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An Overview of the Literature on Design Thinking: Trends and Contributions*

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This paper discusses the findings of a systematic review of the literature on Design Thinking from 1980 to 2014. A multi-methods approach combining bibliometrics, content analysis and semantic analysis was applied. The findings indicate that Design Thinking projects share a common set of phases; however, there is no consensus about the most relevant tools and methods to be applied in each project phase. A definition of Design Thinking is proposed. Some Design Thinking characteristics are highlighted: the centrality of the user in a human-centered approach; an iterative prototyping method; exploring wicked and ill-structured problems; applying problem-solving concepts; the reasoning approach is divergent-convergent thinking based on abductive logic; the use of visual techniques to explore ideas; and the importance of interdisciplinary and multidisciplinary team collaboration.

Keywords: design thinking; designerly thinking; innovation process; systematic literature review

1. Introduction

The continuous need to innovate in relevant markets requires new approaches for the development of innovative products, services, and systems, preferably combining knowledge, methods and tools from different areas of expertise. In the first half of the 20th Century, Design Thinking initiatives have been related by designers in differentiating the Industrial Design from the Artistic Design, applying objective and structured methods to support the creation process [1]. Design Thinking (DT) has been traditionally applied to connect Design and Engineering in educational environments and inside organizations [2–3].

Along the first decade of the 21st-century, Design Thinking emerged as an approach that can promote radical and incremental innovation in companies that look for innovative products and services. After the publication of Brown's article [4] in Harvard Business Review and the diffusion of the first "Design Thinking Bodies of Knowledge", research about Design Thinking grew significantly and the number of published papers in referenced journals found in the Web of Knowledge database concerning the theme raised from 11 before 2000 to more than 180 papers in 2014. Design Studies Journal published a special issue dedicated to Design Thinking in 2013 [5].

Despite this growing interest from academia and organizations, Design Thinking concepts, techniques and bodies of knowledge are not yet consolidated, generating confusion among practitioners and researchers about its definitions and best practices. It is still not clear what are the consolidated results obtained with the application of the Design Thinking approach in different organizational contexts, and the findings from empirical research have to be systematized aiming to evidence the best practices for this particular Design approach, both in quantitative and qualitative terms. There is much to be done to systematize the findings from empirical research from different areas and consistent Design Thinking implementation is still a challenge for most companies [3]. Moreover, there are fuzzy frontiers between Design Thinking approach and other Design methods and tools, leading to a relevant question: is there anything significantly new in DT approach or is it a managerial fad?

Aiming to fill these research gaps, this paper presents the outcomes of a systematic literature review on Design Thinking that explored the evolution of concepts, approaches, initiatives and their contributions presented by the relevant literature from 1980 to 2014. Research objectives include the comprehension of the relevant conceptual definitions, the identification of the most influential authors, significant research initiatives and published papers, and the promotion of a common understanding of the Design Thinking approach. The methodological approach combines three main

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research methods: bibliometrics, content analysis and semantic analysis.

The paper is structured as follows. Section 2 presents the methodological approach applied. Section 3 presents the systematic literature review results based on the bibliometrics and network analysis. Section 4 presents the results of the semantic analysis and proposes a definition of Design Thinking. Section 5 presents the results of the content analysis. Finally, Section 6 presents the conclusions and contributions of the research.

2. Research methods

Aligned with the research objectives, a Systematic Literature Review (SLR) was conducted, applying transparent and replicable procedures in search procedures and data analysis, as suggested by the related literature [6–8]. The SLR can combine multimethods such as the bibliometric analysis, meta-analysis, semantic analysis and content analysis [6]. Considering the lack of empirical quantitative studies in Design Thinking, statistic meta-analysis method could not be applied. Thus, in this study, the research approach combines three techniques: bibliometrics, content analysis, and semantic analysis.

2.1 Data collection

The data collection phase was performed first in the ISI Web of Knowledge (Web of Science) database, updated until 2014. This database was selected because it includes all journals evaluated by Journal Citation Report (JCR), including journals published in other databases [6]. The initial search resulted in a sample of 181 papers from the ISI Web of Science database, covering the period between 1980 and 2014. The search strings were "design think*" or "design-think*". The search result was filtered considering only "article" in the parameter "document types" because these are publications that went through the peer-review process. All articles were analyzed and evaluated in accordance with the scope of the research. The criterion for the inclusion of additional publications was the number of citations in the initial sample. The searches started on October 2013 and were updated in December 2014.

After obtaining the initial sample the snowball sampling based approach [9] was applied considering other databases and the articles' references. The Scopus database was analyzed considering the same search strings, filters and exclusion criteria. The results obtained from this analysis evidenced a strong intersection of articles from the Scopus database and the initial sample (84%). The snowball method was also applied aiming to expand the initial sample to incorporate the most cited references of the articles to the sample, including books and other types of documents.

2.2 Data analysis

After the revision of the articles a data analysis was conducted with the application of network analysis, semantics and content analysis. Three software tools were used for the network analysis: Sitkis 2.0 [10], Ucinet and NetDraw [11]. Four networks were generated: keywords, article to references, co-citations and cross-citations. The content analysis was conducted on all articles of the final sample. The articles were organized using Mendeley software and a Microsoft Access database containing the metadata generated by Sitkis software.

