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ORIGINAL ARTICLE

The origin and evolution of Stanford University's design thinking: From product design to design thinking in innovation management

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Abstract

This article outlines the origin and evolution of one of the most influential design thinking perspectives in the Innovation Management discourse. This study addresses two significant criticisms of design thinking, namely, theoretical grounding and construct clarity. It also illustrates how this humanistic and creative design practice transcended into a comprehensive Innovation Management approach, facilitating entrepreneurship and innovation. Our research analyzes the evolution of the design philosophy and practices developed at Stanford University from 1957 to 2005 through document analysis. We identified design qualities that have been consistent over the decades, providing further construct clarity and insights on managing Design-driven Innovation. These design qualities elucidate design thinking as a cognitive process, creative practice, organizational routine, and design culture. They emphasize finding profound needs and problems and translate them into tangible designs, creating value for people. This design philosophy is deeply rooted in humanistic psychology theories, particularly on creativity and human values. Collaborations between psychologists, industrial researchers, and designers created this creative and human-centered design approach, known today as design thinking. This value-driven innovation offers a humanistic perspective on innovation theory and practice. It also offers an Innovation Management schema of design qualities essential for developing Design-driven Innovation capabilities in organizations and educational institutions. We emphasize that developing a creative design culture in which people have the human values, abilities, and confidence to collaboratively identify continuous emerging problems and needs and contribute through tangible designs generates an era of innovation and is essentially innovation management.

KEYWORDS

design qualities, design thinking, design-driven innovation, innovation management

Practitioner Points

- Design thinking as a step-by-step process with tools prevents fluency in thinking and flexibility in approach, which are essential in Design-driven Innovation.
- An essential innovation management task is to develop a design culture and capabilities by freeing teams from emerging blocks imposed by the environment.
- In organizations, Design-driven Innovation requires the development of micro-foundation, such as abilities and attitudes & values, and capabilities, such as creative routines and environments of support and psychological safety and freedom.
- Innovation managers and educators need to consider essential design qualities when enabling people to design tangible solution for open and complex problems.

1 | INTRODUCTION

Design thinking (DT) has become an accepted term in the Innovation Management (IM) discourse as an approach to creativity and innovation based on designers' practices (Brown, 2008; Magistretti et al., 2020; Martin, 2009). The excitement for DT in the IM field emerged around the mid-2000s, stimulated by the work of IDEO's Tim Brown (2008, 2009) and his collaborator Roger Martin (2009), which established it as an umbrella construct (Dunne & Martin, 2006; Micheli et al., 2019). Over the last years, various scholars investigated and conceptualized DT in teams and organizational settings (e.g., Brown, 2008; Cagan et al., 2013; Carlgren et al., 2016; Elsbach & Stigliani, 2018; Liedtka, 2015; Sonalkar et al., 2013; Swan et al., 2005). In this discourse, DT is often conceptualized as a process or set of activities incorporating various methods (Beckman & Barry, 2007; Elsbach & Stigliani, 2018; Seidel & Fixson, 2013). Three common activities and methods are need-finding, brainstorming, and prototyping within multidisciplinary teams (Brown, 2009; Seidel & Fixson, 2013). Practicing these DT activities has the potential to facilitate creativity and innovation, overcome cognitive biases, and influence an organization's culture (Brown, 2009; Elsbach & Stigliani, 2018; Liedtka, 2015). However, scholars noted that the construct DT in the IM discourse lacks construct clarity (Micheli et al., 2019). Various scholars tried to clarify it through different approaches (Carlgren et al., 2016; Dell'Era et al., 2020; Johansson-Sköldberg et al., 2013; Micheli et al., 2019). By reviewing the IM and design literature, Micheli et al. (2019) identified attributes, such as user-centeredness, ability to visualize, and tolerance for ambiguity and failure. These attributes provide an overview of the loosely coupled diverse phenomena that constitute this umbrella construct (Hirsch & Levin, 1999). Furthermore, unlike most umbrella constructs, scholars criticized that DT in IM lacks theoretical grounding even though it has practical relevance (Johansson-Sköldberg et al., 2013; Micheli et al., 2019). This gap resulted due to IDEO's influential practice-based accounts (Brown, 2009; Kelley & Littman, 2001). This lack of theory is problematic, as it prevents the critical evaluation and advancement of DT as an IM and design-driven innovation practice. Without such clarity, DT is practiced without attention to essential design qualities necessary for innovation. As a resolution, scholars suggested that the design practice must be grounded in theories, such as Simon (1969), Schön (1983), Buchanan (1992), Lawson (1980) and Cross (2006), or Krippendorff (2006) (Johansson-Sköldberg et al., 2013). IDEO's practices are of particular relevance, as several scholars express that they have been central to the DT movement and their models and literature have been highly influential in the IM discourse (Brown, 2008, 2009; Gruber et al., 2015; Johansson-Sköldberg et al., 2013; Liedtka, 2015; Micheli et al., 2019). These practices are closely linked to Stanford's design philosophy and practice as most of their methodology, founders, and professional staff were involved in and came from Stanford's Joint Product Design (JPD) program (Kelley, 1999). However, little is published in the IM discourse about the origins and evolution of this influential design philosophy and practice and how it turned into an IM approach. This study sheds light on how this design philosophy and practice, developed in Stanford's JPD program and Design Division, evolved into DT as an IM approach. By doing so, the research reveals theoretical foundations and practical learnings developed over half a century providing insights on how essential design qualities enable design-driven innovation. This article shows that DT attributes are not loosely coupled phenomena but a comprehensive, creative, and humanistic design philosophy and practice that led to entrepreneurship, innovation, and growth. This study contributes to IM and design theory and practice by, first, identifying that DT is deeply rooted in humanistic and gestalt psychology theories. It offers a different design theory distinct from and complementary to the theories mentioned above. Second, the study illustrates how the creative and humanistic design

practice transcended into the IM discourse. Finally, the study provides further clarity of the construct DT by revealing essential design qualities, representing DT as a philosophy, culture, practice, and cognitive process. By offering more significant insights on design-driven innovation, these qualities provide a schema for managers and educators to support people and organizations in developing their creative capacity and innovation capability.

2 | METHODOLOGY

This study is designed to provide a historical account of the evolution of the design philosophy and practice developed in Stanford's Joint Program in Design (JPD) and Design Division from 1957 to 2005. In 1957, John E. Arnold was hired as a professor of both the Department of Mechanical Engineering and the Graduate School of Business to develop the creative product design education at Stanford University. In 2005, scholars started publishing their research about DT in the IM literature. This article examines the period between these two points in time through document analysis.

2.1 | Data collection

We collected the Stanford Bulletin from 1957–58 to 2005–06 in order to examine the evolution of the teaching in the JPD and related courses. The Stanford Bulletin is Stanford University's official catalog of courses, degrees, policies, and degree requirements published each year. The systematic search followed the process illustrated in Figure 1.

The search criteria were (1) courses of the JPD program for both the Bachelor and Master program and (2) additional courses incorporating the term: "design" related to the Design Division. This review resulted in two thousand six hundred seventeen course abstracts. The software Leximancer was used to identify inherent concepts through unsupervised semantic mapping of natural language (Smith and Humphreys, 2006). Informed by this analysis, courses with technical aspects, such as systems control, were excluded as these are not the focus of this study, resulting in one thousand eight hundred sixty course abstracts. We collected the course number (e.g., 214), the course name (e.g., Philosophy of Design), course outline (e.g., "An introduction to ..."), in which quarter taught (e.g., winter quarter), and course instructor's name (e.g., McKim). An example of a course description from 1967–68 is outlined as follows:

> **214. Philosophy of Design—**An introduction to the philosophy of comprehensive design. A discussion of the attitudes and view points of the designer and an investigation of the techniques of analysis, synthesis, and evaluation that [s]he uses. Emphasis will be placed on understanding the creative process and the factors that influence it. Limited registration. Prerequisite: graduate standing. *3 units, Winter quarter (McKim)*

