R&D MANAGEMENT

Design thinking and dynamic managerial capabilities: a quasi-experimental field study in the aviation industry

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Recent academic literature has suggested that design thinking training has a positive impact on dynamic managerial capabilities that are vital for firm performance. However, it is yet not clear how these effects are realized. We suggest that the positive impact of design thinking training on dynamic managerial capabilities can be attributed to changes in two aspects of managerial cognition: creative problem solving as a mental process and creative self-efficacy as a psychological belief. We test our hypotheses in a quasi-experimental pretest–posttest field study in the aviation industry among 100 mid- and lower-level managers and a 5-month time lag. The intervention is a 2-day design thinking training based on experiential learning. We find that design thinking training realizes its effects on dynamic managerial capabilities rather indirectly through creative problem solving and creative self-efficacy. Our study provides a more nuanced understanding of the relationship between design thinking and dynamic managerial capabilities and showcases the role changes in managerial cognition play in the dynamic capability development of mid- and lower-level managers. Furthermore, it contributes to the scarce empirical research on the effects of design thinking on individual-level effects. For practitioners, our research shows how organizations can benefit from design thinking training by boosting their managers abilities to spot and take advantage of new business opportunities.

1. Introduction

As an iterative, human-centered approach to innovation and problem solving, design thinking has become a common practice in companies. It is widely applied in the idea generation and development phases of the innovation process (Bagno et al., 2017; Magistretti, Dell'Era, et al., 2021) as well as in the earlier research phases (Magistretti, Dell'Era, et al., 2021). Besides positively influencing organizational innovation performance (Robbins and Fu, 2022) and promoting changes in organizational mindset and routines (Kurtmollaiev, Fjuk, et al., 2018), design thinking has also been identified

as a key source for the development of dynamic managerial capabilities (Kurtmollaiev, Pedersen, et al., 2018). Dynamic managerial capabilities are "capabilities with which managers build, integrate, and configure organizational resources and competences" (Adner and Helfat, 2003, p. 1012). They help managers to sense and seize opportunities and transform organizational assets (Teece, 2007). Thus, these sensing, seizing, and transforming capabilities (Teece, 2007) are important antecedents to strategic changes (Helfat and Martin, 2015a) aiming at better firm and innovation performance (Helfat and Martin, 2015b; Khan et al., 2020).

Even though previous research acknowledges the connection between design thinking, dynamic managerial capabilities, and their impact on firm performance (Agarwal and Helfat, 2009; Trahms et al., 2013; Magistretti, Ardito, et al., 2021), there is still little understanding of the mechanisms underlying dynamic managerial capability development through design thinking. There are several compelling reasons to unlock the "black box" of this process. Understanding the inner working of design thinking training and its impact on the development of dynamic managerial capabilities would allow organizations to create more effective individual development programs that are targeted at improving managers' abilities to sense and capitalize on new business opportunities more successfully. In addition, it is crucial to improve our understanding of how design thinking achieves its desired outcomes, as much of the empirical research on the effects of design thinking is still anecdotal and prescriptive (Liedtka, 2015; Cousins, 2018; Micheli et al., 2019). By deepening this understanding, we can build a more robust and evidence-based foundation for promoting innovation within the organization.

According to the dynamic managerial capability theory, differences in managers' abilities to sense and seize business opportunities, and transform assets can come from differences in three core underpinnings of dynamic managerial capabilities: human capital, social capital, and managerial cognition (Helfat and Martin, 2015a). Thereby, managerial cognition with its various facets—managers' beliefs, mental models, and mental processes utilized to make better decisions (Adner and Helfat, 2003)—is found to be the only underpinning that can be directly influenced through training (Helfat and Peteraf, 2015). Interestingly, some elements of managerial cognition, such as perception, social cognition, and attention, either form through experience over time (Helfat and Peteraf, 2015) or are unlikely to be affected by design thinking practices. In contrast, individual-level effects of design thinking focussing on creative problem solving (Benson and Dresdow, 2015) seem to be a promising way forward for two reasons. First, design thinking has been linked to better creative problem solving—a mental process through which complex problems are approached and resolved (Ungaretti et al., 2009; Benson and Dresdow, 2015). Second, design thinking has also been associated with higher creative self-efficacy (Kelley, 2012; Kelley and Kelley, 2012)—a psychological belief associated with creative problem solving. Combining dynamic managerial capability theory with propositions from the research on the individual-level effects of design thinking, we propose that the positive effects of design thinking training on dynamic managerial capabilities are attributed to two specific changes in managerial cognition. Specifically, we argue that design thinking training realizes its effects through changes in (a) creative problem solving as a mental process design thinking practitioners go through when developing solutions, and (b) creative self-efficacy – a psychological belief design thinking practices trigger.

We conducted our study in a field setting—three aviation companies in Europe. This setting allowed us to explore an industry that faced substantial challenges and was in need to realize new business opportunities even before the disastrous effects of the COVID-19 pandemic (Bouwer et al., 2022). All three companies selected mid- and lower-level managers to participate in a two-day design thinking training. The training was based on action learning and introduced managers to design thinking principles, processes, and practices through direct application of the learned content on company-selected design challenges. We tested the effects of this intervention using a quasi-experimental pretest–posttest design with a control group and a 5-month time lag.

This study offers several contributions. First, our study provides a more nuanced understanding of a previously established relationship between design thinking and dynamic managerial capabilities and provides empirical evidence on the so far scarce individual-level effects of design thinking and acquisition of design thinking skills (Micheli et al., 2019). More specifically, we show that mechanisms through which design thinking training realizes its effects are attributed to two sides of managerial cognition. Design thinking training not only changes the way managers perceive their creative abilities (psychological belief) but also changes the way they approach problems (mental process). Second, we contribute to the dynamic managerial capability literature that has called for more research among mid- and lower-level managers (Ambrosini and Altintas, 2019). The setting in which empirical data were gathered

provides insights into the development of dynamic managerial capabilities among mid- and lower-level managers—a group largely ignored by previous research that has focused on top management (Von den Driesch et al., 2015; Huy and Zott, 2019). Third, we contribute to practitioners' understanding of how to introduce design thinking into organizations. Even though short trainings in other management areas can create positive effects (Singh et al., 2022), the promise of short design thinking workshops generating any significant design thinking skills is sometimes met with skepticism (McCullagh, 2010), as participants of these training often fail to apply the learned skills after the training (Royalty et al., 2015). Our findings show that a 2-day design thinking training can indeed generate medium-term positive effects.