The content analysis was performed as suggested by [12], in three steps: coding, analysis of content (frequency counts and cross-tabulations) and interpretation of results. The semantic analysis was applied to analyze the Design Thinking definitions. A computer-aided approach was applied, using Semantic Knowledge software and Tropes software. Semantic Knowledge software was used to prepare a quantitative description of the main verbs, adjectives and nouns and to quantify the most frequent relationships between words. Tropes software was used to generate three graphical analyses: area graph, actors graph and stars graph. To perform this semantic analysis, the researchers conducted four group dynamics. Each dynamic used visual display techniques, affinity diagram analysis, and Tropes Semantic Knowledge software support. Finally, the third step, SLR synthesis, was conducted to identify insights that emerged from the two previous steps.

3. Results of bibliometrics and network analysis

3.1 Sample demographics

The initial search of the ISI Web of Science database resulted in the identification of 181 articles. The first article found in the database was published in 1980 [13]. During the initial selection process, 42 articles (24%) were excluded from the sample because they were not aligned with the research core scope, such as [14] whose research was about a doppler interferometer and appeared in the search processes. Applying the snowball method, 25 key references were included in the sample because they were cited by a significant part of the selected papers.

The final sample included articles published in 100 different journals, however 77 journals only published one article on Design Thinking. The primary journals, with more than 5 published

articles are: Design Studies (11%), International Journal of Engineering Education (7%), Design Issues (4%), Codesign International Journal of Cocreation in Design and the Arts (3%), and International Journal of Art Design Education (3%). Most of the publications are classified in two areas: Engineering (42%) and Educational Research (20%). The geographic distribution includes 30 different countries, with an important hub in the United States of America (32%), primary in three universities: Stanford University (6%), Carnegie Mellon University (3%) and University of California System (3%). Outside of USA, just two institutions have more than four articles: Technion Israel Institute of Technology and the Delft University of Technology.

3.2 Sample citation profile

The most cited article is Brown [4] followed by Goldschmidt and Smolkov [15], Oxman [16], Maier and Fadel [17], Hey et al. [18], Beckman and Barry [19], Barry and Rerup [20], Christiaans and Venselaar [21] and Oxman [22]. Considering the evolution of the number of citations by year the key articles in the sample are shown in Fig. 1

The most mentioned article is Brown's 2008 Harvard Business Review [4]. For the IDEO CEO, Design has been historically considered a less relevant phase in product development and designers had no important role in the conception of innovations. Brown highlights that in the 21st-century Design Thinking is a fundamental approach because designer's abilities and techniques can be effectively applied to solve complex problems and to develop innovative solutions that correspond to users' wants and needs, that are technically viable and that can result in innovative organizational strategies.

Goldschmidt and Smolkov [15] conducted an experiment based on three different physical environments and analyzed the impact of the visual stimuli on the problem-solving performance of the sample, concluding that a richer visual stimuli environment contributes to the development of better Design solutions. Oxman [16] analyzed the impact of electronic tools such as CAD in the work of designers and concluded that in the first digital age of Design the most remarkable characteristic is the understanding and accommodation of complexity in Design solutions. Maier and Fadel [17] propose an affordance-based theory to tackle Design problems considering the relations among users and objects and among objects.

Hey et al. [18] analyzed the use of metaphors and analogies as core activities for the Design process and concluded that metaphors are used to map, understand and analyze users' reactions to a product and therefore are applied in the initial development phases and analogies are used to link Design solution to the problems that originated it and, therefore, are used in the concept generation phase. Beckman and Barry [19] analyzed a generic model for the innovation process considering "abstract—concrete" and "analysis—synthesis" perspectives and the resulting phases: observations (contexts), frameworks (insights), imperative (ideas) and solutions (experiences). The authors also analyzed the effectiveness of the application of Design techniques in each identified phase.

Barry and Rerup [20] consider the area of organizational Design fairly new in terms of the application of Design principles and thinking and analyzes how aesthetically sophisticated Design Thinking from the arts might be applied in organizational Design. Christiaans and Venselaar [21] analyzed the process of knowledge acquisition among novice Design students and the quality of their work and concluded that understanding the kind of knowledge a designer needs during the Design process is fundamental to problem-solving in general and Design education in particular. Finally, Oxman [22] developed a pedagogical framework called