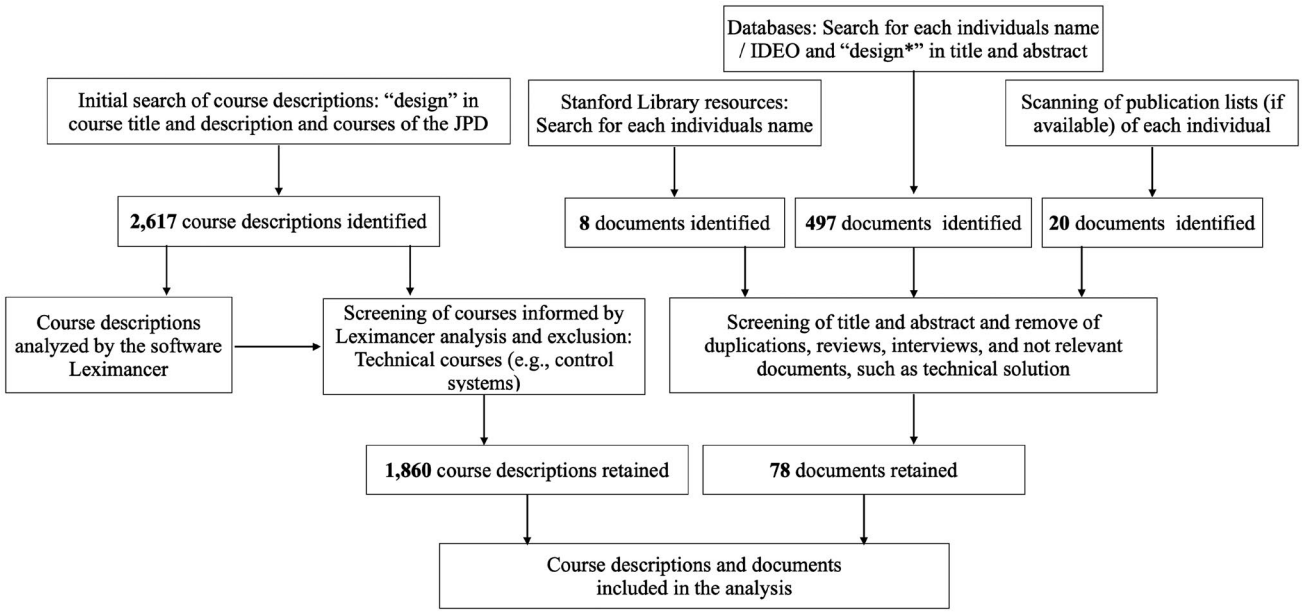

FIGURE 1 Data collection process

The data collection of courses allowed identifying individuals teaching in the JPD and Design Division. A limitation of this study is that numerous course instructors and teaching assistants are not listed in the Bulletin and therefore are not included in this study. Identify individuals at specific points in time allowed searching for the literature about the design philosophy and approach, as outlined in Figure 1. We employed three different search strategies to identify relevant documents between 1957 and 2005. First, we utilized the Stanford library catalog to identify documents of the early years. Second, we used the databases Business Source Complete, Science Direct, ABI ProQuest, SCOPUS, ACM Digital Library, and SAGE to identify academic and peer-reviewed articles. The search string was the individual's first and second name AND "Design*" within the period of the individual's involvement in the JPD and Design Division as identified through the Bulletin. The search included the literature from and about IDEO, with the search string "IDEO" AND "Design*," as IDEO played an essential role in transferring the design practice into an IM approach. Third, we scanned the title and abstracts of available publication lists (e.g., Google Scholar profiles) and reference lists to identify additional relevant documents. This systematic search resulted in five hundred twenty-three documents. These documents were assessed for relevance. Documents were excluded when they were limited to the description of technical solutions and general design projects. We included documents that described aspects of a design approach, including, e.g., creativity, need-finding, visualizing, prototyping, and business management practices. The search resulted in one thousand eight hundred sixty course abstracts and seventy-eight documents included in the analysis.

2.2 | Data analysis

The two thousand six hundred seventeen course abstracts were analyzed through the software Leximancer. Leximancer allowed investigating the qualitative data through unsupervised semantic mapping of natural language to map concepts inherent in the dataset (Smith & Humphreys, 2006). The resulting main concepts are Human Emphasis (321 matches), System Design (256), Professional Skills (203), Techniques Introduction (198), Market Development (192), Industrial Products (174), Socio-technical integration (150), Project-based (149), and Project Teams (135) (Appendix A in Supporting Information). The revealed concepts illustrate an emphasis on people, integration of technological and market development, development of professional skills and introduction to various techniques, and project and team-based learning. The second analysis focused on identifying the central themes and their evolution within the one thousand eight hundred sixty course abstracts and seventy-eight documents. As Miles et al. (2013) advocate, we employed a Time-Order Matrix, organizing course descriptions and literature along a timeline to identify progress and evolution. The data is organized into five main periods. The first period is early influences, including collaborators and cited publications in early writings. The second to fourth periods are the developments at Stanford University and IDEO based on the time-order matrix. The last period incorporates the DT attributes, as identified by Micheli et al. (2019), representing the contemporary DT in IM discourse. Second, we identified themes for each period following guidelines, as advocated by Glaser and Strauss (2017), reading, re-reading, comparing, and contrasting the courses and literature data. We also employed a word frequency analysis to identify the inherent data structure and emphasis in each period (Appendices B and C in Supporting Information). This second-order schema was developed following closely the language used in the data. Additionally, we interviewed more than five individuals for each period who either taught or studied in the JPD to gather contextual information and validate the findings.

3 | FROM PRODUCT DESIGN TO DESIGN THINKING IN INNOVATION MANAGEMENT

The data analysis revealed eight themes representing qualities of the design philosophy and practice consistent over the decades. Table 1 shows the evolution throughout the five periods. The first period shows early theoretical foundations, primarily psychology, creativity research, and design practices. The second to fourth periods attest to Stanford University's evolution from 1957 to 2005. The last period is the current debate in the DT in IM literature (Micheli et al., 2019).

This section outlines findings for the second to fourth periods in detail. First, we discuss the period from 1957 to 1964. In this period, the first comprehensive, creative, and humanistic design philosophy and practices are introduced. Second, this section outlines the period from 1965 to 1985, in which the design philosophy and practice expanded. In this period, various entrepreneurial activities transferred the design approach into organizations, such as Apple and Hovey-Kelley Design (IDEO). Finally, the period from 1986 to 2005 is outlined. In this period, developments resulted in the comprehensive

TABLE 1 Evolution of design thinking

	1st Period: Early influences	2nd Period: 1957 to 1964	3rd Period: 1965 to 1985	4th Period: 1985 to 2005	5th Period: DT in IM
Thinking modes	Productive Thinking including divergent and convergent thinking (Guilford, 1950, 1956; Wertheimer, 1945); Plausible reasoning (Pólya, 1957)	Analysis, Synthesis, & Evaluation (Arnold, 1959; Guilford, 1959);	Seeing, imagining, drawing (visual thinking) (McKim, 1972, 1980a, 1980b), based on Gestalt psychology (Arnheim, 1954, 1969; Perls et al., 1951)	Ambidextrous thinking (rational and intuitive modes) (Faste, 1994)	Problem-solving, abductive reasoning, blending rationality and intuition
Attitudes & Values		Questioning, Observing, Associating, Predicting (Arnold, 1959)	Questioning-attitude (Adams, 1974a, 1980)	Questioning-attitude (Adams, 2001; Dym et al., 2005; Eris, 2003)	
	Human values & needs (Hartman, 1959a; Maslow, 1954, 1959b); Designing for people (Dreyfuss, 1955)	Human needs, emotions, morality, & values (Hartman, 1959b; McKim, 1959)	Human needs, emotions, morality, & values *e.g., ME115a Introduction to Product Design; ME116b Advanced Product Design*	Human experiences, needs, emotions, values, & participation (Faste, 1987; Fulton Suri, 2000a; Gilmore & Velázquez, 2000; Segal & Fulton Suri, 1997)	User centeredness and involvement
Attributes	Openness to experience incl. tolerance for ambiguity (Rogers, 1954); Problem sensitivity, fluency, flexibility, & originality (Guilford, 1950, 1956)	Openness to experience, problem sensitivity, fluency, flexibility, & originality (Arnold, 1959, 1962a; Guilford, 1959; Harman et al., 1966)	Problem/need sensitivity, fluency & flexibility (Adams, 1974a, 1980; McKim, 1972, 1980a, 1980b)	Problem sensitivity, fluency, and flexibility (Adams, 2001)	Tolerance of ambiguity and failure (individual)
		Motivation, Drive, & Confidence (Arnold, 1959)	Motivation & Confidence (Adams, 1974a, 1980)	Motivation, & Confidence (Adams, 2001)	
Abilities		Understand people & context, communication, balance analysis, synthesis, evaluation, mastery of the creative process (Arnold, 1959)	Understand people & context, Visual & communication abilities, and alternate thinking languages (Adams, 1974a, 1980; McKim, 1972, 1980a, 1980b)	Understand people & context, Visual & communication abilities, and alternate thinking languages (Adams, 2001; Faste, 1994)	Ability to visualize, Gestalt view
	Comprehensive design, the synthesis of artist, inventor, mechanic, objective economist, and evolutionary strategist (Fuller, 1957)	Design as Science, Art, & Humanities (Arnold, 1959; McKim, 1959)	Multidisciplinary, including engineering, arts, marketing, manufacturing, biomedical *e.g., ME214b Design in the Corporate Environment, ME215 Designer in Society*	Interdisciplinary team (Srinivasan et al., 1997) *e.g., ME293a Design of Interactive Devices, ME315a,b Integrated Design, Manufacturing, and Marketing*	Interdisciplinary collaboration
	Group creativity (Gordon, 1961; Osborn, 1957)	Collaborative creativity through brainstorming rules (Arnold, 1959)	Collaborative teamwork (Adams, 1974a, 1980) *e.g., ME210a,b,c Engineering Design*	Collaborative teamwork (design as a social process) (Brereton et al., 1996; Tang & Leifer, 1988)	