2. Conceptual background and hypotheses

2.1. Dynamic managerial capabilities

Dynamic managerial capabilities are managers' capabilities to build, integrate, and configure organizational assets—their resources and competences (Adner and Helfat, 2003; Helfat and Martin, 2015a). They are an extension of the dynamic capability view that is concerned with how firms can maintain and increase their competitive advantage in the face of changes (Teece et al., 1997; Teece, 2007). Dynamic capabilities refer to organizational abilities to integrate, build, and reconfigure internal and external resources and competences (Teece et al., 1997; Helfat and Martin, 2015a). While dynamic capabilities are often seen as embedded in the organizational and strategic routines of organizations (Eisenhardt and Martin, 2000; Zollo and Winter, 2002), developing these capabilities requires managerial action (Teece, 2007). Thus, dynamic managerial capabilities are a particular type of dynamic capabilities that emphasize the role that managers, individually and in teams, play in developing and executing routines in the light of new opportunities to help companies sustain and enhance their competitive advantage (Ambrosini and Altintas, 2019; Martin, 2010; Adner and Helfat, 2003; Helfat and Martin, 2015).

Sensing, seizing, and transforming capabilities are three types of dynamic managerial capabilities (Teece, 2007). Sensing capability is manager's ability to scan, create, learn, and interpret information from different sources in order to recognize opportunities and threats (Helfat and Martin, 2015a; Ambrosini and Altintas, 2019). It involves an ability to identify customer needs, technological changes, developments in industries, and markets (Teece, 2007). Seizing capability refers to manager's ability to bring an identified opportunity into fruition by, for example, deciding which opportunities to pursue, the level of investment they require, the appropriate organizational structure, and personnel (Helfat and Martin, 2015a). Managers also have to be able to make decisions about different aspects of the business model in order to create the most value for customers and the organization (Ambrosini and Altintas, 2019). Transforming capability describes manager's capacity to reconfigure existing organizational structure, resources, and routines to seize opportunities and maintain organization's growth and profitability (Helfat and Martin, 2015a). This entails being able to develop and invest in cospecialized assets, developing and maintaining appropriate organizational structure and processes, integrating and combine knowledge and taking responsibility for the decisions made. All three capabilities are interdependent: to seize opportunities, managers first need to be able to identify opportunities (Teece, 2007), and they are likely to transform organizational assets when seizing these opportunities (Fainshmidt and Frazier, 2017). Thus, transforming capability depends on seizing capability, whereas seizing capability depends on sensing capability (Teece, 2018; Kurtmollaiev, Pedersen, et al., 2018).

Though theoretical underpinnings of dynamic managerial capabilities are known, little research has been done so far on how managers can increase their abilities to sense and seize opportunities and transform organizational assets. One of the approaches that have shown promising results is design thinking training (Kurtmollaiev, Pedersen, et al., 2018).

2.2. Design thinking training

Design thinking is a human-centered approach to creative problem solving and innovation (Brown, 2008; Liedtka, 2015). Despite a few process-focused depictions (Brown, 2008; Design Council, 2021), it is best defined by iterative use of four distinctive practices within an interdisciplinary setting: user-centeredness, problem framing, visualization, and experimentation (Liedtka, 2015; Carlgren et al., 2016; Micheli et al., 2019; Auernhammer and Roth, 2021). These practices are supported by various techniques (Auernhammer and Roth, 2021). Even though it is not enough to mechanically go through a set of techniques to practice design thinking, it is an effective approach to learn design thinking as these tools and methods help manifest otherwise vague practices into concrete actions and routines (Auernhammer and Roth, 2021).

User-centeredness refers to building empathy for users, taking their perspectives, and identifying their hidden needs (Brown, 2008; Carlgren et al., 2016). It can be practiced through a variety of ethnographic methods, such as observation, interviewing, and informant diaries, as well as sense-making techniques, such as personas and journey maps, or cocreation (Beckman and Barry, 2007; Brown, 2008; Carlgren et al., 2016; Micheli et al., 2019).

Problem framing refers to the unconstrained exploration of the problem through questioning initial assumptions and exploring the problem from different perspectives before converging to the solution creating the most value (Brown and Wyatt, 2010; Lindberg et al., 2010; Liedtka, 2015; Carlgren et al., 2016; Garbuio et al., 2018). It builds on divergent thinking and openness to the unexpected (Carlgren et al., 2016), which can be practiced through sense-making tools like personas and journey maps that allow one to look at the initial problem through the customers perspective before defining the point of view.

Visualization refers to the creation of early visible representations of the observed information, ideas, and solutions (Carlgren et al., 2016). This practice is supported by techniques like storytelling, roleplays, sketches, and simple mock-ups (Cooper et al., 2009; Carlgren et al., 2016).

Experimentation refers to the trial-and-error approach to developing new ideas through series of iterations (Beverland et al., 2015; Carlgren et al., 2016). It is supported by field experiments that allow to test key assumptions in the field with customers and other external stakeholders (Liedtka, 2015).

This conceptualization of design thinking as a set of practices supported by various techniques in an interdisciplinary setting forms the basis for design thinking training formats. Learning specific methods and tools enables nondesigners to live design thinking practices. When mastered and applied conscientiously and repeatedly, they can help nondesigners creatively solve complex problems (Arnold, 1962), thus realizing the potential of design thinking (Auernhammer and Roth, 2021).

2.3. *Development of dynamic managerial capabilities through design thinking training*

Design thinking is often chosen as an approach to address complex innovation problems and develop new offers (Dell'Era et al., 2020). As this approach entails identifying new opportunities, developing, integrating, and configuring organizational assets, most recently, scholars have suggested that there is a strong link between design thinking and dynamic capabilities both individual (Kurtmollaiev, Pedersen, et al., 2018) and firm levels (Magistretti, Ardito, et al., 2021). Design thinking practices and interactions, when performed effectively, can help managers individually and collectively to take managerial actions at different organizational levels to better sense and seize opportunities, transform organizational assets in a way that provides a source of differentiation and competitive advantage for the company (Carlgren et al., 2014; Micheli et al., 2019).