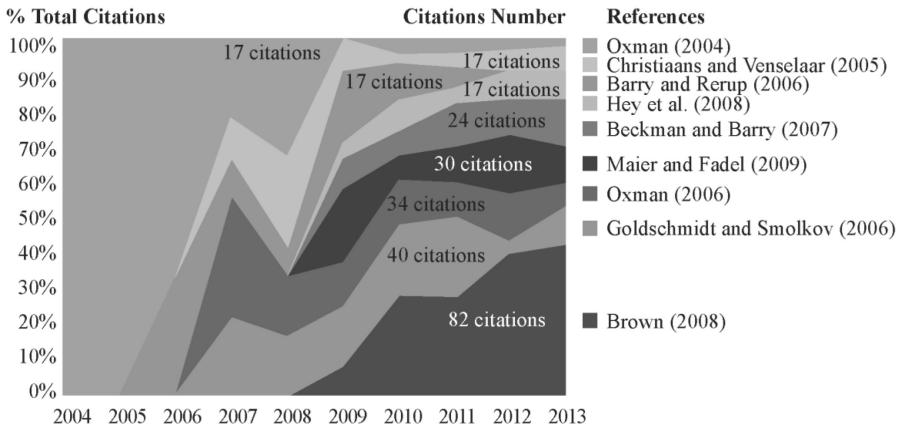

Fig. 1. Top cited articles.

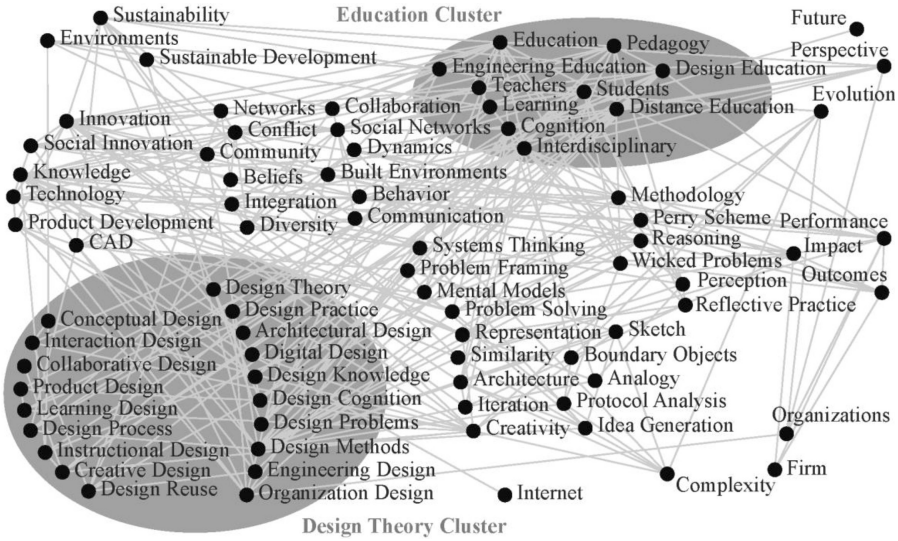

Fig. 2. Keyword network.

"Think-Maps" to model knowledge domains and its relations during the Design process, resulting in structured representations of concepts and their relationships with other concepts.

3.3 Keywords network analysis

The keywords network analysis was performed based on references [10–12] and seven thematic clusters were identified: Design approaches, innovation, education, collaboration, sustainability and performance (see Fig. 2). The ties in Fig. 2 show the keywords that have been mentioned together in the sample, and the strength of the ties corresponds to the intensity of such relationship. The main bridge between clusters occurs between Design approaches and Education. This highlights the importance of Design Thinking as an educational approach that is particularly relevant for Engineering Education.

In order to identify the key researchers in Design Thinking area, three networks were developed. The article-to-references network is presented in Fig. 3. After analyzing the article-to-reference network, the co-citation network and the cross-citation network were developed (see Fig. 4 and 5).

The analysis of the identified references in the co-citation network makes possible an overview of the evolution of the theme Design Thinking during the last decades.

In its origins, Simon [23] analyzed "Ill-Structured Problems (ISP)", problems whose structure lacks definitions in some aspects, and discusses the differences between ISP and "Well Structured Problems" (WSP), observing that in general the problems

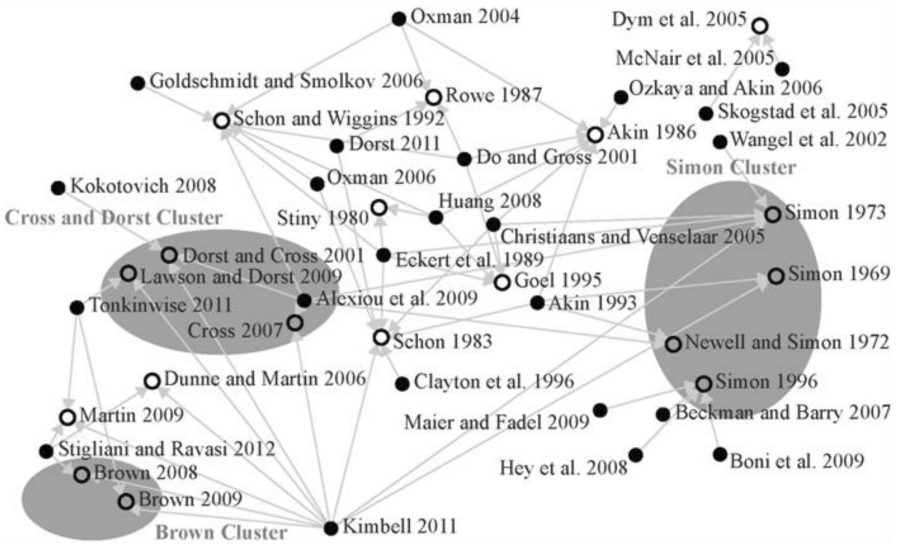

Fig. 3. Article-to-references network (detailed references in: 1–5, 13, 15–22, 24–26, 28–47, 49–50, 52–81, 87–197).

