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Designing Creative Space

A Systemic View on Workspace Design and its Impact on the Creative Process

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DESIGNING CREATIVE SPACE

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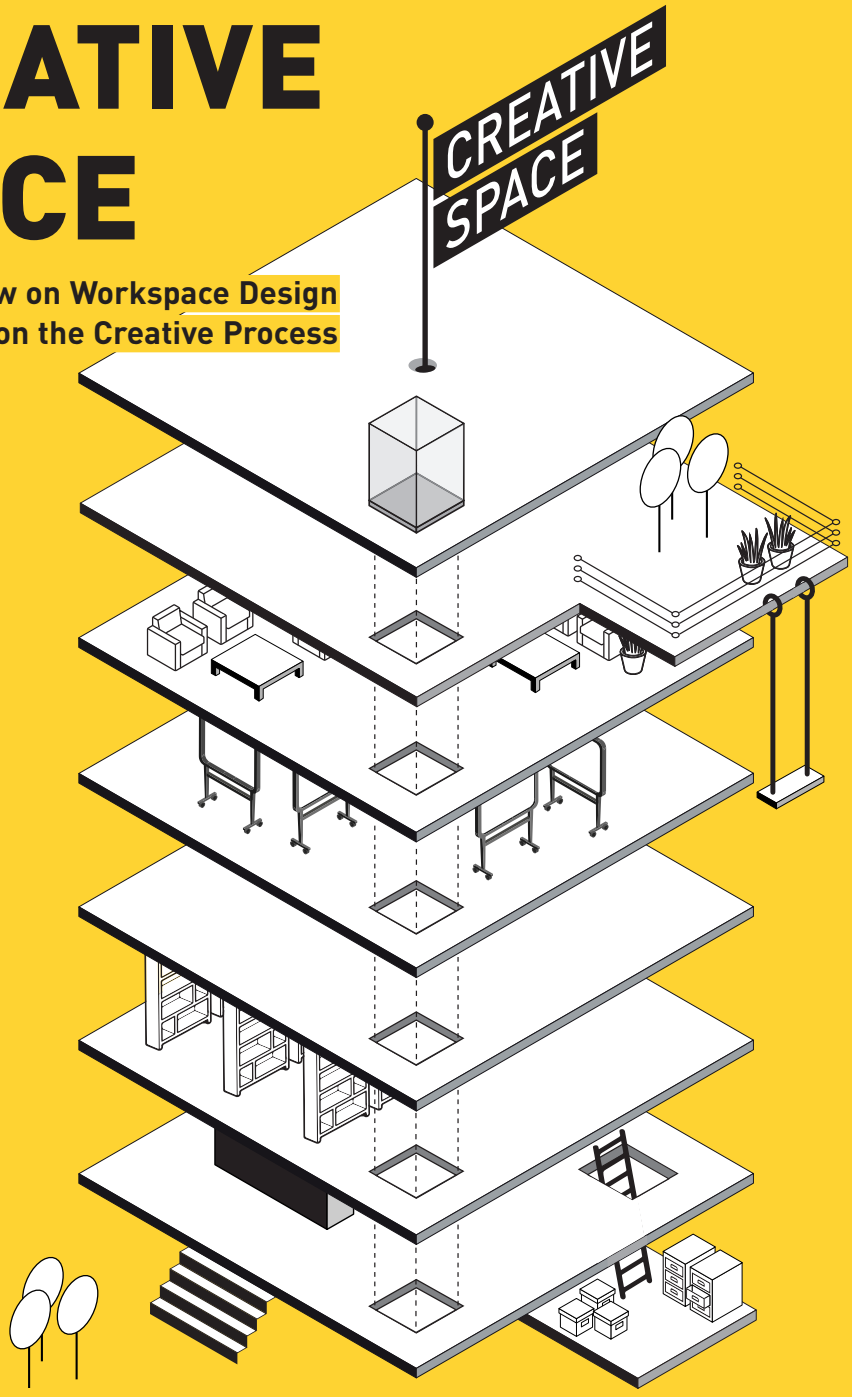

Katja Thoring

DESIGNING CREATIVE SPACE

A Systemic View on Workspace Design and its Impact on the Creative Process

Katja Thoring

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A Systemic View on Workspace Design and its Impact on the Creative Process

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ENGLISH SUMMARY

Work and study environments that facilitate creative design processes, the so-called creative spaces, have been gaining increased interest in recent years. The question whether or not the physical environment could support creative activities has attracted the attention of design schools, startups, and global enterprises. This PhD project contributes to this emerging field by providing a holistic investigation of the topic from different angles. The first part of this thesis explores the topic through four empirical studies, in order to gain a broad understanding of creative work and study environments. The second part pursues a practice-based design science approach that consolidates the findings in a set of tangible artifacts.

Empirical Part

A Typology of Creative Spaces
What kinds of spaces are required for creative activities and what qualities need to be provided by a space? In order to understand the system of creative spaces from a user's perspective, we conducted a qualitative study using cultural probes (Gaver, Dunne, & Pacenti, 1999) in a design educational, a design thinking, and a practitioner's environment. Through this approach it was possible to identify five different space types for creative activities, as well as five qualities a space should provide in order to support the respective activity. The findings were summarized in a typology of creative spaces.

A Pattern Language of Creative Spaces
How do creative organizations design their workspaces and what spatial design principles can be derived from it? Through an exploratory study in 18 organizations we developed an inventory of creative spaces that provides rich insights into contemporary workspace design. We were able to identify a total of 49 abstracted design principles that were summarized in a pattern language of creative spaces.

A Theory of Creative Spaces
How do specific spatial designs impact creativity? Based on nine expert interviews and related literature, we developed a total of ten propositions describing possible causal relationships between space and creativity. The resulting theory of creative spaces provides insights about possible working mechanisms of creative spaces and hence leads to a better understanding of the consequences of particular design decisions.

A Case Study of an Idea Lab
How are creative spaces designed and implemented in practice? Through a longitudinal case study of an idea lab, we gained first-hand insights on the planning and developing process of a real-life spatial planning project. The evaluation of the implemented space after two years of use provided insights about the requirements of different stakeholders. Moreover, the findings from this creative space development project informed the second part of this PhD project, namely, the design of creative space development tools.

Design Part

A Toolkit for Designing Creative Spaces
How can we facilitate and guide the process of designing creative spaces? We have developed a tangible toolkit that consolidates the collected insights from the previous studies, as well as a workshop concept for developing creative spaces in a co-creation approach. The toolkit consists of three elements: (1) inspirational cards with 49 abstracted design patterns and pictures of exemplary spaces, (2) several canvases for determining spatial configurations on (adaptable) floorplans, and (3) a set of trigger questions to prompt users to question and reconsider their spatial requirements. The toolkit is supposed to be used in a co-creation workshop together with spatial planners and future users of a space in order to involve all stakeholders in the spatial planning process.

The findings and results of this thesis contribute to the emerging topic of creative spaces in manifold ways. Researchers will benefit from the theoretical propositions that inform a better understanding of the causal relationship between physical space and creativity. We have highlighted several gaps open for future research in order to develop this emerging field further. Practitioners can find numerous examples of creative workspace designs that they will be able to adapt to their own contexts. Moreover, they can use the proposed tools to analyze and design their own work or study environments. And finally, also individual laypersons may find useful information about the impact of space on creativity, which will enable them to adjust their individual workspaces accordingly.

NEDERLANDSE SAMENVATTING

Werk- en studieomgevingen die creatieve ontwerpprocessen faciliteren, de zogenaamde creatieve ruimtes, hebben de afgelopen jaren steeds meer belangstelling gekregen. De vraag of, en zo ja hoe de fysieke omgeving creatieve activiteiten kan ondersteunen, heeft de aandacht getrokken van ontwerpscholen, startups en wereldwijde ondernemingen. Dit doctoraatsproject draagt bij aan dit opkomende domein door middel van een holistisch onderzoek van het onderwerp vanuit verschillende invalshoeken. In het eerste deel van dit proefschrift wordt het onderwerp verkend aan de hand van vier empirische studies, om zo een breed inzicht te krijgen in creatieve werk- en studieomgevingen. In het tweede deel volgt een praktijkgerichte ontwerpwetenschappelijke benadering die de bevindingen samenbrengt in een reeks van tastbare artefacten.

Empirisch Deel

Een typologie van creatieve ruimtes
Welke ruimtes zijn nodig voor creatieve activiteiten en welke kwaliteiten moet een ruimte bieden? Om het systeem van creatieve ruimtes te begrijpen vanuit het perspectief van de gebruiker, voerden we een kwalitatief onderzoek uit met behulp van *cultural probes* (Gaver, Dunne, & Pacenti, 1999) in een designonderwijs-, design thinking- en praktijkomgeving. Met deze benadering was het mogelijk om vijf verschillende soorten ruimtes voor creatieve activiteiten te identificeren, evenals vijf kwaliteiten die een ruimte moet bieden om de betreffende activiteit te ondersteunen. De resultaten werden samengevat in een typologie van creatieve ruimtes.

Een patroontaal van creatieve ruimtes
Hoe ontwerpen creatieve organisaties hun werkplekken en welke ruimtelijke ontwerpprincipes kunnen daaruit worden afgeleid? Via een verkennend onderzoek van achttien organisaties ontwikkelden we een inventarisatie van creatieve ruimtes, die een rijk inzicht geeft in de hedendaagse werkplekinrichting. In totaal hebben we 49 geabstraheerde ontwerpprincipes kunnen identificeren, die zijn samengevat in een patroontaal van creatieve ruimtes.

Een theorie van creatieve ruimtes
Hoe beïnvloeden specifieke ruimtelijke ontwerpen de creativiteit? Op basis van negen interviews met experts en relevante literatuur hebben we in totaal tien stellingen geformuleerd, die mogelijke causale verbanden tussen ruimte en creativiteit beschrijven. De resulterende theorie van creatieve ruimtes geeft inzicht in mogelijke werkingsmechanismen van creatieve ruimtes en leidt zo tot een beter begrip van de gevolgen van bepaalde ontwerpbeslissingen.

Een casestudy van een *idea lab*
Hoe worden creatieve ruimtes ontworpen en geïmplementeerd in de praktijk? Aan de hand van een longitudinale case study van een *idea lab* kregen we uit eerste hand inzicht in het plannings- en ontwikkelingsproces van een reëel ruimtelijk planningsproject. De evaluatie van de geïmplementeerde ruimte na twee jaar gebruik bood inzicht in de behoeften van de verschillende belanghebbenden. De resultaten van dit creatieve ruimteontwikkelingsproject vormden bovendien de basis voor het tweede deel van dit doctoraatsproject - het ontwerp van creatieve tools voor ruimte ontwikkeling.

Ontwerp Deel

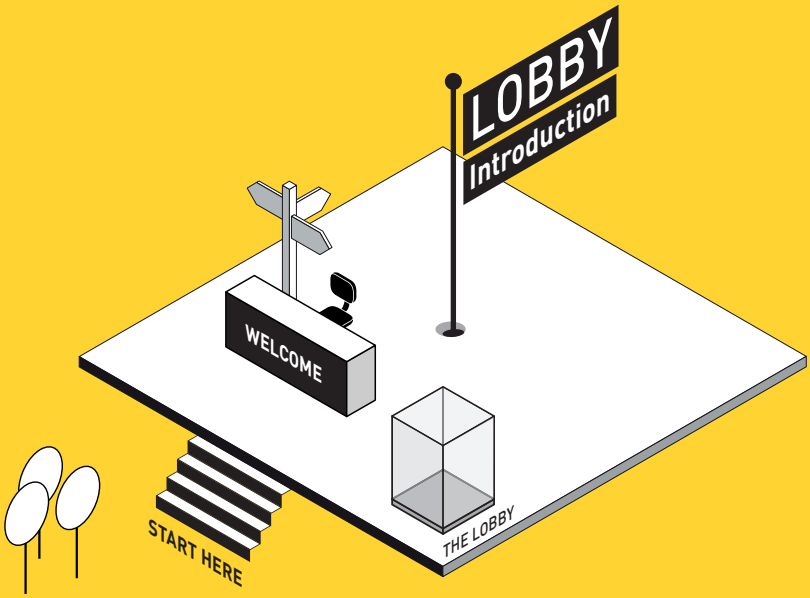
Een toolkit voor het ontwerpen van creatieve ruimtes
Hoe kunnen we het proces van het ontwerpen van creatieve ruimtes faciliteren en begeleiden? We ontwikkelden een tastbare toolkit die de verzamelde inzichten uit de vorige studies consolideert. De toolkit bestaat uit drie elementen: (1) inspirerende kaarten met 49 geabstraheerde ontwerppatronen en foto's van voorbeeldruimtes, (2) verschillende canvassen voor het bepalen van ruimtelijke configuraties op (aanpasbare) plattegronden en (3) een reeks triggervragen om gebruikers aan te zetten tot het onderzoeken en heroverwegen van hun ruimtelijke eisen. De toolkit is bedoeld om te worden gebruikt in een co-creatie workshop samen met ruimtelijke planners en toekomstige gebruikers van een ruimte om alle belanghebbenden bij het ruimtelijke ordeningsproces te betrekken.

De bevindingen en resultaten van dit proefschrift dragen op verschillende manieren bij aan het opkomende onderwerp van creatieve ruimtes. Onderzoekers zullen baat hebben bij de theoretische voorstellen die een beter begrip van de causale relatie tussen fysieke ruimte en creativiteit mogelijk maken. We belichten een aantal startpunten voor toekomstig onderzoek om dit opkomende domein verder te ontwikkelen. Mensen in de praktijk vinden tal van voorbeelden van creatieve werkplekontwerpen die ze kunnen aanpassen aan hun eigen context. Bovendien kunnen ze de voorgestelde tools gebruiken om hun eigen werk- of studieomgeving te analyseren en in te richten. Tot slot kunnen ook niet-specialistische lezers nuttige informatie vinden over de impact van de ruimte op de creativiteit, zodat ze hun individuele werkplekken kunnen aanpassen.

WELCOME... TO THE HOUSE OF CREATIVE SPACES.

1ST FLOOR: THE LOBBY

Start your tour on the 1st floor, in the lobby. Here, you will find lots of information about what to expect in this space. You can then stroll through the entire building to explore the different levels, or if you are in a hurry take the elevator and go directly to the top floor to THE PLAYGROUND, where you can find the tools that consolidate the insights from the previous floors. Enjoy your stay.



1. INTRODUCTION

1.1. MOTIVATION AND RESEARCH OBJECTIVE

Creativity has been identified as one of the key 21st century skills that are considered relevant for economic success and individual growth (P21, 2017). The skill-set proposed by the "Partnership for 21st Century Learning" includes the "4Cs": (1) critical thinking, (2) communication, (3) collaboration, and (4) creativity, which they suggest, should be implemented early into the curriculum of educational systems (P21, 2017). Similarly, in business and industry contexts, creativity and innovation have been recognized as major drivers for organizational success. For example, in his book "Creative Intelligence" Nussbaum described the emerging need for organizations to become more creative (Nussbaum, 2013). He refers to the 2010 IBM Global CEO Study, where more than 1,500 chief executive officers from around the world were surveyed. The results revealed that chief executives value *creativity* as the most important leadership quality, even more important than skills such as integrity or global thinking (Berman, 2010; Nussbaum, 2013, p. 16).

Consequently, it has become evident that creativity is highly relevant for the success of both, individuals and organizations. Hence, it comes as no surprise that in the last decades, various facets of creativity have been extensively investigated. The range of topics that have been studied include, but are not limited to, social influences (Amabile, 1983, 1990), cognitive states of mind, such as creative cognition (Ward, Smith, & Finke, 1999) and "flow" (Csikszentmihalyi, 1990, 1996), sources of inspiration (e.g. Goldschmidt, 2015; M. Gonçalves, Cardoso, & Badke-Schaub, 2014), creative personalities (Feist, 1999; Kelley & Littman, 2005; Sternberg & Lubart, 1995), creativity enhancement mechanisms (Amabile, 1996, p. 243 ff; Nickerson, 1998), computational creativity (Gero, 2000; Sosa & Gero, 2016; Wiggins, 2006), biologically-inspired creativity (Martindale, 1999; Simonton, 1999a, 1999b; Thoring & Müller, 2011), cultural aspects of creativity (e.g. Csikszentmihalyi, 2014; Lubart, 1999), creativity in teams, (Leonard-Barton & Swap, 1999; Stempfle & Badke-Schaub, 2002), as well as hindrances to creativity (Amabile, 1998), fixation effects (Jansson & Smith, 1991; Purcell & Gero, 1996), or "stuckness" (Sachs, 1999).

However, the role of the physical environment for facilitating creativity and innovation processes, and the workspace design in particular, have not yet been investigated in detail. On the contrary, the potential of the space to facilitate

creativity and innovation is one of the least considered factors. In her seminal book "*Creativity in Context*", Amabile (1996) discussed, among various other aspects, the possible influence of the work environment on creativity (Amabile, 1996, pp. 210–211, 230–236). She pointed out that to date (1983—the first edition of the book) there are almost no empirical studies on the influence of the work environment on creativity (as opposed to learning environments that were investigated in more detail). Later (1996—the updated edition of the book), she defined a set of nine intangible characteristics of the work environment that would influence creativity: freedom, project management, sufficient resources, organizational climate, encouragement, recognition, sufficient time, challenge, and pressure. However, none of these aspects addressed the *physical* work environment.

Only recently, an interest in creativity-supporting physical work environments has emerged. For example, the US company WeWork, an organization that rents creatively designed office spaces worldwide, is frequently valuated at several billion US Dollars (Hempel, 2017; Kessler, 2016). This company's rapid growth demonstrates the high value that is nowadays placed on workspace design.

The goal of this PhD project is to systematically analyze the role of the physical environment for creative work processes in design and innovation contexts. This so-called "creative space" is viewed as a complex system of architectural spaces for specific creative activities. The main focus of this research project is to identify the space types, qualities, and characteristics that facilitate creative activities, and to better understand the relationships and dependencies of these spatial parameters. The complexity of the system involves many aspects that can influence the creative work process; the range spans from specific spatial attributes, to cultural or personal preferences, to systemic arrangements and layouts of spaces, buildings, rooms, and furniture that might affect workflows and performance issues. This complex system of "creative space" shall be analyzed and understood from a systemic point of view. Additional guidelines and tangible tools will be developed that can be used to analyze, modify, or design a creative space from scratch, according to one's individual preferences, requirements, and prerequisites.

1.2. CREATIVE SPACE – A DEFINITION

The term "creative space" describes a relatively recent phenomenon of innovative workplace design. It consists of the two parts "creative" and "space", which define the research area between creativity and the built environment (Figure 1).

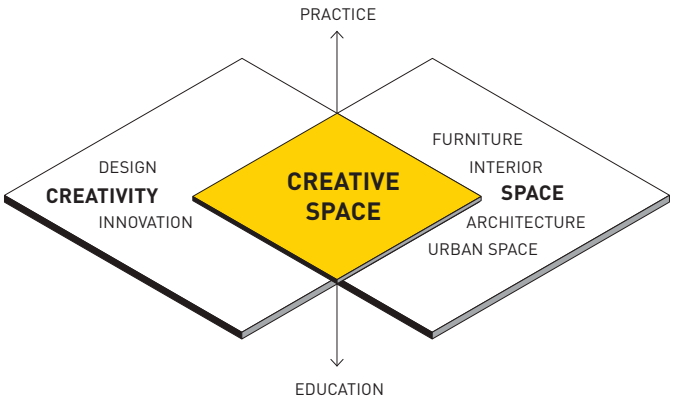


Figure 1. Research area "Creative Space" covers the intersection of creativity and the built environment in both education and practice contexts.

The term "creative" in this context is used as an umbrella term for different creative activities related to design and innovation processes (e.g. idea generation, prototyping, sketching, presenting). Hence, this investigation is not solely focusing on an attempt to enhance individual creativity, but rather looks at the entire creative process, which also addresses the general innovation processes in organizations. The term "space", on the other hand, refers to any aspect of the physical environment that could have an influence on this process and that can be modified or designed.

We define creative spaces as physical structures and elements at different scales that are deliberately designed to support creative work processes or to facilitate creativity. The range of scales includes small-scale single elements (items), the room's layout and interior design (interior), the architectural building (architecture), and the location within a specific urban context (neighborhood), as illustrated in Figure 2.

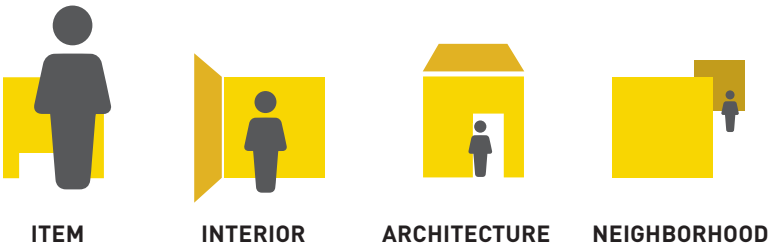


Figure 2. Different scales on which a creative space can be addressed.

More specifically, the smallest scale (1) refers to items that are not fixed and do not belong to the users but are part of the equipment (examples are pieces of furniture, potted plants, posters on walls, tools, and other equipment). The interior (2) includes entire rooms (e.g., kitchen, meeting rooms), arrangements within one room that form a complex system (e.g., lounge areas comprised of various pieces of furniture), as well as installed elements within the room that are not easy to move or to change (such as wallpaper, wall-to-wall carpeting, dividing walls, etc.). Intangible characteristics of the work environment, such as smells or sounds, are also considered part of the interior. The architecture (3) addresses the entire building, the exteriors of the building (e.g., façade, balcony), the interplay of several rooms, as well as structural aspects, such as windows, doors, or staircases. Finally, the neighborhood (4) refers to the interplay of several buildings and the space between buildings (e.g., a campus area), outdoor areas, as well as the location within a broader urban context (such as the proximity to the city center). The borders between the scales are blurred; for example, wall dividers on wheels fall into the "item" category, whereas a wall divider that is mounted to the floor becomes part of the "interior".

A creative space covers spaces in both, educational and corporate environments. The creative activities are comparable in both contexts, but educational institutions have a stronger focus on knowledge transfer and learning. However, learning also plays an important role in practice. Design practitioners constantly have to adapt to new situations and contexts. No design project is the same, and research is part of almost any design project. At the same time, today's design education is mainly centered on project work, sometimes involving real clients. Consequently, design educational environments are considered to have similar requirements as spaces in design practice. Analyzing creative spaces in both design education and design practice is expected to reveal interesting insights for both worlds.

We have also looked at creative spaces in affiliated institutions, such as incubators, makerspaces, co-working spaces, and innovation labs. Creative spaces in other creative contexts, such as art or music, are outside the scope of this research. Following the definition provided above, a creative space does not necessarily have to look differently than traditional office space, as long as it is able to facilitate creative activities. Nevertheless, companies such as Google, have coined the general notion of creative spaces with their unorthodox office designs, involving, for example, beanbags, napping areas, and slides between office floors.

As a result of the media coverage of creative spaces from companies such as Google or WeWork, when people think of a creative workspace, the first picture that comes to mind could be a fancy open-plan office with Vitra furniture and beanbags. This image can lead to the premature assumption that one only needs to install such peculiar interior elements to automatically transform the organization into a successful innovation game changer. Unfortunately, it is not that simple. The system of creative space is far more complex and involves more aspects and parameters than just installing new furniture. This complex system is the focus of this investigation.

1.3. PRACTICAL RELEVANCE

The design of the workspace can have a substantial impact on an organization on different levels. The consequences affect the organization internally—for example, increase or decrease employees' well-being and comfort, as well as their productivity and efficiency. At the same time, the workspace design might also affect the organization's external image, either on-site, among customers, or in the media. The various choices and possible design decisions for spatial elements and configurations can result in certain qualities of a work environment that can in turn cause a specific impact. Hence, a better understanding of the impact of such decisions is vital for an organization's success.