(Continues)

TABLE 1 Continued

	1st Period: Early influences	2nd Period: 1957 to 1964	3rd Period: 1965 to 1985	4th Period: 1985 to 2005	5th Period: DT in IM
Blocks	Factors influencing creativity (Bruner, 1950; Bruner et al., 1956; Duncker, 1945)	Perceptual, cultural, & emotional blocks (Arnold, 1959; Maslow, 1959a, 1962)	Perceptual, cultural & environmental, emotional, expressive & intellectual blocks (Adams, 1974a, 1980)	Perceptual, cultural & environmental, emotional, expressive & intellectual blocks (Adams, 2001)	Tolerance of ambiguity and failure (culture)
Activities & Practice	The creative process (Guilford, 1950; Osborn, 1957; Pólya, 1957; Wallas, 1926)	Define a problem, gather & analyze information, list solutions, evaluate ideas, and synthesize & verify results (Arnold, 1959)	Need-finding, Imagining & Visualizing, Mock-up building, Evaluation, and Refinement (Express, Test, Cycle) (McKim, 1972, 1980a, 1980b)	Understand, Observe, Visualize, Refine, Implement (Gilmore & Velázquez, 2000; Moggridge, 1993; Perry, 1995; Simsarian, 2003)	Iteration and experimentation
Techniques	Crawford's (1954) Attribute Listing, Zwicky's (1948) Morphological Analysis, Osborn's (1957) Brainstorming, Operational Creativity (see Gordon, 1961)	e.g., Attribute Listing, Morphological Analysis, Brainstorming, and Operational Creativity (Synectics) (Arnold, 1959, 1962b)	e.g., Brainstorming, Synectics, visual thinking exercises and techniques, including relaxation technique, mock-up building (McKim, 1972, 1974; Prince, 1968)	e.g., Brainstorming, Scenarios, Storytelling, Role-playing (Black et al., 1994; Moggridge, 1993; Simsarian, 2003; Verplank et al., 1993)	Design tools and methods
Environment	Psychological Safety & Freedom (Rogers, 1954)	Psychological Safety & Freedom (Arnold, 1959; Arnold et al., 1960)	Supportive environment & Design Loft to play freely with materials (Adams, 1974a, 1980; McKim, 1972, 1980a, 1980b)	"Brainstorming culture" & Design Loft: psychology safety, freedom, & help (Hargadon & Sutton 2000; Sutton & Hargadon 1996)	
		Machine Shop & Sculpture Studio	Machine Shop & Sculpture Studio	Machine Shop (Sutton & Hargadon, 1996)	

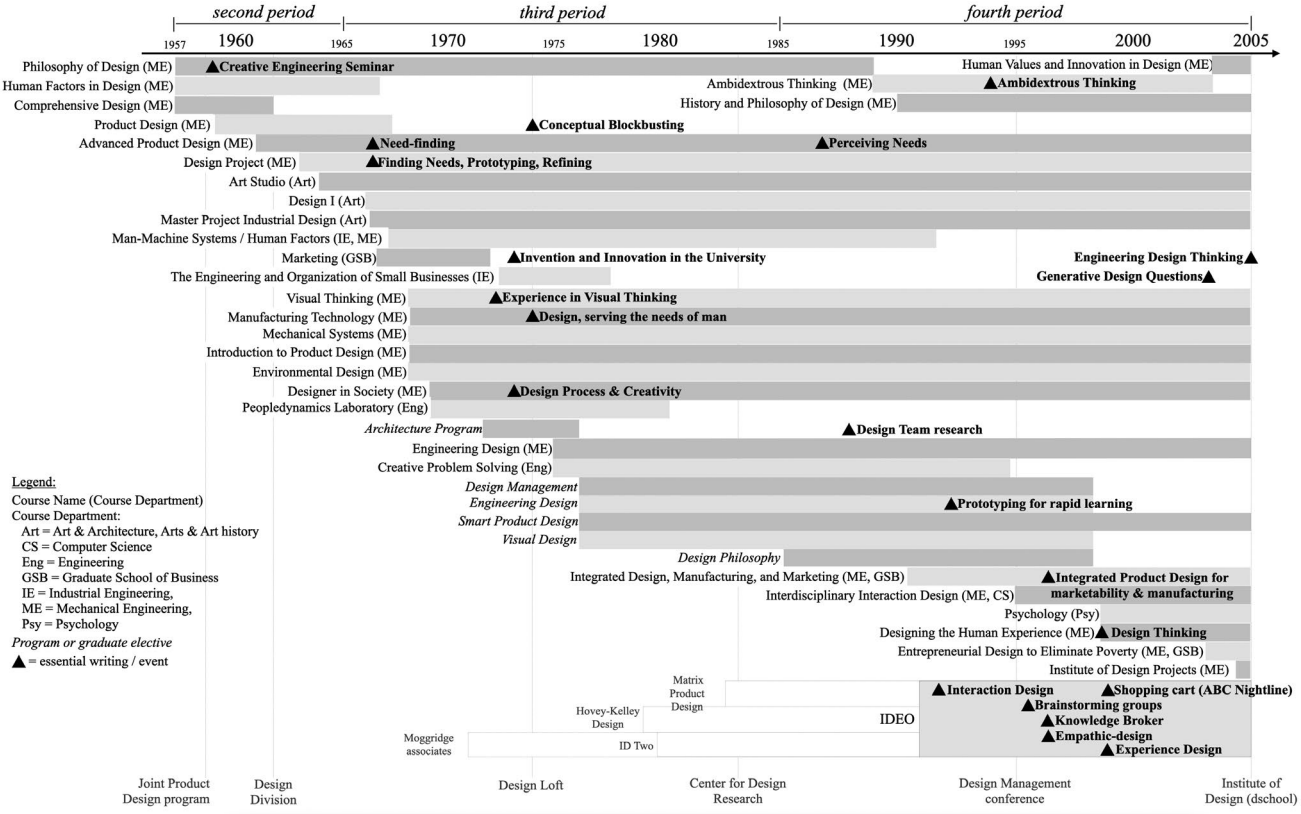

FIGURE 2 Visualization of Time-Order Matrix of selected courses, literature, and events. The overview incorporates a small number of selected core courses

integration of design and business practices, and the term design thinking was introduced to represent the design philosophy and practice. Figure 2 provides an overview of selected essential courses, literature, and events of these periods.

3.1 | The beginning: From 1957 to 1964

In the 1940s and 1950s, John E. Arnold, a psychologist and engineer, organized several seminars, consulted for various large organizations, and taught several Product Design classes, first at the Massachusetts Institute of Technology and starting in 1957 at Stanford University. He collaborated with psychologists, such as Abraham Maslow, Robert Hartman, and J.P. Guilford, designers, such as R. Buckminster Fuller, Henry Dreyfuss, Walter Baermann, and Robert McKim, and industrial researchers, such as William J.J. Gordon and Charles H. Clark (Arnold, 1959; Arnold & Clancey, 2016; Pulos, 1988). In 1959, at Stanford University, the collaborative effort between John Arnold, Robert McKim (Mechanical Engineering), and Matthew Kahn (Arts) established the Joint Program in Product Design (JPD) between the Departments of Mechanical Engineering and Art and Architecture. This program was considered "unusual combinations in engineering that do not fit into the existing accredited curricula." The official start of the JPD with a Bachelor's and Master's program was in 1963. John Arnold established the Design Division within the Department of Mechanical Engineering and hired Robert McKim, Bernard Roth, Peter Bulkeley, and Robert Keller.