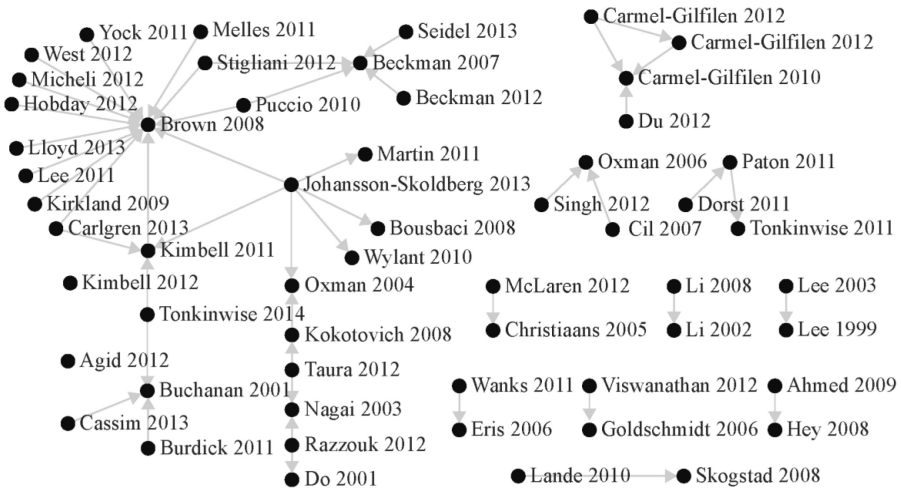

Fig. 4. Cross citation network (detailed references in: 1–5, 13, 15–22, 24–26, 28–47, 49–50, 52–81, 87–197).

proposed to problem solvers are best regarded as ISPs. It is important to observe that solving ''Ill-Structured Problems'' is Design Thinking most important objective. Schön [24] examined how five professional categories tackle routine problems, observing that these professionals initially structure the problem, move towards the solution and analyze the obtained results; the author concludes that the best professionals have tacit knowledge that cannot be externalized and apply this knowledge to achieve professional excellence.

Design, according to Rowe [25], is the fundamental investigation by which architects and planners perceive and conceive ideas of buildings and public spaces. Rowe's book, Design Thinking, provides a general picture of the Design that characterizes its inherent qualities and that differentiates itself from other forms of research. Schön and Wiggins [26] describe architectural Design as a process that consists of reflective observations from the practical application of materials in a particular Design experience and explores the kinds of seeing involved in designing. Simon [27] considers different perspectives including economics, business, engineering, and psychology to characterize complex artificial systems defined by their desired goals, purposes and constraints. The author also observes that each resulting system might be different because the Design process requires choices from the designer that has to consider among different and apparently appropriate alternatives.

Dorst and Cross [28] investigated how creativity happened in a Design project observing nine experienced industrial designers in a laboratory setting,

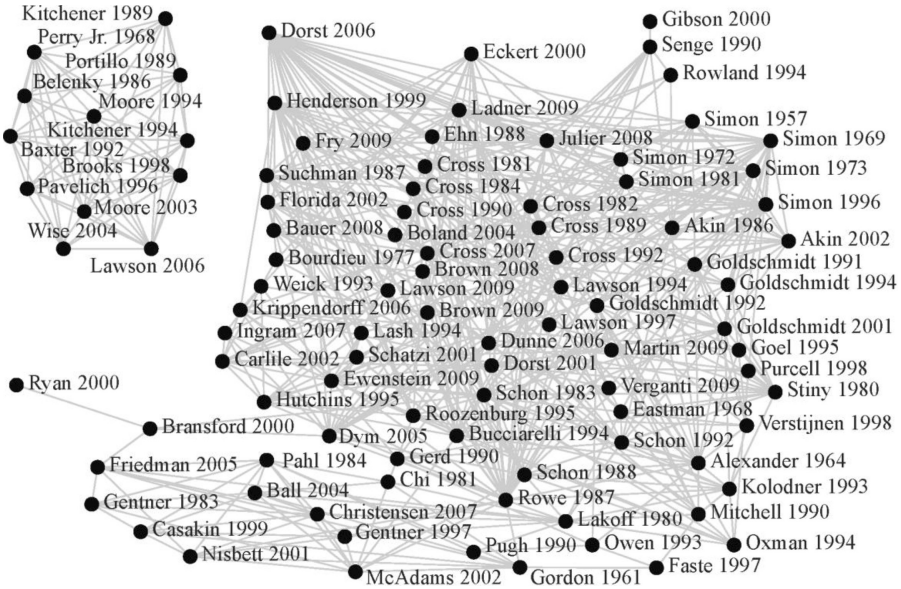

Fig. 5. Co-citation network (detailed references in: 1–5, 13, 15–22, 24–26, 28–47, 49–50, 52–81, 87–197).

applying the ''think-aloud'' protocol and analyzing the quality of the resulting Design concepts. The authors observed that creative Design is a result of the refinement of both the formulation of the problem and the ideas for its solution. Dym et al. [29] characterized Design as the distinguishing activity of engineering and consider that engineering programs should form engineers who can design solutions to meet social needs. The authors conducted an experiment in the context of two courses and concluded that because Design Thinking is a complex process of investigation and learning and a Problem Based Learning (PBL) approach is a more effective way for students to learn Design because they experience Design as active participants.