As early as the 1950s and 1960s research has been done on the influence of the office environment on work performance and on employees' well-being, which is mainly found in literature on ergonomics and human factors or in historic essays about office environments (Clements-Croome, 2006; Kroemer & Robinette, 1968; Rho & Franz, 2008; Saval, 2014). Since then, office work has transformed from pure administration and information processing (bureaucracy) toward focusing on the requirements of creative work (Drucker, 1954, 1985) while administration is more and more automated. However, office space

originated from the context of administrative work (Saval, 2014) and still resembles this origin in many traditional companies.

"Creative space" is a newer concept that has emerged in the past decades. Mainly in start-up companies it has become clear that the majority of employees was working creatively, which raised the question if and how space could facilitate this creative work. This has led to a trend toward designing "creative" offices and workspaces—where "creative" mainly meant "fancy" or "different" (Borges, Ehmann, & Klanten, 2013; Groves, Knight, & Denison, 2010). Moreover, a company's need to innovate has been widely recognized and, hence, a well-designed work environment that would actually facilitate the innovation potential of companies and individuals bears the chance for competitive advantages. Consequently, the investigations presented in this PhD thesis might serve as guidelines for companies and design practitioners, who want to increase their innovation potential through their workspace design. The evidence-based toolkit for designing creative spaces, presented in Chapter 8, provides organizations and individual practitioners with a tangible instrument for analyzing their work environments, for defining spatial requirements, and for developing spatial design ideas in a co-creation approach.

1.4. THEORETICAL RELEVANCE

As we will demonstrate in our literature review (Chapter 3), the research on creative spaces is still in its beginnings. Although creative spaces are widely implemented in companies and educational institutions, and new working concepts, such as co-working spaces and hot-desking are becoming popular, there is relatively little theoretical underpinning. What is lacking is a holistic understanding of the causal relationships between spatial design decisions and creative impact, in conjunction with theoretical explanations as to why in particular situations one spatial design would work better than another one.

As Goldschmidt outlined in an extended editorial in the *International Journal of Design Creativity and Innovation*, the need for a fundamental theory of design creativity persists (IJDCI, 2013, p. 7). With this PhD project, we aim to contribute to this effort by providing an explanatory causal model of the influence of the built environment on creativity. We argue that with this preliminary theory of creative spaces (presented in Chapter 6), and the underlying design patterns for creative spaces (presented in Chapter 5) we provide a piece that might help to complete the bigger picture of a fundamental theory of design creativity.

1.5. RESEARCH METHODOLOGY

We tackled the question of how the spatial work environment can facilitate creativity from different angles. Our methodological approach is comprised of various qualitative and explorative studies, before we condensed our findings into several designed artifacts and a co-creation workshop concept that support practitioners with designing creative spaces. The following subsections describe the thesis structure, the individual research and design questions, as well as the methods and studies to address those questions.

1.5.1. Thesis Structure and Overview

This thesis is composed of two major parts: The first part explores the topic theoretically through various empirical investigations that resulted in a typology of creative spaces, a pattern language with abstracted design principles, and a theory about possible working mechanisms of creative spaces. Moreover, a longitudinal case study of an idea lab yielded insights into practical requirements for creative spaces, as well as spatial planning processes. The second part consolidates the findings into several tangible tools for designing creative spaces. In an iterative action design research approach, several tools and a workshops concept were developed and tested. Figure 3 illustrates the overall research course. The diamond shape reflects both, the explorative nature of the empirical part, in which various studies were conducted, and the convergent nature of the design part, in which the findings were condensed and synthesized.

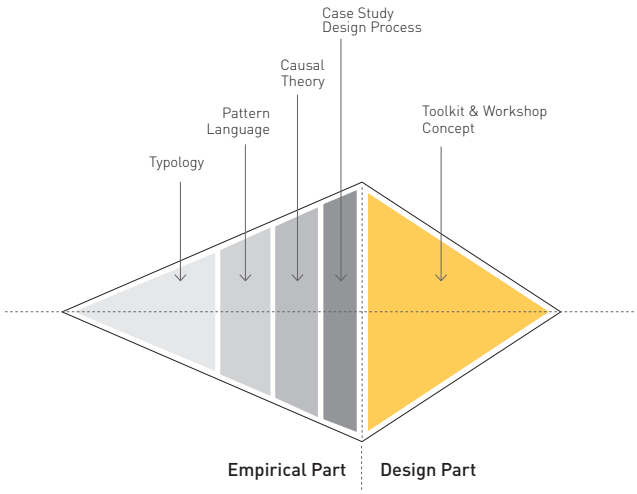


Figure 3. Two-part thesis structure: Empirical part (understanding creative spaces) and design part (designing creative spaces).

1.5.2. Research and Design Questions

This PhD project is guided by a central research question and a resultant design question.

> ***Central Research Question:*** *How can the physical work environment facilitate creativity and innovation?*

We want to understand the possible impact of the workspace design on creative activities and design processes in different contexts and for different stakeholders. Furthermore, we want to understand possible theoretical explanations for the working mechanisms of specific spatial designs. When this question has been answered sufficiently a subsequent design question emerges.

> ***Resulting Design Question:*** *How can we provide practitioners with the required knowledge and tools to design workspaces that facilitate creativity and innovation?*

To answer these two main questions, several sub-questions were formulated that guided the overall process of this PhD project. They were addressed through various theoretical investigations and literature reviews, several empirical studies, and a design science approach with several iteration loops. These sub-questions evolved over time and were rephrased after each of the preceding steps. For better comprehensibility, we present the reader with the final questions that were used for each individual sub-step of the entire project. Figure 4 outlines the conducted studies in alignment with the respective research and design questions, the chosen research approach, and the resulting outcomes.

To dive into the topic, we first looked into existing sources of literature.

> ***Research Question 1****: What is the historical context in which creative spaces emerged?*
>
> ***Research Question 2****: What is the state of the art of research on creative spaces according to the literature?*

To answer these questions, we searched relevant literature on the history of the workplace and present a brief overview in Chapter 2. Following this, we conducted a systematic literature review on the topic of creative spaces. The results are summarized in Chapter 3.

To establish a foundation for the further development of the research project, we aimed at developing a classification system of relevant parameters within the realm of creative spaces.

***Research Question 3**: What are types and qualities of creative spaces in design and innovation contexts?*

With this question we wanted to find out what kinds of spaces are necessary for creative work and what qualities such a creative space should provide. This question was addressed through a qualitative user study with cultural probes in two different institutions (Study 3). The participants provided personal insights on their respective existing workspaces, as well as their wishes and ideas for improvements. As a result, we developed a typology of creative spaces that outlines five different space types and five different qualities of a creative workspace. Additionally, we formulated a requirements matrix that outlines the requirements of a space according to the spatial qualities, based on the insights from the two user studies. After finalizing the typology, we conducted another study to evaluate its applicability.

***Research Question 4**: Can we transfer the typology [developed following RQ3] to different contexts and to different stakeholders?*

In order to validate the developed typology, we tested it in an action research workshop (Study 4) in a different context and with different stakeholders than the participants in Study 3. The results of both studies are presented in Chapter 4.

Following this step, we searched for real-life examples of creative spaces in different organizations to identify emerging patterns of creative spaces.

***Research Question 5**: How do organizations from the creative sector design their workspaces, and what spatial design patterns can be identified?*

We conducted a holistic multi-case study in 18 organizations from the creative sector (Study 5). The insights from this study were consolidated by mapping the found examples to the previously developed typology of creative spaces. The results are presented in Chapter 5.

Subsequently, we wanted to understand possible theoretical explanations as to why specific spatial configurations could result in the facilitation of creativity.

***Research Question 6**: What are spatial conditions for facilitating creativity and innovation and how can these be explained through theory?*

To answer this question, we conducted nine interviews with experts from different creative fields that would provide us with different perspectives on the subject (Study 6). The interviews were supplemented by an additional literature review. As a result, we developed ten propositions that form a preliminary theory of creative spaces. The results are presented in Chapter 6.

In the next step, we wanted to understand how organizations plan, design, and implement creative spaces.

> ***Research Question 7**: What can we learn from an organizational creative space implementation project?*

To answer this question, we conducted a longitudinal case study in one institution that was studied for more than two years—from the initial planning process to the actual use of the finished space (Study 7). The insights we gained are summarized in Chapter 7. The findings informed our final step, which is to design tools for supporting the development process of creative spaces.

> ***Design Question 8**: How can we support the process of designing creative spaces?*

In order to support people and organizations who are planning to design a creative space, we developed toolkit consisting of a workshop concept and a set of creative space facilitation tools (Study 8). Among the tools we developed were a card set containing insights gained through Study 5 and 6, several canvases, stickers, and floorplans to facilitate a co-creation workshop.

According to the pursued action design research approach, we also evaluated the developed tools in a realistic context.

> ***Research Question 9**: Is the creative space development toolkit useful and feasible for organizations?*

In order to test, improve, and validate the toolkit and the workshop concept we developed, we conducted a workshop at an institution that was in the process of designing a new workspace (Study 9). The analysis of this evaluation workshop yielded several insights that resulted in various modifications of the toolkit. The entire toolkit development process, the evaluation workshop, and the final toolkit are summarized in Chapter 8. We conclude by summarizing our findings from all of the studies and present an outlook for future work in Chapter 9.

Figure 4 Illustrates the entire thesis project and outlines the conducted studies, the underlying research and design questions, the chosen research approach, and the resulting contributions.

Chapter	Section Title	Research/Design Question	Method/Study	Result
1	LOBBY			INTRODUCTION
2	LIBRARY	1 What is the historical context in which creative spaces emerged?	1 Exploratory literature study	HISTORY
3		2 What is the state of the art of research on creative spaces, according to the literature?	2 Systematic literature review	LITERATURE REVIEW
4	STUDY ROOM	3 What are (a) types and (b) qualities of creative spaces in design and innovation contexts?	3 Cultural probes studies – Dessau Design School – HPI Potsdam	TYPOLOGY Typology of creative spaces, Requirements matrix
		4 Can we transfer the developed typology to different contexts?	4 Action research workshop at Kassel Idealab	Typology validation
5	LAB	5 How do organizations from the creative sector design their workspaces, and what spatial design patterns can be identified?	5 Exploratory multi-case study in18 institutions. Pattern development through conceptual mapping	INVENTORY Best-practice examples PATTERN LANGUAGE 49 Abstract design principles
6	LOUNGE	6 What are spatial conditions for creativity and innovation and how can these be explained through theory?	6 Expert interviews literature review	THEORY Evidence-based theory: 10 Propositions with theoretical explanations
7	BALCONY	7 What can we learn from an organizational creative space implementation project?	7 Longitudinal case study at Kassel Idealab	CASE STUDY Requirements for creative space development tools
8	PLAY-GROUND	8 How can we support the process of designing creative spaces?	8 Design science approach: – practice based design – visual mapping	TOOLKIT Set of facilitation and planning tools
		9 Are the developed tools applicable to real projects?	9 Evaluation Workshop – Nottingham University	Toolkit validation Toolkit iteration
9	ROOFTOP			CONCLUSIONS Discussion, reflection and outlook

Figure 4. Overview of chapters, research and design questions, related studies, and outcomes.

1.5.3. Triangulation of Studies and Methods

The various relationships of constructs within the topic of creative space require a complex braid of different approaches. We wanted to learn about the users' assessments of their workspaces, but also to understand the point of view of architects, office planners, and other experts. Moreover, we were interested in what types of spaces were relevant for what activities, and in understanding why a certain spatial design would have a specific impact. Finally, we wanted to see how

creative spaces are designed in different organizations, how such spaces were developed, and how we could facilitate such a development process through adequate tools. Consequently, a multitude of different methodological approaches guided this thesis. Through the triangulation of different approaches we were able to develop a holistic picture of the complex system of creative workspace design and its impact on the creative process.

The first, empirical, part of this thesis is comprised of several qualitative studies. We collected data from multiple sources, such as design educational institutions, design thinking institutions, design practice, co-working spaces, and from the innovation departments of large enterprises. We conducted interviews with experts from various fields and looked into related studies that had already investigated particular spatial aspects and their impact on creative work. We followed the qualitative method as suggested by Yin (2003) and Lee and Baskerville (2003) to ensure a high degree of research rigor. Moreover, we applied several cultural probes studies (Gaver et al., 1999; Mattelmäki, 2006) to gain insights on the users' assessments of and requirements for their workspaces. Through the triangulation of different data sources, different research methods, and different researchers, we were able to develop a holistic understanding of the complex system of creative space. We provide more details about each study's methodology in the respective Chapters 4, 5, 6, and 7.

The second part of this thesis condenses the empirical findings into a set of practicable tools and a workshop concept that has been developed to support practitioners when assessing or designing creative workspaces. This toolkit was developed following a design science and action research approach as suggested by Hevner et al. (2004) and Sein et al. (2011). It has been applied and tested in a realistic spatial planning workshop and has passed through several iteration cycles. More information on the design science methodology can be found in Chapter 8.

All of the conducted studies informed each other. The empirical findings are triangulated with each other and with the related literature. The developed typology, pattern language, and causal theory were used to inform a practical toolkit. Figure 5 shows a visual graph that illustrates the relationships and interdependencies of the studies and how the different contributions inform each other. More details on the literature review (Study 1 and 2) can be found in Chapter 2, starting on page 41, and Chapter 3, starting on page 51, respectively. Study 3—the cultural probes study that explores the requirements of creative spaces

from a user's perspective and yielded in a typology of creative spaces—is described in Chapter 4, starting on page 71. The description of the typology validation workshop can be found in Section 4.6, starting on page 99. The multi-case study (Study 5), where we investigated contemporary workspace designs in 18 organizations, yielded an inventory of existing creative spaces. Through the mapping of the instantiations with the typology of creative spaces, we identified patterns that were summarized as a pattern language of creative spaces, (Chapter 5, starting on page 113). The causal theory of creative spaces, which was developed based on nine expert interviews and evidence from the related literature (Study 6), is described in Chapter 6, starting on page 153. A longitudinal case study of the design of an idea lab (Study 7, page 193) informed the toolkit development (Study 8), which is presented in Chapter 8, starting on page 213. Section 8.6, starting on page 223, describes the action research cycle of designing, evaluating, and iterating the toolkit (Study 9).

The typology of creative spaces provides structure to the pattern language, to the causal theory, and to the toolkit. The pattern language becomes part of the toolkit in the form of 49 pattern cards. The pattern language has also been mapped to the causal theory, in order to present the theoretical explanations for the possible working mechanisms of each pattern. Figure 5 outlines the relationships of the different studies and their relating contributions.

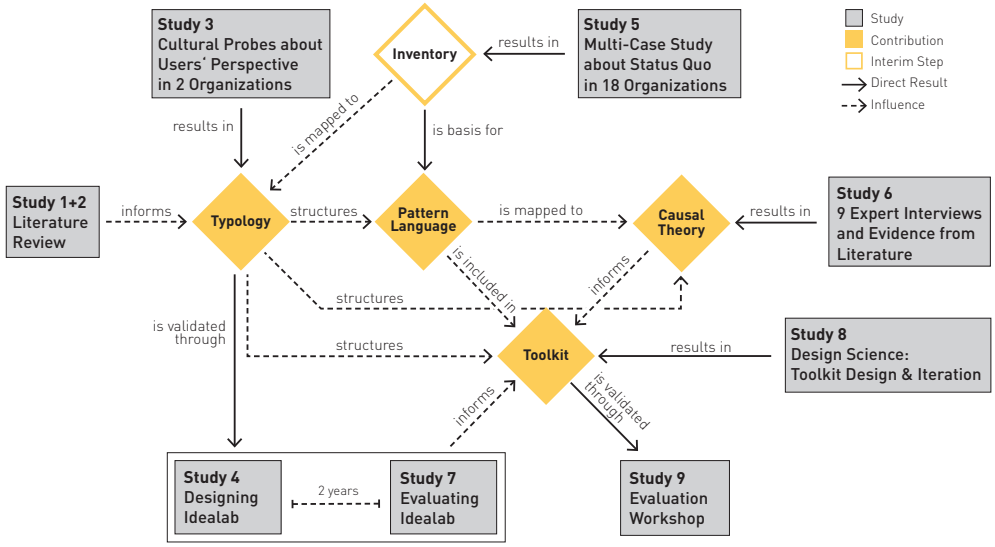


Figure 5. Interrelationships of studies and contributions.

1.6. WHAT THIS THESIS IS NOT ABOUT

The readers might expect to find several aspects in this thesis, which, however are not included, for various reasons.

(1) No quantitative studies or experiments are part of this thesis. Instead, we provide a holistic, systemic perspective on the topic, which has been developed based on several qualitative studies. This explorative approach allows us to study the topic in realistic contexts and to derive evidence-based theories. Hence, the focus of this PhD project is on theory-building through an inductive approach, rather than on theory-testing. The developed preliminary theory provides a holistic understanding of relationships between space and creativity. This causal theory can be tested in the future through further experimental studies designed to validate its applicability and generalizability.

(2) We do not provide concrete, prescriptive design solutions nor style-guides that would suggest, for example, specific furnishings or color schemes to the readers, because such design decisions are dependent on varying factors, including personal preferences, cultural context, and size and type of the organization. Instead, we present evidence-based, abstracted design principles that provide the readers with the required knowledge about possible causal relationships and inter-dependencies. Furthermore, we provide a selection of best-practice examples, along with theoretical explanations about possible working mechanisms, as well as possible benefits and drawbacks of the presented spatial configurations. With these provided insights and tools, the readers are enabled to make their own design decisions.

(3) We have focused on the physical aspects of the work environment, and have observed how people interact with the space. We do not, however, consider people's personal preferences and character traits, even though these might also affect the perceived quality of a creative space. Moreover, we disregard the intangible climate of the workspace (such as supervisory encouragement, time pressure, and personal freedom). An investigation of these aspects has been dedicated to future work.

1.7. PUBLICATIONS RELATED TO THIS THESIS

Parts of this PhD thesis have been published in or submitted to the following journals and conference proceedings.

1.7.1. Journal Publications

(1) K. Thoring, P. Desmet, and P. Badke-Schaub, 'Creative Environments for Design Education and Practice: A Typology of Creative Spaces', *Design Studies*, vol. 56, pp. 54–83, May 2018.

(2) K. Thoring, R. M. Mueller, C. Luippold, P. Desmet, and P. Badke-Schaub, 'Co-Creating an Idea Lab: Lessons Learned from a Longitudinal Case Study', *CERN IdeaSquare Journal of Experimental Innovation*, vol. 2, no. 1, pp. 30–37, 2018.

(3) K. Thoring, R. M. Mueller, P. Desmet, and P. Badke-Schaub, 'A Pattern Language of Creative Spaces, *Journal of Product Innovation Management* (under review).

1.7.2. Conference Papers

(4) K. Thoring, P. Desmet, and P. Badke-Schaub, 'Creative Space – A Systematic Review of the Literature', in *Proceedings of the 22nd International Conference on Engineering Design (ICED19)*, Delft, The Netherlands, 2019

(5) K. Thoring, R. Mueller M., P. Badke-Schaub, and P. Desmet, 'An Inventory of Creative Spaces – Innovative Organizations and their Workspace', in *Proceedings of the 22nd International Conference on Engineering Design (ICED19)*, Delft, The Netherlands, 2019

(6) K. Thoring, R. Mueller M., P. Desmet, and P. Badke-Schaub, 'Design principles for creative spaces', in *Proceedings of the 15th International Design Conference*, Dubrovnik, Croatia, 2018.

(7) K. Thoring, R. M. Mueller, P. Badke-Schaub, and P. Desmet, 'A creative learning space development toolkit: empirical evaluation of a novel design method', in *Proceedings of the 21st International Conference on Engineering Design (ICED17)*, Vancouver, Canada, 2017, vol. Design Education, pp. 245–254.

(8) K. Thoring, M. Gonçalves, R. M. Mueller, P. Badke-Schaub, and P. Desmet, 'Inspiration Space: Towards a theory of creativity-supporting learning environments', in *Proceedings of the Design Management Academy (DMA)*, Hong Kong, CN, 2017, vol. 5, pp. 1539 – 1561.

(9) K. Thoring, R. M. Mueller, P. Badke-Schaub, and P. Desmet, 'Design the Campus: Introducing a Toolkit for Developing Creative Learning

Spaces', in *Proceeding of the International Cumulus Association Conference*, Nottingham, UK, 2016, pp. 358 – 368.

(10) K. Thoring, C. Luippold, R. M. Mueller, and P. Badke-Schaub, 'Workspaces for Design Education and Practice', in *Proceedings of the 3rd International Conference for Design Education Researchers*, Chicago, USA, 2015, pp. 330–346.

(11) K. Thoring and R. M. Mueller, 'Spatial Knowledge Management in Design Education', in *Proceedings of the Spring Cumulus Conference*, Aveiro, Portugal, 2014.

(12) K. Thoring, C. Luippold, and R. M. Mueller, 'Where do we Learn to Design? A Case Study About Creative Spaces', in *Proceedings of the International Conference on Design Creativity*, Glasgow, UK, 2012.

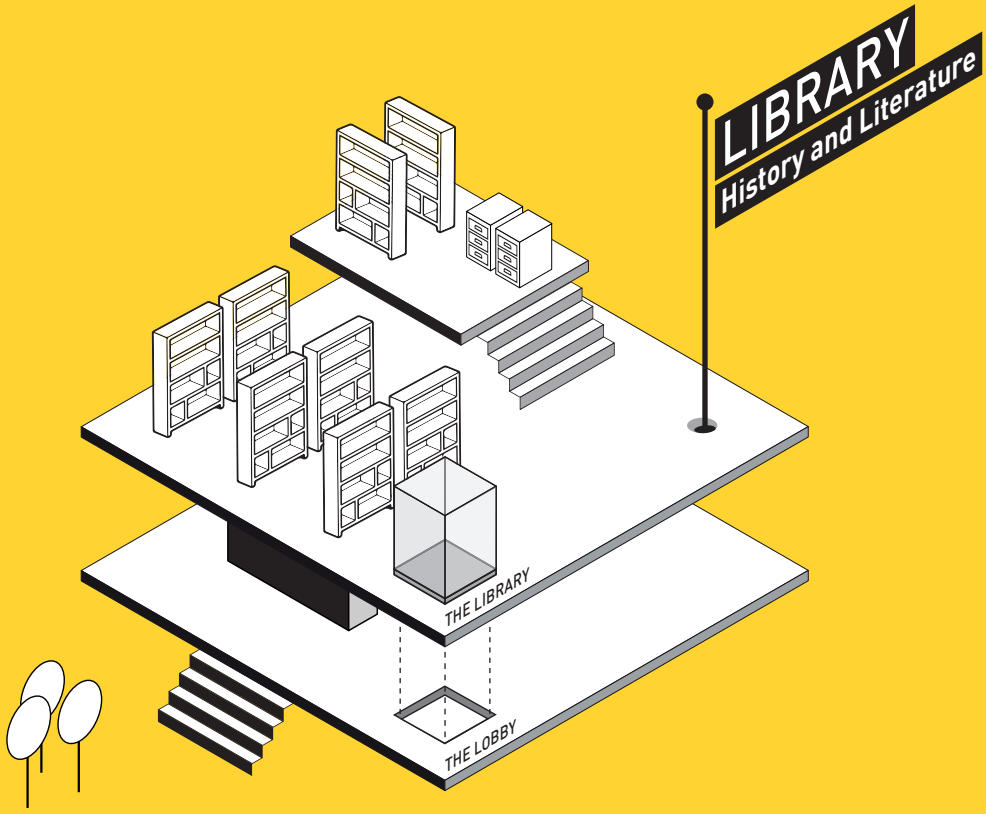
(13) K. Thoring, C. Luippold, and R. M. Mueller, 'Creative Space in Design Education: A Typology of Spatial Functions.', in *Proceedings of the International Conference on Engineering and Product Design Education*, Antwerp, Belgium, 2012.