To be more specific, user-centeredness allows understanding of the customer perspective, which puts managers in a better spot to sense and discover market opportunities (Brown, 2008). Problem framing through questioning assumptions, differing judgments, and embracing ambiguity can aid them in sensing opportunities better (Magistretti, Ardito, et al., 2021). Furthermore, changing perspectives and reframing the problem and solutions can assist managers in reconfiguring organizational resources effectively (Paton and Dorst, 2011). Visualization of insights enables quicker comparison of information important for managerial sensing capability (Goldschmidt, 1994), whereas visualization of ideas through simple prototypes leverages managerial seizing capability by allowing managers to present these opportunities and gather support for the necessary resource changes (Magistretti, Ardito, et al., 2021). Finally, experimentation is especially of high value for seizing opportunities. Through iterative experiments, managers can test their hypotheses about the market, the viability, and feasibility of ideas and transform the opportunities into business models (Magistretti, Ardito, et al., 2021). To sum up, managers who are aware of and capable of successfully applying design thinking practices are more likely to have higher dynamic managerial capabilities.

Training in relevant practices and techniques is an effective way to increase managers' skills and abilities to take the desired action (Zollo and Winter, 2002), as past research on creativity and entrepreneurship training shows (Amabile, 1988; Glaub et al., 2015). When an individual gains practical experience in performing an activity, the likelihood of repeating the activity better in the future increases (Zollo and Winter, 2002). For example, research on creativity trainings shows that individuals who gain practical experience in applying various creativity techniques are more likely to try to apply

them in the future when given the challenge to come up with creative ideas and thus generate better results (Scott et al., 2004). In a similar manner, design thinking training that not only delivers information on design thinking practices but also gives participants a first-hand experience in applying design thinking practices will positively affect managers' capability to apply design thinking principles in the future and improve their dynamic managerial capabilities. Recent empirical research has found a positive impact of design thinking training on dynamic managerial capabilities (Kurtmollaiev, Pedersen, et al., 2018). In line with this finding and outlined arguments, we propose

Hypothesis 1 Design thinking training will have a positive effect on managerial dynamic capabilities.

2.4. *The mediating role of managerial cognition*

Three types of resources—social capital, human capital, and managerial cognition—underpin dynamic managerial capabilities and explain the differences in managers' abilities to sense and seize opportunities and transform the organizational resource base (Helfat and Martin, 2015b). Neither managerial social capital—goodwill derived from formal and informal relationships that managers have (Adler and Kwon, 2002)—nor managerial human capital, knowledge and expertise in functional, technological, industry-specific, and firm-specific areas (Helfat and Martin, 2015b), can be directly influenced through training (Helfat and Peteraf, 2015). In contrast, specific components of managerial cognition can change over time either as a reaction to environmental stimuli (Apfelthaler et al., 2011) or as a result of practice and training (Helfat and Peteraf, 2015). Therefore, a change in managerial cognition could be a mechanism that potentially mediates the relationship between design thinking training and dynamic managerial capabilities (King et al., 2012).

Managerial cognition refers to managerial belief systems, mental models, and mental processes managers use to make decisions (Adner and Helfat, 2003) and influences what information managers decide to search for and how they interpret the information they receive (Helfat and Martin, 2015a). Researchers have identified several elements of managerial cognition that underpin sensing, seizing, and transforming capabilities, such as perception, social cognition, attention, language, and nonverbal communication as well as creative problem solving (Hodgkinson and Healey, 2011; Helfat and Peteraf, 2015).

An element like perception or managers' ability to perceive information and recognize patterns largely depends on managerial experiences gathered over time, as experts perceive information more accurately and quickly than novices (Helfat and Peteraf, 2015). Social cognition or managers' ability to process socially relevant information, such as colleagues' emotions and positions, is largely automatic (Bargh and Chartrand, 1999). Although attention or focused awareness on a certain type of perceptual information can generally be trained (Rueda et al., 2005), design thinking training is not likely to create any substantial changes in one's attention as design thinking encourages being open to any type of information (Beckman and Barry, 2007). Similarly, design thinking training is not targeted at changing the language and nonverbal communication managers use to persuade their organizations. We, therefore, focus on two aspects of creative problem solving that have also been previously identified as individual-level effects of design thinking, that is, creative problem solving **as a mental process** and creative self-efficacy as **a psychological belief** associated with creative problem solving (Ungaretti et al., 2009; Kelley, 2012; Benson and Dresdow, 2015).

2.5. *Creative problem solving as a mediator*

Creative problem solving is a series **of mental processes** to identify a relevant problem, generate alternative ideas, and evaluate them (Im et al., 2015). Design thinking is often described as an approach to creative problem solving (Brown, 2008). It offers a way to find innovative solutions to complex problems by combining various types of thinking, seeking inspiration in unexpected places, focusing on users and involving them closely in the process, and reframing the problem from different angles (Dell'Era et al., 2020).

Design thinking has also been previously described as experiential learning (Beckman and Barry, 2007; Glen et al., 2014; Beckman, 2020; Pratomo et al., 2021). Engaging with design thinking practices allows participants to learn solving complex problems by experiencing all four learning styles described by Kolb (1984): divergent learning, assimilated learning, convergent learning, and accommodated learning. More specifically, ethnographic methods through which human-centeredness is practiced allow participants to

engage in observation and reflection that characterize divergent learning (Beckman and Barry, 2007). Problem framing that is lived through sharing insights and analyzing them with sense-making tools allows assimilated learning—a combination of shared reflections and their analysis (Hölzle and Rhinow, 2019). The tools used in problem framing also foster convergent learning—a mix of discussing problems and suggesting imperatives for possible solutions (Beckman and Barry, 2007; Beckman, 2020). Finally, visualization of ideas through simple prototypes that can be tested with potential customers or users fosters accommodated learning—a combination of generating concrete ideas, transforming them into specific offerings, and experimentation (Hölzle and Rhinow, 2019). Going through these four learning styles in design thinking training allows participants to find ways to solve complex problems creatively.