3.1.1 | Creative thinking and human values to serve people's needs

In 1959, the summer program in Creative Engineering took place in which Abraham Maslow, Robert Hartman, and J.P. Guilford (psychology), and Robert McKim and John Arnold (design) contributed. In this program, Arnold (1959) and his collaborators outlined a design philosophy and practice that focused on creativity and invention. The second period in Table 1 provides an overview of this comprehensive, creative, and humanistic design approach (see Appendix D: Period 2 in Supporting Information for details).

Based on the research by Guilford (1950, 1956, 1957), Arnold (1959) outlined the combination of analysis, synthesis, and evaluation as the three Thinking Modes that

constitute "organized creativity." He expressed requirements for a creative activity as follows:

> [...] not just any synthesizing process combined with analysis and evaluation that I would like to call creative activity. [...] The creative process is primarily a mental process whereby one combines and recombines past experience, possibly with some distortion, in such a fashion that the new combination, pattern, or configuration better solves some need of [hu]mankind. In addition, the end result must be tangible, something you can see, feel, or react to in some way, it must be forwardly oriented in time, and it must have synergetic value.

This approach illustrates that the cognitive process of creativity is inseparable from the interactions with the environment and requires making tangible solutions that serve people's needs and is synergetic in value as the resulting whole is greater than the sum of its parts. Essential for this creative performance, Arnold (1959) and his collaborators expressed two types of Attitudes & Values: Creative attitudes and human values. Arnold (1959) expressed the creative attitudes of Questioning, Observing, Associating, and Predicting as follows:

> I don't actually like to think of them [questioning, observing, associating, predicting] as steps of a process that are followed in a certain definite sequence. To me these four words represent attitudes of the mind or the personality of the learner, the seeker, or the creative problem solver. They represent the cognitive process as well as the process of science. The first three should be going on all the time, simultaneously or in almost any kind of combination or sequence.

In addition, Guilford (1959), Hartman (1959b), Maslow (1959a), and McKim (1959) contributed through human values on creativity, describing the importance of needs, goodness, and emotions. For example, McKim (1959) expressed that "human values and needs is of prime importance to the designer. Design is, after all, a response to human needs." A design must serve physical, intellectual, and emotional human needs, which requires morality as not all needs are good needs (McKim, 1959). Arnold (1959) expanded further that designers require mental and emotional Attributes to perform this creative act. Rogers (1954) and Guilford (1950, 1956, 1957, 1959) identified openness to experience and problem sensitivity as essential in recognizing a problem and need, fluency in idea production, flexibility in the use of methods, and originality. These attributes are essential in finding problems and generating creative solutions. The emotional attributes of a creative individual are motivation to take a chance, self-confidence in own ability, and drive, as it takes a tremendous amount of effort to perform a creative act resulting in a tangible outcome that serves people's needs (Arnold, 1959). The Abilities of the creative designer include craftsmanship in the design profession, inventiveness like an artist, and deliberation like a scientist. Influenced by Buckminster Fuller's (1957) comprehensive design, which is "an emerging synthesis of artist, inventor, mechanic, objective economist, and evolutionary strategist," Arnold (1959) outlined the abilities of a comprehensive designer as follows:

> [First] motivated by very broad concepts of human thought and behavior. Broad because a viewpoint should be worldwide rather than national or local. Second, [s]he must be thoroughly familiar with the organism for which [s]he is designing, and the total environment in which [her/]his product must operate. Third, [s]he must be articulate in all types and all levels of communication. Fourth, [s]he must be able to maintain a delicate balance between [her/]his ability to analyze, to synthesize, and to evaluate. And last, [s]he must have complete understanding of and mastery in the use of the creative process.

The Thinking Modes, Attitudes & Values, and Attributes, in combination with Ability, aim to produce creative individuals that are able to accomplish innovation that solves global challenges and serves people's needs. Furthermore, Arnold (1959) and his collaborators outlined Blocks, Activities & Practices, Techniques, and a conducive Environment to enable creativity in people and produce innovation.

Arnold (1959) and Maslow (1959a) expressed that Blocks to creativity are inherent in individuals and the environment. Perceptual blocks are preventing from recognizing a problem or clue relevant to the solution. Cultural blocks include the desire to conform to an accepted pattern and difficulties arising from over-generalizations. Emotional blocks, such as fear of making a mistake or making a fool of yourself and pathological desire for security, block people's creativity (Arnold, 1959; Maslow, 1959a). Arnold (1959, 1962a) developed Activities & Practices that guide individuals to exercise their creative potential and overcome their blocks. He described the activities of creative product design as follows:

> first clearly define your problem and in as general terms as possible; second, gather together as much data and background information as possible; third, analyze it to bring out the desirable and the limiting features; fourth, list all the possible solutions you can think of in each of the four design areas (use checklists, attribute listing, brainstorming, every technique that you can think of); fifth, evaluate your ideas and pick out the most promising for more detailed investigation; and sixth, synthesize and verify the results.

As expressed above, these Activities & Practices are supported by various Techniques. Arnold (1959, 1962b) describes the usefulness of Crawford's (1954) Attribute Listing, Zwicky's (1948) Morphological Analysis, Osborn's (1957) Brainstorming, and Gordon's (1961) Operational Creativity (Synectics). He emphasized that "these techniques, when applied conscientiously and repeatedly, will help awaken and strengthen your own creative potential" (Arnold, 1959). These techniques allow individuals and groups to explore problems and produce various combinations to synthesize and generate new solutions. Arnold (1959) further proposed that cultivating these Activities & Practices supported by Techniques has the potential to enable an Environment conducive to creativity and innovation. He states this as follows:

> In the same way, the brainstorming rules can be applied and should be extended to a much larger group than the original six or ten. There is no reason why a modified form of these rules can't be applied to a whole research section or even to a whole company. If all members of an organization were encouraged to think as daringly as possible, without fear of immediate evaluation or possible ridicule, and without fear of making a mistake, I can't see but how the company would benefit. The ideas suggested would eventually be individually evaluated, the wholly "crack-pot" schemes would be eliminated before damage was done, but the resultant activity would be much more daring and imaginative than that which occurs in many organizations today. If all members of an organization could be treated as individuals with dignity and integrity, but with varying potentials, and their evaluation were based on to what degree they had realized their own potentials and their actual tangible accomplishment, rather than on what they said, psychological freedom and safety would in part be insured and the number of new and better solutions to old problems would rapidly increase.

Similarly, Rogers (1954) expressed that psychological freedom and safety through empathy drives creativity and innovation in social contexts. To support his proposal, Arnold, with two colleagues from Stanford's Graduate School of Business, investigated the environment of companies such as Hewlett-Packard, Stanford Research Institute, and Boing Aircraft (Arnold et al., 1960). They outlined various management practices that are conducive to creativity and innovation, including identifying creative individuals, stimulate them to initiate action, assisting with the physical environment for the success of the operation, establishing an environment of psychological safety and freedom to maintain a high level of productivity over a long time, and provide an adequate reward for creative work. In the JPD, a similar Environment was developed, including a Student Machine Shop (today Product Realization Lab) and Sculpture Studio to enable students to rapidly build their design concepts into tangible solutions, enabling them to break and rebuild prototypes learning from failure. This environment supported faculty and instructors in teaching this creative design approach for identifying problems and inventing for people. An overview of selected courses, in which the creative and humanistic design approach was taught focusing on invention in arts and engineering, is presented in Appendix D: Period 2 in Table S2 in Supporting Information.

3.2 | Growth and entrepreneurship: From 1965 to 1985

In 1963, John Arnold passed away during a sabbatical in Italy ("Prof. Arnold Dies Traveling in Italy," 1963). Bob McKim, Matt Kahn, Peter Bulkeley, Bernie Roth, and others continued to develop the JPD program. James Adams returned, and Henry Fuchs and John Manning joined the faculty in the mid and late 1960s. Many others, including Douglas Wilde, Robert Piziali, William Verplank, Ernest Chilton, Daniel DeBra, David Beach, and James Fadiman, joined early and mid-1970s. Larry Leifer returned as faculty, and many others, including Philip Barkan, Drew Nelson, William Moggridge, David Kelley, and J. Craig Milroy, joined in the late 1970s and early 80s. The Design Division expanded the Design Loft into a unique design space in the 1970s, and Dave Beach took over the Student Shop, creating an environment for creative making through coaching. Larry Leifer established the Center for Design Research in 1984.

