought to have applied some of the book's concepts.

42
Adams, J. L. Conceptual Blockbusting: A Guide to Better Ideas. San Francisco: W.H. Freeman, 1974, p. 125.

43
Adams, J. L. Conceptual Blockbusting. p. 143.

44
Adams, J. L. Conceptual Blockbusting: A Guide to Better Ideas. San Francisco: W.H. Freeman, 1974, p. 145.

Adams has published a number of other books: *Good Products, Bad Products* (2011), *Flying Buttresses, Entropy, and O-Rings—The World of an Engineer* (1993), *The Care and Feeding of Ideas* (1986) and, summarized here, *Conceptual Blockbusting* (1974). It is this last one that ties his research and opinions to the roots of design thinking at Stanford.

Conclusion

Arnold's "creative engineering" approach to design emphasized external provocations and tethers to related fields like psychology, business, art and media. His use of elaborate science fiction prompts in teaching was ground-breaking for how that redefined "user-centeredness." McKim privileged the visual, spatial and experiential, not just through drawing and other image-and model-making scenarios, but through harnessing the imagination and expanding the mind. In the late 1960s McKim embraced the "touchy-feely" Human Potential Movement as proffered by the Esalen Institute in Big Sur, California, and he separately participated in a local study to "explore the relation between creativity and psychedelic-drug use."[45] Adams was concerned with how to enable conceptual development in design, and—anathema to this process—the psychological and sociological limitations on creative thinking, including organizational structures, traditions and habits.

Besides Stanford's own legacy in providing the philosophical and epistemological foundations of design thinking, the concept does have roots elsewhere. Stefanie Di Russo, a scholar at the Swinburne University of Technology in Australia and an external coach to Stanford's global ME 310 course collaboration with Professor Larry Leifer, claims to have identified the first use of "design thinking" in print. Quoting British design educator and researcher L. Bruce Archer from his 1965 article Systematic Method for Designers, "In the face of this situation there has been a world wide shift in emphasis from the sculptural to the technological. Ways had to be found to incorporate the knowledge of ergonomics, cybernetics, marketing and management science into *design thinking*."[46] [Italics by paper author.]

The MIT Press published Peter Rowe's book *Design Thinking* in 1987.[47] Although largely concerned with architecture and urban planning, its theories apply to other design activity. In 1992, Richard Buchanan, former head of the school of design at Carnegie Mellon University, published the article Wicked Problems in Design Thinking in the journal *Design Issues*. He posited that design thinking might be best thought of as a liberal art.[48] Scholar Nigel

45 Markoff, J. What the Dormouse Said: How the 60s Counterculture Shaped the Personal Computer. New York: Viking Press. 2005. p. 65.

46 Di Russo, S. "I think, I design" blog on https://ithinkidesign.wordpress.com/2015/04/21/the-underrated-writings-of-bruce-archer/ 2015.

47 Rowe, P. Design Thinking. Cambridge MA: The MIT Press. 1987.

48 Buchanan, R. "Wicked Problems in Design Thinking" in Design Issues, Vol. 8, No. 2, Cambridge, MA: The MIT Press, 1992, pp. 5-21.

Cross has contributed to design thinking theory since the 1980s with academic articles and a book devoted to "designerly ways of knowing," in which he advocates for "design cognition as an essential aspect of human intelligence." [49]

Decades later, articles in the popular press such as the Wall Street Journal's "Forget B-School, D-School Is Hot," [50] The New York Times' "Solving Problems for Real World, Using Design" [51] and Bloomberg's "Tomorrow's B-School? It Might Be A D-School" [52] helped cement the d.school's national and international acclaim. Design thinking courses, workshops, consultancies, books, websites and videos have proliferated well beyond Stanford, with many universities and companies offering their take on the concept. Fast forward to 2015 and Jon Kolko's essay Design Thinking Comes of Age [53] in the *Harvard Business Review*—the term design thinking is now a buzzword in commerce, culture and education.

The term "design thinking" is meant as a cognitive activity that is the precursor to creating actual designs—even when acted out in social, collaborative environments with white boards and Post-it® notes. The d.school's d.mindset of "bias towards action" advocates for this. Thinking alone will not produce buildings, automobiles, electronic devices, clothing, chairs, books, typefaces, websites, lamps, sports equipment, apps, bridges, space craft, wedding cakes, stage sets or any other designed artifact, experience or system. The hope is that design thinking, broadly defined (inclusive, diverse, accessible, multi-disciplinary, sustainable, affordable, etc.), leads to better design making, and so improves the human condition.

Arnold, McKim and Adams did not stop at design thinking—they applied their theories and ideas to professional design work. Arnold consulted for General Electric, Ford and Bell Laboratories, and won a NASA grant to work on a lunar vehicle. McKim worked for industrial designer Henry Dreyfuss in New York and consulted for several Silicon Valley clients. Adams' CV lists over one hundred companies he worked with including 3M, Lucasfilm, AT&T, The North Face and IBM.