Creative problem solving as **a mental process** serves as a foundation for dynamic managerial capabilities, that is, successful sensing and seizing opportunities and transforming organizational assets. Sensing opportunities requires identifying a relevant problem that has not yet been solved adequately, and thus, represents an opportunity for an organization. Seizing the identified opportunity requires designing an effective business model, which in turn calls for high-level creative problem-solving skills (Peteraf and Reed, 2007; Helfat and Peteraf, 2015; Ferraris et al., 2022). Managers must be able to use divergent and convergent learning to generate alternative proposals for business model elements, that is, value proposition, customer needs and relationships, channels, and strategic partners (Teece, 2018). They also must be able to evaluate the given options and fit together these various elements into a viable business model. Finally, creative problem solving is important to getting internal commitment to pursuing a chosen business opportunity and making sound strategic investments as well as a commitment to the necessary financial resources or efforts to develop new organizational capabilities (Ferraris et al., 2022). Hence, managers engaging in creative problem solving are more likely to make better decisions regarding the design and execution of business models (Peteraf and Reed, 2007; Helfat and Peteraf, 2015), thereby demonstrating better dynamic managerial capabilities.

Following these arguments, we propose:

Hypothesis 2 Creative problem solving mediates the relationship between design thinking training and dynamic managerial capabilities.

2.6. *Creative self-efficacy as a mediator*

Creative self-efficacy is "the belief one has the ability to produce creative outcomes" (Tierney and Farmer, 2002, p. 1138) and is derived from Bandura's (1997) general definition of self-efficacy. Both general self-efficacy and creative self-efficacy are rooted in the social cognitive theory, which proposes that individuals as active agents learn behavior through observation, direct experience, and reproduction of this behavior to maximize rewards (Bandura, 1986). In social cognitive theory, learning is not only a social but also a cognitive process, meaning knowledge and behaviors are not only generated from the environment in which individuals operate but they also come from individuals processing information and choosing to act upon it depending on the personal characteristics and expected rewards. Self-efficacy as a central tenet of social cognitive theory explains how before individuals choose to act, they assess information about their perceived capabilities to succeed in a specific behavioral setting (Bandura, 1997). For example, individuals with high creative self-efficacy beliefs are more likely to approach a setting, in which they must engage in producing creative outcomes, whereas individuals with low creative self-efficacy beliefs are more likely to avoid such setting. Empirical research shows that as part of managerial cognition, this psychological belief about one's ability to produce creative outcomes positively affects innovative behavior (Newman et al., 2018), creative performance (Wang et al., 2014; Zhang and Zhou, 2014). Based on social cognitive theory, there are four sources for developing creative self-efficacy: enactive mastery experience, vicarious experience, verbal persuasion, and psychological and affective states. In line with previous research (Rauth et al., 2010; Jobst et al., 2012), we argue that at least three of these sources can be positively affected through design thinking training.

First, design thinking training can stimulate enactive mastery—the ability to act out and master a difficult task through small successes (Bandura, 1997). Design thinking trainings are based on solving design challenges—complex or "wicked" problems chosen by companies—through a series of small iterative steps based in design thinking practices. Learning to iteratively apply design thinking tools and use them as small steps to gradually solve a larger design challenge helps participants to gain confidence in their ability to find creative solutions despite the ambiguity of complex and "wicked" problems (Jobst et al., 2012).

Second, design thinking training helps to provide a vicarious experience or watching successful behavior models dealing with difficult problems and demands (Bandura, 1977). Design thinking training emphasizes the benefits of interdisciplinary teams with complementary skill sets when solving complex challenges (Jobst et al., 2012) and is therefore organized in groups. Observing other training participants overcoming challenges and succeeding in finding creative solutions positively contributes to participants' confidence in their creative ability.

Third, design thinking training can also enhance verbal persuasion. Design thinking is based on trial-and-error approach and encourages learning from failure (Beverland et al., 2015; Carlgren et al., 2016). Therefore, a crucial part of design thinking training is supportive atmosphere, in which trainers and fellow colleagues can give feedback on participants' creative successes and failures (Jobst et al., 2012). If the trainer gives positive feedback on participants' creative successes and frames failures as part of the design thinking approach instead of a personal failure, one's creative self-efficacy is likely to increase.

Self-efficacy is a strong predictor for behavior, the amount of effort a person decides to exert and the length of their persistence in the face of obstacles (Bandura, 1977). Individuals with higher creative self-efficacy are more likely to challenge the status quo, exert more effort in pursuing creative goals, perceive opportunities rather than obstacles, and be more persistent when facing difficulties and failures (Bandura, 1997; Tierney and Farmer, 2002; Newman et al., 2018), all of which are necessary to sense, seize and transform opportunities (Kevill et al., 2017). If individuals believe in their ability to produce creative outcomes, they will enact searching for new opportunities and customers' latent needs, converting these opportunities into profitable business, and reconfiguring the necessary routines, resources, and structures for long-term success. Based on these arguments, we propose

> **Hypothesis 3** Creative self-efficacy mediates the relationship between design thinking training and dynamic managerial capabilities.

Figure 1 illustrates the hypothesized research model used in this study. It comprises the hypothesized direct effect design thinking training creates on dynamic managerial capabilities and an indirect effect mediated by creative self-efficacy and creative problem solving.

3. Methodology

3.1. Design and treatment

To test our hypotheses, we employed a field intervention with a pretest–posttest design and a 5-month time lag. The intervention was a two-day design thinking training, which was offered to mid- and lower-level managers of three European aviation companies.

Aviation industry generates around 3% of the global GDP and is a key driver in business and tourism (Saxon, 2019). Even before the COVID-19 pandemic, it was a dynamic industry with many challenges, with over 60% of the airlines showing losses from 2012 to 2019 (Bouwer et al., 2022). Its challenges create many opportunities for product and service innovation that managers need to be able to sense, seize and successfully implement (Janssen et al., 2015), presenting a compelling empirical setting for our study.