3.2.1 | Visual thinking and human values

In the late 1960s and early 1970s, the Design Division extended the creative and humanistic design approach, as

illustrated in the third period in Table 1 (see Appendix D: Period 3 in Supporting Information for detail). The approach expanded as McKim (1972, 1980a, 1980b) introduced visual thinking and need-finding, and Adams (1974a, 1980) expanded on the blocks to creativity and how to overcome them. The program focused on creativity, invention, and entrepreneurship (Adams, 1974b; Roth, 1973). Several aspects became tacit over time. For example, the observe-attitude is not explicitly mentioned as an Attitude but is evident in the Thinking Modes of seeing and related visual Techniques, perceptual Blocks, and the need-finding Activities & Practices.

Bob McKim (1972, 1980a, 1980b) expanded the Thinking Modes with the visual thinking modes of seeing, imagining, and drawing, including mock-up building, grounded in Gestalt psychology (e.g. Arnheim, 1954, 1969; Perls et al., 1951). Visual thinking emphasizes visual imagery in creative problem-finding and solving, as expressed by McKim (1972) as follows:

> The visual thinker utilizes seeing, imagining, and drawing in a fluid and dynamic way, moving from one kind of imagery to another. For example, [s]he sees a problem from several angles and perhaps even chooses to solve it in the direct context of seeing. Now prepared with a visual understanding of the problem, [s]he imagines alternative solutions. Rather than trust to memory, [s]he draws a few quick sketches, which [s]he can later evaluate and compare. Cycling between perceptual, inner, and graphic images, [s]he continues until the problem is solved.

His experiential and strategic approach aimed to enhance individuals' professional creativity (Abilities) and support them through various exercises and Techniques (McKim, 1972, 1980a, 1980b). For example, visual thinking languages such as graphs and diagrams support in perceiving problem situations and creating abstract ideas and concepts (concrete-to-abstract), and languages, such as rough three-dimensional mock-ups and working models, support in bringing these ideas into concrete prototypes to be able to evaluate them (abstract-to-concrete) (McKim, 1980a, 1980b). He stated that prototyping is:

> Although not strictly a language, three-dimensional modeling fits naturally at the end of the abstract-to-concrete continuum of graphic languages.

Visual and creative thinking requires learnable Attributes, particularly flexibility in thinking. McKim (1980b) emphasized flexibility as follows:

> The strategy approach presented in this book is emphatically not intended to be used as a step-by-step problem-solving method. Effective problem-solving does not follow a cookbook pattern [...] Quite the opposite, visual thinking that is equipped with a wide range of responses moves flexibly to solve problems.

Adams (1974a, 1980) expanded Arnold's Blocks and how to overcome them. He outlines perceptual, cultural and environmental, and emotional blocks, and introduced intellectual and expressive blocks, and describes a questioning attitude (Attitudes & Values), fluency and flexibility (Attributes), various Techniques, and alternate thinking languages (Ability) to overcome the several blocks, facilitating creativity in individuals, groups, and organizations (Adams, 1974a, 1980). For example, emotional Attributes such as under- and over-motivation can block creativity (Adams, 1974a, 1980). In 1967, McKim also introduced a groundbreaking innovation Activity & Practice in the course ME116b, which he called need-finding, expanding his idea that "design is the response to a human need" (McKim, 1959). Like problem-finding, need-finding aims to discover profound human needs by observing and engaging with people, understanding their life situation and broader context, and communicating design ideas within a person's context through various means to validate the grasped need. With each iteration, the problem situation and need are redefined. Need-finding and Activity & Practice related to visual thinking form a set of activities to design solutions for people by understanding their needs, imagining and visualizing solutions, and rapidly prototype them iteratively, redefining the problem and need. This practice incorporates human Attitudes & Values, such as morality and sensibility for people and their needs (McKim, 1959). These visual Thinking Modes, humanistic Attitudes & Values, Attributes of fluency and flexibility, overcoming Blocks through alternate thinking languages, and Activity & Practice, including hands-on and experiential activities, such as need-finding, drawing, sculpturing, prototyping, and engineering analysis, were taught in various courses, as shown in Appendix D: Period 3 in Table S2 in Supporting Information. McKim also established a Stanford-Esalen program collaborating with the Esalen Institute. From this program, courses such as Peopledynamics Laboratory and The Individual and Technology (Designer in Society) emerged, emphasizing humanistic Attitudes & Values. As early as 1967, the entire approach came together in the three-quarter graduate design project in the course ME299a,b,c, as described as follows:

a. In the first quarter, the student uses rational and intuitive problem-finding procedures to identify a design project with in an unexplored area of need, presents a project proposal, and performs research.
b. In the second quarter, [s]he prepares a design program, develops concepts, performs necessary experiments, and carries project to the stage of a working prototype.
c. In the third quarter, [s]he refines design from the standpoint of cost and production, builds demonstration model, and presents project to professional jury.

These course activities were supported through the Environment, including a Design Loft to stimulate creative activities and Sculpture Studio and Student Machine Shop. McKim (1972, 1980a) described the Design Loft Environment and equipment as conducive to visual thinking by allowing visual thinkers to play freely with materials. For group work, McKim (1972) expressed that:

> [...]an openly interactive group can form a "group-mind" possessing breadth of information and powers of association unattainable in a single mind. [...] Clearly, an interactive group needs to be able to work over a shared visual image, suggesting modifications and changes, making erasures. [...] To my knowledge, no one has yet devised a workable system to facilitate visual group-think. Such a system would be extremely useful, however, for thinking about complex, interdisciplinary problems – problems of the urban environment for example.

Courses, such as ME115b, ME293, ME112, and ME210a,b,c focused on developing these team collaboration Abilities. Furthermore, the program offered Arts, Engineering Design, Design Management, Smart Products, and Bioengineering specializations. They incorporate the same design philosophy, focusing on public needs, creativity, invention, and innovation (Adams, 1974b; Beakley & Chilton, 1974; Roth, 1973).

3.2.2 | Entrepreneurship

Adams (1974b) outlined the design pedagogy, which included creativity among technical people through open-ended problems, projects as a teaching technique, considerations of emotional, intellectual (aesthetics) and physical aspects of design, concerns for public needs, and problem- rather than tool-orientation. The pedagogy developed creative and humanistic designers with aesthetic and technical knowledge, and the approach resulted in inventions and entrepreneurship. Adams (1974b) emphasized that ingenious and well-detailed prototypes of marketable items emerged in the countless projects in which students are involved in a year. In the 1970s, these entrepreneurial activities resulted in creating and supporting new companies, such as Powell-Peralta, Concept2, Apple Computer, and Hovey-Kelley Design (today IDEO). Alumnus Jerry Manock was the first designer at Apple, working first as a consultant and then as an employee. He and his colleagues produced a video on Apple's design values mirroring the design philosophy of the JPD (WCC, 2012). In this video from the early 1980s, the first statement says:

> The Apple industrial designer is a generalist who integrates the arts, the humanities, the social sciences and technology in order to understand the customer, perceive [her/] his needs and desires, and create new and innovative product solutions.

JPD graduates Jerry Manock, Bill Dresselhaus, Dean Hovey, David Kelley, and several others collaborated with Steve Jobs on many projects, including the Apple II, III, Lisa, Macintosh, and created Apple's first mass-producible computer mouse, thereby transforming personal computing (Pang, 2002). At the Stanford Entrepreneurship conference, McKim (1982) presented his need-finding approach to illustrate the value of understanding people's needs in entrepreneurial activities and the importance of the capability to translate the need into a tangible result to generate value for people.

3.3 | Design thinking: From 1986 to 2005

Most people in the Design Division continued their efforts. In the mid-1980s, Bob McKim retired, and Rolf Faste joined, replacing him as the director of the JPD program. Many others joined around the same time, such as Mark Cutkosky, Sheri Sheppard, William Burnett, Sara Little Turnbull, Barry Katz, and J. Edward Carryer. In the 1990s, Kosuke Ishii, J. Christian Gerdes, Michael Barry, Ade Mabogunje, and several others joined.