Dunne and Marting [30] analyzed the application of Design approaches to tackle managerial problems, concluding that management education should provide tools for students to tackle management problems in the same way designers approach Design problems, applying Design Thinking techniques to solve wicked problems. Cross [1] observed that research in Design had no clear focus and explored in his book three important issues concerning Design research: what level of detail must a designer know, what part do designers play in the Design process and what kind of creation should designers create. The author nominates this research as the ''designerly ways of knowing''.

Brown [31] argues that in the first years of the 21st-century organizations and societies need new approaches to promote innovation and to generate breakthrough ideas. The author considers Design Thinking as a human centered approach that can deal with those issues since it combines designers' abilities to develop solutions that meet human needs considering technical and economic constraints and can be applied by people that are not designers. Lawson and Dorst [32] consider Design as one of the most complex and sophisticated professional activities and difficult to teach because Design is a confusing term and each Design project is unique. The authors examine what knowledge, skills, attributes and experiences are necessary to Design as an expert considering the combined evolution of the formulation of the problem and the ideas for its solution. Martin [33] considers that the Design Thinking approach is imperative to companies aiming to innovate since it balances analytic mastery and intuitive originality considering the knowledge funnel proposed by the author.

4. Semantic analysis

An initial list of sixty-nine Design Thinking definitions was obtained from the semantic sample space considered in this study. Fourteen definitions were removed because they represented generic Design definitions, i.e., definitions that concern not only Design Thinking, but that can be generalized to any Design context (for example, ''to consider a simplified view of the Design Thinking process in general, the creative Design process can be described as a conversion process that starts with the description of a goal and ends with the representation of this goal in a form'' [34]), Eight definitions were removed because they focus explicitly on the Design Thinking processes (for example, ''Design Thinking essentially consists of three processes-awareness, idea generation, and refinement.'' [2]). These proposed DT process definitions are analyzed separately in the content analysis (see Table 3). The final sample was composed of 47 definitions.

After the core group of definitions was selected, semantic analysis was performed based on the frequency of occurrence (verbs, adjectives and nouns, and the relation between them) (see Table 1).

Figure 6 shows the area graph for Design Thinking definitions; the sphere is proportional to the

Table 1. Tropes statistics report

	Word	Frequency
Reference fields 1 (Main themes ranked by frequency)	Cognition (understanding, assumption, reasoning)	35
	Business (business, market, investment, firm, enterprise)	14
	Creation (innovation, creation)	14
	Language (dialogue, text, term)	12
	Communication (discourse, communicating, information)	12
	Education (scholars, pedagogy, learning, faculty)	10
Relations (Tightly connected)	(design thinking > designer)	5
	(design thinking > procedure)	4
	(design thinking > discussion)	4
	(similarity > innovation)	3
	(design > activity)	3
	(design thinking > design)	3
	(design > part)	3
	(way > problem)	3
	(design thinking> human-centered)	3
	(design > reasoning)	3

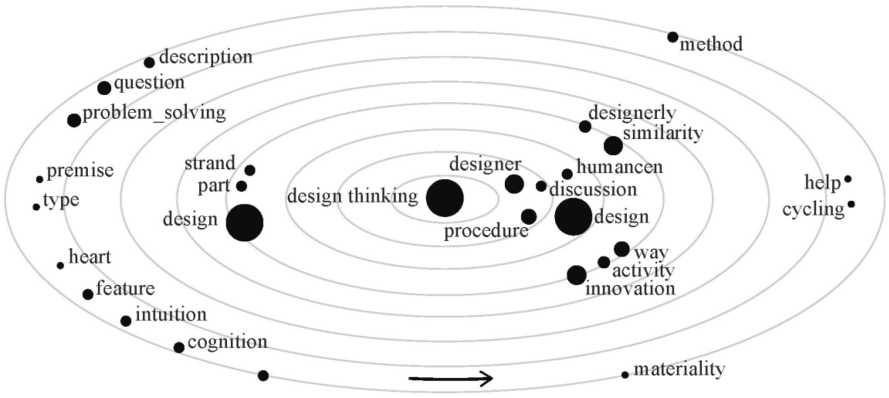

Fig. 6. Area graph for Design Thinking definitions.