We chose a 5-month lag so that participants would have time to form habits (Lally et al., 2010) and start new projects in their companies, which would give them the freedom to choose the approach and methods to achieve the project goals. Trainings were

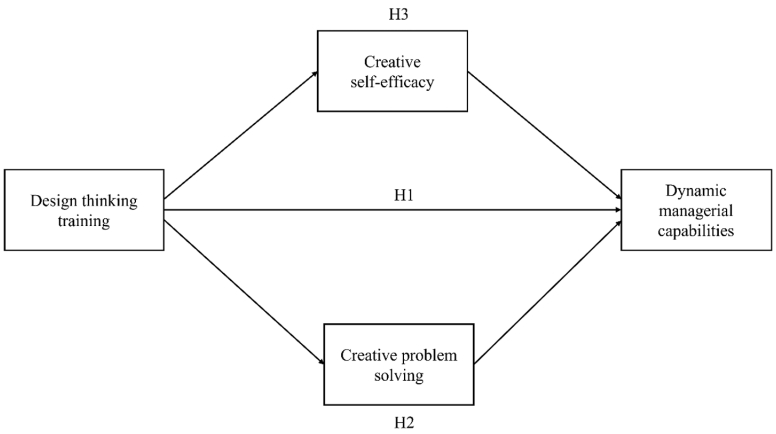

Figure 1. Hypothesized research model.

organized in five groups of 12–18 participants, each at a different point in time from February 2019 to January 2020. Data were collected through two online surveys: one – shortly before the training, 1–5 months after the training.

The purpose of the design thinking training was to introduce the design thinking approach with its practices, methods, and tools through experiential learning (Kolb, 1984). Participants were given design challenges defined by each company that involved developing processes or product innovations. The training consisted of short theoretical inputs on practices, methods, and tools mixed with their practical application on the given design challenges. The participants worked in cross-functional teams of four to five people.

Table 1 summarizes the training program content, learning goals, and the applied tools. It irrors the practices and tools identified in the literature (Liedtka, 2015; Carlgren et al., 2016; Micheli et al., 2019). Training content is based on the training content used in other experimental studies on design thinking (Kurtmollaiev, Pedersen, et al., 2018) and is structured according to the design thinking process proposed by prominent design thinking education institutions IDEO and Stanford Design School (Brown, 2008).

3.2. Sample

Our sample consisted of an intervention (design thinking training) group and a control group to increase the external validity. A total of 143 mid- and lower-level managers from three companies participated in the study; 72 belonged to the intervention group and 71 to the control group. Employees could self-select for the training if they had an opportunity to develop a new product, service, or process in their daily jobs and if they had no or only very limited knowledge about design thinking. To increase the external validity, companies' HR departments approached participants who worked in the same departments, performed similar functions to form a control group, and were sufficiently similar in age and gender. The control group was offered design thinking training after the study was completed.

Both design thinking training participants and participants in the control group received pre- and posttraining surveys at the same time. Participants who only filled out one of the two questionnaires were eliminated from the sample. Hence, we obtained 100 complete responses from both surveys: 52 from the intervention group and 48 from the control group, representing a 70% response rate. The response varied across the three companies (77%, 68%, and 56%), as the posttraining data collection in the last two training groups took place in May and June 2020, when European aviation companies were struck by changes and layoffs (Harper, 2020).

In the final sample, 63% of participants were female (71% in the control group and 56% in the intervention group). The mean age was 41 years with no statically significant differences between the intervention and control groups ($t(98) = -.293$, $p = .770$). Participants represented different departments: operations (33%), human resources (14%), project management and consulting (13%), finance (8%), marketing and communication (7%), general management (6%), IT (5%), and other departments (14%).

3.3. Measurements

The variables were adapted from established multi-item reflective scales and were measured on a 5-point Likert scale (where 1 = strongly disagree and 5 = strongly agree).

Creative self-efficacy was measured by three items adapted from Tierney and Farmer (2002). Items assessed a person's belief in being able to generate novel ideas and come up with creative ways to solve problems. A sample item read "I have confidence in my ability to solve problems creatively." Cronbach alphas for internal consistency reliabilities were .834 (pretraining) and .850 (posttraining).

Creative problem solving was measured by five items adapted from Whetten and Cameron (2011). Items assessed how a person approaches problem solving, that is, whether a person looks at it from different perspectives, generates multiple solutions, and uses different thinking styles. A sample item read "I try to be flexible in the way I approach the problem by trying out several different alternative methods rather than relying on the same approach every time." Cronbach alphas internal consistency reliabilities were .775 (pretraining) and .820 (posttraining).

Dynamic managerial capabilities were assessed by six items adapted from Kurtmollaiev, Pedersen, et al. (2018)—a study that has shown empirical evidence between design thinking training and dynamic managerial capabilities. Items captured sensing, seizing, and transforming capabilities. A sample item read "I systematically identify opportunities from changes in customer needs, new technologies, and the activities of other companies." Cronbach alphas internal consistency reliabilities were .839 (pretraining) and .814 (posttraining).

Table 1. Training program content and learning goals

Content	Learning goal (after completion of the trainings, participants …)	Learned tools
Introduction to design thinking	… understand the core practices of design thinking (user-centeredness, problem framing, experimentation, visualization) and its iterative process	–
Empathizing with users and identifying their unmet needs	… can apply ethnographic techniques (e.g., interviews) to gain deeper insights into customer	Ethnographic methods
Analysis of the generated results	… can synthesize the data gathered through ethnographic techniques and develop a hypothesis	Personas
		Journey maps
		Mind mapping
Problem framing	… can redefine a problem statement based on the generated customer insights	Point of view
Idea generation	… can apply creativity techniques for idea generation	Brainstorming
		Mind mapping
Visualization and rapid prototyping	… can convey ideas in simple, clear, and creative ways and create simple prototypes	Prototyping techniques (e.g., paper or Lego prototypes, click-dummies, role plays)
Testing with users	… can develop concept tests and engage users in co-developing ideas further	Field experiments
		Cocreation

4. Results

4.1. Manipulation check

We conducted a manipulation check to ascertain participants' knowledge of design thinking tools taught in the training. In the pretraining survey, we gave participants a list of eight tools (ethnographic methods, personas, journey maps, Brainstorming, mind mapping, prototyping techniques, field experiments, cocreation) and asked them to check the ones they are familiar with. In the posttraining survey, we asked them the same question. The manipulation check was done in two out of three companies. Rapid changes in operations due to the pandemic (Harper, 2020) prevented us from collecting additional data. However, as the training content was the same, we suggest that the result would be similar.