3.3.1 | Ambidextrous thinking and design as a social process

The design approach evolved further, as illustrated in the fourth Period in Table 1 (see Appendix D: Period 4

in Supporting Information for detail). In the late 1980s, Rolf Faste expanded the Thinking Modes through ambidextrous thinking and Activities & Practice, such as need-finding (Faste, 1987). Faste (1994) expressed that:

> ME313 grows out of a course called Visual Thinking [...]. "Ambidextrous Thinking" was chosen as the name because it alludes to more than visual thinking, and also to solve problems using all of an individual's talents and resources.

Around the same time, Larry Leifer started collaborating with Xerox PARC through the work by John Tang and Scott Minneman investigating the collaborative Abilities and Activities & Practices in design teams within work environments (Minneman, 1991; Tang & Leifer, 1988). Design team research became core research in his lab, emphasizing that design is a social process (e.g., Brereton et al., 1996; Leifer, 1998). Furthermore, the design approach expanded through the integration of business management.

3.3.2 | The intersection between design and management

In the early 1990s, several Design Division scholars collaborated with business scholars intensifying the relationship between business and design. William Lovejoy and V. Srinivasan (business) and Dave Beach (design) started a course on Integrated Design, Manufacturing, and Marketing. The course brought together business and engineering design students through Activities & Practices of market research, need-finding, build prototypes, and simulated market conditions with their prototypes of pricing and production decisions (Dahan & Srinivasan, 2000; Lovejoy & Srinivasan, 2002; Srinivasan et al., 1997). Sara Little Turnbull established the Process of Change, Innovation, and Design Lab in the Graduate School of Business. In collaboration with Marco Iansiti from the Harvard Business School, Philip Barkan researched the Activities & Practices of rapid prototyping as a learning tool and identified its value for reduced risk and development time and minimized adverse effects, thereby fostering superior product development (Barkan & Iansiti, 1993). Adams (1991) outlined five critical factors to facilitate creativity in an organizational context based on his creative Activities & Practices and Blocks. Other courses integrated business management and design, as shown in Appendix D: Period 4 in Table S2 in Supporting Information. In July 1995, the Design Division hosted the Design Management Institute's 7th International Forum on Design Management Research and Education.

3.3.3 | Organizational innovation

In 1989, Bill Moggridge and David Kelley taught Advanced Product Design two years before they co-founded IDEO with Mike Nuttall. By then, they were involved in the JPD for over a decade. IDEO expanded and refined the creative approach through their countless projects, winning the most design awards year after year throughout the 1990s (published yearly in BusinessWeek: The Best Product Designs of the Year). In the mid-1990s, business scholars became interested in IDEO's practices and culture that led to routinely creating innovation (Hargadon & Sutton, 1997; Leonard & Rayport, 1997; Sutton & Hargadon, 1996). Sutton and Hargadon (1996) and Hargadon and Sutton (1997) identified two essential findings: (1) Brainstorming culture and (2) Knowledge brokering. This Brainstorming culture (Environment) is enabled by modified Brainstorming rules (Techniques), outlined as follows:

> [Brainstorming] rules are (1) defer judgment, (2) build on the ideas of others, (3) one conversation at a time, (4) stay focused on the topic, and (5) encourage wild ideas.

Sutton and Hargadon (1996) elaborate that these rules are effective because they are developed within teams with past and future task independence, past and future social relationships, using the ideas and brainstorming expertise (Abilities). Sutton and Hargadon (1996) provided evidence for the suggestion by Arnold (1959) that modified brainstorming rules cultivated throughout a company resulting in increased creativity. Brainstorming is related to visual thinking, as developed by McKim (1980a). Sutton and Hargadon (1996) stated this relationship as follows:

> IDEO brainstorms teach and remind designers to generate many ideas, develop a few in depth, make many changes in developed ideas, and reflect the belief that many bad ideas can lead to a few good ones. This iterative process occurs in brainstorms as participants generate lists and sketches; [...] The words and sketches generated during brainstorms spur designers to produce prototypes after these sessions. Designers use materials like cardboard, foam, silver tape, Lego blocks, and crude combinations of existing products to "get three-dimensional as

> quickly as possible." [...] IDEO's machine shop is integral to this prototyping process, producing wood, metal, foam, and plastic models based on designers' sketches or CAD drawings.

Visual Thinking Modes, Activities & Practices, and an Environment of psychological safety and freedom, and a machine shop support creativity and innovation at IDEO. This Brainstorming culture contributes to the organizational memory of design solutions, providing skill variety for designers (Abilities), supporting an attitude of wisdom (Attitude & Values), impressing clients, and generating income (Sutton & Hargadon, 1996). Furthermore, Hargadon and Sutton (1997) outlined a model in which IDEO's network position between industries and their organizational memory inherent in the designers results in a new combination of existing ideas (Thinking Modes). These findings mirror the observation and association Attitudes that result in combinations that are greater than the sum of its parts, generating synergetic value, as expressed by Arnold (1959). Hargadon and Sutton published their findings in several articles within the management discourse (e.g., Hargadon, 1998, 1999, 2003; Hargadon & Sutton, 2000). Around the same time, Leonard and Rayport (1997) published their article based on IDEO outlining Empathic Design practices. They described that Empathic Design is a set of Activities & Practices, such as observation, capturing data, reflection and analysis, brainstorming, and developing prototypes. They emphasized that empathic-design Techniques contribute to the flow of ideas that need further testing. In addition, David Kelley stated "ten secrets" to instilling the organization's innovation attitude (Kelley, 1998, pp. 271–281). These are encouraging creativity through multidisciplinary teams (Abilities), small team size, learning happens away from the desk, understand the product's user (Activities & Practices), live in the future, destigmatizing failure (Blocks), join prototyping to brainstorming, the mantra of Understand, Observe, Visualize, Evaluate, Implement (Activities & Practices), leaders and mentors, not bosses, and fun workplace (Environment). His brother, Tom Kelley, outlined this approach and culture in detail through various case studies (Kelley, 1999, 2005; Kelley & Littman, 2001; Sutton & Kelley, 1997). The findings from Sutton and Hargadon (1996), Hargadon and Sutton (1997), and Leonard and Rayport (1997) mirror the visual Thinking Modes, humanistic Attitudes & Values, Activities & Practices, particularly need-finding, Techniques, such as brainstorming, and an Environment, including a machine shop and psychological safety.

3.3.4 | Interaction and experience design

Employees at IDEO published several articles themselves, contributing to the design literature and practice. These articles outlined an "idealized" design process of Understand, Observe, Visualize, Evaluate, and Refine (Brouwer-Janse et al., 1997; Moll-Carrillo et al., 1995; Spreenberg et al., 1995). The process represents the Thinking Modes and design Activities & Practices. They furthermore outlined useful Techniques and Activities & Practices to design interactions and experiences, including storytelling, scenarios and metaphors, observations and interviews, and role-playing (Black et al., 1994; Moggridge, 1993; Simsarian, 2003; Verplank et al., 1993). They also outlined humanistic principles representing the Attitudes & Values to design for people and their lives and experiences (Buchenau & Fulton Suri, 2000; Fulton Suri, 2000b, 2003; Gilmore & Velázquez, 2000; Moggridge, 1999). Employees at IDEO expanded the creative and humanistic approach into digital and experience design, creatively generating novel design Techniques.

3.3.5 | Design thinking

In 1999, Larry Leifer[1] introduced a course with the title: Designing the Human Experience - An Exploration into the Theory and Practice of Design Thinking. This introductory course emphasized that design education is for everyone, and DT is a liberal art of integrating science, arts, and humanities. The second DT course was Human Values and Innovation in Design, introduced by David Kelley. The course outline states:

> Introduction to the philosophy, spirit, and tradition of the product design program. Hands-on design projects used as vehicles for design thinking, visualization, and methodology. The relationships among technical, human, aesthetic, and business concerns. Drawing, prototyping, and design skills. Focus is on tenets of design philosophy: point of view, user-centered design, design methodology, and iterative design.

Around the same time, IDEO started calling their approach DT, which was already well-known through the 1999 ABC's Nightline News featured documentary entitled "The Deep Dive." In this documentary, IDEO illustrated how an interdisciplinary design team redesigned a shopping cart. Kelley and Littman (2001, p. 13) stated that this documentary led to dozens of calls from executives who wanted to know more about the creative

approach. The central philosophy, spirit, and tradition of the JPD program developed throughout half a century were combined under the term: "Design Thinking." In 2005, Hasso Plattner, the co-founder of SAP, funded the Hasso Plattner Institute of Design at Stanford (dschool) around the same time the DT discourse emerged in the IM literature.