The author of this thesis is the first author and main contributor of all of the publications. The respective co-authors are the two promoters of this thesis, and for some papers the colleagues who assisted with the data collection or data analysis process.

The pronoun "we" is used throughout this thesis. It refers to the author of this thesis and includes both, the readers and the colleagues who assisted with parts of the research. Consequently, "we" is used synonymously with "I".

2ND / 3RD FLOOR: THE LIBRARY

Spend some time here and browse through the literature. You will find some interesting insights about the history of creative spaces and other people's research.



A preliminary version of the literature review has been published in:

Thoring, K., Desmet, P., and Badke-Schaub, P, 'Creative Space – A Systematic Review of the Literature', in Proceedings of the 22nd International Conference on Engineering Design (ICED), Delft, The Netherlands, 2019

2. A BRIEF HISTORY OF CREATIVE WORKSPACES

2.1. RATIONALE

To evaluate the current phenomenon of creative spaces it might be helpful to see it in the context of the historical development of creative work and study environments. While the following short synopsis cannot go into depth and does not claim to be exhaustive, it still provides some valuable insights into the background and gives the reader an idea, why and how this phenomenon emerged.

RQ 1: What is the historical context in which creative spaces emerged?

2.2. HISTORY OF CREATIVE WORKSPACES

2.2.1. First Records

Since the creation of Plato's Academy in Ancient Greece, whenever people have dedicated themselves to creative and explorative activities, they have also deliberately or intuitively designed their work or study environments. However, little has been documented from those early times. One early example of such practices is pictured in Albrecht Dürer's engraving of *St. Jerome in His Study* from 1514, where one can see St. Jerome's (Hieronymus's) study, decorated with inspirational or facilitating objects such as skulls, hourglasses, and scientific instruments (Burkhard, 1933). In the late 16th century, French philosopher Michel de Montaigne painted the ceiling of his study with inspirational quotes of wisdom from the Bible or from ancient philosophers (De Botton, 2014). Both examples are depicted in Figure 6.

While these early examples depict preferences of creative or scholarly individuals, at the beginning of the 20th century a new approach set in, which focused on increasing work efficiency and productivity and to date this has still influenced traditional office design.

Figure 6. Left: Albrecht Dürer, St. Jerome in his study. (photo: www.deutschefotothek.de/obj30105649.html, Public Domain). Right: Inspirational quotes from the Bible or Philosophy, painted in Michel de Montaigne's study room's ceiling (photo: commons.wikimedia.org/wiki/File:Les_poutres_de_Montaigne_04.jpg, Public Domain).

2.2.2. Taylorism (around 1900)

At the beginning of the 20th century, Frederick Winslow Taylor introduced the "scientific management" style to large corporations in the United States, which stood for an optimized and highly efficient work process, including quality control mechanisms, segmentation of tasks, separation of manufacturing and administrative or knowledge work, and payment incentives by performance (Saval, 2014, p. 49). Soon, the concept became known as 'Taylorism".

Figure 7. Typical Taylorism workspaces. Left: Division of Classification and Cataloging, 1937 (photo: Public Domain). Right: Larkin Administration Building, Frank Lloyd Wright, Buffalo, New York (VR Rendering: Creative Commons flic.kr/p/Qt6GSE, created by www.HookedOnThePast.com)

Accordingly, office space design was characterized by large halls with desks aligned in rows, with dozens or even hundreds of clerks working on administrative tasks (Figure 7). The manufacturing work was located remotely in separated halls. This office layout represents a highly hierarchical management style, where the superiors were located on different levels of the building to observe the workers, sometimes measuring their work performance with a stopwatch (Saval, 2014, p. 33). As a result of the scientific management method, work productivity at that time could be increased significantly, which is reflected, for example, in the success of Ford Motor Company.

Following this "Taylorism" office concept, the architect Frank Lloyd Wright introduced atmospheric aspects to such office environments. His design for the Larkin building in Buffalo was characterized by a large, cathedral-like hall in which the administrative work took place (Figure 7). Indirect lighting from above and a good ventilation system added ambiance to the work environment, as did the custom-designed furniture, but still, observatory lookout from superiors on higher floors reflected the command and control management style, which was typical for that time.

Soon, criticism regarding the scientific management style emerged, mainly because of the standardized, monotone work conditions and the pressure caused by the observations and performance measurements. This situation gave room to new concepts that would later be known as "cubicles", which defined office design for the next decades (see Section 2.2.5 on page 46).

2.2.3. European Modernism (1920ies)

In the 1920s, a very different architectural concept emerged mainly in Europe, but quickly spread worldwide—modernist architecture.

When Walter Gropius designed the new building for the avant-garde design school—the Bauhaus—in Dessau, Germany, in 1926, he tried to create architecture that would facilitate the design students' creative activities (MacCarthy, 2019, p. 176). Large windows provided plenty of light and scenic views (Siebenbrodt & Schöbe, 2012, p. 194). Another innovative aspect of the building was the integration of different spatial functions within one building (Siebenbrodt & Schöbe, 2012, p. 193). Each functional section was dedicated to its own architectural area (Figure 8). The "Werkstattflügel" (workshop wing) housed the workshops; the "Bridge" was dedicated to administrative offices, and

the "Atelierhaus" (studio building) served as the students' dormitory. The "Meisterhäuser" (masters' houses), located nearby, were private accommodations for the Bauhaus "masters"—the professors.

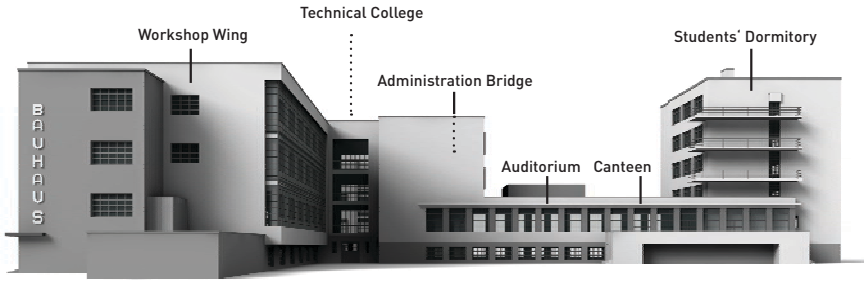


Figure 8. The Bauhaus (built 1926 by Walter Gropius) integrated various innovative spatial concepts into its building design (image: Public Domain CC0 by Max Pixel).

The moving of the Bauhaus school from Weimar to Dessau in 1925 involved two major spatial changes: first, the new location in the industrial area of Dessau, which was in close proximity to the German aircraft and engine manufacturer Junkers, and second, the accommodation in the newly-built Bauhaus building (Siebenbrodt & Schöbe, 2012, p. 193; Wilhelm & Gropius, 1983, p. 93). The time of the moving also marked a significant change in the overall Bauhaus approach and the resulting designs. While the Weimar era was characterized by the goal to "synthesize the arts" and a strong focus on the teaching of craftsmanship (Wilhelm & Gropius, 1983, p. 12), in Dessau the focus shifted toward industrialization and mass production (Siebenbrodt & Schöbe, 2012, p. 30). Although this conceptual shift cannot be solely attributed to the spatial changes, the correlation of both incidents remains remarkable and warrants the hypothesis that the space had a major impact on the school's creative output.

Also, in the area of office design, modernism had an impact. Swiss-French architect and designer Le Corbusier was impressed and influenced by Taylorism (Saval, 2014, p. 128), but he developed the concept further by trying to improve the space's "psycho-physiological conditions" with the goal to add "luxury, perfection, quality in the whole building—halls, elevators, the offices themselves" (Saval, 2014, p. 129). Typical for his designs were large glass façades and open-plan interior structures, which both became possible through the use of steel frames and concrete columns, placed within the center of a building to remove weight from the outer walls. He designed offices for the city of Algier, Algeria, and administrative buildings in Chandigarh, India.

2.2.4. Bürolandschaft (Office Landscape)

In post-war Germany in 1956, the "Quickborner Team"—an office planning consultancy near Hamburg—propagated non-hierarchical office environments (Myerson, 2013). The rigid grid of clerk-desks in open plan offices known from the Taylorism era were dissolved and replaced by organic layouts of varying desks and chair combinations that were occasionally broken by sofas and casual meeting areas (Piotrowski, 2016, p. 123). The resulting non-orthogonal layout resembled the shapes of landscapes, which gave birth to the name of the concept "office landscape" (German: *Bürolandschaft*) (Piotrowski, 2016, p. 123). The main idea was to provide flexible open plan offices with lots of light, free furniture groupings, and irregular arrangements (Myerson, 2013; Piotrowski, 2016, p. 124). Noise should be reduced by installing sound-reflective partitions like shelves, panels, or plants. Figure 9 compares a typical Taylorism office layout with a typical *Bürolandschaft*.

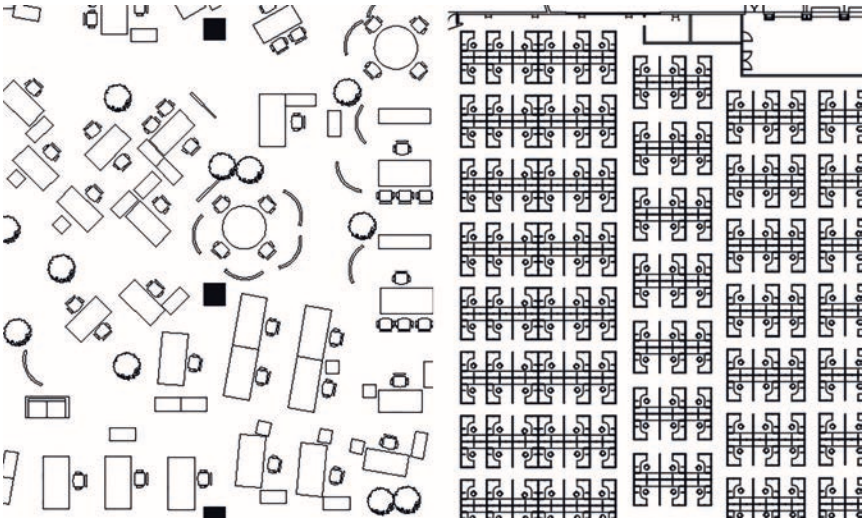


Figure 9. Organic layout of the Bürolandschaft (left) and Taylorism office layout (right), (photo left: wikipedia.org/wiki/File:Office-landscape-plan.jpg, Public Domain, photo right: wikipedia.org/wiki/File:Sea-of-cubicles-2.jpg, Public Domain).

As a matter of fact, the *Bürolandschaft* concept inspired Herman Miller and Robert Propst to design the Action Office (Saval, 2014, p. 204), which became the quasi-standard of office design for the next decades (described in the next section). However, the *Bürolandschaft* itself was not as successful. In the mid-1970s office-landscaping was largely replaced by the cubicle concept.

2.2.5. The Rise of the Cubicle

In the late 1960ies, the Herman Miller Research Corporation started to think about solving furniture-related problems at the workspace (Woodham, 2016). Their goal was to increase work efficiency and productivity and to improve the functionality of the furniture, rather than mere aesthetics (Kahlen, 2013, p. 30; Sparke & Fisher, 2016, p. 273). Robert Propst and George Nelson developed several lines of furniture under the name "Action Office" (Propst, 1966), which was constantly being further developed and is still available today in its latest version (Sparke & Fisher, 2016, p. 273). The Action Office was characterized by portable partition walls to isolate office workers from noise and distraction in order to increase their focus and work productivity. Several furniture elements (shelves, walls, desks, drawers) can be arranged and combined to the specific needs of the individual worker. These cubicles were lined up next to each other in large open plan offices to provide some privacy to the employees, as well as the possibility to customize their space by adding personal decoration.

Herman Miller researchers conducted several extensive studies about their office design concepts. For example, they sent a survey with 105 questions to office workers, inquiring about aspects, such as the possibility of napping in their respective office, or the visibility of papers. Moreover, they involved various scientists in their design strategy. For example, one insight gained from following these studies was the fact that bodily movement would result in "mental fluency and alertness" (Abercrombie, 2000, p. 211), As a consequence standing desks were integrated into the Action Office line in order to motivate bodily activity. Although the initial idea of the cubicle was to provide office workers with more independence, autonomy, and privacy, the effect was quite the opposite. The concept was widely copied by other companies and resulted in a large quantity of people crammed into windowless halls (Figure 10), whereas upper-level management was still enjoying windowed corner offices on the perimeter of the building.

George Nelson, originally one of the main designers of the Action Office, dissociated himself from the Action Office II. which he called a "dehumanizing effect as a working environment" (Abercrombie, 2000, p. 207; Saval, 2014, p. 216). Nevertheless, the cubicle became a great success, particularly in the United States, and is still prevalent today in conservative and hierarchical, non-creative sectors, for example in call centers.

Figure 10. Office cubicles in Gulf Worldwide Sales & Marketing Team, (photo: Mark Jayson Aranda, CC Share Alike).

2.2.6. "Starchitecture" (Today)

Recently, a new trend has emerged that focuses on the exterior architecture of educational buildings. Many universities, and specifically design schools, hire star architects to design their educational buildings.

Figure 11. PolyU Hong Kong Innovation Tower, by Zaha Hadid Architects, (own picture).

Examples that illustrate this trend are the Innovation Tower of Poly-U Hong Kong by Zaha Hadid (Figure 11), the Paper Bag Building of Sydney Technical University (by Frank Gehry), and Leuphana University of Lüneburg (by Daniel Libeskind).

2.2.7. Co-Working Spaces and Campus Offices (Today)

Even though open office structures were criticized because of the increase in noise levels and lack of privacy (Hedge, 1982), the New Economy of the early 1990s took this approach even further. Open space offices without cubicle dividers became popular based on the idea that this would increase the flow of information between employees and, hence, foster innovation. Companies such as Google introduced the "fun factor" into the work environment, for example, by installing slides between different floors (Dunne, 2014). The company, which is well-known for its innovative campus offices, is ranked number 1 as the best employer worldwide (Forbes, 2017). Google offices are arranged like a campus so that people feel familiar in an environment that they know from having studied at a university (E. Schmidt, 2014, p. 35). There are spaces dedicated for napping, a fitness center, a library, and lots of plants and outdoor areas (see Figure 12 for exemplary pictures of Google's workspaces). Such concepts were picked up by many start-up companies. Consequently, offices in these times were characterized by open plan offices with plenty of unusual furnishings, such as beanbags, slides, room-in-a-room huts, integrated sports facilities, etc., which has by now become sort of a standard for many companies who consider themselves as "innovative".

Figure 12. Google offices with privacy pods, playful zebra statue, game area, and outdoor swing (photos: Google, with permission).

2.3. CONCLUSIONS

All these examples, ranging from past centuries to the present day, demonstrate different approaches for fostering creativity and innovation within work or study environments. The presented approaches range from interior decoration and furniture to room layout and architectural aspects. The need for developing educational and business environments that promote creativity and innovation is important; as the aforementioned examples demonstrate.

A lot of experimentation and scientific attempts were done in the past century. Interestingly, many of the (rather negative) examples from the era of scientific management are still prevalent today. Many scientific studies today focus on the question, how the work environment might increase productivity and work efficiency (as we will outline in the next chapter), however, the main concern is now on creative output rather than administrative performance. The superiors with stop watches have been replaced by the Internet of Things, which allows for a constant measurement of employees' work productivity.

Herman Miller is still selling its Action Office cubicles, although with modern touches and involving famous designers, such as Yves Béhar, Naoto Fukasawa, or Studio Scholten & Baijings. Cubicles are still widely in use, especially in small and medium sized companies (SMEs) in the USA, from rather non-creative sectors.

When looking at the historical developments of workspace design, the triadic influence among organizational culture, emerging technologies, and workspace design becomes evident. On the one hand, the workspace reflects current managerial practices; just as the Taylorism approach resulted in observatory lookouts on higher floors to enable a command and control management style. On the other hand, the workspace design enables specific work practices (like the privacy pods at Google's offices, which allow for personal withdrawal and more focused work). Finally, technologies enable specific modes of work, such as mobile laptops and the presence of wireless networks allowing people to work literally anywhere. This interplay among management style, technological developments, and the workspace needs to be carefully considered when designing a creative space.

3. LITERATURE REVIEW OF CREATIVE SPACES

3.1. RATIONALE

To further investigate the topic, we aimed to provide an overview of the state-of-the-art research on creative workspaces by presenting a systematic literature review. This overview will help us to better understand the possible impact of creative workspace design and to identify research gaps for conducting further research in this field. As Amabile stressed, "there is almost no empirical research on the effects of work environments on creativity" (Amabile, 1996, p. 210). However, since the publication of her (updated) book in 1996, numerous studies have been conducted that addressed this topic. This leads to the following research question:

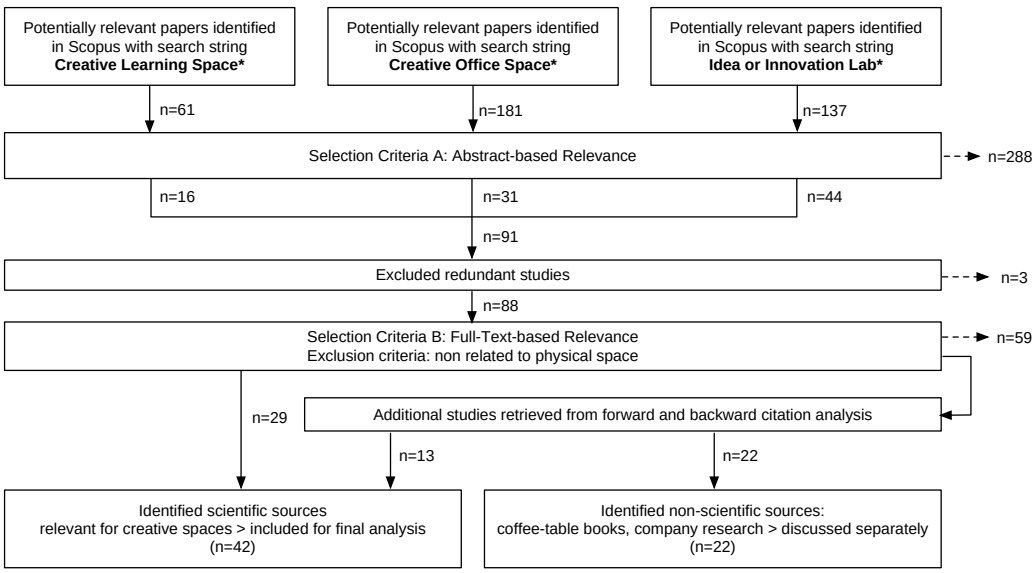
> *RQ2: What is the state-of-the-art research on creative spaces, according to the literature?*

3.2. SYSTEMATIC LITERATURE SEARCH PROCESS

We conducted a three-step keyword search within the Scopus database to identify relevant sources. More specifically, we searched for literature on (1) creative spaces in educational contexts, (2) creative spaces in work or office environments, and (3) special forms, such as innovation or idea labs. We also included educational contexts because here new pedagogical and also spatial concepts emerge, that might provide relevant insights on the topic. We excluded FabLabs and makerspaces from our search, because these were considered only as a technical infrastructure for prototyping activities and, hence, not considered relevant for the general notion of creative spaces. Similarly, we also excluded coworking spaces from our search funnel, because these were considered not specific to creative spaces, according to our definition presented in the introduction (on page 23). We included idea labs and innovation labs, because these address early stages of the innovation process that are more closely related to idea generation, whereas incubators and accelerators were excluded, because these focus on the later stages of the innovation process and on implementing existing ideas (Narayanan, 2017). For all three searches, possible combinations with synonyms were also considered (e.g. space vs. environment, creative vs. innovative, office vs. work, learning vs. education). The results were limited to only peer-reviewed

journal and conference publications. Figure 13 illustrates our search and selection process.

We analyzed the returned 379 sources based on their abstract. We identified papers for exclusion that were either unrelated to the topic or limited to one specific aspect of the creative environment (e.g. lighting, ergonomics of office chairs, etc.) as well as papers that addressed a peculiar (non-design-related) context, such as hospitals, libraries, or nursing homes (selection criteria A). After excluding redundant sources from all three search steps we conducted a full-text analysis on the remaining 88 sources, which left us with 29 sources identified as relevant. Our selection criterion at this point was to include only papers with a focus on the physical environment, whereas sources that regarded the environment in a rather abstract way (e.g. financial constraints, encouraging leadership, or virtual spaces) were disregarded (selection criteria B). Finally, we conducted a backward and forward citation analysis on the remaining 29 sources, in which we also included non-peer-reviewed sources such as books and PhD theses, as well as coffee-table books and corporate research that appeared to be of relevance. This procedure resulted in a total number of 42 scientific sources that were included for further analysis and 22 non-academic sources that are discussed separately in the following subsection. Figure 13 illustrates the systematic search process.



* Synonyms were included (creative/innovative; learning/education; office/work; space/environment, lab/laboratory

Figure 13. Systematic literature search process.

3.3. NON-ACADEMIC SOURCES

3.3.1. Coffee Table Books

Recently, public interest in creative environments has increased, which can be reasoned from the large number of coffee table books on the topic of creative office spaces (e.g. Borges et al., 2013; Georgi & McNamara, 2016; Groves et al., 2010; Stewart, 2004). Simultaneously, an increased interest in creative learning environments is emerging in the area of elementary schools and kindergartens (e.g. Boys, 2010; Dudek, 2000, 2012; Ehmann, Borges, & Klanten, 2012; Mirchandani, 2015). However, such books about creative learning space design in higher education are rarely to be found. Also, some special types of work environments, such as co-working spaces or makerspaces, are covered by such illustrated books (e.g. A. Davies & Tollervey, 2013; Kinugasa-Tsui, 2018).

All these publications merely present a collection of photographic case examples of peculiar creative spaces. They rarely provide any theoretical background nor explanations about the possible impact of the spatial designs. Seldom are they categorized systematically and neither do they provide any theoretical underpinning about possible reasons why the spaces are designed as they are.

Nevertheless, these examples demonstrate an increased public and corporate interest in the topic of creative working and learning environments that warrants further investigation. Interested readers can consult these sources to find inspirational examples of creative workspace designs.

3.3.2. Corporate Research

At the same time, various industrial corporations conducted research about creative workspaces. While these publications are usually not peer-reviewed, they still provide novel research on various practice-related topics. Since these companies usually have access to a large number of customers or employees, they are able to conduct quantitative research that is of high practical relevance. For example, M. Arthur Gensler Jr. & Associates, Inc. (in short, known as "Gensler") is an American architecture and design firm, based in San Francisco. They regularly publish workspace surveys—the so called "Gensler Workplace Survey", in which they present results of surveys done with office workers, mainly in the U.S., but more recently they have also included issues for the U.K, Asia, and Latin America. In the latest U.S. issue from 2016 (Gensler, 2016, p. 3), they surveyed a panel-based sample of more than 4,000 randomly selected U.S. office workers in

11 industries. The goal of the survey was to understand "where, and how, work is happening today, and the role design plays in employee performance and innovation, […] to provide critical insight into how the workplace impacts overall employee experience" (Gensler, 2016, p. 3). One main finding was that "great workplace design drives creativity and innovation." (Gensler, 2016, p. 3). They identified four modes for successful work performance: focus work, collaboration, learning, and socializing (Gensler, 2008).

