Less Structure, More Impact? An evaluation of structured design thinking methods in higher education in architecture.

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Abstract: Design thinking is widely known as a creativity and innovation method among management disciplines and practitioners. While creative design disciplines have benefited from the rising awareness and application, the discipline of architecture has not embedded this development with an approach of its own, despite being at the forefront of designerly ways of working and design thinking as a mind-set. To assist architects in contributing and applying their particular form of design thinking, to foster entrepreneurial initiatives and to reduce the gap between architectural practice and other practices of design thinking, four different creativity formats based on existing methods have been evaluated at the Department of Architecture at the Technical University of Munich (TUM). The results provide a critical view of practiced phase-structured creativity formats for innovation. The key findings provide directions to develop an architectural design thinking approach, which is applicable to industries and challenges beyond building design and can re-integrate design expertise and meaning in the quest for innovation.

Keywords: design thinking; architecture; methods; innovation

1. Introduction

To cope with rising environmental and detailed complexities in industries and markets, management disciplines have learned from design-led professions and their abductive way of thinking (Boland & Collopy, 2004; Buchanan, 2008; Dorst, 2015; Martin, 2013). While industrial design, software and mechanical engineering have successfully developed and implemented a method of design thinking in fields beyond their specific domain, architecture has not rigorously applied its designerly ways of working to open and complex problems of strategy, organization, product and service development (Chantzaras, 2019c; Fisher, 2015; Lewrick, Link, & Leifer, 2017; Luebkeman, 2015). Despite being at the forefront of design thinking as a discipline and a mind-set for the past century, architecture has still to leverage its potential as an integrative and interdisciplinary discipline for transformation (Chantzaras, 2019a; Dorst, 2011; Rowe, 1987; Shamiyeh, 2016). Research into the practice of design professions and design thinking as conducted by Schön (1983), Rowe (1987) Cross (2007, 2013), Lawson (2005) and Lawson and Dorst (2009) reference architects as a study group, with a specific approach to design thinking (Chantzaras, 2019d). The continuing relevance of design thinking for the development of new structures and systems

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in industries, institutions and societies offers a window of opportunity for architecture to contribute and apply an architectural design thinking based on a critique of currently applied methods as overly linear, stage-phased, business-oriented, and decoupled from intuition, aesthetics, design expertise and creative engineering (Buchanan, 2015; Clancey, 2016; Verganti, 2017).

2. Theoretical Framework: Architectural Thinking & Design Process

Architectural thinking and the specific pre-design phase in the architectural design process serve as a theoretical framework whose specific characteristics are relevant to applied design thinking methods in other industries. Within this framework, a method for innovation and creativity initiatives has not been developed. Though the architectural programming approach has sought to apply architectural thinking and tools in a structured way to complex challenges beyond building design, it has not received broader attention, adoption and application (Chantzaras, 2019a; Cherry, 1999). Architectural programming has remained largely a method for effective communication with clients, for requirement planning and brief design. By evaluating creativity formats from other fields, implication and directions can be derived to develop an architectural design thinking methodology within the framework of architectural thinking.