4 | DISCUSSION AND CONTRIBUTIONS

This multiple document review study provides an evidential account of how Design was reconceptualized into a comprehensive design-driven innovation practice, including attitudes, abilities, and organizational environments, overcoming focusing on merely aesthetics and appeal or solving technical problems. This historical review showed that the comprehensive design philosophy, culture, and practice resulted in entrepreneurial activities, creating value for people and business success by creatively designing for people's needs (Arnold, 1959; McKim, 1959, 1982). These innovation practices incorporated design qualities, such as human values, visual thinking, multidisciplinary collaboration, and creative attitudes. These qualities and practices were popularized as design thinking, methods, and designers' sensibilities (Brown, 2008, 2009; Martin, 2009; Martin & Euchner, 2012). Underlying these design qualities are the psychological theories on creativity and human values, explaining why and how people create new value, meaning, and solutions (Arnheim, 1954; Arnold, 1959, 1962a, 1962b; Bruner, 1962; Duncker, 1945; Guilford, 1950, 1957, 1959; Maslow, 1954, 1959b, 1962; McKim, 1972; Rogers, 1954; Wertheimer, 1945). These design qualities clarify the construct DT and represent a comprehensive IM approach to enable design-driven innovation.

4.1 | Management of design-driven innovation

Thinking Modes, Attitudes & Values, Attributes, and Abilities are necessary for creative Activity & Practice, and overcoming Blocks. Techniques and Environments support these organizational, creative design routines and capabilities, as outlined in Figure 3.

The design qualities represent DT as a culture, creative inquiry, imaginative act, and cognitive processes (Buchanan, 2015). In an organizational context, they represent the micro-foundations and organizational routines and capabilities of design-driven innovation (Felin et al., 2012). It is a cognitive, organizational, and strategic approach to innovation (Mahmoud-Jouini et al., 2016). The ambidextrous Thinking Modes are essential in grasping human needs and solving open and complex problems in ambiguous situations, overcoming the predominant analytical approach in management (Buchanan, 1992; Dorst, 2011; Faste, 1987; Glen et al., 2014, 2015; Luotola et al., 2017; Wertheimer, 1945). Visual thinking produces aesthetic knowledge, supporting organizational members in seeing previously hidden relationships and problem interpretation (Arnheim, 1969; McKim, 1972; Stephens & Boland, 2014). Identifying profound human needs and creating value for people requires Human Values and Attributes of problem/need-sensitivity, including the tolerance for ambiguity, often contradicting the highly context-independent quantitative management approach (Elsbach & Stigliani, 2018; Guilford, 1950; Kolko, 2015; Rogers, 1954). Innovative DT incorporates Attitudes of questioning given problems and accepted patterns and keen observation (Arnold, 1959). However, such Attitudes and related behavior often do not fit managerial attitudes and organizational cultures, producing Blocks (Adams, 1991, 2001; Edmondson, 1999; Edmondson & Lei, 2014). Developing a mass-marketable, tangible design that satisfies people's needs requires confidence in own creative Abilities and intrinsic motivation, which is influenced by the organizational environment (Amabile, 1998; Amabile & Pillemer, 2012; Arnold, 1959; Arnold et al., 1960; Kelley & Kelley, 2013). Innovative design is a collaborative practice requiring diverse Abilities (Arnold, 1959). It requires communicating concepts and collaborating with diverse stakeholders and people in need to generate a tangible design that helps them in their everyday lives. These collaborative Abilities and Activity & Practices transcend boundaries within and outside the organizations (Mintrom & Luetjens, 2016). Activity & Practice such as need-finding, visualization, prototyping, and evaluation provides an organizational routine of discovering innovation opportunities, reorganizing schema into new designs, and rapidly evaluating design concepts from diverse perspectives (Arnold, 1959; Sutton & Hargadon, 1996; Wertheimer, 1945). Such collaborative Activities & Practices generate meaning from different perspectives and value for people by translating needs into tangible designs, incorporating reinterpreting visual languages to communicate the new design (Gilmore et al., 1999; Krippendorff, 2006; McKim, 1959, 1982; Verganti, 2008). Such translation is a constant reframing and reinterpretation of needs and problem situations by viewing it from different points and validating needs by communicating sketches and prototypes (McKim, 1972; Schön, 1983). These flexible organizational routines generate emergent strategy, overcoming strategy as planning (Auernhammer & Warner, 2020; Fixson & Rao, 2014). In

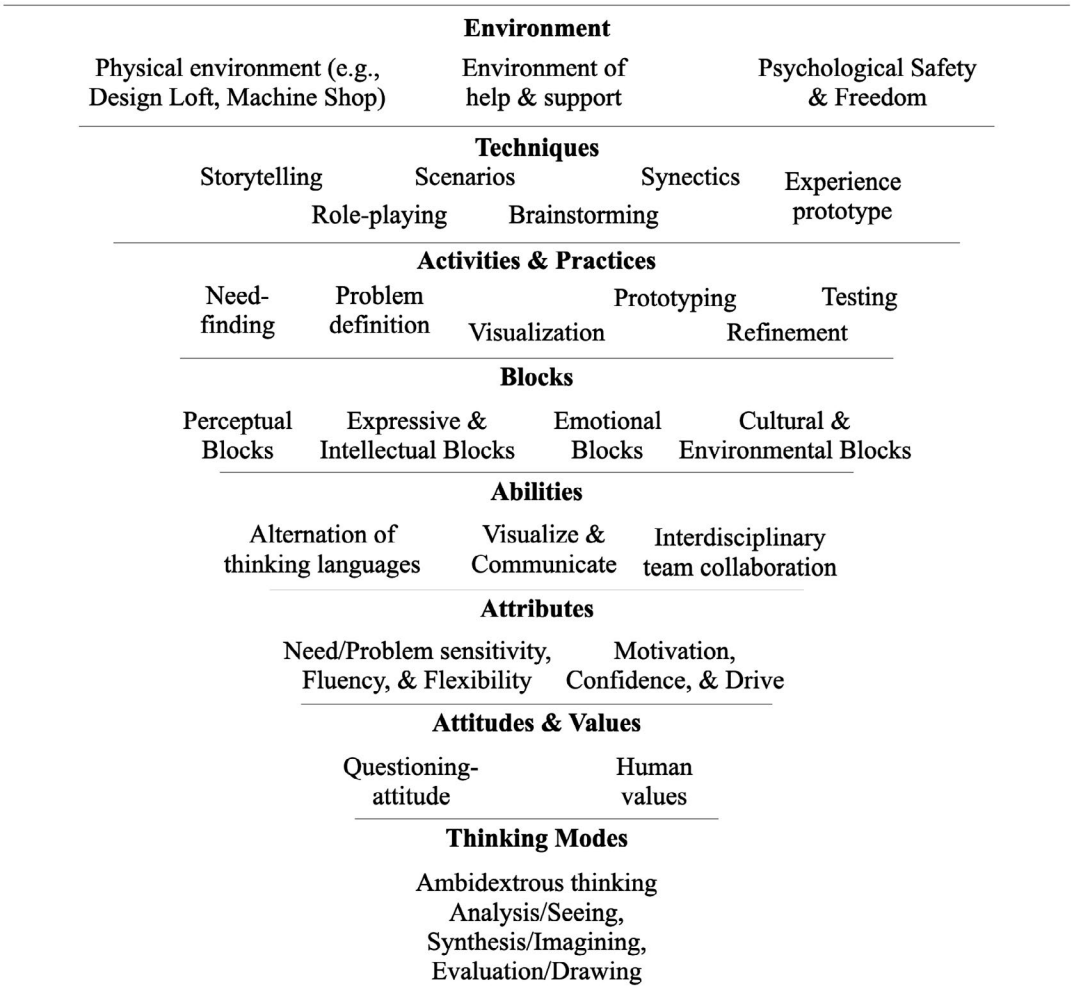

FIGURE 3 Design qualities to enable Design-driven Innovation

these practices, various Techniques are useful and, when applied conscientiously and repeatedly, can help foster people's creativity (Arnold, 1962a, 1962b). However, an overemphasis of process steps and related methods, as currently stressed in the IM discourse, prevents fluency in thinking and flexibility of thinking languages (Adams, 2001; Guilford, 1950). Such flexibility in thinking requires a specific Environment as organizations have a predominant effect on the thinking and behavior of individuals (Buchanan, 2015). The organizational Environment constrains or enables creative agency, which produces the social structure (Auernhammer, 2012; Giddens, 1984). Cultivating human values, such as psychological safety and freedom, is essential in facilitating creativity and learning in organizations (Auernhammer & Hall, 2014; Edmondson, 1999; Rogers, 1954). These design qualities transcended into fields, such as policy-making, public sector, value-based selling, healthcare, project management, innovation management, food innovation, and sustainable business modeling (Auernhammer, 2020; Deserti & Rizzo, 2014; Geissdoerfer et al., 2016; Hobday et al., 2012; Koomans & Hilders, 2016; Luotola et al., 2017; Mahmoud-Jouini et al., 2016; Olsen, 2015). Such value-driven innovation can routinely satisfy people's needs, generate value and meaning, create new experiences and innovation, and produce profit and growth (Arnold, 1959; Fulton Suri, 2003; Krippendorff, 2006; McKim, 1959; Sutton & Hargadon, 1996).