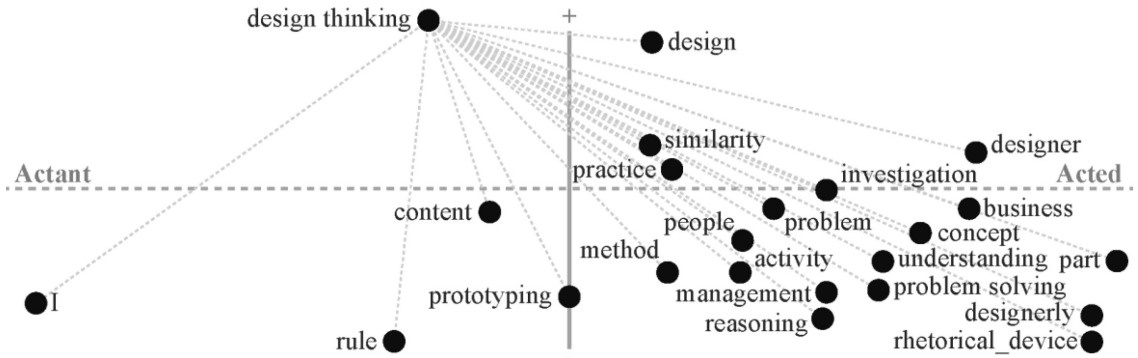

Fig. 7. Actor graph for Design Thinking definitions.

number of words it contains and the distances between the central class and the other classes are proportional to the number of relationships that connects the classes. Fig. 7 shows the actors graph in which the concentration of relationships between the main actors is on the top and the actant and acted are illustrated in the left and right sides respectively.

From the obtained sample of definitions some characteristics were highlighted frequently, however not simultaneously. Ten definitions focus on the centrality of the user [19, 35–36], classifying Design Thinking as a human-centered approach [4, 35–40]. Seven articles connect Design Thinking with prototyping methods [39, 41–42], particularly as a rapid prototyping [38, 40] and iterative prototyping [43] approach. Five articles explored the problem characteristics of Design Thinking initiatives such as wicked problems [43] and ill-structured problems [44–45] and the focus on problem-solving concepts and ideas [44–47], arguing that DT fits very well with the nature of this kind of problems' resolution. The reasoning approach is explored in three definitions, highlighting divergent views [48] and the divergent-convergent thinking paradigm [49], as well as the abductive logic [50]. Other interesting issues that were explored in the semantic sample space were the use of visual techniques to explore ideas [40, 51–52], the importance of interdisciplinary [53] and multidisciplinary team collaboration [36, 41, 54].

To establish a definition for Design Thinking the research group conducted a workshop where panels presenting affinity diagrams of the definitions and all the graphs generated using the Tropes software (which was also available for online access) were available. After considering the content and semantic analysis, the following definition for Design Thinking is proposed:

> Design Thinking is a human-centered approach applied to wicked problem-solving that starts with the understanding of different users' perspectives. It involves multidisciplinary teamwork based on the balance between cooperation-conflict among different actors in a co-creation process, in which the conflict of ideas become the genesis for the establishment of innovative solutions.

Johansson-Sköldberg et al. [55] differentiate the activities performed by designers and the activities performed by non-designers and, based on Cross [1] observations, propose two concepts, "Designerly Thinking" and "Design Thinking". Fig. 8 explores the continuum between these two concepts. From this continuum, it is possible to observe how the

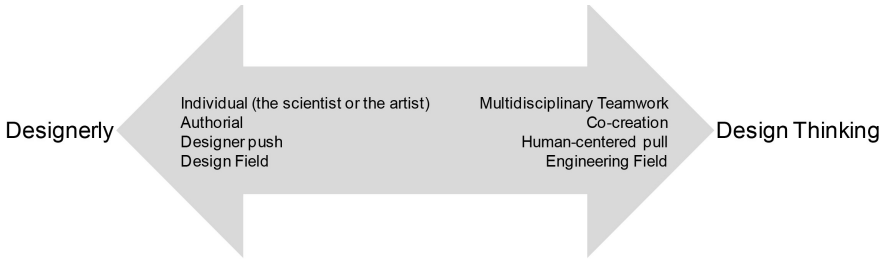

Fig. 8. Continuum from "Designerly Thinking" to "Design Thinking".

designer capabilities are incorporated into a multidisciplinary teamwork approach, moving from an individual perspective into a multidisciplinary teamwork co-creation process.

5. Applying design thinking in innovation development processes: The content analysis

The Design Thinking approach is considered a powerful approach for the development of disruptive innovations inside companies and for corporate chains, bringing the customers point of view into the center of the innovation process. However, the vast majority of the related experiences were developed in academic contexts (127 identified articles, 93% of the sample). It is important to note that most of these articles relate punctual initiatives, conducted in the context of academic courses, inside classrooms, applying Design Thinking tools and techniques and observing the obtained results.

In the academic context results are analyzed mainly based on qualitative evidence. Only 23 of the analyzed articles applied some kind of quantitative approach, usually using a simple quantitative tool (e.g. reaction questionnaires). From the 127 academic focused articles only 16 related some kind of financial support (13%), revealing that this kind of research is not a target for financial support agencies.