Architectural thinking and the design process can be described by principle forms of reasoning and making. First, the thinking is directed to a betterment, what ought to be, and is less driven by possible solutions, market applicable and business feasible implementations (Boschung & Jachmann, 2013; Lawson, 2005; Mäscher, 2018; Nelson & Stolterman, 2012). It is inherently optimistic with a quest for synthesis in the real world to achieve a successful application of a new whole (ibid.; Dator, 2016; Gänshirt, 2012). In their thinking architects embrace complexity, challenge existing circumstances, integrate contradictory goals, sustain uncertainties until the very end of a design process, and work prospectively and constructively towards an alternative situation (Bachman, 2012; Gänshirt, 2012; Lawson, 2005). Architectural thinking considers relations and interdependencies in space and time. The implications and consequences of a design that is going to be built need to be imagined in advance in a "holistic approach with a long-term perspective beyond current client, user, or market demands." (Chantzaras, 2019d, p. 544; Cross, 2007). Second, the architectural design process is a reflection-in-action process, with a prototype-mindset and an intense use of non-verbal means, such as sketching, diagramming and modelling to create boundary objects (ibid.; Star, 2010; Wagner, 2000). The process foregrounds principles of acting rather than pre-defined process-steps to be followed and pre-selected tools to be used (Rowe, 1987). Activities to constantly move, represent, interpret, evaluate, manage, and formulate evolve from the skills and design expertise an architect has accumulated, and are agily combined throughout the process (Lawson & Dorst, 2009). Embracing complexity, re-interpreting the task, applying a large set of non-verbal tools to `think, play, do' (Dodgson, Gann, & Salter, 2011), especially with diagrams and 3-dimensional models, are skills which make architects bring to design thinking processes and which have applications beyond building design (Lewrick & Link, 2015; Oswalt & Vassal, 2016). Their thinking and design process can add a socially-oriented, holistic approach to the design of innovations, since architects must "design a thing by considering it in its next larger context" as Finnish architect Eliel Saarinen describes it (Keeley, Pikkel, Quinn, & Walters, 2013, 116). This resonates with a system design approach favored by design scholars and practitioners (Buchanan, 2001, 2015; Luebkeman, 2015; Senge, 2006).

Through testing different creativity formats for innovation at higher education, an empirical basis can be provided to discuss applicability and relevance of an architectural thinking approach in the current business-oriented practice of design thinking methods. The study provides first insights into the advantages and shortcomings of structured innovation methods and their application (Keeley et al., 2013,

p. 2; Verganti, 2017). It also allows to investigate the behavior and performance of students from architecture and other disciplines before experience as professionals might constrain and narrow their problem solving strategies. The four interdisciplinary formats were conducted, evaluated, and documented from October 2017 to September 2019, in cooperation with an alliance of five leading European architectural departments, funded by an Erasmus+ Grant on Strengthening Architecture and Built Environment Research (SABRE)[1]. The workshops (referred to as activities in the grant) also provided an opportunity to engage with different industries and relate new challenges in the context of the built environment to academia. The workshops were intended to foster architectural entrepreneurship, i.e. an entrepreneurial approach based on values and characteristics in architectural thinking, design processes and tools. During the workshops, the following hypotheses were tested:

- H1: Architectural students through their skills and knowledge innovation methods can positively impact and operate effectively in modes of collaboration and co-creation.
- H2: Structured, rapid & collaborative innovation methods taken from other fields are applicable in the context of Architecture and the Built Environment.
- H3: Creativity formats are applicable and useful in linking emerging challenges from practice of different industries with academia.

This paper describes the set-up, content and structure of each workshop. It summarizes the evaluation of each activity (i.e. workshops) and critically reflects key findings, learnings and limitations. It concludes by suggesting directions to develop a method of architectural design thinking within the framework of architectural thinking, and contributes to the discourse of applied methods of design thinking infuture.

3. Methodology: Preparation and Methodological Set-Up

Design Sprints, Business Games, Makethons, Hackathons and Enterprise Design Thinking formats are used across industries to foster collaboration, generate new ideas and develop new processes, products and services or business models (Chantzaras, 2019c; Knapp, Zeratsky, & Kowitz, 2016). Despite their popularity, the extent to which these methods improve collaboration, creativity and innovation, and what the drivers or inhibitors are for a successful process are requires further research (Keeley et al., 2013; Lewrick et al., 2017). The formats for the study were selected depending on the kind of problem in industry and society. The challenges formulated from this addressed social relevance, impact on specific industries and novelty in academic discourse and education. The subject of circularity was scheduled in 2017 (A), transformations in the architecture, engineering and construction industry (AEC) were investigated in 2018 (B), followed by the topic of future of work in the same year (C). In 2019, new concepts of living for urban nomads were set as a topic (D). Two workshops followed a rigidly defined process (A,C), two workshops were conducted with a more open agenda regarding tasks and tools (B,D). In each workshop, industry partners set the challenge or problem and participated to various extents as lecturers and facilitators. The application process, in which students needed to provide a motivation letter, a short curriculum vitae, and – for two workshops (C,D) – a portfolio of projects – ensured an interested and engaged group of participants. Credit points were granted for successful participation in