All three of the mechanical engineering design professors also had some background in the fine arts, an important distinction when considering the disciplinary roots of design thinking. At the University of Minnesota, his undergraduate institution, Arnold was a musician and actor. McKim drew and sculpted the human figure, and did a post-baccalaureate industrial design program at Pratt Institute in New York, where he became a fan of ballet. Adams took a year of graduate art courses at the University of

49 Cross, N. Designerly Ways of Knowing. London: Springer-Verlag, 2006, p. v.

50 Korn, M. and Silverman, R. "Forget B-School, D-School Is Hot: 'Design Thinking' Concept Gains Traction as More Programs Offer the Problem-Solving Courses." The Wall Street Journal, 2012. https://www.wsj.com/articles/SB10001424052702303506404577446832178537716

51 Perlroth, N. "Solving Problems for Real World, Using Design." The New York Times, 2013. https://www.nytimes.com/2013/12/30/technology/solving-problems-for-real-world-using-design.html

52 Merritt, J. and Lavelle, L. "Tomorrow's B-School? It Might Be A D-School." Bloomberg Businessweek, 2005. https://www.bloomberg.com/news/articles/2005-07-31/tomorrows-b-school-it-might-be-a-d-school

53 Kolko, J. "Design Thinking Comes of Age" in Harvard Business Review. https://hbr.org/2015/09/design-thinking-comes-of-age, 2015.

California—Los Angeles (UCLA) prior to completing his PhD in engineering at Stanford. For these engineer-designers, the so-called "left-brain" cognitive processes of analysis, reason and deduction were supplemented with art's expressive, subjective and intuitive qualities. (The art component of design at Stanford ended in 2017, unfortunately—after 59 years of educating students through the Joint Program in Design—when the Department of Art & Art History withdrew its participation.[54])

Design thinking today has evolved into an ecosystem of socio-cultural, geo-political and economic considerations that employs empathy, entrepreneurism, emergent technologies, material science, collaboration and human centeredness across all scales and configurations. The work of the Stanford University faculty revealed in this paper preceded this paradigm and should be considered both historically foundational to design thinking in general and elemental to the d.school's packaging of design thinking as a popular methodology and as a competitive advantage for business. Affirming this influence, David Kelley stated in 2016, "The fact that we're still using McKim's methodology—I still talk like Bob McKim without much modification, 'need-finding' in particular—is amazing. We're talking, like, forty years later!"[55] Professors John Arnold, Bob McKim and Jim Adam planted the some of the seeds that bear the fruit of today's design thinking movement.

54
McCarthy, S. Design at Stanford: A Visual History of Thinking and Doing. Blurb.com, 2019, p. 93.

55
Kelley, D. Kelley–McCarthy conversation. Recorded June 9, 2016.

References

Adams, James L. *Conceptual Blockbusting: A Guide to Better Ideas.* San Francisco: W.H. Freeman, 1974.

Arnold, John. "What is Creativity" manuscript (1959) in *Creative Engineering: Promoting Innovation by Thinking Differently* edited by William J. Clancey, 2016. https://www.inist.org/library/1959.John%20E%20Arnold.Creative%20Engineering.pdf (accessed 5 Oct. 2020)

Arnold, John Jr. "The Arcturus IV Case Study," 2016. https://stacks.stanford.edu/file/druid:rz867bs3905/SC0269_Arcturus_IV.pdf (accessed 28 Sept. 2020)

Arnold, John Jr. Son of John Arnold email communication with author, 15 Nov. 2018.

Buchanan, Richard. "Wicked Problems in Design Thinking." *Design Issues*, Vol. 8, No. 2, (Spring, 1992), Cambridge, MA: The MIT Press. pp. 5–21.

Cross, Nigel. *Designerly Ways of Knowing*. London: Springer-Verlag, 2006, p. v.

Di Russo, Stefanie. "I think, I design." 2015. https://ithinkidesign.wordpress.com/2015/04/21/the-underrated-writings-of-bruce-archer/ (accessed 22 Oct. 2020)

Hunt, Morton. "The Course Where Students Lose Earthly Shackles." *Life*. May 16, 1955. pp. 186–190.

Katz, Barry. *Make it New: The History of Silicon Valley Design*. Cambridge, MA: The MIT Press, 2015.

Kelley, D. Kelley—Faste email in Faste papers. Privately held. January 10, 2002.

Kelley, D. Kelley—McCarthy conversation. Recorded. June 9, 2016.

Kolko, Jon. "Design Thinking Comes of Age." *Harvard Business Review*. 2015. https://hbr.org/2015/09/design-thinking-comes-of-age (accessed 9 October 2020)

Korn, Melissa and Silverman, Rachel Emma. "Forget B-School, D-School Is Hot: 'Design Thinking' Concept Gains Traction as More Programs Offer the Problem-Solving Courses." *The Wall Street Journal*. 2012. https://www.wsj.com/articles/SB10001424052702303506404577446832178537716 (accessed 28 September 2020)

Kuang, Cliff and Fabricant, Robert. *User Friendly: How the Hidden Rules of Design Are Changing the Way We Live, Work, and Play*. New York: MCD, Farrar, Straus and Giroux, 2019.