An independent sample t test showed the observed means of the intervention and control groups did not vary in the pretest survey, $t(36) = .814$, $p = .421$. In the posttraining survey, participants who attended design thinking training (M = 5.50, SD = 1.86) demonstrated better knowledge of design thinking tools than participants in the control group (M = 2.30, SD = 1.87), $t(36) = 5.29$, $p < .001$.

4.2. Exploratory factor analysis

We first conducted an exploratory factor analysis on a data set where pretraining and posttraining data were combined. We obtained three factors with self-values higher than 1. As can be seen in Table 2, the factor loadings are high enough, the variables load significantly only on one factor. For the factor analysis, all the primary factor loadings were above .603, which meet the requirements as identified by Comrey and Lee (1992).

4.3. Testing hypotheses

Descriptive statistics of the variables at both points of data collection and their correlations are presented in Table 3.

To establish initial equivalence between the intervention and the control group, we first examined whether key variables at T0 (pretraining time) and demographics were significantly difference between the two groups. There were no significant differences between the training and control groups in age, experience in the company, gender. No significant differences were found in either of the dependent variables prior to the intervention:

Table 2. Exploratory factor analysis: matrix of rotated components

Item	Dynamic managerial capabilities	Creative problem solving	Creative self-efficacy
I systematically identify opportunities from changes in customer needs, new technologies, and the activities of other companies	.792		
I systematically introduce changes in the ways of delivering products and services (i.e., inexisting routines and structures)	.769		
I routinely ensure that potentially good ideas do not get lost but instead are developed and actioned	.719		
I frequently share knowledge that has the potential to influence changes in existing products and services or organizational routines/structures	.713		
I frequently imagine how things look from the customers' perspective	.672		
I frequently take the risk of championing investments in new product and service solutions	.603		
I try out several definitions of the problem. I do not limit myself to just one way to define it.		.754	
I try to think about the problem from both the left (logical) side of my brain and the right (intuitive) side of my brain		.727	
I try to find underlying patterns among elements in the problem so that I can uncover underlying dimensions or principles that help me understand the problem		.716	
I try to be flexible in the way I approach the problem by trying out several different alternative methods rather than relying on the same approach every time		.668	
I try to unfreeze my thinking by asking lots of questions about the nature of the problem before considering ways to solve it		.657	
I often break down the problem into smaller components and analyze each one separately			.867
I have confidence in my ability to solve problems creatively			.855
I am good at finding creative ways to solve problems			.754
Explained variance (%)	35.803	12.777	11.403
Accumulated variance (%)	35.803	48.580	59.983

Note: Rotation method: Varimax with Kaiser Normalization. Loadings under <.350 are blended out.

Table 3. Means, standard deviations, and intercorrelations

	Variable	Time	M	SD	1	2	3	4	5	6	7
1	Dynamic managerial capabilities	T0	2.77	.76	.73						
2	Dynamic managerial capabilities	T1	3.08	.68	.66**	.68					
3	Creative self-efficacy	T0	3.67	.74	.28**	.22*	.71				
4	Creative self-efficacy	T1	3.76	.73	.30**	.41**	.73**	.85			
5	Creative problem solving	T0	3.61	.67	.28**	.16	.26**	.24*	.84		
6	Creative problem solving	T1	3.72	.65	.33**	.53**	.31**	.47**	.48**	.84	

Note: $N = 100$, T0 = pretraining, T1 = posttraining, square root AVE in the diagonal.
**Correlation is significant at the .01 (two-tailed).
*Correlation is significant at the .05 (two-tailed).

creative self-efficacy and creative problem solving (see Table 4). The intervention group had slightly higher dynamic managerial capabilities ($F(2,98) = 3.193$; $p = .077$) and had more opportunities to develop new products and services in their daily tasks ($F(2,98) = 3.611$; $p = .060$). To account for the possible effects of the opportunities to develop new products and services, we included this construct as a control variable in our model.

Finally, to test our hypotheses about the mediating role of creative self-efficacy and creative problem solving, we calculated the change of each dependent variable for each participant. We then used the SPSS process (Hayes, 2020) and bootstrapping procedure to examine the significance of the indirect effect. The path (direct effect) from design thinking training to the change in dynamic managerial capabilities was not statistically significant (coeff = −.085, SE = .119, $p = .478$). The path from design thinking training to the change in creative problem solving is positive and statistically significant (coeff- = .374, SE = .133, $p = .006$). The direct effect from the change in creative problem solving to the change in dynamic managerial capabilities was also positive and statistically significant (coeff = .302, SE = .088, $p = .001$). The path from design thinking training to the change in creative self-efficacy is positive and statistically significant (coeff- = .246, SE = .109, $p = .026$). The direct effect from the change in creative self-efficacy to the change in dynamic managerial capabilities was also positive yet not statistically significant (coeff = 201, SE = .107, $p = .064$). The paths from opportunity to develop new products and services to any of the dependent variables were not statistically significant.

The indirect effect was tested using nonparametric bootstrapping. If the null of 0 falls between the lower and upper bound of the 95% confidence interval, then the inference is that the population indirect effect is 0. If 0 falls outside the confidence interval, then the indirect effect is inferred to be nonzero. In this case, the indirect effect (IE = .163) is statistically significant at 95% CI = (.050, .316). Thus, the effect of design thinking training on dynamic managerial capabilities is fully by mediated problem solving and creative self-efficacy, rejecting Hypothesis 1 and confirming Hypothesis 2 and 3. Figure 2 summarizes the results.