[1] The workshops were part of the 3-year Erasmus+ Strategic Partnership "Strengthening Architecture and the Built Environment Research" (SABRE). The BauHow5 alliance is a partnership of five leading European research intense universities in architecture & the built environment (UCL The Bartlett, TU Delft, Chalmers, ETHZ d.arch, TU Munich). SABRE is co-funded by the Erasmus+ programme of the European Union.

the workshop and the submission of an report of process and outcomes. For each activity, a physical space was set-up as a co-creative lab with toolboxes, plenum and breakout area. The workshops were organized by the internal academic staff of the Department of Architecture at TUM, and partially supported by researchers from the partnering universities and representatives of the industry partners.

4. Four Tested Formats, Four Themes

4.1 Design Sprint on 'The Circular University' (A)

The first creativity method in October 2017 was conceptualized as a design workshop on defining new concepts for circularity in higher education and universities. The design sprint was conducted with a German-based architectural practice and a Swiss furniture manufacturing company (Chantzaras, 2019c). The method developed by google ventures (GV) is characterized as "a "greatest hits" of business strategy, innovation, behavioral science, design, and more-packaged into a step-by-step process, that any team can use." (Knapp et al., 2016, p. 6). To foster interdisciplinary work, the call for applications was open to Bachelor's and Master's degree students from architecture, industrial design, management, civil and environmental engineering, science and technology studies, politics and informatics. The 35 participants assembled themselves into six teams with 5-7 members (72% female/28% male; 40% Bachelor's degree/60% Master's degree). 33 participants completed the five-day workshop, 28 submitted an extended post-workshop report. The days were scheduled from 10 am to 5 pm following the steps described in "Sprint: How to Solve Big Problems and Test New Ideas in Just Five Days" (Knapp et al., 2016): Day 1 - Context; Day 2 - Target; Day 3 - Decision; Day 4 - Prototype; Day 5 - Interview, Present. Afterwards, the teams were given additional time to iterate their work, integrate comments on their presentations and submit a report on concept and process. Five out of six teams finalized their work.

4.2 Creative Business Game on 'Start-Up Architecture' (B)

As second workshop, the Creative Business Game focused on new entrepreneurial directions for architectural practices and new business models in the AEC industry. The built environment and construction industry , which is among the largest industries in the world has not embraced innovation potentials offered by digital technologies (World Economic Forum, 2016). In a 2-day interdisciplinary business game with 24 Master's degree students from architecture, design, management and informatics, future entrepreneurial opportunities were questioned. Three business tasks were set by industry partners from an architectural practice. The workshop was conducted as a loosely structured format with few design tools and limited facilitation. The 24 participants from architecture and management studies assembled themselves into 6 teams of 4 members (39% female / 61% male; 96%). The teams worked independently on two days from 9am to 7pm: Day 1 - Context & Challenge; Day 2 - Model & Pitch. 5 of the 6 teams completed the workshop; only one group submitted a report as team; of the other four groups, only one team member in each completed and handed in their own documentation.

4.3 Enterprise Design Thinking Lab 'Workspaces for DigitalYou' (C)

In the third activity, future workplaces in knowledge-intense industries were focused on. Together with an international consulting firm and an information technology company, a 3-day enterprise design thinking lab was conducted with Master's degree students from architecture, management and information technology. Workspaces for the future were thought from a people-, technology- and building-driven perspective. The lab followed the IBM Enterprise Design Thinking Field Guide. Each team

was facilitated by researchers or one design thinker from IBM Watson IoT, who explained and supported the steps in the field guide throughout the three days (IBM, 2020). The 24 participants were assigned prior to the workshop to six specific teams of four to ensure an interdisciplinary and diverse mix of students (43% female/57% male). The workshop ran from 8am to 6pm daily: Day 1 - Context & Challenge; Day 2 - Ideation & Concept; Day 3 - Prototype & Pitch. Additionally, the final day of the workshop was documented in a short video: https://www.youtube.com/watch?v=5omeUayPyJc&feature=youtu.be