American furniture manufacturer Steelcase also conducted research about various interior-related topics, such as "well-being", "the privacy crisis" at the workplace, or "active learning spaces". Their findings were published in their internal magazine called "360°". Two of the latest issues focus on creativity and innovation in the workplace: "The creative shift" (Steelcase, 2017) and "inside innovation" (Steelcase, 2018), where scientific insights, for example the effects of posture on the brain, or the impact of social interaction on creativity, are juxtaposed with Steelcase's furniture concepts.

Similarly, Knoll, another American furniture manufacturer, regularly publishes short papers about various topics related to the workplace and the learning environment under the label "Knoll Workplace Research". Among the studies presented there were survey results and case studies, addressing, for example, ergonomic questions, start-up culture, or future work and technology trends. Of particular interest for the topic of creative spaces are the articles on "the rise of co-working" (Roth & Mirchandani, 2016), which presented statistical data and demographics about co-workers and their preferences, and "adaptable by design" (O'Neill, 2012), which addressed the importance of flexible and customizable workspaces.

WeWork is an American company that provides coworking spaces for start-ups, entrepreneurs, small businesses, and freelancers. As of 2017, they have been managing a total of approximately 1 million square meters of office space and are valuated at several billion US$ (Hempel, 2017). Besides interviewing their customers to enquire about their level of satisfaction with the workspaces they provide, WeWork developed several innovative research approaches to study the effects of their workspace designs. Through spatial analytics, which involves location-based data together with random enquiries through Apps or text messaging, WeWork is able to measure and count workspace usage statistics, for example, the average number of people using a conference room, or whether spaces with more phone booths would receive fewer complaints about noise distractions (Davis, 2016). Furthermore, Building Information Modeling (BIM),

which is a software-based planning tool for architects, is being utilized to create detailed 3D models of their office spaces in order to customize and optimize their office designs and make them more efficient (Rhodes, 2016).

3.4. ACADEMIC SOURCES

3.4.1. Theoretical Contributions

According to our research question stated above, we were particularly interested in the theoretical contribution of the identified 42 scientific sources retrieved though our systematic search process—that is, in what way the designed spaces would be able to facilitate creativity and innovation in work and study environments. Gregor (2006) distinguished among five types of theories that we used and adapted to categorize the analyzed sources.

Type 1: Theories for analyzing that only describe and analyze the reality, for example, as a framework, classification system, typology, or as a list of categories (what is?) or requirements (what should be?).

Type 2: Interpretative theories for explanation that attempt to explain specific incidents (what is, how, why, when, and where?). They provide a deeper understanding of a complex situation, for example through rich, qualitative data.

Type 3: Theories for prediction that attempt to predict certain incidents but without providing causal explanations (what is and what will be?).

Type 4: Causal theories for explanation and prediction that attempt to predict specific incidents and also provide testable propositions and causal explanations (what is, how, why, when, where, and what will be?).

Type 5: Design theories that provide explicit prescriptions for constructing an artifact (how to do something?).

We categorized the included 42 scientific sources according to their theoretical contribution. In the following sections, we will discuss these sources by category.

Theories for Analyzing, Type 1. The biggest part of the analyzed sources (n=16) presented Type 1 theories that described or analyzed a creative space—as is. From these 16 sources, eight presented structured typologies, classification systems, or frameworks (Jankowska & Atlay, 2008; Kohlert & Cooper, 2017; Leurs, Schelling, & Mulder, 2013; Paoli & Ropo, 2017; S. Schmidt, Brinks, & Brinkhoff, 2015; Setola & Leurs, 2014; Snead & Wycoff, 1999; Williams, 2013). In contrast, eight sources presented unstructured lists of requirements that a creative space

should fulfil, but without detailing how exactly this could be achieved (Haner, 2005; Lindahl, 2004; Martens, 2008; Moultrie et al., 2007; Narayanan, 2017; Oksanen & Ståhle, 2013; Peschl & Fundneider, 2014; Walter, 2012). We will discuss these 16 sources in more detail in Chapter 5.

Interpretative Theories for Explanation, Type 2. Nine sources presented qualitative or interpretative theories that tried to explain more complex situations regarding particular spatial configurations, mainly based on qualitative user studies and individual opinions, such as interviews or case studies. They did not provide any testable propositions or predictions (Bryant, 2012; Cannon & Utriainen, 2013; Edström, 2014; Greene & Myerson, 2011; Groves-Knight & Marlow, 2016; Kristensen, 2004; Lewis & Moultrie, 2005; Törnqvist, 2004; von Thienen, Noweski, Rauth, Meinel, & Lang, 2012).

Theories for Prediction, Type 3. Eight sources presented theories with predictions how a specific spatial configuration would impact creative work, but without providing explanations (Ceylan, Dul, & Aytac, 2008; Dul & Ceylan, 2011, 2014; Dul, Ceylan, & Jaspers, 2011; Lin, 2009; Magadley & Birdi, 2009; McCoy & Evans, 2002; Waber, Magnolfi, & Lindsay, 2014).

Causal Theories, Type 4. Four sources presented causal theories, outlining a causal relationship between physical workspace and creativity. (Martens, 2011; McCoy, 2005; Meinel, Maier, Wagner, & Voigt, 2017; Paoli, Sauer, & Ropo, 2017). In Chapter 6, we will focus on these sources to draw comparisons with our own developed theory of creative spaces.

Design Theories, Type 5. Two sources presented design theories that either provided concrete guidelines or principles on how to design a creative space (Doorley & Witthoft, 2012; van Meel, Martens, & van Ree, 2010). We will discuss these (and further sources) in Chapter 5, and compare them with our own attempt to develop design principles in the form of a pattern language for creative spaces.

Tools and Artifacts. Our sample did not yield any scientific sources that presented tools for developing creative spaces. In Chapter 8, we extended our search further to also include tools for designing creative spaces from non-academic sources.

Existing Literature Reviews. Our sample revealed three literature reviews on the topic of creative spaces (Beghetto & Kaufman, 2014; D. Davies et al., 2013; Jindal-Snape et al., 2013). Two sources that were already categorized as type-4 theories also presented systematic literature reviews as part of their studies (McCoy, 2005; Meinel et al., 2017). However, none of these five sources appeared to be sufficiently comprehensive. For example, Meinel et al. (2017) who presented the most

comprehensive and rigorous literature review that culminated in a causal theory, did not include learning spaces. Moreover, their sample size of 17 articles seems rather limited. In contrast to that, Beghetto and Kaufman (2014) and Davies et al. (2013) only focused on educational contexts. For our own literature review, we included these existing reviews in our co-citation analysis to identify additional relevant sources that were possibly not covered through our own search criteria.

3.4.2. Scope

This section identifies the scope of the included sources. We made distinctions between educational contexts, practice-based work or office environments, innovation labs, and sources that addressed both, practice and educational contexts. The literature reviews were not considered in this overview.

Educational context. Seven sources focused on educational contexts, either with or without a creative focus, which included kindergartens, elementary schools, and higher education institutions (Cannon & Utriainen, 2013; Doorley & Witthoft, 2012; Edström, 2014; Jankowska & Atlay, 2008; Leurs et al., 2013; Setola & Leurs, 2014; von Thienen et al., 2012).
Practice context. 23 sources focused on practice environments (Bryant, 2012; Ceylan et al., 2008; Dul & Ceylan, 2011, 2014; Dul et al., 2011; Greene & Myerson, 2011; Kristensen, 2004; Lewis & Moultrie, 2005; Lin, 2009; Lindahl, 2004; Magadley & Birdi, 2009; Martens, 2008, 2011; McCoy, 2005; Meinel et al., 2017; Moultrie et al., 2007; Paoli & Ropo, 2017; Paoli et al., 2017; Peschl & Fundneider, 2014; Snead & Wycoff, 1999; van Meel et al., 2010; Waber et al., 2014; Williams, 2013).
Education and practice contexts. Five sources addressed both, education and practice environments (Groves-Knight & Marlow, 2016; Kohlert & Cooper, 2017; McCoy & Evans, 2002; Oksanen & Ståhle, 2013; Walter, 2012).
Innovation laboratories. While we found a substantial number of publications about innovations labs (n=44), not many of them discussed the spatial settings within these institutions, but they focused rather on other aspects that might or might not influence creativity and innovation, such as funding issues or the organizational climate. From the 44 initially sourced studies on innovation labs, only five were finally included in our analysis (Dul et al., 2011; Haner, 2005; Lewis & Moultrie, 2005; Narayanan, 2017; S. Schmidt et al., 2015). We will discuss these sources in Chapter 7.

3.4.3. Spatial Impact on Creativity

The analyzed 42 scientific sources provided manifold insights on various aspects of spatial designs in creative work and study environments. We searched these sources according to the following criteria: (1) what different types of spaces were considered relevant for creative activities (what activity should the space support?), (2) what kind of (abstract) requirements for creative spaces were mentioned (what effect should the space provoke?), and (3) what concrete physical characteristics as well as (4) what ambient characteristics should the space obtain in order to facilitate creative activities (how should the space be designed?). The results from these four questions are summarized in the following four tables.

Table 1 presents an overview of sources that mentioned different space types for different creative activities, regardless of whether or not these space types were presented as a structured typology or simply mentioned within the text.

Table 1. Addressed space types for different creativity-related activities.

Identified Space Types	**Mentioned by Source**
Personal Space, Focus Space	Dul et al. (2011), Dul & Ceylan (2011), Dul & Ceylan (2014), Greene & Myerson (2011), Groves-Knight & Marlow (2016), Haner (2005), Kohlert & Cooper (2017), McCoy (2005), Meinel et al. (2017), Oksanen & Ståhle (2013)
Collaboration Space	Doorley & Witthoft (2012), Kohlert & Cooper (2017)
Making Space, Experimentation Space	Doorley & Witthoft (2012), Groves-Knight & Marlow (2016), Leurs et al. (2013), Meinel et al. (2017), Setola & Leurs (2014), Walter (2012)
Exhibition Space	Lewis & Moultrie (2005), Magadley & Birdi (2009)
Presentation Space, Sharing Space	Doorley & Witthoft (2012), Lewis & Moultrie (2005), Magadley & Birdi (2009), Setola & Leurs (2014), Kohlert & Cooper (2017)
Disengaged Space, Intermission Space	Groves-Knight & Marlow (2016), Magadley & Birdi (2009), Meinel et al. (2017), Williams (2013)
Relaxation Space, Well-being Space	Kohlert & Cooper (2017), Lin (2009), Martens (2008), Martens (2011), Meinel et al. (2017), Paoli & Ropo (2017), Paoli, Sauer, & Ropo (2017)
Unusual Space, Play Space	Meinel et al. (2017), Oksanen & Ståhle (2013), Paoli & Ropo (2017), Paoli, Sauer, & Ropo (2017), Snead & Wycoff (1999)
Virtual Space	Bryant (2012), Haner (2005), Moultrie et al. (2007)
Preparation Space, Exploration Space	Dul & Ceylan (2011), Groves-Knight & Marlow (2016), Haner (2005), Kristensen (2004), Lin (2009), Martens (2008), Martens (2011), Peschl & Fundneider (2014), Setola & Leurs (2014), Walter (2012)

Illumination Space	Dul & Ceylan (2011), Groves-Knight & Marlow (2016), Haner (2005), Kristensen (2004), Lin (2009), Martens (2008), Martens (2011), Walter (2012)
Verification Space, Analysis Space	Dul & Ceylan (2011), Groves-Knight & Marlow (2016), Haner (2005), Kristensen (2004), Leurs et al. (2013), Lin (2009), Martens (2008), Martens (2011), Peschl & Fundneider (2014), Setola & Leurs (2014), Walter (2012)
Incubation Space, Reflection Space	Dul & Ceylan (2011), Groves-Knight & Marlow (2016), Haner (2005), Kristensen (2004), Lin (2009), Martens (2008), Martens (2011), Walter (2012)

Table 2 outlines sources that provided abstract requirements for creative spaces. Again, we looked for references to spatial qualities within the texts, even if these were not presented as a structured classification.

Table 2. Abstract requirements of a creative space.

Identified Requirements	**Mentioned by Source**
Social Dimension, Chance Encounters	Groves-Knight & Marlow (2016), Haner (2005), Kohlert & Cooper (2017), Kristensen (2004), McCoy (2005), McCoy & Evans (2002), Waber et al. (2014)
Stimulation, Ambiance	Groves-Knight & Marlow (2016), Lin (2009), Martens (2008), McCoy (2005), Walter (2012)
Knowledge Processing	Martens (2011), Peschl & Fundneider (2014)
Process Enabler, Affordances, Infrastructure	Doorley & Witthoft (2012), Groves-Knight & Marlow (2016), Haner (2005), Lewis & Moultrie (2005), Schmidt, Brinks & Brinkhoff (2015), Williams (2013)
Engaging Space, Activate Participation	Cannon & Utriainen (2013), Doorley & Witthoft (2012), Jankowska & Atlay (2008), Kohlert & Cooper (2017), Lindahl (2004), Paoli, Sauer & Ropo (2017), Setola & Leurs (2014)
Comfort and Ergonomics	Doorley & Witthoft (2012), Groves-Knight & Marlow (2016), Oksanen & Ståhle (2013), Walter (2012), Williams (2013)
Health and Safety	Lindahl (2004), Oksanen & Ståhle (2013)
Surprising Space, Unexpected Space	Edström (2014), Jankowska & Atlay (2008), Törnqvist (2004)
Flexible Space, Changeability	Cannon & Utriainen (2013), Doorley & Witthoft (2012), Jankowska & Atlay (2008), Haner (2005), Martens (2008), McCoy (2005), Meinel et al. (2017), Moultrie et al. (2007), Oksanen & Ståhle (2013), Setola & Leurs (2014), Walter (2012)
Culture of Space, Reflect Identity, Symbolic Aspects	Cannon & Utriainen (2013), Groves-Knight & Marlow (2016), Kohlert & Cooper (2017), Lewis & Moultrie (2005), Lindahl (2004), Martens (2008), Moultrie et al. (2007), Oksanen & Ståhle (2013), Paoli & Ropo (2017), Paoli, Sauer, & Ropo (2017), Walter (2012), Williams (2013)

Ownership of Space	Cannon & Utriainen (2013), Leurs et al. (2013), Lewis & Moultrie (2005), Schmidt, Brinks & Brinkhoff (2015), Setola & Leurs (2014)
Accessibility	Moultrie et al. (2007), Schmidt, Brinks & Brinkhoff (2015)
Facilitator, Assistant	Cannon & Utriainen (2013), Doorley & Witthoft (2012), Lewis & Moultrie (2005), Magadley & Birdi (2009), Narayanan (2017)
Additional Services (events, expertise etc.)	Lewis & Moultrie (2005), Oksanen & Ståhle (2013), Schmidt, Brinks & Brinkhoff (2015)

Table 3 provides insights on what spatial characteristics were considered relevant for creative spaces.

Table 3. Concrete physical characteristics and configurations of a creative space.

Identified Concepts	**Description**	**Sources**
Geographic Location	Neighboring businesses or institutions provide contacts	Moultrie et al. (2007), Oksanen & Ståhle (2013), Schmidt, Brinks & Brinkhoff (2015)
Milieus	Neighborhoods attract creative people	Törnqvist (2004), Schmidt, Brinks & Brinkhoff (2015)
3rd Place	Cafe, home, train, etc. as workplace alternative	Törnqvist (2004), Williams (2013)
Remoteness	Dislocation from daily routine provides autonomy	Groves-Knight & Marlow (2016), Lewis & Moultrie (2005), Magadley & Birdi (2009), McCoy (2005), Schmidt, Brinks & Brinkhoff (2015)
Field Access	Mobility allows easy access to users and supplies	Paoli & Ropo (2017), Törnqvist (2004)
Changing Locations	Change of perspective	Edström (2014), Törnqvist (2004)
Outdoor Spaces	Nature, surrounding garden, access to fresh air	Kohlert & Cooper (2017), Kristensen (2004), Oksanen & Ståhle (2013)
Open Space	Open plan office instigates communication and stimulation	Cannon & Utriainen (2013), Doorley & Witthoft (2012), Greene & Myerson (2011), Haner (2005), Kristensen (2004), Martens (2008), Paoli, Sauer, & Ropo (2017)
Spaciousness	Large spaces provide 'space for thought'	Groves-Knight & Marlow (2016), Leurs et al. (2013), Martens (2008), McCoy (2005), Paoli, Sauer, & Ropo (2017), Williams (2013)
Proximity	Short distances enable collaboration and meetings	Groves-Knight & Marlow (2016), Haner (2005), McCoy (2005)
Open Views	Windows to nature, sky, outdoors	Bryant (2012), Ceylan et al. (2008), Dul et al. (2011), Dul & Ceylan (2011), Dul & Ceylan (2014), Groves-Knight & Marlow (2016), Kohlert &

Identified Concepts	Description	Sources
		Cooper (2017), McCoy & Evans (2002), Snead & Wycoff (1999), Williams (2013)
Vistas	Views in between and across rooms; eye contact and stimulation	Bryant (2012), Cannon & Utriainen (2013), Haner (2005), McCoy (2005), Williams (2013)
Semitransparency	Visual privacy, curtains, lamellas; protection with peeks	Doorley & Witthoft (2012), Greene & Myerson (2011)
Reduced Interior	White or empty room leaves space for creative ideas	Ceylan et al. (2008), Doorley & Witthoft (2012)
Complex Shapes	Ornaments and textures are visually stimulating	Kohlert & Cooper (2017), McCoy & Evans (2002), Meinel et al. (2017)
Decoration, Art	Graphics, posters, wall-art	Haner (2005), Jankowska & Atlay (2008), Lin (2009), Meinel et al. (2017), Oksanen & Ståhle (2013), Snead & Wycoff (1999)
Unconventional Architecture	Asymmetry, curved walls, dead spaces; can trigger creativity	Edström (2014), Lewis & Moultrie (2005), Kristensen (2004), Kohlert & Cooper (2017), Magadley & Birdi (2009), Martens (2008)
Buzz	Busy atmosphere, chaos, aliveness	Edström (2014), Groves-Knight & Marlow (2016), Martens (2011), Oksanen & Ståhle (2013), Williams (2013)
Theme Park	Interiors resembling space stations, cable cars, yurts, or igloos, etc.	Doorley & Witthoft (2012), Lewis & Moultrie (2005), Paoli & Ropo (2017)
Greenery	Indoor plants, green areas, nature imagery on wallpaper	Ceylan et al. (2008), Dul et al. (2011), Dul & Ceylan (2011), Dul & Ceylan (2014), Kohlert & Cooper (2017), Meinel et al. (2017), Paoli & Ropo (2017), Paoli, Sauer, & Ropo (2017), Snead & Wycoff (1999)
Gallery	Observe others without disturbing	Doorley & Witthoft (2012)
Central Meeting Space	Theatre-style auditorium, forum for intense group meetings	Doorley & Witthoft (2012), Lewis & Moultrie (2005), Kristensen (2004)
Face-to-Face Meeting Space	Shared rooms or 2-by-2 seating arrangements for intense talks	Bryant (2012), Doorley & Witthoft (2012), Greene & Myerson (2011), Haner (2005), Magadley & Birdi (2009), McCoy (2005), Moultrie et al. (2007), Setola & Leurs (2014), Snead & Wycoff (1999), Von Thienen et al. (2012), Walter (2012)

Identified Concepts	Description	Sources
Informal Lounge Area	Sofas, hallway seating for casual meetings	Bryant (2012), Doorley & Witthoft (2012), McCoy (2005), Von Thienen et al. (2012)
Cozy Capsule	Booths, small room-in-a-room for personal withdrawal	Doorley & Witthoft (2012), Greene & Myerson (2011), Paoli, Sauer, & Ropo (2017)
Flex Desk, Hot Desk	Flexible workspaces instigate new connections every day	Greene & Myerson (2011), Haner (2005)
Personalized Space/Items	Assigned workspaces or objects allow for personal expression	Bryant (2012), Kristensen (2004), McCoy (2005), Oksanen & Ståhle (2013), Setola & Leurs (2014)
Cafe, Kitchen	Hub for casual meetings	Doorley & Witthoft (2012), Greene & Myerson (2011), Oksanen & Ståhle (2013), Paoli & Ropo (2017), Von Thienen et al. (2012)
Writeable Surface	Displayed knowledge and visual thinking on whiteboards etc.	Bryant (2012), Cannon & Utriainen (2013), Doorley & Witthoft (2012), Greene & Myerson (2011), Jankowska & Atlay (2008), Lewis & Moultrie (2005), McCoy (2005), Moultrie et al. (2007), Narayanan (2017), Oksanen & Ståhle (2013), Peschl & Fundneider (2014), Snead & Wycoff (1999), Williams (2013)
Anchors	Attractors or spatial bottlenecks instigate chance encounters	Doorley & Witthoft (2012), Edström (2014), Waber et al. (2014)
Information Access	Book library or access to digital sources	Moultrie et al. (2007), Von Thienen et al. (2012), Walter (2012)
Technical Infrastructure	Wifi, rapid prototyping facilities, printing, electronic brainstorming etc.	Bryant (2012), Cannon & Utriainen (2013), Ceylan et al. (2008), Greene & Myerson (2011), Haner (2005), Jankowska & Atlay (2008), McCoy (2005), Magadley & Birdi (2009), Moultrie et al. (2007), Narayanan (2017), Oksanen & Ståhle (2013), Peschl & Fundneider (2014), Schmidt, Brinks, & Brinkhoff (2015), Snead & Wycoff (1999)
Access to Equipment	Materials and tools are visible and ready to use	Cannon & Utriainen (2013), Doorley & Witthoft (2012), Kristensen (2004), Leurs et al. (2013), Lin (2009), Meinel et al. (2017), Moultrie et al. (2007), Narayanan (2017), Schmidt, Brinks, & Brinkhoff (2015), Setola & Leurs (2014), Snead & Wycoff (1999), Von Thienen et al. (2012), Williams (2013)

Identified Concepts	Description	Sources
Visual Inventory of Tools	Indicate what tools are available and how to use them	Cannon & Utriainen (2013), Doorley & Witthoft (2012), Kristensen (2004)
Toys and Games	Computer games, table tennis, etc. for inspiration and distraction	Lewis & Moultrie (2005), Narayanan (2017), Paoli & Ropo (2017), Paoli, Sauer, & Ropo (2017), Snead & Wycoff (1999), Von Thienen et al. (2012)
Gym	Sports facilities to workout	Paoli & Ropo (2017), Paoli, Sauer, & Ropo (2017)
Unusual Furniture	Hammock, beanbag, etc. indicate that casual breaks are permitted	Cannon & Utriainen (2013), Lewis & Moultrie (2005), Setola & Leurs (2014), Snead & Wycoff (1999)
Activating Furniture	High chairs or swivel chairs enforce bodily movement	Doorley & Witthoft (2012), Cannon & Utriainen (2013), Setola & Leurs (2014)
DIY Style	Old furniture and rough materials instigate experimentation	Doorley & Witthoft (2012), Paoli & Ropo (2017)
Communal Table	Shared desks; work in company but not necessarily together	Paoli & Ropo (2017), Paoli, Sauer, & Ropo (2017), Snead & Wycoff (1999)
Interim Showcase	Exhibitions of project work or models, e.g. combined with storage	Kristensen (2004), Martens (2008), Doorley & Witthoft (2012)

Several sources also addressed intangible and sensorial characteristics of a space, such as colors (cool, warm, pale, bright), different light situations (natural, artificial), temperatures, air quality, sounds (positive, negative, distracting), smells, and haptics. These characteristics are summarized under the term "ambiance" in Table 4.

Table 4. Ambient characteristics of creative spaces.