5. Discussion and conclusions

The objective of this paper was to examine the mechanisms underlying the development of dynamic managerial capability through design thinking. Data from our quasi-experiment with 100 mid- and lower-level managers show that there is no statistically significant direct relationship between design thinking training and the improvement in dynamic managerial capabilities. Instead, this relationship is fully mediated by changes in creative self-efficacy and creative problem solving, latter having a stronger effect. To an extent, our findings are consistent with previous research that links design thinking training with dynamic managerial capabilities (Kurtmollaiev, Pedersen, et al., 2018). However, instead of confirming previous findings of a direct relationship between design thinking training and dynamic managerial capabilities (Kurtmollaiev, Pedersen, et al., 2018), we show that this effect is rather indirect and is realized through two specific changes in managerial cognition: improved creative problem solving as a mental process and improved creative self-efficacy as a psychological belief. Interestingly, the direct effect of the change in creative self-efficacy and the change in dynamic managerial capabilities was positive, yet not statistically significant.

A plausible explanation for these results might be that design thinking training does not realize its effects just by simplistically applying practices

Table 4. One-way ANOVAs to validate initial equivalence between intervention and control conditions

	Intervention group		Control group			
Variable	M	SD	M	SD	*F* test	*p* value
Age	41.65	10.46	41.06	9.73	.086	.770
Opportunities	3.00	.93	2.65	.94	3.611	.060
Experience in the company	9.18	9.47	11.77	9.75	1.812	.181
Gender	1.56	.50	1.71	.46	2.441	.121
Dynamic managerial capabilities	2.90	.67	2.63	.83	3.193	.077
Creative self-efficacy	3.71	.78	3.62	.70	.401	.528
Creative problem solving	3.63	.68	3.59	.67	.083	.773

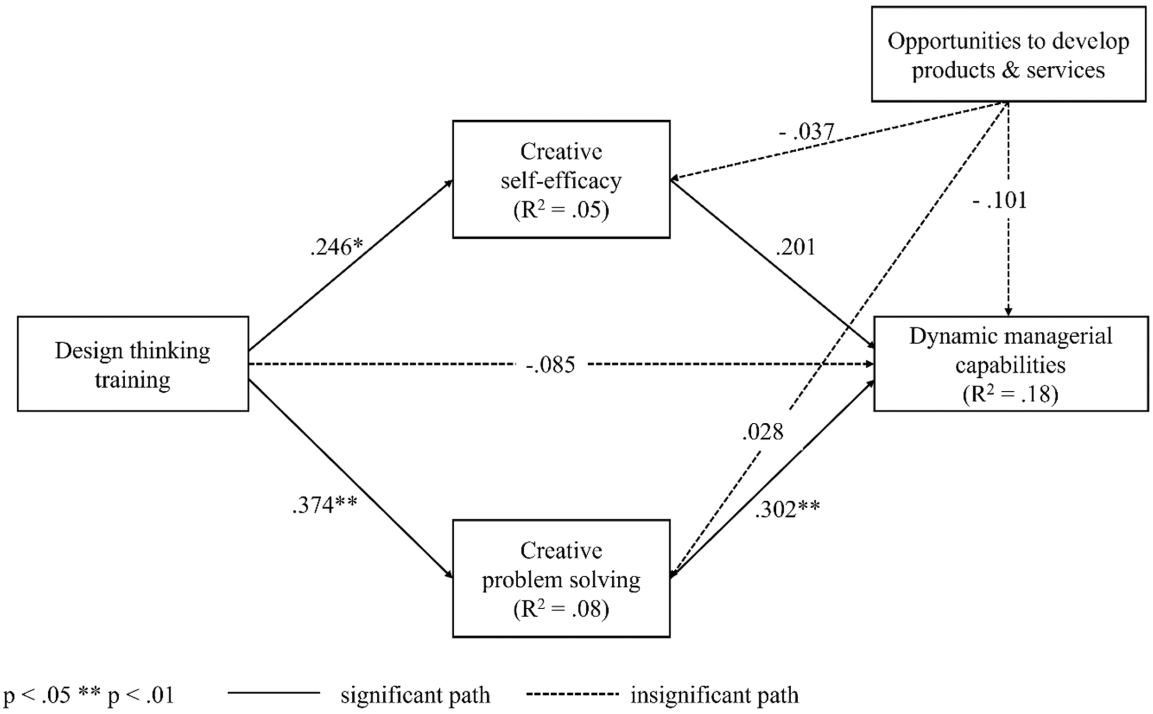

Figure 2. Model path and significant path coefficients, without controls.

and tools that are necessary for sensing and seizing opportunities and transforming organizational structures, resources, and routines. Instead, these practices and tools create a shift in managers' cognition that are invisible to the outside observer by altering managers' mental beliefs and their approach to creative problem solving, the latter having a stronger effect.

5.1. Theoretical contributions

The present study offers several theoretical contributions to the academic literature. First, it contributes to the academic discussion on the role of managerial cognition as an underpinning of dynamic managerial capabilities, which so far has been largely conceptual (Helfat and Peteraf, 2015) or focused on other aspects, for example, attention (Eggers and Kaplan, 2008). Research on managerial cognition has so far been labeled as complex and challenging, as it is difficult to observe individuals' thoughts and actions resulting from these thoughts (Corrêa et al., 2018). Consequently, there has been a call for more studies on how various mental and psychological mechanisms enable the development of more effective dynamic capabilities (Ambrosini and Altintas, 2019). Our results strengthen the proposition that dynamic managerial capabilities encompass not only physical but also cognitive activities (Helfat and Peteraf, 2015). Specifically, we show that dynamic managerial capabilities depend on both, a mental process that managers go through when they identify a relevant opportunity, generate, and evaluate alternative ideas on how to seize them (creative problem solving), and a psychological belief in their own creative abilities (creative self-efficacy). By improving their creative problem solving and creative self-efficacy, managers can enhance their dynamic managerial capabilities.

Second, our study contributes to the emerging discussion on dynamic managerial for mid- and lower-level managers. Teece (2016) argues that managers at all levels of the organization should exhibit sensing, seizing, and transforming capabilities, to achieve firm-level competitive advantage. Although previous research has mainly focused on examining top managers, the question of how mid- and lower-level managers can build up dynamic managerial capabilities has not been adequately addressed yet (Helfat and Peteraf, 2015; Ambrosini and Altintas, 2019). As our experimental study was conducted among mid- and lower-level managers, results broaden our understanding of how these managers—despite the lack of hierarchical power—are capable to use other resources such as their proximity to customers to spot and seize opportunities.