4.4 Community Design Lab - 'Designing Social Hubs for Urban Nomads'

In the fourth activity, the topic of future living in urban communities was emphasized. Together with a start-up incubator, a concept branch of a mobility company and an architectural magazine, the participants developed spatial, technological and social concepts for temporary communities in the city. The process followed a simply structured agenda. The 24 participants were grouped in advance into six teams of four (47% female/53% male) and were facilitated throughout the 2.5 days by one researcher or industry partner. The workshop days, except Day 1, were scheduled from 8:30 am to 6pm: Day 1 - Context; Day 2 - Problem & Ideation; Day 3 - Concept & Pitch. Five of six teams completed the workshop, but only six of the 24 participants handed in documentation. Additionally, the industry partners documented the workshop on video: https://www.youtube.com/watch?v=xkKGaHU21Uc

4. Discussion: Evaluating the Formats

All workshops were evaluated with a questionnaire to the participating students, and documented with pictures, video recordings and interviews. In the first part of the questionnaire, concept, workload, collaboration, results and benefits were assessed. The questions could be answered on a scale of 1, representing "strong agreement", to 5, representing "strong refusal." The plus signs in Table 1 represent the number of positive replies, in which "agreement" and "strong agreement" are aggregated (1+2).[2] The second part of the questionnaire comprised open questions to elicit personal statements, recommendations and advice for future development and implementation.

Table 1: Evaluation of the workshop based on questionnaires after completion.

Evaluation acc. Questionnaire	Design Sprint	Creative Biz Game	Enterprise DT Lab	Community Design Lab
(N: Number of participants)	33 replies N= 33	23 replies N=24	24 replies N=24	15 replies N=24
Concept, consciousness, target of circularity increased	++++	++	+++	++++
Workload, process, implementation were feasible	+++	++	+++	++++
Collaboration, interdisciplinarity, integration increased	+++	++	++++	+++++
Results, willingness to pursue idea further were satisfying	+++	++	+++	+++
Benefits to apply skills and use new insights occurred	++++	++	+++	++++

[2] Regarding the limited number of questionnaires, percentages are replaced by "+". Two plusses represent half of the participants with agreement and strong agreement, three plusses represent above 60%, four plusses above 80%, five plusses above 90%. Detailed figures in percentages are available in the workshop documentations: http://www.bauhow5.eu/output-2-2/

Overall, the format of a design sprint was well accepted by the participants. The majority regarded the method as an important extension of their architectural education and would favor an integrated module in future education to strengthen a structured discourse on complex problems. The time limitations for each task and day were appreciated by the students, and considered as a useful tool in working more focused and effectively on the architectural design process, as well as experiencing an "after-work-mode." On the other hand, the structured process was reported to impede in-depth discussions and hindered the working process, especially when a task needed to be conducted in a specific way, where architectural students would have preferred to apply other tools and invest more time. Due to the over-representation of architectural students, interdisciplinarity could not be achieved. The satisfaction rate was above average in the 33 replies, cumulating "agreement" & "strong agreement" (number of participants N=35). Regarding the Creative Business Game, nearly 60% of the participants were students from management studies, 40% came from the disciplines of architecture and landscape architecture. Only two teams assembled themselves equally with management and architecture students. Two teams proceeded with one architectural student, and two teams were entirely uni-disciplinary. Surprisingly, the students of architecture did not approach the challenge of redesigning the future practice of architectural offices. Satisfaction was decent in the 23 cumulated replies, and lowest across the other workshops (N=24). The Design Thinking Lab showed a high rate of acceptance among the participants. The strong user focus and work with the concept of personas offered a new approach for architects, but limited, on the other hand, more visionary and alternative approaches. The graphical tools applied (e.g. post-its) constrained the opportunities for the architects to use a broader range of non-verbal and visual tools. The satisfaction rate was high in 24 replies (N=24). In the Community Design Lab, participants came partially from outside academia. The response rate of the evaluation was 15 out of 24 participants. The highest satisfaction rate was evident in the 15 replies of (N=24) all conducted workshops, but at the same time, showed the lowest rate of development of ideas and the lowest rate of submitted documentation. This discrepancy needed to be further analyzed in order to derive key findings from the study.