Identified Ambiance	Mentioned by Source
Style and Atmosphere	Groves-Knight & Marlow (2016), Paoli, Sauer, & Ropo (2017)
Artificial Light	Williams (2013)
Natural Daylight	Bryant (2012), Dul et al. (2011), Dul & Ceylan (2011), Dul & Ceylan (2014), Kohlert & Cooper (2017), Snead & Wycoff (1999), Williams (2013)
Task Light	Bryant (2012)
Ambient Light	Bryant (2012), Paoli, Sauer, & Ropo (2017), Peschl & Fundneider (2014)

Identified Ambiance	Mentioned by Source
Indoor Climate	Dul et al. (2011), Dul & Ceylan (2011), Dul & Ceylan (2014), Martens (2008), Meinel et al. (2017), Walter (2012), Williams (2013)
Positive Smell	Dul et al. (2011), Dul & Ceylan (2011), Dul and Ceylan (2014), Meinel et al. (2017), Williams (2013)
Positive Sound	Bryant (2012), Dul et al. (2011), Dul & Ceylan (2011), Dul & Ceylan (2014), Groves-Knight & Marlow (2016), Martens (2008), Meinel et al. (2017), Williams (2013)
Warm Colors	Paoli & Ropo (2017)
Energetic Colors, Bright Colors, Colorful	Bryant (2012), Ceylan et al. (2008), Dul & Ceylan (2011), Dul & Ceylan (2014), Martens (2008), Paoli, Sauer, & Ropo (2017), Von Thienen et al. (2012)
Pale Colors	Paoli, Sauer, & Ropo (2017)
Cool Colors	Ceylan et al. (2008), Dul & Ceylan (2011), Dul & Ceylan (2014)
Materials, Haptics, Finishings	Kohlert & Cooper (2017), Martens (2008), Snead & Wycoff (1999)
Natural Materials, Wood, Textiles	McCoy & Evans (2002), Paoli & Ropo (2017), Paoli, Sauer, & Ropo (2017)

For all four tables, we included only those spatial concepts that were mentioned by more than one source. Also, we excluded concepts that remained very vague and unspecific. For example, some sources mentioned concepts like “furniture”, “view”, “colors”, or “presence of computers”, without providing any more details, which did not provide much relevant information for designing creative spaces.

3.5. DISCUSSION

The analyzed literature revealed that the topic of creative environments attracts interest in various disciplines. There are attempts to address the field from different perspectives, such as theoretical investigations or as prescriptive guidelines. It has become apparent that the majority of the analyzed sources provided only descriptions or analyses of the status-quo of creative spaces (type 1 or 2 theories). Some go a step further and present also predictions on how spatial configurations might impact creative behavior (type 3 theories), but without providing explanations for the possible working mechanisms. Only five sources presented causal (type 4) theories that provided not only predictions and theoretical explanations for certain impacts, but also provided testable propositions.

However, none of the respective sources appeared to be comprehensive in terms of scope, empirical evidence, and theoretical underpinning, which indi-

cates that the need for a holistic causal theory of creative spaces still persists. Similarly, the offered design principles (type 5 design theories) are very limited, and tools for guiding development processes of creative spaces were not identified through the literature search.

In summary, the analyzed sources all come to the conclusion that a deliberate and inspiring design of workspaces is important and that it can have an actual impact on creativity. However, most of them do not specify how exactly those spaces should be designed and why.

Consequently, the presented sources do not seem to adequately cover the persisting demand of practitioners for clear instructions on how to design creative spaces with information about the underlying working principles, which also presents great opportunities for future research and warrants our own endeavor to investigate the topic of creative work environments with this PhD project.

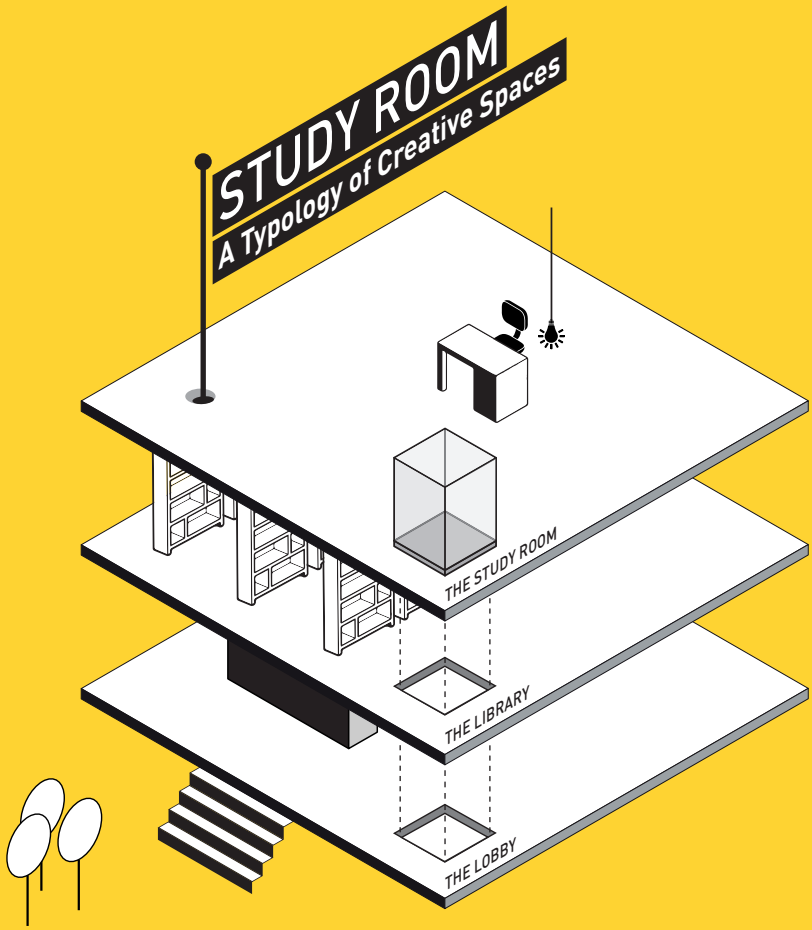
3.6. CONCLUSIONS

The gained insights into the current state of the literature on creative spaces revealed that the interest in the topic is rising. After the publication of Amabile's updated book in 1996, 42 studies on the topic of creative spaces were published that were identified through our search process. Although the analyzed sources presented various insights, it has become evident that several research gaps still persist. In the following chapters of this thesis we are going to tackle the challenges to develop (1) a holistic typology of creative spaces in Chapter 4, (2) a pattern language of creative spaces in Chapter 5, (3) a causal theory of creative spaces in Chapter 6, and (4) a toolkit with guidelines for designing creative spaces in Chapter 8. Moreover, we will report on an in-depth case study of one particular organization in Chapter 7.

In each chapter, we will refer back to the literature and discuss it in more detail, to compare the current state of the literature with our own approaches.

4TH FLOOR: THE STUDY

Do some focus work, in the study room. Nobody will disturb you here. Find your desk, sit down, and start analyzing the first study. You will get a better idea then, about the different types and qualities of a creative space.



Preliminary versions of the typology of creative spaces have been published in:

Thoring, K., Desmet, P., & Badke-Schaub, P. (2018). 'Creative environments for design education and practice: A typology of creative spaces'. Design Studies, 56, 54–83. https://doi.org/10.1016/j.destud.2018.02.001

Thoring, K., Mueller, R. M., Luippold, C., Desmet, P., & Badke-Schaub, P. (2018). 'Co-creating an idea lab: lessons learned from a longitudinal case study'. CERN IdeaSquare Journal of Experimental Innovation, 2(1), 30–37.

Thoring, K., Luippold, C., Mueller, R. M., & Badke-Schaub, P. (2015). 'Workspaces for Design Education and Practice'. In Proceedings of the 3rd International Conference for Design Education Researchers (pp. 330–346). Chicago, USA. https://doi.org/10.13140/RG.2.1.1200.7520

Thoring, K., Luippold, C., & Mueller, R. M. (2012). 'Creative Space In Design Education: A Typology of Spatial Functions'. In *Proceedings of the International Conference on Engineering and Product Design Education*. Antwerp, Belgium

4. A TYPOLOGY OF CREATIVE SPACES

4.1. RATIONALE

We start our empirical analysis with a qualitative user study. In order to gain insights into the general system of creative spaces, i.e. what types of spaces people would need for being creative, and how those spaces could support the intended activities, we invited users of a given creative work environment to document their workspace.

> *RQ 3: What are types and qualities of creative spaces in design and innovation contexts?*

The goal of this study is to extract relevant categories and qualities that would constitute a creative workspace, as viewed from a user's perspective. The resulting typology represents the foundation for the subsequent studies, by providing the framework to align future insights and propositions.

4.2. RELATED WORK ABOUT CREATIVE SPACE CLASSIFICATIONS

4.2.1. Procedure

As outlined by our systematic literature review presented in Chapter 3, starting on page 51, we identified 16 sources that presented some sort of classification system or requirements list, which is comparable to our goal with this chapter. However, eight sources remained rather vague and unstructured. The remaining eight sources presented their findings in a structured framework or typology of creative spaces, but with different foci. We will take a look at those eight sources in more detail in the next section. Subsequently, we looked at our entire sample of 42 sources to identify similarities in used terminology for different types of spaces. We analyzed the 42 sources and recorded any references to some sort of space type—that is, a space dedicated for a specific purpose or activity. In a similar vein, we also searched for references to particular spatial qualities—that is, the general impact of a space. The references were recorded in an Excel table and grouped according to emerging themes. These themes were constantly named, renamed, grouped, and regrouped, until no further categories emerged; to the point of theoretical saturation (Corbin & Strauss, 2014). Through this procedure we were able to identify relevant categories of creative workspaces.

4.2.2. Identified Typologies

In this section, we will describe the eight sources that presented some sort of structured classification system of creative spaces.

Jankowska and Atlay (Jankowska & Atlay, 2008) presented a framework in which they distinguished three types of learning spaces: S-space (social learning space), F-space (formal space), and C-space (creative space). They found that C-spaces enhance creativity with visual and aesthetic qualities, writable walls, flexible layout, and special technologies.

Leurs, Schelling, and Mulder (2013) distinguished between space (three-dimensional surroundings) and place (space with meaning, value, and functions that foster commitments and team spirit). They suggested a three-stage process: (1) make space, in which students are provided with space, supplies, and tools; (2) make place, wherein students establish ownership, i.e. students make the space their own; and (3) make sense, in which meaning-making occurs—i.e. students identify patterns and connections among research data, insights, sketches, and ideas.

Kohlert and Cooper (2017) presented a collection of case studies from design education and practice, which they mapped to different spatial qualities, such as the ability to encourage certain behaviors or to promote creativity or well-being.

Paoli and Ropo (2017) presented a set of five spatial themes that might foster creativity in the workspace based on empirical investigations of 40 companies' workspace pictures found on the internet. The five identified themes are: (1) home, (2) sports and play, (3) technology (imaginative future and past), (4) nature and relaxation, and (5) symbolism, heritage and history. We do not consider the suggested themes a classification of spaces as such, but a classification of different design styles.

Schmidt, Brinks and Brinkhoff (2015) presented a classification of different innovation labs. Their typology, however, was only distinguishing among different funding forms and did not discuss relevant space types.

Setola and Leurs (2014) presented a framework for creative learning spaces, which they labelled "the wild", "the pub", "the attic", and "the workplace". This metaphor maps onto Kolb's (1984) learning cycle. "The wild" suggests the activity of observation; "the pub" is identified as a space for sharing thoughts with others; "the attic" should be used for analysis; and "the workplace" is for planning and making things.

Snead and Wycoff (1999) suggested several design features of a space that would facilitate collaboration and teamwork. They provided some abstract spatial configurations that should support the identified categories of (1) interaction, (2) visual thinking, (3) beauty, (4) fun, (5) abundance, and (6) tools. However, they provided no evidence or theoretical underpinning as to why the suggested spatial settings would result in improved collaboration. Moreover, space types other than collaboration spaces were disregarded.

Williams (2013) presented a typology of creative workplaces, based on the metaphor of linguistics' grammar. She distinguished between behaviors (engage or disengage with people or ideas), and place (official workspace, semi-official workspace, informal workspace, informal spaces at work), plus five non-workspaces, such as home or transportation.

It becomes evident that some of the existing typologies are not classifying physical workspace concepts, but rather referring to abstract concepts, such as beauty, fun, or ownership. Some refer to process steps or types of behaviors, while others refer to concrete space types with metaphorical names. Apparently, a comprehensive typology of space types and qualities for creative activities in education and practice contexts was lacking.

4.2.3. Identified Space Types

By analyzing all 42 sources from our initial literature review through the clustering and grouping of the mentioned concepts, we identified a total of 13 different space types. These space types are listed according to the number of sources that referred to them: (1) verification space to perform analysis and synthesis processes (11 references), (2) personal space for focused work (10 references), (3) preparation or exploration space to investigate a topic or problem, for example, through research (10 references), (4) illumination space, where one would find inspiration and sudden insights (8 references), (5) incubation or reflection space, mainly for unfocused work (8 references), (6) relaxation or well-being space (7 references), (7) making or experimentation space, including workshops (6 references), (8) presentation or sharing space (5 references), (9) unusual space or play space (5 references), (10) disengaged or intermission space, used for breaks (4 references), (11) virtual space (3 references), (12) collaboration spaces for teamwork (2 references), and (13) exhibition space (2 references). The overview of these concepts and the related sources can be found in Table 1 on page 58.

4.2.4. Identified Spatial Qualities

In the subsequent step, we searched the 42 sources for references to qualities or intended impacts on a creative space. Here, we identified 14 re-appearing themes: (1) Space should reflect a specific culture and identity, for example, by displaying symbolic aspects (12 references). (2) Space should be flexible and changeable (11 references). (3) A space should facilitate social interaction and chance encounters (7references). (4) A space should be engaging and activate participation (7 references). (5) The space should facilitate workflows and provide affordances and appropriate infrastructure (6 references). (6) A space should provide stimulation and ambiance (5 references). (7) Space should be maintained by a facilitator or assistant (5 references). (8) Space should indicate ownership; preferably it should belong to its users (5 references). (9) Space should provide comfort and ergonomic features (5 references). (10) Space should be surprising and unexpected (3 references). (11) Space should provide additional services, such as events or access to external expertise (3 references). (12) Space should secure health and safety (2 references). (13) Space should be accessible (2 references). And finally, a space should enable (14) knowledge processing (2 references). The overview of these concepts and the related sources can be found in Table 2 on page 59.

4.2.5. Summary

Our analysis of the literature revealed that the different sources all make use of their own terminology. Often, different terms are used for similar concepts. For example, the terms disengaged space, intermission space, relaxation space, well-being space, and reflection space, all describe a similar concept of some sort of withdrawal from the focused work, or even a break activity. Among the spatial qualities there are several that are not related to the physical work environment, such as ownership or the presence of a facilitator. Others describe concepts that are not directly related to creativity, for example health and safety.

There seems to be no universal classification system, which warrants our attempt to systematically develop a typology of creative spaces. More specifically, we want to develop a typology that is (a) comprehensive, (b) addressing design education and practice, (c) based on empirical data, (d) provides tangible examples of spaces, and (e) is validated through an additional study. In the following subsections, we will outline the development of our typology of creative spaces.

We will refer back to the analyzed sources and compare them again with our own developed typology in Section 4.7.2 on page 104.

4.3. APPROACH AND METHOD FOR TYPOLOGY DEVELOPMENT

The goal of this study is to identify different types and qualities of spaces within two analyzed institutions. We wanted to understand how these spaces were used by the participants by analyzing their behavior and collecting their ideas and visions for creative spaces. For this purpose, we conducted a qualitative study following a grounded theory approach (Glaser & Strauss, 1967), using cultural probes (Gaver et al., 1999; Mattelmäki, 2006). We chose this qualitative approach to analyze the system of creative spaces in a realistic context.

We conducted our study at two different institutions: The design department of Anhalt University of Applied Sciences in Dessau, Germany ("Dessau Design School") and the School of Design Thinking of the Hasso-Plattner-Institute in Potsdam, Germany ("HPI D-School"). We recruited a total of 18 participants (nine from each institution). Each participant was given a set of cultural probes to document and assess the existing work environments and to provide ideas and wishes for their ideal work and learning spaces. The two institutions were chosen for the following reasons.

The Hasso Plattner Institute's School of Design Thinking (HPI D-School) in Potsdam, Germany is an educational design thinking institution, which we expected to provide a broader and more comprehensive design education than a traditional design school, because it focuses on creativity and innovation from several disciplines, while still integrating classical design skills, such as sketching and model making. Moreover, design thinking addresses design as a problem-solving technique beyond mere form giving, which reflects a more contemporary idea of design (Dorst, 2011). Finally, design thinking as it is practiced in this institution has a strong practice focus. Education here is mainly based on real client projects. The students, who are enrolled all have prior work experience in various fields and are completing the program as some sort of further education.

The second institution, Dessau Design School, is a traditional design school located in Dessau, the city of the historic Bauhaus, offering bachelor and master programs in "integrated design", which combine the disciplines of product design, communication design, and time-based media. The learning environment consists of several buildings, two of which were built in the early 20th century, and were originally used as industrial production facilities. The other build-

ings are newer, built in the mid-1990s specifically for the purpose of design education. There are well-equipped workshops (metal, wood, ceramics, printing, photography, etc.) as well as traditional theatre-style lecture rooms, a separate library building, and a canteen building.

Both institutions are located in rural areas of Germany and are quite close to each other (within a range of approximately 100 km); hence, they are quite comparable in terms of infrastructure, cultural background, and societal context. That being said, the two employ different design strategies, which is reflected in their spatial designs. The Dessau Design School is largely influenced by the historic Bauhaus approach, combining artistic and manual crafts with new technologies in an integrated design program, which focuses on project-based design cases. By contrast, the HPI D-School represents a more recent design thinking approach, which focuses on multidisciplinary team work in small groups geared mainly toward conceptual outputs rather than finished design prototypes. The differences in targeted learners (design students vs. multidisciplinary mixed teams involving industry project partners), year of construction (early 20th century vs. 1998), and design approaches (mainly individual project work and lectures vs. design thinking projects in small teams) engender major differences in the two spatial environments. Hence, we expected that the findings from the study cover a broad range of possible applications and might be transferable to additional contexts.

4.4. CULTURAL PROBES STUDY

Cultural probes are a method for qualitative user probes (Gaver et al., 1999; Mattelmäki, 2006) that provide participants with a set of tools, typically consisting of single-use cameras, user diaries, maps, postcards, or the like, with detailed instructions on how to complete the tasks. The participants work independently on these tasks for a specified amount of time. The advantage of this method is that the participants may document and comment their existing environments independently, and they can provide their wishes, critique, and visions about the spaces as well.

The cultural probes box we prepared for the participants in this study contained several items they were encouraged to use to document and evaluate their study and work environments. Among the prepared tools were a diary with printed questions, several floor plans to indicate positive and negative spaces, a single-use camera, a postcard to describe an envisioned "perfect" workspace, a

journey map to document involved spaces during one project, and a set of stickers with icons to indicate specific locations on the maps. See Figure 14 for an overview of the cultural probes items. The individual items can be found in Appendix A.

4.4.1. Procedure

We recruited a total of 18 participants (nine per institution) and handed each of them a set of identical cultural probes to complete within two weeks' time. The participants were selected to represent a broad range of different backgrounds. At HPI D-School, we included only advanced students from the second semester, because they would be familiar with the entire campus. The recruited participants had various professional backgrounds, see Table 5. At Dessau Design School, we chose students from both the Bachelor and the Master programs, from all three study fields (product design, visual communication, and time-based media), see Table 6.

Figure 14. The set of cultural probes that were handed to the participants.

Table 5. Participants from HPI D-School.

P#	Background	M/F	Origin
1	Management, IT	F	Filipina
2	Business Communication	M	German
3	Interface Design	F	German
4	Educational Sciences	F	German
5	Business Engineering	F	German
6	Dance, Dance Theory	F	German
7	IT-Systems Engineering	F	German
8	Communication Design	F	German
9	Science Philosophy, Theatre, Drama Theory	F	German

Table 6. Participants from Dessau Design School.

P#	Background	M/F	Origin
1	Product Design, BA	M	German
2	Illustration, BA	F	German
3	Digital Media, BA	F	German
4	Product and Communication Design, BA	M	German
5	Visual Communication, BA	F	German
6	Digital Media, BA	F	German
7	Visual Communication, BA	F	German
8	Product and Communication Design, BA	F	German
9	Visual Communication, MA	M	Chinese

The cultural probes box, pictured in Figure 14, contained twelve items. (1) A single use camera with 27 pictures. A cardboard frame and an arrow could be used to highlight important aspects within the photographed motifs. (2) A campus map and floor plans of selected buildings. (3) Sticky dots with icons and numbers to indicate positive and negative spaces on these maps and floor plans. (4) A photo list to enter additional information about each taken picture and the marked spaces. (5) A diary with some pre-defined captions on some of the pages, such as "this is how I organize my workplace", or "I would like to have my work-place in this movie … because", or "my typical postures when I'm working". These diary pages were supposed to be filled with personal notes and sketches. Additionally, we collected some behavior samples by sending unanticipated text

messages to the participants, in order to enquire details about the situation they were in when receiving the message. Those details were also to be captured in the diary. (6) A "postcard to grandma" on which the participants were supposed to visualize their perfect (imaginary) creative workspace and explain it to a layperson. (7) A journey map of one former project that the participants could choose themselves. This project should be illustrated in eight steps, regarding the frequented workspaces. (8) A tag cloud with words around the topic of creative space to inspire the participants and to indicate what kind of information we were interested in. (9) A bar of chocolate and a teabag for a creative break. On the reverse side of the wrappings we provided some questions about the qualities of the particular space the participants were in, when consuming these goods. This procedure yielded also some random insights on the frequented workspaces. (10) Three pens (red, green, and black) to use for filling out the maps and diaries. (11) A blank CD for additional digital files (optional). (12) A card with handwritten instructions. Figure 14 illustrates the cultural probes box and parts of the content. All items can be found in Appendix A.

4.4.2. Returned Data

The study yielded a significant amount of rich data (sketches, pictures, and field notes). Each of the approximately 400 photos we received included a written description of why the depicted space was evaluated as positive or negative and in what way the spaces were able to support or hinder the respondent's creative work process. Each photo was marked on one of the provided maps of the university's buildings or campus with a red or green sticker to indicate a negative or positive aspect, respectively. The diaries and postcards revealed insights about participants' wants and needs and their insights about spaces that were lacking within the institution's environments. After an initial data analysis, we invited each participant for an individual follow-up interview to answer any emerging questions and to clarify reasons why respondents had marked certain spaces as positive or negative. Then, the resulting data were analyzed using a grounded theory approach with open and axial coding (Corbin & Strauss, 2014). This step is described in more detail in Section 4.4.3.

Figure 15 shows an overlay of the campus map from all of the HPI D-School participants, which allowed us to identify areas with frequent indications of positive or negative spatial aspects. Each icon on the map represents a photograph taken by a participant. Red indicates a negative impression; green, a positive one. Each picture was described in more detail with handwritten notes.