It is important to note that only 5 articles relate corporate experiences. The most relevant is Tim Brown's Harvard Business Review article [4] that presents some brief corporate examples of Design Thinking applications. Fujitsu has fostered a pioneer social program applying Design Thinking techniques to generate new ideas for products and services, involving customer companies, local governments, users, administrations and NPOs in co-creation dynamics [3] and the main results obtained in this project are reported by Takeda [2]. The development of a therapeutic orthopedic device for home use prescribed by orthopedic surgeons to enhance and accelerate fracture repair is described by Ana et al. [56]. Finally, Desbarats [57] presents examples of well-succeeded products that can be considered as representatives of their companies.

One important consideration about Design Thinking is that its application is specially focused on the development of innovations. The research identified articles that explicitly characterized the scope of the innovation development and the majority (81.6%) focused on breakthrough innovations; a minority (18.4%) mentioned incremental innovations as its target. Results are summarized in Table 2.

5.1 The emergence of Design Thinking Bodies of Knowledge

In the year of 2008, Design Thinking consolidated its position as a relevant Design approach because of the publication of Brown's article [4] and also because of the emergence of the first "Design Thinking Body of Knowledge", books that propose consolidated sets of best practices for conducting Design Thinking projects. This research identified and analyzed the best practices presented by 6 Bodies of Knowledge published since 2008: "Design Thinking" [4]; "Bootcamp Bootleg" [82]; "Human Centered Design" [83]; "Design Thinking" [84]; "Design Thinking for Educators" [85] and "Playbook for Strategic Foresight and Innovation" [86]. Considering the focus of innovation, all the analyzed books characterize and consider breakthrough and incremental innovations. However, all the books highlight that Design Thinking is more effectively for designing breakthrough innovations.

Table 2. Tropes statistics report

Type of Innovation	Number of References	References
Breakthrough	31	[2–4, 15–16, 19–20, 37, 40–41, 51–52, 55–56, 58–67, 69–75]
Incremental	7	[50, 76–81]

Table 3. Design Thinking phases according to BOKs

BOK	Phases
Design Thinking [4]	Inspiration, Ideation and Implementation
Bootcamp Bootleg [82]	Empathize, Define, Ideate, Prototype and Test
Human Centered Design [83]	Hear, Create and Deliver
Design Thinking for Educators [85]	Discovery, Interpretation, Ideation, Experimentation, Evolution
Design Thinking [84]	Immersion, Analysis and Synthesis, Ideation and Prototyping
Playbook for Strategic Foresight and Innovation [86]	Knowledge, Comprehension, Application, Analysis, Synthesis, Evaluation

Table 4. Design Thinking phases synthesis according to the studied sample

Phase	Number of References	References
Immersion	9	[4, 19, 41, 44, 72, 87–90]
Ideation	18	[4, 17, 22, 37, 40–41, 51–53, 63, 75, 80–81, 91–95]
Prototyping	40	[2–4, 35, 37–43, 46, 50–52, 54, 60, 62–64, 66–67, 71–72, 74, 77–81, 87, 96–104]

Table 5. Design Thinking tools according to the studied sample

Number of Citations	Mentioned Tool
4	CAD
2	Perry Scheme
1	Annotation, ANOVA, Chat recorder, CompendiumDS, Computational algorithms, CoNEKTR model, D-MOSA, Drawing board, Drawings, E-scape system, Ethnographic interviews, Experience maps, Informant diaries, Intercepts, Interface elements, Kolb—Experiential Learning theory (ELT), Message board, MID—Measure of Intellectual Development, MindDigger, Mind maps, Mintzberg strategy model, MOD—Measure of Designing, Netnography, Neural networks modeling, Non-participant observation, OpenDesignStudio, OpenSimulator, Pareto analysis, Participant observation, Post-it board, Project Space, Projection pursuit, PROMETHEE II, Reliability checks, Reliability tables, Repertory grids, S-DTPM, Short annotation, Sketch board, Storyboards, Student pages, TCTT, TeamMind, Text chat, TPACK, U101, Virtual ethnography, VIKOR, VW tools, Web Pad, Wiki

5.2 Design Thinking most important phases

The analysis of the previously mentioned Design Thinking BOKs also revealed three major phases that should be considered in a Design Thinking project: Immersion, Ideation, and Prototyping. The Immersion phase initiates the application of Design Thinking, usually considering an Ill-Structured Problem [23] as a starting point and conducting preliminary research to subsidize the creation process; Ideation is the creative intermediary phase for generating innovative solution concepts and Prototyping is the final phase of the Design Thinking approach, when concepts are incorporated into concrete prototypes and customers are invited to analyze its effectiveness, validate its concepts and propose improvements. The analyzed BOKs considers all these three phases but with small differences, as presented in Table 3.

One significant difference concerning the analyzed articles and Bodies of Knowledge is that the BOKs have special focus and provide more accurate details for the development of the initial phases of the project, i.e., for the Immersion phase. However, the majority of the analyzed articles have special concern with the Prototype stage (61.2%) and Immersion is the less analyzed phase, considered only in 12% of the articles, as presented in Table 4.