5. Key Findings: Outcome follows Structure.

In addition to the findings from the questionnaires, the workshops were analyzed and compared according to their structure and working process, the intensity of facilitation and support provided, the disciplines represented and the achieved level of outcomes, i.e. the teams' projects and reports (Table 2).

Table 2: Review of the workshop based on set-up, idea development and rate of submitted reports.

Structure of Workshops	Design Sprint	Creative Biz Game	Enterprise DT Lab	Community Design Lab
Detailed agenda with tasks provided	yes	no	yes	no
Facilitation provided continuously	yes	no	yes	yes
Catering provided	no	partially	partially	yes
Disciplines present (if more than 2 representatives)	1	2	3	4
Share of architectural students	~ 85%	~ 40%	~ 60%	~ 30 %
Submitted reports by students (teams, individually)	28 of 35	8 of 24	20 of 24	6 of 24

Three key findings could be retrieved, regarding the impact of methodological structure, facilitation and the formulation of the challenge. First, structure had a positive impact on work process and development of concepts, but influenced the kind of outcomes. The structured format of a design sprint

and enterprise design thinking lab worked best in a setting of higher education. Both provided the students with comprehensible schedules and tools. However, the proposed tools and time constraints impeded the creative work of architectural students. For example, they had difficulties sketching on and thinking with sticky notes instead of the familiar mediums of large sheets of paper, sketch rolls and tangible models. The students were not used to interrupting a design process or design flow and proceeding with a subsequent task if a satisfying preliminary resolution had not been discovered. The structure influenced the direction and kind of outcomes but lead to a thorough development of the ideas and the highest submission rate of reports.

Second, facilitation had a positive impact if conducted by experienced and dedicated facilitators, as in the enterprise design thinking lab. The personal commitment of the supporters and lecturers contributed to a positive atmosphere. During the workshops, the consistency of the brief and its alignment to the problem context led to higher engagement among the students. Where facilitation was provided to a limited extent and in an unskilled way, teams struggled to proceed and perform.

Third, the formulation of the challenge and the kind of problem addressed influenced the number of applications and their diversity. When a societal impact in the challenge was stated, the number of applications, specifically by architectural students was higher. The interest and engagement of the participating students may be more intrinsically driven than can be fostered by extrinsic drivers such as prizes, awards and publicity. The creative business game with its direct focus on entrepreneurship and economic prosperity had the lowest application rate, and the second lowest rate of submitted reports after the activity. In the case of the community design lab, the societal impact was not perceived by the students as open as in the case of circularity in the design sprint or the theme of the future of work. Though the community design lab showed the highest satisfaction among students, the decent level of participation by the discipline of architecture and the lowest rate of submitted report leaves questions open for further research. In total, the outcomes reached the highest level of idea development in the structured methods, as evidenced in the enterprise design thinking lab and design sprint. The engagement of management students in the first-mentioned raised the level of completeness in the submissions.

Further observations could be made regarding the infrastructure, duration of each workshop and diversity in the teams. In terms of organization, the effort invested in the set-up, infrastructure, prize donations and catering across the workshops did not correlate with depth and quality of the elaborated outcomes. Regarding duration, at least 3-days were observed to be necessary for thorough development of ideas and were also confirmed as the preferable time frame by the students. The stakeholder engagement and interest correlated with the size of the company and the experience with structured methods for creativity and innovation. The larger the industry partner was, the more time it invested in the workshops. Regarding diversity, different gender, origin and study level positively influenced collaboration in teams in all workshops. A mix of Bachelor's and Master's level students increased the vitality of the workshops, especially among architectural students. The hypotheses set out at the beginning of the study were partially confirmed. The involvement of architectural students raised the breadth and novelty of the ideas developed (H1). Distinct elements of structure were recognized and shown as valuable for architectural design processes (H2). Current and emerging challenges from industry and society were shown to be transferable to higher education in a rapid way (H3).