Third, we contribute to a scarce body of literature on the impact of design thinking on individual-level effects (Micheli et al., 2019) by providing empirical evidence on two important factors often linked to design thinking. Design thinking as an approach to

creative problem solving and design thinking as an approach to creative confidence have been identified as two out of four ways organizations interpret and adopt design thinking (Dell'Era et al., 2020). Despite the majority of organizations applying design thinking as an approach to creative problem solving (Dell'Era et al., 2020), the link between design thinking and individual creative problem solving skills has not been explicitly addressed in empirical research. It has been suggested that design thinking training should result in better creative problem-solving skills (Glen et al., 2014), yet this proposition has not been put to test. Similarly, boosting one's creative confidence has been often mentioned as one of the key outcomes of the design thinking approach (Kelley, 2012), which has motivated a significant part of firms to adopt design thinking (Kelley and Kelley, 2012; Dell'Era et al., 2020). However, despite strong conceptual arguments that design thinking training should result in increasing individual's trust in their creative abilities (Jobst et al., 2012), until now empirical evidence has been scarce (Ohly et al., 2017). By showing a significant positive relationship between design thinking training and both creative problem solving and creative self-efficacy, our study contributes to this important endeavor. Furthermore, it a more nuanced understanding of the so far unknown mechanisms through which design thinking realizes its effects on dynamic managerial capability development (Kurtmollaiev, Pedersen, et al., 2018).

Last but not least, in a broader sense our findings also add to the conversation that aims at bridging the boundaries between design thinking and dynamic capability literature (Liedtka, 2018; Magistretti, Ardito, et al., 2021). Magistretti, Ardito, et al. (2021) have recently proposed that design thinking itself is a dynamic capability for innovation that is anchored in processual, individual, and structural microfoundations. They argue that if an organization applies design thinking practices like empathizing with users, experimenting, prototyping, and deferring judgment, it has a dynamic capability for innovation (Magistretti, Ardito, et al., 2021). Furthermore, this capability is anchored in employees' individual mindsets and thinking styles, as well as certain organizational structures that, for example, encourage building creative confidence, and learning by doing (Magistretti, Ardito, et al., 2021). Thus, this theoretical perspective implies that despite an ineffective or wrong choice of design thinking practices a firm can sense, seize, and transform opportunities for innovation successfully as applying any design thinking practices constitutes a dynamic capability for innovation. We offer an alternative to this theoretical perspective and suggest that the relationship between design thinking and dynamic capabilities is rather causal in nature: when applied effectively, design thinking practices can help organizations to develop better dynamic capabilities. This is in line with propositions of Liedtka (2018) who argued that when viewed as a set of organizational routines design thinking can help organizations achieve the creation of a dynamic capability for innovation.

5.2. *Managerial implications*

From a practical perspective, our findings can assist managers who opt for a designated design thinking training format as a way to introduce design thinking into the organization, as suggested by previous literature (Hölzle and Rhinow, 2019). Our findings suggest that despite propositions that short workshops cannot result in any meaningful skill acquisition (McCullagh, 2010), a 2-day training can create positive medium-term effects. Table 1 outlines an overview of a possible training format that centers around acquiring design thinking methods and tools while working on a design challenge. In addition to the acquisition of methods and tools that support the implementation of design thinking practices, such training formats can help managers to improve their dynamic capabilities to spot and take advantage of opportunities in the market that have been proven strategically important for firm performance (Adner and Helfat, 2003). Furthermore, such trainings can also be used to improve creative self-efficacy and creative problem solving, both of which are antecedents for a series of other positive outcomes, such as sustainability of engagement (Bandura, 1997), and creativity (Eder and Sawyer, 2007).

Our study also shows an approach that industries can use when facing complex challenges. Since the COVID-19 pandemic, the aviation industry, which provided the empirical setting for our study, has only seen an increasing number of problems. The industry is currently grappling with significant labor market challenges, particularly in countries where the pandemic has been rapid. There is a shortage of pilots and other aviation personnel, which is making it difficult for the industry to meet its workforce needs (Boeing., 2022). The conflict between Russia and Ukraine has led to new no-fly zones, forcing some airlines to search for creative ways to offset the impacts this decision has created (IATA, 2022). Fuel prices have been rising and volatile, significantly affecting profitability and forcing airlines to optimize other costs (IATA, 2022). Another challenge the aviation industry faces is its own impact on climate change and raising customer concerns as well as the effects

climate change has on its daily operations as weather unpredictability is increasing (Gratton et al., 2021). Design thinking training shows a promising way to increase managers' abilities to sense opportunities in such environments, seize, and successfully implement them.

5.3. Implications for further research

Several limitations to this study need to be acknowledged. First, our study has a single-respondent design, which could pose challenges of common method bias. A multi-respondent design was not possible due to the companies' policies. To determine the robustness of our results, future studies could combine self-reported measures with supervisors' or peers' evaluations for dynamic managerial capabilities.

Second, as participants self-selected to participate in the design thinking training our study lacks the random assignment of participants to the intervention group. This might have aided the result that people in the intervention group perceived the opportunities to develop new products and services more. However, random assignment is rarely feasible in a real-world setting and may negatively affect the authenticity of the situation (Grant and Wall, 2009). The creation of an additional control group of managers with similar job tasks and experience as well as measurement of variables before and after the training program in both groups at the same time, helps to strengthen internal validity. Further studies that aim to extend this research and explore the development of further cognitive or psychological underpinnings of dynamic managerial capabilities and their interplay with human and social capital underpinnings of dynamic managerial capabilities could, however, benefit from classic experimental designs.

Third, our findings cannot be extrapolated to all types of design thinking training. We tested a training format commonly offered by consulting firms and design agencies. However, we cannot rule out the possibility that training with a different length, content, or learning methodology would deliver different results, leaving this for future research.

Finally, as a significant part of the research was conducted at the beginning of the COVID-19 pandemic, which was characterized by turbulent times, high uncertainty, and reduction of personnel, future research could repeat the study in the postpandemic situation.

Acknowledgments

This project was funded by a grant from the FFG Dissertation Program of the University of Applied Sciences Upper Austria, Project No. 868831 "Design Thinking – Its Effects on Product Innovativeness, Individual Development and Cognitive Biases."

Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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