Lloyd, Peter. "You make it and you try it out: Seeds of design discipline futures." *Design Studies*, vol. 65. 2019. 167–181. https://doi.org/10.1016/j.destud.2019.10.008 (accessed 7 Apr. 2021)

Markoff, John. *What the Dormouse Said: How the 60s Counterculture Shaped the Personal Computer*. New York: Viking Press, 2015.

McCarthy, Steven. *Design at Stanford: A Visual History of Thinking and Doing*. Blurb.com, 2019.

McCarthy, Steven. Design at Stanford: the D.school's Daddy. *REDES 2019, Research & Education in Design* conference proceedings. London, UK: Taylor & Francis, 2020. 207–210. https://www.taylorfrancis.com/chapters/edit/10.1201/9781003046103-23/design-stanford-school-daddy-mccarthy?context=ubx&refId=dc9e88f9-6877-4c3a-837d-f6b0ddb862bb (accessed 7 Apr. 2021)

McCarthy, Steven. Digital Typography at Stanford. *She Ji: The Journal of Design, Economics, and Innovation*. Tongji University and Tongji

University Press. Publishing services by Elsevier B.V., 2020. pp. 546–560. https://authors.elsevier.com/sd/article/S240587262030068X (accessed 30 June 2021)

McKim, Robert. "Designing for the Whole Man" (1959) in Arnold, J. *Creative Engineering: Promoting Innovation by Thinking Differently* edited by W. J. Clancey. 1956/2016. https://www.inist.org/library/1959.John%20E%20Arnold.Creative%20Engineering.pdf (accessed 22 Oct. 2020)

McKim, Robert. *Experiences in Visual Thinking*. Pacific Grove, California: Brooks/Cole Publishing, 1972.

Merritt, Jennifer and Lavelle, Louis. "Tomorrow's B-School? It Might Be A D-School." *Bloomberg Businessweek*, 2005. https://www.bloomberg.com/news/articles/2005-07-31/tomorrows-b-school-it-might-be-a-d-school (accessed 22 Oct. 2020)

Moore, Erik. University of Minnesota archivist email communication with author, 14 Nov. 2018.

Pang, Alex Soojung-Kim. "Mighty Mouse" in *Stanford* magazine, Palo Alto CA: Stanford University, March/April 2002. p. 56.

Perlroth, Nicole. "Solving Problems for Real World, Using Design." *The New York Times*. 2013. https://www.nytimes.com/2013/12/30/technology/solving-problems-for-real-world-using-design.html (accessed 28 Sept. 2020)

Rowe, Peter. *Design Thinking*. Cambridge MA: The MIT Press, 1987.

Stanford University d.school. 2009. http://dschool.stanford.edu/wp-content/uploads/2009/12/bootcampbootleg20091.pdf (accessed 15 Jan. 2017)

The Tech LXXV, No. 54. Cambridge, MA: Massachusetts Institute of Technology, 1956. http://tech.mit.edu/archives/VOL_075/TECH_V075_S0323_P002.pdf (accessed 23 November 2020)

Toh, Eileen. "ME101 addresses student concerns about workload, not work space." *The Stanford Daily*, 2015. http://www.stanforddaily.com/2015/08/17/me101-addresses-student-concerns-about-workload-not-work-space/ (accessed 22 Oct. 2020)

von Thienen, Julia, William J. Clancey, Christoph Meinel. "Theoretical Foundations of Design Thinking. Part II: Robert H. McKim's Need-Based Design Theory." *Design Thinking Research: Looking Further: Design Thinking Beyond Solution-Fixation*. Cham, Switzerland: Springer International Publishing, 2019.

Wikipedia. https://en.wikipedia.org/wiki/John_E._Arnold, 2018 (accessed 22

Oct. 2020)

Xu, Fangqi & Henry Andersen. "Thinking about the Roots of Design Thinking." 12th European Conference on Innovation and Entrepreneurship ECIE 2017. Reading, UK: Academic Conferences International Limited, 2017. pp. 662–668.

Biography

Professor Steven McCarthy (MFA, Stanford University) has been on the University of Minnesota graphic design faculty since 1998, and recently achieved emeritus status. He taught graphic design at Northern Kentucky University for nine years prior to this. His long-standing interest in theories of design authorship as both scholar and practitioner has led to lectures, exhibits, publications and grant-funded research in a dozen countries. McCarthy's creative work has been in over 135 juried and invitational exhibitions, and has been awarded inclusion in the AIGA annual and in *Graphis Poster.* Institutional 'special collections' that have acquired McCarthy's work include these universities and art and design academies: Yale, Harvard, Stanford, Virginia Commonwealth, Minnesota, Cincinnati, Ohio State, the Art Institute of Chicago and Washington (Seattle). He has published written work in *Design Issues, Eye, Visible Language, Visual Design Scholarship, The Poster,* and *Visual Communication* among others. His book on the topic of design authorship, *The Designer As… Author, Producer, Activist, Entrepreneur, Curator and Collaborator: New Models for Communicating* was published in 2013 by BIS Publishers, Amsterdam.