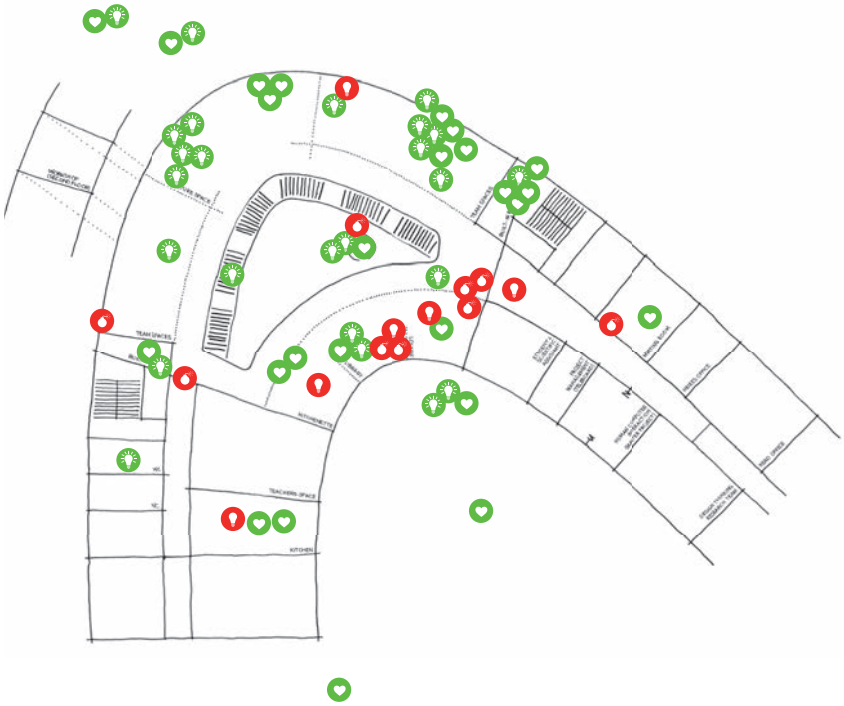


Figure 15. Indication of positive (green dots) and negative (red dots) aspects on provided floor plan of HPI D-School, aggregated from all participants; each dot represents a photograph.

Figure 16 shows the similar aggregation of all participants from Dessau Design School, indicating positive and negative areas on that campus. Selected photos taken by the participants from both institutions are presented in Sections 4.4 and 4.5.

Figure 16. Indication of positive (green dots) and negative (red dots) aspects on provided campus map of Dessau Design School, aggregated from all participants; each dot represents a photograph.

Figure 17 and Figure 18 show exemplary results from the diaries from participants form both institutions, delivered according to the prompt "This disturbs me when I'm creative", "I need this to be creative", "this is where I have my best ideas", and "I would love to work here, because…".

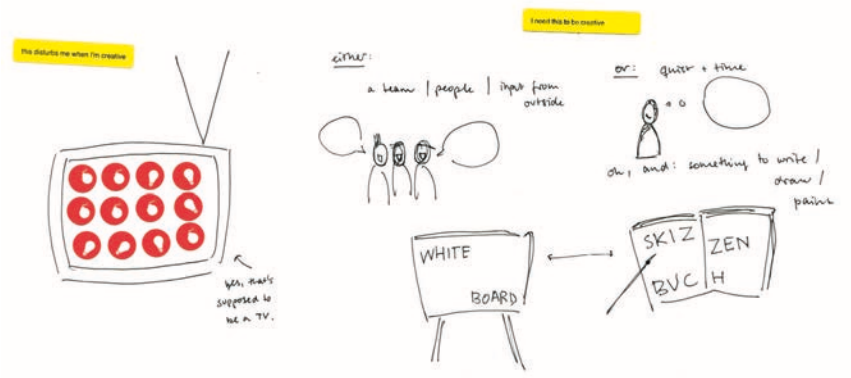


Figure 17. Selected pages from the diary of one participant from HPI D-School: responses to the pre-printed prompts, "this disturbs me when I'm creative" (left), and "I need this to be creative" (right).

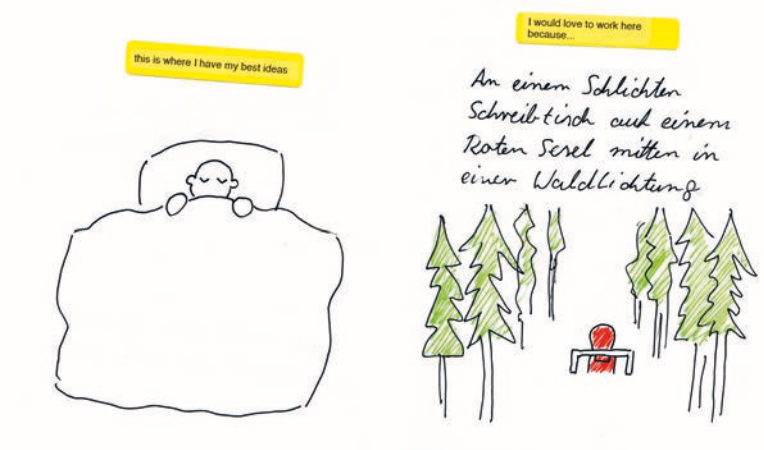


Figure 18. Selected pages from the diary of one participant from Dessau Design School: responses to the pre-printed prompts, "this is where I have my best ideas" (left), and "I would like to work here, because…" (right).

Figure 19 and Figure 20 show selected examples of returned postcards, depicting the "perfect creative workspace" of two participants. The diaries and postcards allowed the participants to express their wants, needs, and visions regarding their institutions' creative environments. Using these, we were able to identify the types and qualities of existing spaces as well as those that might be lacking.

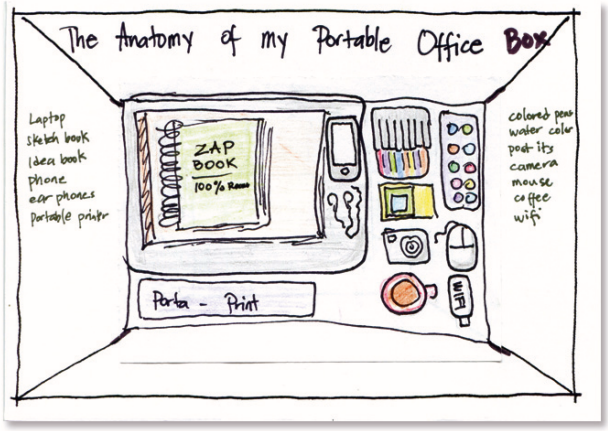


Figure 19. Exemplary postcard ("My perfect workplace"), selected participant from HPI D-School.

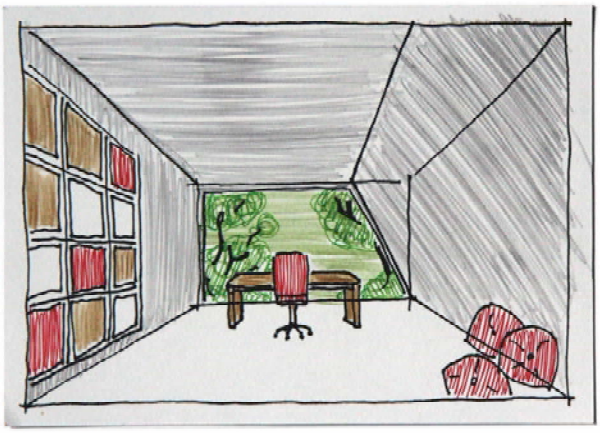


Figure 20. Exemplary postcard ("My perfect workplace"), selected participant from Dessau Design School.

4.4.3. Data Analysis

The data analysis was conducted by three researchers (one is the author of this thesis), using open coding in order to identify categories, and axial coding in order to identify connections between concepts (Corbin & Strauss, 2014). Together, the researchers read all the written notes and examined all the sketches and other visual material provided by the participants. After conducting several follow-up interviews to clarify any questions that emerged, the researchers transcribed the main insights from each item (photo, sketch, or note) as well as the insights from the interviews onto color-coded Post-it notes. These notes were tagged with (+) or (–) symbols to indicate positive or negative comments about the given space. Subsequently, the researchers clustered the Post-it notes according to the similarity of the material. Data, codes, and clusters were compared constantly with each other and merged, split, named, and renamed as necessary. This procedure was repeated until no further categories emerged; i.e., to the point of theoretical saturation (Corbin & Strauss, 2014).

Through this procedure it was also possible to identify relationships and influences between categories (axial coding). We were able to classify different types and qualities of creative spaces by extracting insights from the participants' documentation of existing spaces, as well as from the diaries and postcards that revealed the spatial needs that were not met by the existing spaces. In this way, it was possible to identify additional space types and spatial qualities, even if they were not currently present in the environment of the analyzed institutions. The process resulted in ten identified clusters: five *types* and five *qualities* of creative

spaces. The typology developed based on these findings is described in the next section.

4.5. A TYPOLOGY OF CREATIVE SPACES

4.5.1. Definitions and Overview

A space type is a dedicated space for a specific activity at a specific time (e.g. presentation, teamwork, model-making). Each space has an inherent "affordance" (Norman, 1999, 2002) that suggests the kind of activity for which the space is mainly intended, which is enforced through its configuration (e.g. the room layout and furniture). This configuration can be changed, which means that a space type can also change. However, changing a space type requires some time and effort, whether it be moving chairs or breaking down walls. The degree of time and effort required to change a space from one type to another determines its degree of flexibility.

We distinguish between five different types of creative spaces: (1) the personal space, for working or learning alone; (2) the collaboration space, for working or learning together with co-workers, classmates, or teachers; (3) the presentation space, for giving presentations, attending lectures, and displaying or examining creative work examples; and (4) the making space, in which people are able to experiment, try things out, build stuff, and make noise. A fifth category emerged from the data: intermission space for transition and recreation (5). This category includes spaces that are not deliberately intended for creative design work but connect the other space types—for example, hallways, cafeterias, or the outdoors—and provide spaces for breaks. These five space types covered all the existing spaces within the analyzed institutions (Figure 21, left).

Orthogonal to the space type, we identified another category: the "spatial quality" (Figure 21, right). This is a space's capacity to facilitate a specific purpose independent of the space type. We distinguished between five different qualities of a creative space: a given space can be (a) a knowledge processor; (b) it can be an indicator of organizational culture; (c) it can act as a process enabler by providing an appropriate infrastructure; (d) it can have a social dimension; and (e) it can be a source of stimulation. The quality can have a positive or negative effect on the work process, depending on the respective process phase, the extent and characteristic of the quality, or individual preferences.

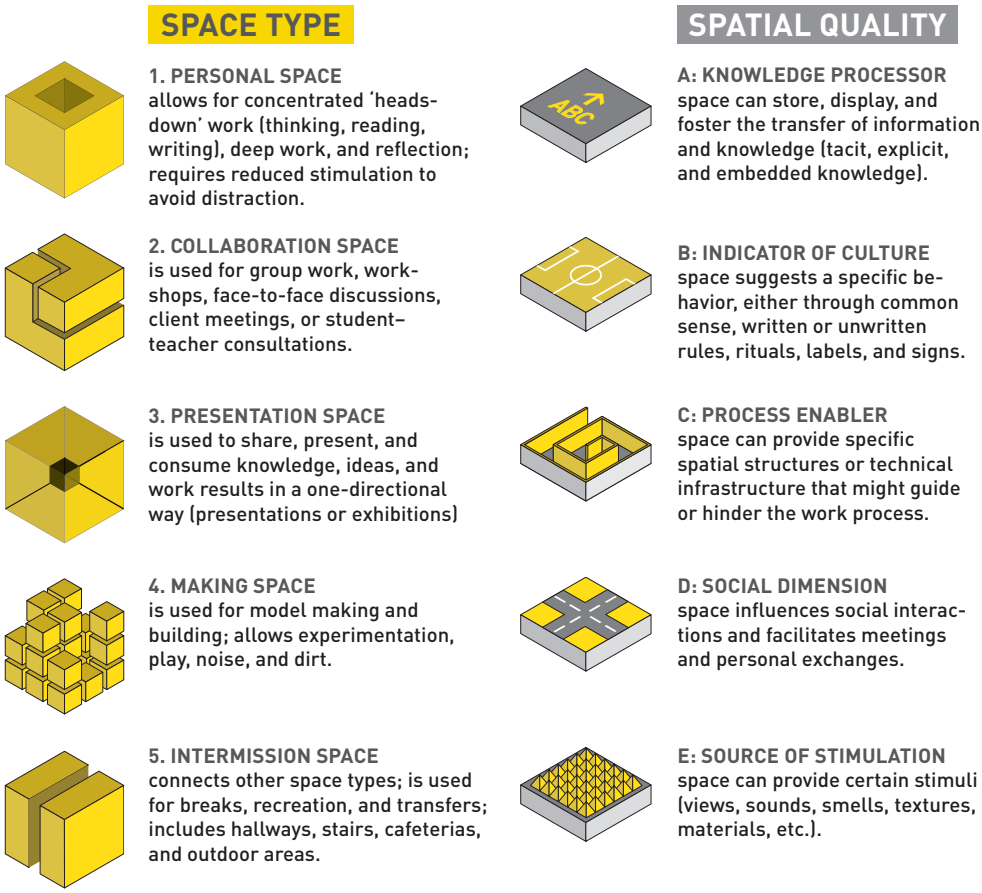


Figure 21. Typology of creative spaces. Overview of space types and spatial qualities.

Figure 21 illustrates the space types and qualities. Each space type and each spatial quality is described in detail in the following sections and is illustrated with examples from the analyzed institutions. Most of the photographs were provided by the participants as part of their cultural probes tasks. Selected pictures were re-taken by the researchers to improve image quality or to illustrate phenomena that were only described in text form.

4.5.2. Space Types

Personal Space.

Just like a monastery, the personal space allows for concentrated working (thinking, writing, reflection, meditation, focus work) and is usually characterized by a

silent atmosphere and a lack of distractions. Newport (2016) coined the term "deep work" for this kind of working style. People use these spaces for personal alone time and for intense work activities like research, reading, writing, CAD work, or individual ideation.

The students at the HPI D-School used the so-called spy-spots for personal withdrawal—secluded areas of approximately 5 m^2, built at a slight elevation above the normal workspace, which allow for observation of the entire floor. These spaces were purposefully designed to provide opportunities for personal withdrawal. Besides that, there were few venues for individual work. Many students mentioned outside areas like a tree bench or a commuter-train ride for this purpose (Figure 22).

Figure 22. Personal spaces at HPI D-School: Outdoor tree bench; spy-spot.

Figure 23. Personal spaces at Dessau Design School: Library; photography workstation.

Examples for personal spaces, drawn from the responses of students from Dessau Design School, included their homes, a train ride, the university library, or individual workstations in laboratories or workshops. The library is of particular interest, because it is actually not a place to be alone; however, the need to work individually in a silent atmosphere, even when in the company of others, seems to be an important factor for concentrated "heads down" work (Figure 23).

At both institutions, the possibilities for individual work were limited. Many participants mentioned their preference for working at home owing to the lack of spaces for personal withdrawal and concentrated work on-site. Especially at the HPI D-School, the lack of such individual workstations was evident, which is attributable to the program's reliance on a collaborative group work model; even so, the participants in the study emphasized that spaces for individual work and personal withdrawal were lacking.

Collaboration Space.

This is a creative space type that invites people to work together as a team, exchange ideas, and communicate with each other. It is characterized by noise, playfulness, and team interactions. The layout of the room should allow for group work and discussions, such as consultation space where students and teachers can meet for feedback and meeting spaces with clients.

Figure 24 shows selected collaboration spaces at HPI D-School. Typical for design thinking facilities, we see separated work booths with moveable whiteboards and stools instead of normal tables and chairs. Up to eight such team spaces are located on the main teaching floors. Outside areas are integrated into the workflow: if the weather permits, students can occupy one of several outdoor booths that are equipped similarly to the indoor team spaces.

Figure 24. Collaboration spaces at HPI D-School: Team booths; outdoor pavilions.

Figure 25. Collaboration spaces at Dessau Design School: Typical classrooms

Figure 25 shows different collaboration spaces at Dessau Design School; these were mostly classrooms. There were no dedicated spaces for teacher–student collaboration or student teamwork outside the lecture rooms.

Making Space.

A making space is a creative space that allows people to experiment, try things out, and build stuff. These spaces allow for experimentation, noise, and dirt.

HPI D-School integrates its making spaces into the main teaching areas. A workbench with tools is located in one corner of the main teaching floor. Prototyping materials are on hand in shelves and transparent boxes (Figure 26).

Figure 26. Making spaces at HPI D-School: Workbench and material storage in the main lecture area.

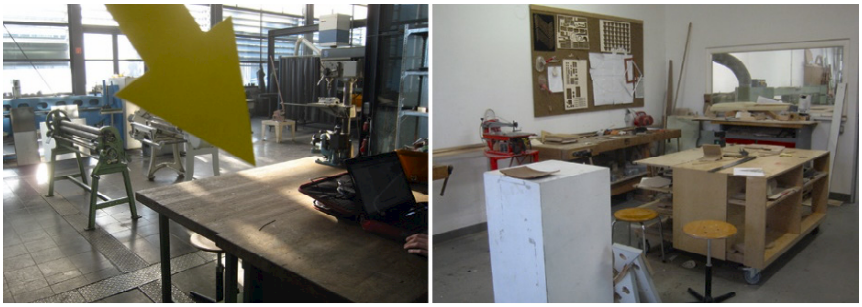


Figure 27. Making spaces at Dessau Design School: Traditional workshops (metal and wood).

Figure 27 shows the making spaces at Dessau Design School: traditional workshops, which are located around the campus in separate building.

Presentation Space.

Presentation space is a term for a creative space where people passively consume input (such as lectures) or actively give input themselves (such as presentations). Usually the layout of such lecture rooms does not facilitate (active) teamwork,

but it does provide for giving and receiving feedback. This space type also includes a passive display of work results and exhibitions (e.g. models in showcases or posters on walls).

At HPI D-School, the lecture space is furnished with moveable sofas on wheels, stacking chairs, and additional seating cubes that can be arranged according to the size of the audience. In another building, theatre-style platforms with cushions are installed in the room, which do not allow for a flexible arrangement. Additional sofas, mainly for guests or invited speakers, provided some variety. Prototypes from previous projects were displayed on shelves and wallboards were provided for occasional project exhibitions (Figure 28).

Figure 28. Presentation spaces at HPI D-School: Various lecture spaces and the display of project results on walls

Figure 29. Presentation spaces at Dessau Design School: Lecture rooms with stackable chairs, showcases displaying work examples, and poster galleries in hallways

At Dessau Design School, lecture spaces were mainly furnished with freestanding stackable chairs, which also allow for group work. Theatre-style auditoriums with fixed rows of chairs were also available, but not used as frequently. Examples of design work were presented throughout the campus (Figure 29).

Intermission Space.

There were some spaces that could not be classified as one of the four above-mentioned space types. Hallways, outdoor spaces like parks or parking lots, the cafeteria and students' café, or walkways were obviously not dedicated areas for creative work; but people nonetheless integrated such spaces into their creative workflow. Such "intermission spaces" were particularly characterized by unintended meetings, chance encounters, and opportunities to take a short break and reflect on previous work. In addition, research activities extend the range of creative spaces to areas beyond the building itself.

Figure 30. Intermission spaces at HPI D-School used for casual meetings and reflection: Staircase; walkway to parking lot; entrance area.

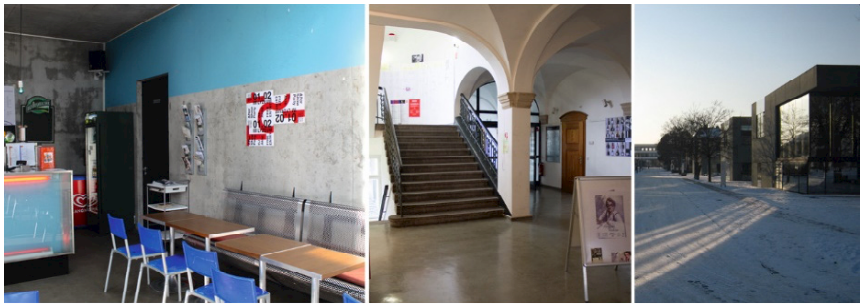


Figure 31. Intermission spaces at Dessau Design School: Student café; hallways with information boards; walkways between buildings.

At HPI D-School, the main intermission spaces were the walkways between buildings for the two study tracks, which were about a 10-minute walk. These distances were mentioned negatively, because they impeded exchange between first and second term students. Most students commuted to the institution by rail; the train was mentioned as a space for thinking, meeting classmates, and doing research. Staircases within the building or the elevator were indicated as meeting spots, whereas outdoor areas, such as parking lots and a bench, were used for recreation and smoking breaks (Figure 30).

At Dessau Design School, students mentioned that the distance between different buildings was sometimes inconvenient and that it further separated students from other faculties. However, the required transition times (e.g. a walk to the workshop building) would allow for reflection between different process steps, as well as casual encounters with other students. Intermission spaces that were actively incorporated into the work process by the participants were a parking lot outside the university building, hallways, staircases, parks, commuter trains, and even restrooms (Figure 31).

4.5.3. Spatial Qualities

Space as a Knowledge Processor.
One interesting aspect of a space is its capacity to serve as a knowledge facilitator or repository. Information can be stored on shelves (in the form of books, materials, notes, pictures, and so on), or on the walls (e.g. sticky notes on whiteboards). Physical models or other work results (e.g. posters) from previous projects or from more advanced students incorporate knowledge, which can be extracted or used as a source of inspiration. Knowledge might be represented visually, so that other people can access it easily. In that way, the space can foster the exchange or even generate knowledge by providing the platform for displaying and accessing it.

At HPI D-School, there were several types of libraries incorporated into the teaching spaces: a small book library, a materials library, and a gadget library. Writeable walls and whiteboards could be used to store notes, pictures, and sketches to be accessed by other students. A bulletin board with pictures of coaches and their individual skills provides information about who is available to help with specific tasks (Figure 32).

At Dessau Design School, many walls of the hallways are used to store and display information, but some of it was very outdated and hence distracting. In the classrooms, examples of previous students' work were displayed (e.g. working models or posters). Pin boards or whiteboards were also occasionally used to store notes and sketches (Figure 33).

Figure 32. Knowledge processors at HPI D-School: Bulletin board with teachers' expertise; whiteboards; bookshelves with a small library.

Figure 33. Knowledge processors at Dessau Design School: Pin boards in classrooms; working models; flyers and posters in hallways.

Space as an Indicator of (Organizational) Culture.

A space can serve as an indicator of a specific (corporate or organizational) culture. Many spaces signalize how the user should behave, either embedded in the layout or by just using common sense (e.g. everyone knows that you have to be quiet in a library or that you are allowed to make noise in a workshop). Written rules within a space can also serve this purpose. It is important to establish a specific culture to avoid misuse or to foster a supportive atmosphere for creative working and learning purposes. In that sense, spatial culture can support the affordance of a space; its ability to indicate how it is supposed to be used or how one should behave in it (Norman, 1999).

At HPI D-School the expressed culture was very playful, with lots of toys on hand. Written rules addressed the design process itself, for example, as brainstorming rules (Figure 34).

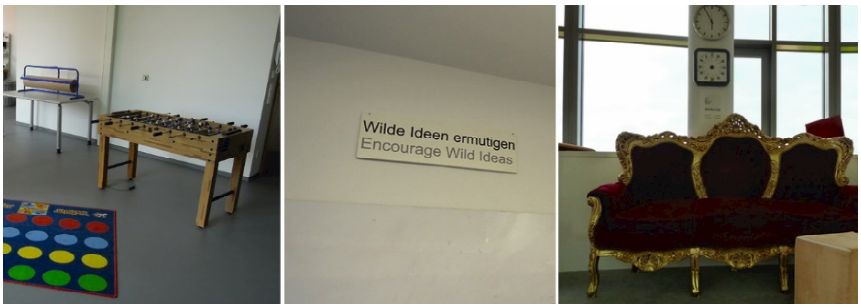


Figure 34. Culture at HPI D-School: Toys, table soccer, and other games on hand indicate a playful culture; written brainstorming rules; a 'VIP' sofa for guest critics.

Figure 35. Culture at Dessau Design School: Messy students' studio; room rules printed on a door.