4.2 | Theoretical implication

Scholars stated that DT had emerged independently from theories (Dell'Era et al., 2020; Johansson-Sköldberg et al., 2013; Micheli et al., 2019). However, this study showed that DT is grounded in psychological theories of creativity, visual thinking, and human values (Arnheim, 1954, 1969; Arnold, 1959, 1962a, 1962b; Bruner, 1962; Duncker, 1945; Guilford, 1950, 1957, 1959; Maslow, 1954, 1959b, 1962; McKim, 1972; Rogers, 1954; Wertheimer, 1945). For example, productive thinking (Duncker, 1945; Guilford, 1950; Selz, 1922; Wertheimer,

1945) provides the theoretical and methodological foundation, including the think-a-loud protocol of several DT studies (Eastman, 1970; Goldschmidt, 1991; Lawson, 1972, 1980; McKim, 1972; Schön, 1992). The same theories are foundational in organizational innovation theory (Amabile, 1996; Kurtzberg & Amabile, 2001; March & Simon, 1958). The grounding of IM in the creativity and human values theories provides a humanistic innovation perspective, incorporating humanities, art, and science and contrasting with the technical-rational doctrine (Buchanan, 1992).

This study contributes to design theory by providing a distinct and complementary perspective to the widely discussed theories (Lawson, 1980; Rittel & Webber, 1973; Schön, 1983; Simon, 1969). For example, Simon (1969) focused on "intelligent" machines with a technical-rational doctrine, while Arnold's (1959, 1962a) and McKim's (1972, 1980a) emphasis was on creativity in people. Arnold's and Donald Schön's (1983) work share similar influences through Bill Gordon's (1961) work. Gordon collaborated with Arnold, and Schön was part of Gordon's Invention Design Group at Arthur D. Little. Similarly, Arnold and Bryan Lawson (1972, 1980) studied design (engineering/architecture) and psychology. Lawson (1972, 1980) refers to the same psychological theories in his cognitive DT perspective (e.g., Guilford, 1956; Wertheimer, 1945). A synergetic design theory to McKim's (1959) need-based design is Horst Rittel's dialectic reasoning to tame wicked problems, as Rittel (1987) emphases the complexity of many interacting human values inherent in a pluralistic society in design projects, such as city planning (Rittel & Webber, 1973).

The conceptualization of design as the creative response to a human need has implications for IM theory and practice. It provides a humanistic and creative innovation perspective on developing technology contrasting the technical-rational doctrine. Innovation is not accomplished by technology but through the value provided, empowering, and enabling people in everyday life. Identifying needs produced by the cultural, natural, and artificial environment are opportunities to create value and meaning for people, which requires design capabilities to translate the need into a tangible design (Gibson, 2014; McKim, 1959, 1982). Such humanistic and creative practices, including visual, technical, and managerial skills, are essentially the practices of innovation, dynamic capabilities, organizational renewal, and entrepreneurship (Auernhammer, 2020; Eisenhardt & Martin, 2000; Hargadon & Sutton, 2000; Rosensweig, 2011; Teece, 2007). These practices permit learning in an uncertain and ambiguous situation when the path to action is unclear (Argyris, 1999; Glen et al., 2014; Schön, 1973; Wertheimer, 1945). The essential task of IM and education for innovation is enabling a design culture and practices in which people have the capabilities, attitudes, values, and confidence to contribute to society by finding needs and creating tangible designs (Arnold, 1962a; Buchanan, 2015; Glen et al., 2014, 2015; Sutton & Hargadon, 1996).

4.3 | Managerial implications

The findings illustrate that DT is a multifaceted set of interrelated Thinking Modes, Attitudes & Values, Attributes, and Abilities that can be learned and supported through various Activities & Practices, Techniques, and a conducive Environment to overcome emergent Blocks. We question the notion that DT is a construct that can be "used" or "implemented" through a step-by-step process and tools. Attributes, such as fluency and flexibility, need sensitivity, visual thinking Abilities, or an environment of psychological freedom and safety need to be developed to enable creativity and innovation. This organizational development requires experimental and experiential learning (Auernhammer, 2020; Beckman & Barry, 2007; McKim, 1972). It is about people and culture (Porcini, 2009). For example, without developing design qualities, such as visual thinking, human values, and fluency and flexibility, as outlined by McKim (1980a, 1980b), DT is performed in a linear cookbook pattern fashion and with little regard to aesthetics and human value. Management has not moved closer to design in such a case, resulting in incremental changes at best (Verganti, 2017). For example, the Design Division/Group constantly co-created new practices, including smart product design, integrated design and management, interaction and experience design, biodesign, and organizational design (e.g., Auernhammer & Leifer, 2019; Miller et al., 2001; Moggridge, 2007; Srinivasan et al., 1997; Winograd, 1996). Similarly, employees at IDEO did not merely use tools but creatively developed new techniques expanding their practices into the design of interactions, experiences, and organizational change (e.g., Buchenau & Fulton Suri, 2000; Coughlan et al., 2007; Moggridge, 2007; Segal & Fulton Suri, 1997; Verplank et al., 1993). An innovation managers' task is to develop a design culture and capabilities by freeing teams from blocks imposed by the environment to enable them to creatively develop new ways of collaboratively and iteratively translate grasped emerging needs into tangible designs without fear of immediate evaluation or possible ridicule and without fear of making a mistake (Adams, 1991; Arnold, 1959; Buchanan, 2015).

5 | LIMITATION AND FUTURE RESEARCH

Historical research provides essential insights when there is a lack of construct clarity and theoretical grounding. Our research clarifies the origin and evolution of one of the most influential design thinking perspectives in the Innovation Management discourse. We addressed the gap of theoretical grounding by providing the link between theories from psychology, design practices, and recent IM studies. The identified design qualities, consistent throughout the several decades, provide further construct clarity. Our research focused on the evolution of a particular DT perspective that emphasizes human values, need-finding, creative thinking, and collaborative practices. Exploring the construct and underlying theories of different perspectives on DT and potential synergies and conflicts holds the potential to advance further our understanding of why, when, and how people create innovation when designing.

An imperative question is how innovation managers create and sustain a design culture and capabilities in organizations. Various companies, including SAP, Steelcase, IBM, Proctor & Gamble, Samsung, Intuit, and Google, embraced and contextualized this human-centered design philosophy and creative design culture (Gruber et al., 2015; Leavy, 2010; Micheli et al., 2019). Empirical research should investigate the practices of creating and sustaining a design culture in educational systems and organizations, enabling people to creatively contribute with tangible and valuable solutions to tame the continuously emerging societal and environmental challenges.

A main contribution of DT is the integration of diverse disciplines, not only in practice but also in research. DT provides the research opportunity to incorporate scientific knowledge from diverse disciplinary perspectives, such as neuroscience (Saggar et al., 2016), psychology (Arnheim, 1993), team dynamics (Tang & Leifer, 1988), and organizational research (Yoo et al., 2006) to understand design, the fundamental human activity of societal progress (Protzen & Harris, 2010). Research on creativity informed the reconceptualization of design and related practices. IM scholars recognized the value of these creative design practices and investigated them empirically, developing new IM theory. Such new knowledge informs new practice in turn, iteratively creating progress. Our research illustrated this evolution in design thinking.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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The corresponding author has read and agreed to the Committee on Publication Ethics (COPE) international standards for authors as published on https://publicationethics.org.

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ENDNOTE

[1] Both Larry Leifer and his group and designers from IDEO were involved in the second DTRS in 1994 (Cross, 2018).

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

Supplementary Material

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