6. Limitations

The conducted workshops, their evaluation and key findings have several limitations in terms of size, provision, teams and timing. The small size of the study allows only a preliminary statement of results,

which would need to be confirmed in further studies. As these kinds of workshops were conducted for the first time at a department of architecture, the quality of organization and conduct of the different activities varied according to the external support through industry partners and experienced facilitators. Appropriate facilitation could not be provided equally during all workshops. The disciplinary bias evoked by involving mostly architects in the workshops' set-up and implementation needs to be considered. The enterprise design thinking lab was led and facilitated by trained professionals. Its positive evaluation outlines the value and impact experienced design facilitation and a thoroughly developed methodology has on the level of overall success. Further, an equal level of team skills, capabilities and interdisciplinarity were difficult to achieve. The number and quality of applications and participation from architectural students varied across the workshops. In the case of the design sprint, the novelty of the format for architectural students may have led to the positive response and evaluation. Reference teams for comparison consisting of entirely architectural students and of interdisciplinary teams without architectural students were not set-up to compare process performances and outcomes. In terms of timing, the awareness of the workshops differed with the time they were held. When the workshops were announced and conducted before, during or after lecture times during a semester made a difference in this respect. Close to the start of lecture times appeared most feasible for students, if no competing formats from other institutions or industries were announced in parallel.

7. Implications & Future Research

The project provides a viable basis to firstly develop an architecture design thinking method, and secondly, to create a new way of conducting research. As a first implication, structured formats as experienced in the design sprint or enterprise design thinking lab can leverage the existing skill-set among architectural students for complex problem solving in interdisciplinary fields. With their structure, the existing formats offer opportunities for architects to immerse themselves in current and future topics to do with the built environment, which are increasingly addressed by other disciplines such as information technology, electrical and mechanical engineering. Regarding the relevance of the built environment for sustainable development goals, architectural students are enabled to engage in different design thinking processes with other industries and apply their own approaches and methods to addressing these issues. Existing formats such as the design sprint and an architectural design thinking methodology should be integrated into architecture study programs in higher education. Thus, modifications are necessary to tap the potentials of architectural thinking and design process in the most beneficial way. An architectural design thinking method should incorporate the design expertise, meaning and form-giving approaches of architects, their broad and open use of non-verbal tools and boundary objects, and their capacity to adapt and change time frames of tasks when needed. A revised method specifically for architects, as was initiated with architectural programming in the 1960s, could attract more architectural students, could foster interdisciplinary collaboration with other disciplines and contribute to the discourse on design thinking methods, in which architects are underrepresented (Chantzaras, 2019a; Cherry, 1999). In an internal review of this study by heads of research in architecture from the involved universities, Murray Fraser from The Bartlett School of Architecture, University College London commented: "It is interesting to see how much less overt 'design' there is in a design sprint compared to how we usually understand the term."

The specific characteristics of architectural thinking and design process may have a positive impact on the evolution of design thinking methods. Its adaptive and agile nature, its use of existing and new design tools, which are developed according to need, escapes the production of isomorphic outcomes which result from practicing existing design thinking methods (Hargadon, 2015; Verganti, 2017). In other words,

if identically structured methods of design thinking with similar tools are applied across organizations and industries, the outcomes will resemble each other, and therefore lose in innovativeness and competitive advantage. To create a distinct, meaningful and socially-oriented innovation, architectural design thinking may become more relevant. A current research direction, developed after the project, focuses on urban planning and urban innovation. The urban prototyping method is conceptualized and tested as a spatial design thinking method, which merges the speed and agility of existing design thinking methods with architectural thinking and processes for urban design. The urban prototyping lab as series of workshops investigates whether a rapid innovation method can be applied to spatial environments by designing, prototyping and testing novel ideas for urbanism.

A second implication is that design thinking methods – architectural and others – can create a new way of conducting research. The formats are suitable for channeling real-world problems from practice back to higher education. They can introduce academics, students and industry partners to new modes of thinking and working to better examine and uncover socially-relevant questions, create a shared understanding and develop research questions with a design-driven approach. As technological advancements continue apace, a value-based design for research and technology may be needed. For further research, and as intended in the funding, the dissemination of the project learnings is of major importance to enable other institutions European wide and globally to approach, test and integrate structured creativity and innovation formats. After a decade of applying design and design thinking for better businesses, the design of better worlds with an architectural approach is certain to gain in importance (Chantzaras, 2019b).

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