At Dessau Design School, the culture was mainly expressed through written or unwritten rules on how to behave in a given space, such as instructions to lock doors. Occasionally, students were allowed to occupy classrooms—for example, the Masters' studio or selected classrooms where coffee machines were available for student use. However, giving the students "ownership" of the space sometimes resulted in a lack of tidiness and order (Figure 35).

Space as a Process Enabler.

The space can also enforce or even dictate specific procedural behaviors, mainly based on the provided infrastructure. For example, tables and chairs affixed to the floor in a lecture hall do not allow group work. In that sense, the process enabler is an extension of the affordance concept—the space dictates a specific usage or behavior, rather than suggests it. The flexibility of a space or equipment is important in allowing for different creative activities. A space's capacity to change from one type to another with minimal time and effort determines its flexibility. Moreover, for a smooth workflow it is helpful if the different types of spaces are aligned next to each other or within short walking distance (reduced transition spaces).

At HPI D-School, furniture on wheels and foldable walls allow for a flexible teaching style; users can adjust the space to suit the purpose and the number of people. Dedicated outdoor spaces with sockets and adequate furniture allow for working in fresh air (Figure 36).

At Dessau Design School, the infrastructure determines the work process in most classrooms. The layout of the room and choice of furniture determined a particular teaching style or direction (Figure 37). A lack of particular process enablers was mentioned negatively by the students; for example, the lack of electrical sockets in outdoor areas prevented them from working outside even when the weather permitted it. Specific workshop workstations were mentioned positively, because these suggest a specific usage.

Figure 36. Process enablers at HPI D-School: Moveable furniture on wheels; outdoor team booth allows working outside; moveable walls for flexibility.

Figure 37. Process enablers at Dessau Design School: Projection wall and lectern determine ex-cathedra teaching; fixed chairs in an auditorium do not allow group work.

Space as a Social Dimension.

Social interactions among co-workers and among students and teachers are an important aspect of creative work. By definition, team spaces are usually designed to allow for social interactions; but intermission spaces, such as cafés or

hallways might enforce accidentally running into each other, which can also support the exchange of information. The strategic placement of central objects, such as copy machines or water coolers, could facilitate social interactions.

HPI D-School housed many casual meeting spots, such as sofas and coffee corners that invite social interaction. Furthermore, entrance areas and the elevator were mentioned as spaces for casual meetings and discussions with classmates. Transparent walls and bookshelves allowed for visual contact (Figure 38).

At Dessau Design School, the main spaces mentioned as facilitating social interaction were not the classrooms but the intermission spaces, such as cafés, hallways, and building entrances. Some of the classrooms actually impeded group discussions because of the layout of chairs and tables (Figure 39).

Figure 38. Social dimension at HPI D-School: Elevator as meeting spot; casual sofas invite personal exchange; transparent walls and shelves allow visual contact.

Figure 39. Social dimension at Dessau Design School: Cigarette break at entrance; hallway with information board as meeting spot; room layout does not facilitate group discussions.

Space as a Source of Stimulation.

The space can act as a source of stimulation by providing noise, smell, views, colors, and textures; by displaying inspirational posters; or by providing games and gadgets. That being said, a space may also trigger creativity by reducing stimulation. The lack of textures and noise might facilitate a creative flow (Csikszent-

mihalyi, 1996). Many participants mentioned that silent and non-distracting atmospheres in nature, or being on a train with passing landscapes, facilitated their creative output. In addition, some stimulation, such as loud noise that impedes concentration, can have a negative effect on the creative workflow.

At HPI D-School, positive stimulation was achieved through natural sounds and smells while working outdoors, whereas the noise level of co-workers in the main lecture area was often a cause for distraction and negative stimulation. In addition, the choice of background music was sometimes grounds for disagreement. Further stimulation was provided through colorful interiors (Figure 40).

At Dessau Design School, participants mentioned positive stimulation, using the large windows and the aroma of coffee as examples; identified sources of negative stimulation included demolition and traces of previously installed exhibitions (e.g. leftover tape and unused nails on walls, Figure 41).

Figure 40. Stimulation at HPI D-School: Open space with background noise; colorful interior.

Figure 41. Stimulation at Dessau Design School: Inspiring books and work examples, wall with traces of removed posters; large windows.

4.5.4. Summary

The presented typology of creative spaces distinguishes among five space types and five spatial qualities that appeared to be relevant and sufficient enough to cover all of the required spatial concepts in the analyzed institutions. The five identified space types (personal space, collaboration space, presentation space, making space, and intermission space) were categorized based on the affordance they provided for particular design and learning activities. One might argue that any space can be used for any designerly activity, which is certainly true; but usually a space provides some kind of optimization for the intended specific activities. For example, a space in a library could certainly be used for model-making, or a wood workshop for a lecture; but those spaces would not be the best choice for these activities. The inherent purpose of a space is explained with the concept of affordance (Norman, 1999); the presented typology employs this concept.

Participants from both institutions identified the same space types for their creative activities, albeit in different shapes and with different characteristics. Also, both institutions revealed different priorities for the different space types. For example, at HPI D-School collaboration spaces were most prominent, whereas making spaces were rarely provided. Personal space was practically nonexistent, which was regarded as a deficiency by the participants. Active presentation spaces were provided mainly for lecturing. By contrast, at Dessau Design School making spaces in various forms were highly relevant, as well as passive presentation spaces like exhibitions or showcases. Collaboration spaces were not provided besides the classrooms, and personal space was also insufficient; both were mentioned as a deficiency by the participants. Intermission spaces were mentioned as highly relevant at both institutions. At HPI D-School they were mainly used for casual meetings or for conducting user research; at Dessau Design School intermission spaces were mainly used to compensate for a lack of personal spaces, for example for personal reflection and deep work.

Regardless of these differences in characteristics and prioritization, all five space types were identified as relevant at both institutions, which warrants our decision to define these five space types as the foundation of our typology. The same applies for the spatial qualities. Even though participants from both institutions defined different degrees or characteristics for each quality; generally, they all came up with the same categories.

The spatial qualities that were derived from the data suggested a certain range or degree of each quality, which depended on the extent to which the quality was present and on the context. For example, the stimulating quality of a space

may be either inspiring or distracting; a space as a knowledge processor can be accessible or locked; a social dimension of a space can be inviting or separating; a space as an indicator of culture can be playful or serious; and a space as a process enabler can be either flexible or fixed. For example, space at the HPI D-School was characterized by a playful atmosphere (culture) and flexible furniture (process enabler); participants at Dessau Design School mentioned fixed chairs in a lecture hall as limiting process enablers, or the lack of their own studio space as an indicator of a negative culture. Consequently, similar concepts were mentioned but with different assessments. The characteristics and peculiarities of the spatial qualities determined whether a space was regarded as positive or negative. Consequently, we will focus on the qualities of a space in the remainder of this thesis. Based on the ratings of the participants, we derived a list of requirements. Table 7 outlines the suggested requirements for the spatial qualities for each space type.

Finally, it is important to point out that there exists some degree of overlap among the categories. For example, social interaction leads to an exchange of tacit knowledge; hidden knowledge in vaults is an expression of a specific (conservative or competitive) organizational culture, and social interactions and related conversations lead to some sort of stimulation, either as a form of inspiration for both parties, or as noise that might lead to the distraction of others. However, we argue that it is important to discuss each concept individually, because this would make it easier to systematically address particular qualities through spatial designs.

The participants in the study also indicated that specific characteristics of spatial elements, such as materials, views, smells, textures, colors, or a particular piece of furniture, had a positive or negative influence on their creative workflow, mood, and performance. However, these insights are not part of this study; they will be investigated further in the next chapters.

Table 7. Possible requirements of space types related to spatial qualities.

	Knowledge Processor	Indicator of Culture	Process Enabler	Social Dimension	Source of Stimulation
Personal Space should / might:	protect knowledge; provide access to explicit knowledge	indicate privacy, provide separation from others; express individuality	provide secluded booths; provide appropriate equipment	reduce social interactions	be protected from external stimulation; provide adjustable stimulation
Collaboration Space should / might:	provide access to knowledge; display explicit knowledge; enable tacit knowledge exchange	indicate rules for usage/behavior; be accessible; be playful; facilitate common rituals	facilitate teamwork; provide collaboration furniture; include flexible and moveable furniture	invite and enable interactions; provide meeting areas	provide visual and acoustic stimulation; allow higher noise level;
Making Space should / might:	provide instructions for usage; display artifact knowledge	invite experimentation; invite trial-and-error; allow noise and dirt	provide materials; provide making infrastructure	facilitate task-related social interactions	allow higher noise/dirt level; limit noise/dirt to acceptable degree
Presentation Space should / might:	facilitate knowledge transfer; display artifact knowledge	upvalue/highlight presenter or work; enable/encourage feedback	provide infrastructure for presenting; provide a platform to display/present work	invite feedback and discussions	reduce external distraction; presentation should become main stimulation
Intermission Space should / might:	facilitate knowledge transfer; display knowledge of general interest; provide access to field/ user research	be inviting, cozy, welcoming, or representative; facilitate common rituals	provide outdoor access; provide recreation area; provide access to suppliers; be in proximity to other spaces	facilitate coincidental meetings; enable collective breaks	provide fresh air and/or food; provide reduced stimulation; provide natural stimulation

4.6. VALIDATION STUDY

To validate the developed typology of creative space types and spatial qualities, as described in the previous section, we conducted a second study at another institution: an associated research facility at the Science Park in Kassel, Germany ("Kassel IdeaLab"). This institution is a research facility and co-working space

where collaboration among students, staff, start-ups, and practitioners is facilitated. Hence, this study provided us with the perspectives of additional practitioners and academic teaching staff. The goal of the validation study was to identify whether the typology is (a) exhaustive, (b) understandable, and (c) without unnecessary categories.

RQ 4: Can we transfer the developed typology to different contexts?

4.6.1. Procedure

We invited nine participants from different creative backgrounds (design teachers and research assistants, independent design practitioners, founders of creative start-up companies, and employees of global companies) to a focus group workshop, following the procedure laid out in Edmunds (1999). The institution and participants were selected to validate the developed typology and to determine whether it can be adapted to a different type of creative environment and to different stakeholders. Moreover, we chose to test it with participants who were not students in order to obtain more diverse perspectives on the topic. The type of institution, a university-affiliated research center and incubator, provided additional insights on the different types of creative work activities other than those found at a design school or a design thinking institution. Hence, varying both the target population and the research approach should enhance the validity of the results.

In preparation for the workshop the participants were asked to document their own work environments and to provide ideas and suggestions as to how to design a co-working space for a heterogeneous cohort of creative people. They were asked to provide pictures of their current workspaces as well as ideas, thoughts, and statements about their ideal co-working space. The prepared material was delivered to and analyzed by three researchers (one is the author of this thesis) in preparation for the workshop.

Subsequently, we invited all nine participants to a focus group workshop to discuss their materials together and to evaluate the data they provided and to compare it with the previously defined typology of creative spaces. During the one-day workshop, the participants were teamed up in groups of two or three. Each team was asked to analyze their material and explain the results to each other. Each team was supported by one researcher who took notes or made visual sketches from the most promising statements and insights. Each team then presented its findings to the entire group. Finally, participants were asked to cluster

the notes and sketches according to different space types and spatial qualities. Although they had heard a brief presentation about our previously developed typology at the beginning of the workshop, they were asked to define their own labels for space types or to create new ones if the provided structure would not suffice and they identified additional space types and functions. The resulting ideas and questions were discussed with the goal of sharing the different perspectives.

4.6.2. Results

The suggested typology of creative spaces and qualities was mainly confirmed through the validation study. The participants came up with the same types of spaces, plus one additional space type, which they called the "virtual space". This space type mainly suggested virtual meeting rooms for collaboration with co-workers in remote locations, as well as access to databases with specific materials, information, or additional expertise. Although this aspect of a space merits further research, we did not consider it as an additional space type, but as a characteristic of the technical infrastructure and, hence, a part of the process enabler category. Such a virtual space could be either a collaborative space (e.g. a virtual meeting room), a personal space (e.g. a blog for personal thoughts), a presentation space (e.g. a pre-recorded video lecture), a making space (e.g. a so-called "sandbox" in which to build digital prototypes), or an intermission space (e.g. Skype or other video conferencing systems that connect remote locations). Hence, we considered the virtual aspect a characteristic of a space rather than a space type of its own.

The study also validated the five spatial qualities. Although individual participants identified different characteristics of each quality, the overall findings confirmed the main categories of spatial qualities as described in our typology. The participants emphasized one additional characteristic of a spatial quality: data privacy. The ability to hide data in locked file cabinets or behind blinds was very important for most practitioners. However, we did not consider this to be an additional quality of a space, but as a characteristic of the knowledge processor quality—which can be represented in several degrees of accessibility.

Considering the initial question that informed the study, we found that (a) the typology's categories were exhaustive, (b) all categories were understood by the participants, and (c) the typology did not show unnecessary categories. Hence, this second study serves to validate the proposed typology of creative spaces.

4.7. DISCUSSION

According to the typology described above, some relationships between space type and quality appear relevant for facilitating creative working and learning in a design environment. The data suggest that a creative environment needs all five types of spaces, albeit in different shapes, proportions, and alignments. A lack of a particular space type resulted in unsatisfied users, leading them to improvise adaptations of other spaces. Whether a space was deemed good or bad for creative working and learning activities was mainly determined by the respective qualities that the space provides. These qualities can be perceived as positive or negative, depending on the respective process phase, the individual preferences and needs of the users, or the extent of the quality in question.

Another aspect to consider is the amount of available resources in terms of time, budget, and space. Sometimes an institution must economize and remain in a small space, or it must deal with an existing building that cannot be extended. With the presented typology, we do not suggest any specifics with regard to appropriate furniture or appearances, but only systemic categories that could be considered in different degrees with various financial and spatial resources.

Consequently, it is impossible at this point to coherently rank the different space types and qualities in any particular order of relevance or to suggest specific design guidelines. Instead, all space types and all qualities should be considered when designing a creative space, and concrete specifications and design decisions should be carefully balanced in adjustment to the applicable situation. Nevertheless, the following section presents a few rules of thumb to consider when designing creative spaces.

4.7.1. Implications

A space's capacity to transform from one type to another seems to be an important merit, because sometimes different activities must occur in a single space within a short timeframe (e.g. presentations followed by groupwork). This flexibility of a space is mainly determined by a flexible infrastructure, i.e., the degree to which the space allows a changeover from one type to another with minimal effort. This process enabling quality of presentation spaces and intermission spaces needs special attention. When presentations occur only sporadically, a highly flexible infrastructure is preferable, which will allow for collaboration or individual work at other times.

A good balance of all different space types seems to be critical for a smooth workflow and a lack of particular space types might result in unsatisfied users. Specifically, personal spaces for individual work were underrepresented at the analyzed institutions. In addition, it might be necessary to combine several space types in a single room or to distribute them across the campus according to the available resources. In either case, designers must consider the problems and opportunities that might emerge, for example, rising noise levels when combining space types, or additional transition time between separated spaces.

The expressed culture within a space plays an important part in encouraging active experimentation. For example, a making space that motivates people to actively experiment and take risks might facilitate experiential learning, according to Kolb (1984).

Sensory stimulation (e.g. noise, sound, smell, dirt) can be inspiring, especially for creative work, but too much of it also presents a risk for distraction. Hence, reduced stimulation might be desirable in personal and intermission spaces.

Intermission spaces, such as pathways between different space types, necessitate time and effort to transfer from one space type to another. This would suggest that most space types should be placed in close proximity to each other. However, this would minimize the potential of intermission spaces for social interaction and reflection.

Presentation spaces and lecturing remain important; a lot of teaching and sharing of ideas still takes place through transfer of explicit knowledge. In the design context, however, other types of knowledge transfer and knowledge generation are also important. Specific attention should be given to the design of consultation spaces (a subcategory of the collaboration space), because feedback from teachers, classmates, co-workers, and clients is crucial for the transfer of implicit and explicit design knowledge. Furthermore, artifact knowledge embedded in work models and tools should be present. Mueller and Thoring (2010) presented an overview of different types of design knowledge that can help to better understand a space's capability to facilitate knowledge processing.

Furthermore, virtual spaces are becoming more relevant for designers and design students to help them facilitate information retrieval, connect with co-workers and fellow students, and replace physical meeting spaces and lecture rooms. This is illustrated in virtual learning spaces, the rise of massive open online courses (MOOCs) and distance design education programs (Sköld, 2011;

Weiss, Nolan, Hunsinger, & Trifonas, 2006), as well as virtual office environments in creative organizations. The virtual aspects range from facilitation of remote working (home office) to virtual reality environments with avatars to simulate team collaboration online. Several aspects of virtual workspaces along with advantages and disadvantages have been discussed, for example, by Thomas (2013), or Zemliansky and St. Amant (2008). Virtual spaces can provide a place for virtual communities and a way for geographically distributed people to communicate (Maher, Skow, & Cicognani, 1999) and facilitate creative activities, such as brainstorming (Bhagwatwar, Massey, & Dennis, 2013). Bridges and Charitos (1997) elaborated on the possible relevance of architectural design knowledge for designing virtual environments.

Moreover, the increased use of mobile devices by designers and students requires creative spaces with an appropriate technical infrastructure, such as sockets and wireless internet access, specifically in intermission spaces like hallways and outdoor areas, where those resources are usually under-represented. Although we did not focus on the specific characteristics and design features of a virtual space, we do emphasize the relevance of physical spaces to facilitate virtual access and connectivity as a space's process enabling quality. The typology of creative spaces presented in this chapter might serve as a foundation for future research in the area of virtual creative spaces and for developing appropriate design specifications for collaborative spaces in the virtual world.

4.7.2. Comparison with Related Literature

Finally, we refer back to the literature to compare our developed typology with the identified space types and qualities found within related work. We will compare our typology with the 13 different space types and the 14 different spatial qualities that were initially identified in the 42 analyzed sources from our literature review (see Section 3.4 on page 55). Table 8 juxtaposes the space types from our developed typology with comparable concepts found in the analyzed related work. The detailed overview of the related sources can be found in Table 1 on page 58.

We argue that several of the space types mentioned by the literature, could be subsumed under one umbrella term. Through this approach, most of the mentioned space types can be covered by the five space types that we identified through our study. "Personal space" covers all space types that include focused work, such as research or analysis space, but also incubation and reflection spaces. "Making space" is the same as the experimentation spaces mentioned in

the literature. "Presentation space" in our model covers both, lecture spaces and exhibition spaces. We argue that both have the same goal (the presentation of work), although through different channels. "Collaboration spaces" are equivalent to the same category (collaboration space) found in the literature. Our suggested category "intermission space" suggests spaces that are not directly related to the work process, but rather address spaces for breaks and food consumption, social spaces, as well as transition spaces like hallways or exteriors. Such spaces would also be able to facilitate relaxation, incubation, and reflection. Several space types referred to in the literature would fall into this category: incubation, reflection, relaxation, well-being, play space, and disengaged space. We argue that all these space types can be subsumed under the term "intermission space".

Table 8. Comparison of the presented typology of creative spaces with space types suggested by related literature.

Identified Concepts	**Covered by our Space Type**
Verification, Analysis Space	Personal Space
Personal space for focused work	Personal Space
Preparation or exploration	Personal Space
Illumination or insight space	Any Space Type, Intermission Space
Incubation or reflection	Personal Space, Intermission Space
Relaxation or well-being space	Intermission Space
Making or experimentation	Making Space
Presentation or sharing space	Presentation Space
Unusual space or play space	Intermission Space
Disengaged or intermission	Intermission Space
Virtual space	n.a.
Collaboration spaces	Collaboration Space
Exhibition space	Presentation Space

Two space types mentioned in the literature are not directly covered by our typology: virtual space and illumination space. The question as to whether or not a virtual space could qualify as an individual space type has already been discussed earlier in this chapter. Although the concept was also referred to in our validation study, we decided not to include it in our typology. The reason for this decision was that a virtual space represents only a specific medium that could apply to various space types.

The "illumination space" is not clearly defined by most authors. Some do not specify it at all, others mention a "retreat space" to trigger an insight. We

argue that this sudden insight could occur in any space type, but especially in an "intermission space" where coincidences occur and new connections can be made.

Table 9 juxtaposes the spatial qualities from our developed typology with the comparable concepts found in our literature review of 42 analyzed sources in Section 3.4 on page 55. The detailed overview of the sources that suggested the respective concepts can be found in Table 2 on page 59.

Table 9. Comparison of the presented typology of creative spaces with spatial qualities suggested by the related literature.

Identified Concepts	**Covered by our Spatial Quality**
Social Dimension, Chance Encounters	Social Dimension
Stimulation, Ambiance	Stimulation
Knowledge Managing	Knowledge Processor
Process Facilitation, Affordances, Infrastructure	Process Enabler
Engaging Space, Activate Participation	Culture
Comfort and Ergonomics	(not creativity-related)
Health and Safety	(not creativity-related)
Surprising, Unexpected Space	Stimulation
Flexible Space, Changeability	Process Enabler
Culture of Space, Reflect Identity, Symbolic Aspects	Culture
Ownership of Space	Culture
Accessibility	Process Enabler
Facilitator, Assistant	Process Enabler (not physical space)
Additional Services (events, expertise etc.)	Process Enabler (not physical space)

Again, we can see some overlap with the spatial qualities proposed by our typology. Numerous authors suggested a "social dimension" of a space, its capability to provide "stimulation", and "process"-related features of a space as relevant aspects of a creative work environment. However, only two sources recognized space as a means to facilitate knowledge management. Moreover, many authors included non-physical aspects of a workspace into their typologies, as well as features of a space that are related to the general infrastructure or basic needs, but not specific to *creative* environments (e.g. health and safety).

We conclude by ascertaining that none of the analyzed sources provided a classification system for creative spaces that is equally comprehensive and not unnecessarily complex. We suggest that a classification system should not be

more complex than necessary, and hence, should propose as few as possible constructs.

4.7.3. Limitations

One limitation of this study is that it is based on two institutions from a mainly educational background. The two analyzed cases represent very different types of institutions, a traditional art school and a more business-related institute of design thinking in further education and, hence, we can argue that they provide insights into quite a broad spectrum of different applications. Nevertheless, the derived findings do not allow for direct transfer to other contexts and industries. Furthermore, both institutions were from one single country. This fact raises questions about the possible influence of national culture on creative environments, which is, however, outside the scope of this thesis.

We tried to compensate for these limitations by (1) validating our typology with participants from a practitioner's context (Study 4 at Kassel IdeaLab, see page 99), and (2) by comparing it retrospectively with the related literature. We were able to corroborate the typology we developed with both steps and, therefore, argue that the suggested space types and qualities are relevant for most design processes and warrant careful consideration when planning a creative space. However, we are aware that these assumptions have to be further investigated through additional studies to cross-validate the findings. For the remainder of this thesis, we made sure to include a greater variety of different data sources in order to mitigate these limitations even further.

4.8. CONCLUSIONS

In this chapter, we presented a typology of creative spaces that was developed based on a qualitative user study in two different organizations. The presented space types and spatial qualities of creative work environments can help designers, educators, and spatial planners to categorize their existing or planned workspaces and to identify requirements and potentials for improvement. We suggest that the five space types are of relevance for any creative work environment, albeit in different shapes and designs. Moreover, a workspace can be adjusted according to the suggested spatial qualities, to enhance a creative workspace.

Our typology of creative spaces will serve as a reference for the next steps of this thesis. In Chapter 5 we will present further examples of spatial instantiations that represent the five space types and spatial qualities. In Chapter 6 we will

present a set of theoretical propositions of how and why a specific spatial design can impact the creative process, in alignment with the typology. Chapter 7 outlines the validation study in more detail, and in Chapter 8 we will introduce a set of tools, including several canvases for designing and detailing creative spaces that were developed in alignment with the typology of creative spaces.