It is possible to observe that among the analyzed articles, Brown [4] and Seidel and Fixson [41] explicitly mentions the three phases of the Design Thinking approach that are considered in the 6 Bodies of Knowledge previously presented.

5.3 Design Thinking tools

One important question concerning Design Thinking is the relevance and importance of the techniques and tools presented by articles and BOKs. However, the analysis of the sample looking for the most frequently mentioned techniques and tools revealed no significant pattern since only CAD and Perry Scheme were mentioned more than once. Other 51 tools were identified in the sample, but these were mentioned only in one article. Analyzed articles present a significant number of different tools, evidencing no standards or best practices, as presented in Table 5.

The analyzed Bodies of Knowledge present few similarities among the suggested tools and the only

Table 6. Design Thinking tools according to the studied BOKs

Body Of Knowledge	Suggested Tools
Design Thinking [4]	Sketch, Brainstorm, Insights, Storytelling, Creative Frameworks, Rapid Experimentation, Prototyping, Web 2.0 Networks and Portfolio of Innovation
Bootcamp Bootleg [82]	User camera study, Interviews, Extreme Users, Analogous Empathy, Story share-and-capture, Saturate and group, Empathy map, Journey map, Composite character profile, 2x2 matrix, Why-how laddering, Point-of-view Madlib, Point-of-view Analogy, Critical reading checklist, Stoke, Bodystorming, Wizard of Oz prototyping, Feedback capture grid, Storytelling
Human Centered Design [83]	PRISM, PRA, Mind Maps, Venn Diagram, Processual Map, Relational Map, 2x2 Matrix, P.O.I.N.T.
Design Thinking for Educators [85]	Worksheet, Question Guide, Jorney Map, Venn Diagram, 2x2 Matrix, Relationship Map, Reality Check, Storyboards, Role-playing, Models, Paper mockup
Design Thinking [84]	Reframing, Exploratory Research, Desk Research, Interviews, Sensibility Notebooks, Generative Session, One day in the life, Shadow, Insight cards, Affinity Diagrams, Conceptual Maps, Personas, Empathy Maps, User's Jorney, Blueprint, Ideas Menu, Positioning Matrix, Paper mockups, Models, Staging, Storyboards, Service Prototype
Playbook for Strategic Foresight and Innovation [86]	Context Map, Progression Curves, S-curves, Janus Cones, Cones of Uncertainty, Milieu studies, Generational Arcs, Population analytics, Generational Research, Personas, Voice of the Customer, Need-finding, Futuretelling, Storytelling, Experiential design, Role-playing, White Spots, Growth-share matrix, BCG matrix, Blue Ocean Strategy, Paper mockups, Dark Horse, Change Path, Backcasting, Strategic Inflection Points, Buddy Checks, Startup speed dating, VOICE stars, Crowd Clovers, Social Network Mapping, Weak Ties, CoIN (Collaborative Innovation Network) Vision Statement, Start-up Elevator Pitches, Mission Statements, DARPA Hard Test, Technology Readiness Scales, Pathfinders, Wayfinding

tool suggested in all BOKs is Storytelling, as observed in Table 6.

6. Conclusions

In this research relevant articles and books concerning Design Thinking were analyzed. This literature was obtained from different epistemological areas, particularly Engineering and Design. The research evidenced a lack of standardization about DT phases, tools and definitions. Aiming to fill some of these gaps the article analyzed and systematized the literature on Design Thinking. To characterize this research area, the article identifies Design Thinking key phases, method and tools. Moreover, a definition of Design Thinking is proposed.

The findings reveal that the majority of the related experiences were conducted in academic contexts (93%). Only 5 articles reported corporate experiences. Most of the analyzed articles present qualitative researches. Only 23 of the analyzed articles applied some kind of quantitative approach. Just 16 articles reported some kind of financial support, revealing that this kind of research is not a target for financial support agencies yet.

Some characteristics were frequently highlighted when defining DT: the centrality of the user in a human-centered approach; DT appears as an iterative prototyping method, exploring wicked and ill-structured problems and applying problem-solving concepts; the reasoning approach is the divergent-convergent thinking considering an abductive logic. Some other relevant characteristics included the use of visual techniques to explore ideas and the importance of interdisciplinary and multidisciplinary team collaboration.

There are some limitations of this research, resulting from the research methods applied, considering the bias in the sampling process and the analysis performed. The start searching point in ISI Web of Knowledge focusing on the indexed journal in JCR as a proxy of quality can lead to miss relevant articles, which was partially mitigated by the snowball method in article-to-reference networks. The period of analysis and the multimethod approach applied to this SLR also brings some bias in the analysis, as the researchers bias in the content analysis of the articles. One of the topics for future research agenda that stood out of this SLR is the need of research papers in the companies, understanding how Design Thinking has been incorporated by firms in innovation and new product development activities. Moreover, future research agenda on Design Thinking highlights the importance of observing the results obtained with the implementation of DT inside companies. Finally, it is important to identify the critical challenges to implement DT in the organizations to expand from an educational experience for a managerial practice.

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