5TH FLOOR: THE LAB

Next stop is the laboratory. It is here where you look at other places, collect insights, identify patterns, and finally synthesize all the bits and pieces into a collection of insights.

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Thoring, K., Mueller, R., M., Desmet, P., & Badke-Schaub, P. (2018). 'Design principles for creative spaces'. In *Proceedings of the 15th International Design Conference*. Dubrovnik, Croatia.

5. A PATTERN LANGUAGE OF CREATIVE SPACES

5.1. RATIONALE

Now, that we have an idea about what types of spaces people would need for their creative work activities, and what qualities these spaces should have, the next step is to look for real-life instantiations of creative work environments. In different organizations from the creative sector, we searched for emerging patterns of creative spaces.

> *RQ 5: How do organizations from the creative sector design their workspaces, and what spatial design patterns can be identified?*

The need for organizations to create an environment that values and facilitates creativity and innovation is well-established (Amabile, 1996; Amabile, Conti, Coon, Lazenby, & Herron, 1996). However, most often the "environment" is defined rather abstractly, for example, as an appropriate "innovation climate", or as a culture that encourages "risk-taking" and "teamwork" (Gupta & Wilemon, 1996; Turnipseed, 1994). The role of the *physical* environment, however, has been lesser investigated. Although there exists a substantial amount of literature with examples of creative spaces, or even suggestions for concrete design solutions, a systematic and comprehensive set of abstracted design guidelines with related explanations about the potential impact of these designs is lacking. The development of such design principles is the concern of the work presented in this chapter.

Our endeavor bears resemblance to the seminal book, *A Pattern Language* (Alexander, Ishikawa, & Silverstein, 1977), but addresses the peculiar area of creative environments in both educational and practice contexts. Alexander et al.'s pattern language presented a total of 253 abstracted guidelines (that they called patterns) for various areas related to architecture and town planning that can be adapted to individual building or construction projects. Only a few of Alexander et al.'s 253 patterns specifically address workspaces (patterns 146 to 153), but without any focus on *creative* workspaces.

We have built on Alexander et al.'s concept and present a set of 49 design patterns that address creative work environments. Following the example of Alexander et al. (1977; 1979), who developed their patterns based on eight years of spatial observations, we have also based our pattern language of creative spaces

on empirical evidence derived from observations made in organizations from the creative sector. We conducted a holistic, multi-case study in 18 organizations that spanned over a total of five years. From our study results, various spatial instantiations were identified that were then developed into a total of 49 design patterns for creative spaces. Each pattern describes an identified problem context, a solution principle, examples from the case studies, and also provides links to supporting literature.

As outlined in Section 3.4.1 on page 55, Gregor (2006) distinguished among five types of theories. The suggested pattern language constitutes a type-5 theory (Gregor & Jones, 2007) because it aims to provide design patterns that explain how to design creative work environments. The focus of this chapter is to develop a theory of how to design such creative spaces, not to test the theory. Therefore, a validation of the proposed pattern language is not part of this chapter, but dedicated to future research.

5.2. RELATED WORK ABOUT CREATIVE SPACE PATTERNS

The systematic literature search that we conducted in Chapter 3, yielded only two sources that provided concrete principles or guidelines for designing creative spaces.

Doorley and Witthoft (2012) presented a collection of 63 instructions for designing collaboration furniture or interior design elements. These detailed blueprints include drawings, material suggestions, and even names of suppliers. Furthermore, each blueprint provides links to other blueprints that might be of relevance in that context, which resembles the Pattern Language of Alexander et al. (1977). However, the presented blueprints are not embedded into a broader system of creative spaces and they do not provide explanations as to how they were developed or how they are supposed to facilitate creative work processes.

Van Meel et al. (2010) provided a set of abstract principles and design considerations for specific themes within the office (e.g., “the work lounge”, “the locker area”) and presented examples for each. However, these classifications resemble a list of resources for architects and office planners rather than systematically developed design principles for creative environments.

To further investigate the topic, we expanded our search funnel using different keywords in order to identify further research that might provide additional insights on patterns or principles for creative spaces. We conducted a second literature search within the Scopus database using a combination of relevant keywords in the search string ("creative space*" AND (guideline* OR tool* OR

principle* OR pattern*)). Through abstract- and full-text-based analysis, as well as co-citation analysis, we identified eight additional sources that appeared to be relevant. From these eight sources, four had already been identified through our initial literature search, presented in Chapter 3, but were not categorized as design guidelines as such. Nevertheless, we are discussing them here to illustrate the identified research gaps.

Williams (2013) developed a linguistic grammar of creative workplaces that also resembles Alexander et al.'s (1977) Pattern Language approach. In a semiotic sentence structure (following an if–then structure known from, for example, computer science), the condition of a specific intended behavior (syntax) would result in a peculiar combination of place, properties, and affordances (lexis). The main portion of Williams' work is dedicated to developing and testing the grammatical elements and providing codes for the characteristics of these elements. The results are instructions for how one could construct spatial rules with the provided grammatical elements (the "act of writing sentences"). To that effect, she developed the grammar but did not develop the language or patterns that would be needed to design creative spaces. For this reason, we have categorized Williams' (2013) work as a type-1 theory (classification) in our initial literature review. Nevertheless, we decided to discuss it here, because it presents a foundation for developing a pattern language of creative spaces.

Ceylan, Dul, and Aytac (2008) measured individuals' perceptions of the extent to which different office designs support creativity. They presented photographs of 25 different offices to 60 managers from a large manufacturing company. Based on these managers' self-reports, preliminary guidelines for creative spaces were developed. The identified physical characteristics that would support creative processes include (1) low complexity, (2) bright light, (3) cool colors, (4) presence of plants, (5) presence of windows, and (6) presence of computers. However, these suggested principles remain very abstract.

Snead and Wycoff (1999) suggested several design features of a space that would facilitate collaboration and teamwork. They provided some abstract spatial configurations that should support the identified categories of (1) interaction, (2) visual thinking, (3) beauty, (4) fun, (5) abundance, and (6) tools. However, they provided no evidence or theoretical underpinning as to why the suggested spatial settings would result in improved collaboration. Moreover, space types other than collaboration spaces were disregarded.

Paoli, Sauer, and Ropo (2017) analyzed images of creative spaces found on the internet and categorized these according to five themes: (1) home, (2)

sports and play, (3) technology, (4) nature, and (5) symbolism. For each theme, they presented a summary of certain design characteristics that can be regarded as design guidelines.

The following four new sources were identified with the additional literature search:

Williams (2011) presented the foundations of her later work with a focus on the physical press (i.e., the physical environment). She made distinctions among the three different categories "specificity (where and what the place is), properties of the place, and its affordances (the possibilities for action that are afforded to the space's users" (Williams, 2011). Further design principles or patterns were not presented.

Al-Falou, Heck, Kriesi, Steinert, and Meboldt (2014) reported on experimental studies in a living-lab environment. They observed people's behavior in workshop settings and conducted supplementary surveys. They derived 13 spatial patterns: (1) people, (2) design, (3) usage, (4) creativity-enhancing, (5) process-enhancing, (6) furniture, (7) technology, (8) tools, (9) team, (10) discipline-relation, (11) activities, (12) aesthetics, and (13) atmosphere. They provided further details on some of these patterns, such as the furniture pattern (café-furniture, traditional office furniture, and team furniture) or the atmosphere pattern (light and textures). However, several patterns were not related to the physical space or appeared to be redundant (e.g., people and team).

Loi and Dillon (2006) suggested two concepts for creative environments: (1) playful triggers and (2) eccentric objects and odd experiences. Playful triggers are described as tools to elicit inspiration, information, and dialog among people. Eccentric objects and odd experiences include unexpected artifacts within the work environment. For both concepts, selected examples are presented.

Luz (2008) developed design rules and principles for learning spaces that would support pedagogical efforts. Among the suggested rules are (1) flexibility, (2) comfort, (3) sensory stimulation, (4) technology support, (5) de-centeredness, (6) studio classroom, (7) information commons/laboratory, (8) living-learning spaces, and (9) niches. Properties of the learning spaces should include (1) fluidity, (2) versatility, (3) convertibility, (4) scalability, and (5) modifiability. Finally, the proposed design principles were: (1) space for multiple uses, (2) flexibility, (3) use of vertical dimension, (4) integration of discrete campus functions, (5) features/functions to maximize teacher and student control, (6) alignment of different curricular activities, and (7) student access/ownership of learning

space. However, these principles neither addressed creative spaces, nor could they be transferred to a practitioner's work environment. Moreover, the principles and rules were not supported by tangible examples.

The related literature reveals that the suggested design principles are either very abstract or they do not provide any theoretical underpinning or explanations. Thus far, there has been no comprehensive overview of patterns for creative spaces that is systematically developed, supported by literature, and supplemented by exemplary spatial instantiations. Such a pattern language would provide practitioners with actionable advice on how to design creative work environments. In the following section, we will present our attempt to develop such a "pattern language of creative spaces". We decided not to use the grammar of Williams (2013) as the foundation for developing our patterns, because Williams is focusing on creative behavior in office settings, while we consider creative spaces as environments specifically for innovation-focused institutions in design education and design practice. Hence, we would need more details for some (design-specific) aspects and therefore, we chose to rely on our own empirical data that was collected from various organizations—including design schools, coworking spaces, and corporate innovation departments.

We base the development of our pattern language on the typology of creative spaces, presented in Chapter 4. This typology has identified five different space types that are necessary for creative activities. Orthogonal to the space type, a spatial quality refers to a space's capacity to facilitate a specific purpose. We use these concepts as the structural underpinning for our pattern development that is described in the following sections.

5.3. APPROACH AND METHOD FOR PATTERN-DEVELOPMENT

The development of our pattern language of creative spaces is based on an extensive multi-case study in 18 organizations where we looked for real-life examples of creative work environments. We followed the case study method suggested by Yin (2003) and conducted an exploratory, holistic multi-case study (Yin, 2003, p. 39). This exploratory approach was chosen because we wanted to develop a theory on how creative workspaces should be designed to facilitate creative work. Therefore, multiple cases from various contexts were necessary to improve the external validity (Yin, 2003, p. 33), to transfer the findings to other contexts, and to maintain the replication logic. We focused on one particular element of the organizations, namely, the entire work environment, and we did

not aim to investigate other units of the organizations. Consequently, this study can be considered a holistic case study (Yin, 2003, p. 39).

5.3.1. Theoretical Sampling

We selected 18 organizations from the creative sector to be included in our study. We based our selection of the 18 institutions on theoretical sampling because the purpose of our research is to develop a theory, not to test it; hence, theoretical sampling was deemed appropriate (Eisenhardt & Graebner, 2007). The included institutions had a somewhat "creative" focus, which could be (1) a creative educational program such as art, design, or architecture; (2) a small or globally operating design firm; (3) an innovation department of a large global corporation, or (4) a makerspace or co-working space from the creative sector. The selected 18 institutions represent different corner cases and, therefore, illuminate the topic of interest from different perspectives. The term "corner case" (Langer, Heinkel, Jerinic, & Müller, 2007; Meck, 2013, p. 102) originates from the engineering discipline and refers to the approach to study extreme cases rather than averages. We pick-up on this concept and include cases that could provide as broad as possible perspectives on the topic

During the selection process for appropriate cases the following requirements were considered:

(1) Variety of creative sectors: Art, design, architecture, and innovation.
(2) Different types of organizations: Educational institutions, design practice and industry, and special forms, such as incubators, makerspaces, and co-working spaces.
(3) Wide range of size and budget: From small and medium sized companies (SMEs) and start-ups with normally lower budgets, to big, publicly listed corporations with larger budgets.
(4) Various cultural backgrounds: We included organizations from northern Europe, central Europe, southern Europe, Asia, and Northern America. Our goal was to rule out the possibility of culture-specific peculiarities, but not to focus on cultural comparisons between countries. Therefore, a strict representation of national cultures in equal numbers did not seem necessary.

By selecting these corner cases, we were able to gain holistic insight into creative work environments from various angles and, thereby, mitigate possible biases.

Table 10 shows the 18 organizations from education and practice that were included in our study.

Table 10. Overview of the 18 studied organizations.

#	Organization	ID	Origin	Description	PRA	EDU
1	IDEO	PRA-1	Northern America (US)	Global design consultancy, Munich branch	x	
2	Steelcase Learning and Innovation Center	PRA-2	Northern America (US)	Furniture manufacturer, Innovation Center, Munich branch	x	
3	MHP Porsche Digital Lab	PRA-3	Central Europe (DE)	Porsche car manufacturer, Digital Innovation Lab	x	
4	SAP, Innovation Lab, AppHaus	PRA-4	Central Europe (DE)	Software company, headquarter, Innovation Lab	x	
5	Zoku	PRA-5	Central Europe (NL)	Co-working space	x	
6	Launchlabs, Berlin	PRA-6	Central Europe (DE)	Berlin-based Startup	x	
7	UnternehmerTUM	PRA-7	Central Europe (DE)	Incubator of Technical University Munich	x	(x)
8	Design Lab University of Twente	PRA-8	Central Europe (NL)	Incubator of Twente University	x	(x)
9	Umeå School of Architecture	EDU-1	Northern Europe (SE)	Design/Architecture faculty (small-sized)		x
10	Technical University Delft	EDU-2	Central Europe (NL)	Faculty of Industrial Design (large-sized)		x
11	ESAD, Porto	EDU-3	Southern Europe (PT)	ESAD College of Art & Design (small-sized)		x
12	Central Saint Martins College	EDU-4	Northern Europe (UK)	Art & Design School (large-sized)		x
13	PolyU Hong Kong	EDU-5	Asia (CN)	"Innovation Tower", Design faculty (medium-sized)		x

#	Organization	ID	Origin	Description	PRA	EDU
14	School of the Art Institute of Chicago	EDU-6	Northern America (US)	Art & Design School, Chicago (large-sized)		x
15	Parsons School of Design	EDU-7	Northern America (US)	Art & Design School, New York (large-sized)		x
16	Design Academy, Berlin	EDU-8	Central Europe (DE)	Private Design School (small-sized)		x
17	Detmold School of Architecture	EDU-9	Central Europe (DE)	Architecture School (medium-sized)		x
18	HPI School of Design Thinking	EDU-10	Central Europe (DE)	Design Thinking further education and professional training (small-sized)	(x)	x

5.3.2. Procedure

Each of the 18 organizations was visited in person by two researchers; one is the author of this thesis. The entire process lasted five years (the first institution was visited in 2014, the last one in 2019).

At each institution, the two researchers were given a guided tour by a staff member. During the tour, we asked a set of open questions regarding (1) how the spaces were usually used and (2) why those spaces were considered successful or unsuccessful in facilitating creative activities. Each room we visited and also the transition spaces, such as hallways, were photographed, and one researcher took notes on the guide's responses. After the official tour, the researchers were able to spend between several hours and several days independently in each organization, so they were able to observe how the spaces were actually used by the students or employees during their daily activities. Moreover, we recorded impressions of the non-visible aspects of the spaces, such as smells and sounds. For each institution, the researchers took notes of their observations and impressions for later analysis.

5.3.3. Case Study Database

The resulting approximately 1,000 pictures were winnowed by removing redundant pictures (for example, different perspectives of the same object, or the same objects that appeared several times throughout one organization). This left us

with a total of 340 pictures that, together with the observational field notes and the reports from the staff members of each institution, were recorded in an Excel table that represents the case study database to be used for further analysis. In this database, each picture was coded according to the previously defined constructs. More specifically, we coded each picture according to (1) its scale (whether it represented a solution on item, interior, architectural, or neighborhood scale, as outlined in Figure 2 on page 24) and (2) which space type(s) the instantiation was found in (in a personal space, a collaboration space, a making space, a presentation space, or an intermission space). We also marked (3) which spatial quality the pictured space would address, which could be inferred from the staff members' responses and our own observations. Moreover, we added (4) keywords and a description of how the space was actually designed; recorded (5) insights on what problem or need the spatial instantiation was supposed to solve, which could also be inferred from our observations and staff members' responses; and made (6) notes on the ambiance of each space (sounds, smells), where applicable.

The case study database enhanced reliability and would allow us to repeat the same procedures in other organizations (Yin, 2003, p. 33). It was our main data source for analysis and pattern formation. The database allowed us to sort and filter all data according to the given parameters, such as scale, the addressed spatial qualities, and the occurrences in different space types. During several rounds of iteration, the keywords and tags for each picture were compared constantly with each other and merged, split, named, and renamed as necessary. We grouped similar spatial patterns in one pattern category and searched for a shared underlying concept that would define the core principle of that pattern. This procedure was repeated until no further categories emerged; i.e., to the point of theoretical saturation (Corbin & Strauss, 2014).

5.4. AN INVENTORY OF CREATIVE SPACES

In order to exemplify the richness of the collected data, we will present a selection of images from the workspaces of the organizations we studied. We decided to present the images according to the spatial qualities, because these would be of most relevance for the capability of a space to facilitate creativity and innovation. This relevance of spatial qualities was identified through our Studies 3 and 4 (as summarized on page 102). Consequently, in the following subsections, we will describe the spatial instantiations identified in the 18 institutions according to

the following five categories: (1) stimulation, (2) knowledge processing, (3) organizational culture, (4) social dimension, and (5) process enabler. Mapping the spaces to the spatial qualities allowed us to draw conclusions about the possible relevance and impact of the spatial designs. Additional literature was utilized to underpin the possible impact of the spatial patterns. In the following section, we will elaborate in greater detail on the patterns that we identified.

5.4.1. Creative Space as a Source of Stimulation

The design of a workspace can provide various sources of stimulation. For example, a loose arrangement of windows varying in size can result in unexpected and varied views (Figure 42A). In addition, the presence of artifacts, (e.g., work models or previous projects) can be a source of inspiration. Shelves to display such objects can be found in various institutions. Some examples were arranged to maintain visual transparency and provide inspiring views into other rooms (Figure 42B, 42C). Furthermore, an optimal sound level is important. The deliberate use of wooden lamellas reduces the noise level but allows at the same time visual contact within the workplace (Figure 42D). Plants were often used as visually stimulating room dividers (Figure 42E). Tactile stimuli could be found, for example, in natural tree bark textures in wall coverings (Figure 42F). Lounge areas that have inspiring views might facilitate contemplation or ideation (Figure 42G). Furthermore, the intangible ambiance of a space can act as a stimulant. For example, plenty of daylight with additional lamps that flood a space with light can have an activating effect (Figure 42H). Similarly, ambient background music can support a creative atmosphere (Figure 42H, not visible in the picture).

Figure 42. A: Various window sizes and positions (EDU-1); B & C: transparent shelves (EDU-3, EDU-9); D: wooden lamellas (PRA-2); E: plants for stimulation and as visual partitioning (PRA-3); F: tree bark wall covering (EDU-7); G: lounge area with a view (EDU-6); H: light and background music (PRA-5).

According to Sarkar and Chakrabarti (2008), a stimulation is a "trigger" that activates one or more senses and, hence, initiates the creative search and exploration process. Consequently, triggers can occur through visual, auditory, olfactory, tactile, or gustatory stimulation of the five senses. Such stimuli create a certain atmosphere in the workspace. Some stimuli, such as loud noises or unpleasant smells, can quickly become annoying or distracting. Others, such as visual textures or the smell of specific materials, might provide inspiration that facilitates creativity. A well-balanced composition of such stimuli is crucial to the constitution of a creative space.

5.4.2. Creative Space as a Knowledge Processor

The work environment can act as a knowledge processor by archiving and displaying information, data, and artifacts, and by facilitating the exchange of written or oral information. Within the analyzed institutions, we found several instantiations of material libraries (Figure 43A and 43B). To allow ideas to be captured spontaneously, specific writeable furniture (Figure 43C and 43D) and writeable walls (Figure 43H) were present at several institutions. Furniture with printed guidelines or instructions for usage helped to communicate how to use tools or equipment (Figure 43E). Traditional book libraries were often integrated into lounge areas (Figure 43F) and accompanied by design or research guidelines (Figure 43I). Spaces for personal withdrawal were also found, for example, a secluded reading corner (Figure 43G). The exchange of tacit knowledge among people was often fostered through casual meeting areas (Figure 43H).

Figure 43. A: material and tool library (PRA-7); B: material and fabric library (PRA-2); C: paper sheet table (PRA-2); D: writable table (EDU-4); E: storage unit with printed instructions (PRA-2); F: book exchange area (EDU-6); G: casual reading corner (PRA-5); H: socialization area with chalkboards (PRA-2); I: library with research instructions (PRA-1).

Cross (2001) pointed out that some knowledge is inherent in the design artifacts (e.g., in their forms and configurations). Materials, tools, or working models can provide access to such knowledge. Moreover, knowledge exchange

and knowledge creation are particularly relevant for innovation processes. By recombining existing information and materials, new concepts can emerge. The space might facilitate this knowledge creation by displaying information and by inviting casual meetings and conversations to foster the exchange of tacit knowledge, which is inherent in people (Polanyi, 1966).

Peschl and Fundneider (2014) discussed the role of the physical work environment for knowledge creation and innovation. They suggested different dimensions of "enabling spaces", including physical, emotional, social, cognitive, epistemological, and technical/virtual space. Based on an experimental study, Moenaert and Caeldries (1996) suggested that spatial proximity within an organization leads to an increased *quality* of knowledge exchange between co-workers; whereas an increase of *quantity* of communication could not be determined. This insight contradicts the common notion that open plan office space would improve social interaction in general.

Thoring and Mueller (2014) presented a framework of spatial knowledge management that suggests different interior design approaches for facilitating (1) an artifact-based "embodiment" strategy, (2) a "socialization" strategy, and (3) a "codification" strategy for managing design knowledge.

The insights presented by these sources can be used to design workspaces specifically to enhance knowledge processing.

5.4.3. Social Dimension of Creative Spaces

Social interaction and collaboration are also aspects that are considered relevant for innovation. The workspace design can facilitate informal meetings, collaboration, and chance encounters. Examples from the cases we analyzed include hallway workstations that enable team work and meetings with passersby (Figure 44A). Cafeterias, coffee stations, and even a mobile food truck bring staff together and enable informal communication (Figure 44B). Several of the analyzed organizations made use of large staircases in their buildings, where people would meet several times throughout the day (Figure 44C). High-back furniture that allowed private discussions was found in many organizations (Figure 44D). Open-plan office layouts increased visual contact between co-workers (Figure 44E). Some companies installed communal tables with additional silence hoods to enable quiet "alone-work" while in the company of others (Figure 44F). A communal kitchen for joint lunch breaks exists in many companies (Figure 44G). Other examples of design elements that encourage social interaction and collaboration include secluded booths for small team meetings (Figure 44H) and

small, wall-mounted hallway tables for spontaneous discussions during coincidental meetings (Figure 44I).

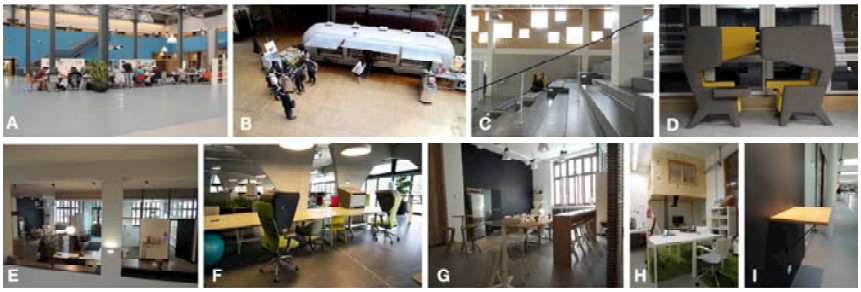


Figure 44. A: hallway workstations (EDU-2); B: food truck on site (EDU-4); C: hallway stairs as meeting spot (EDU-1); D: consultation space for two (PRA-4); E: vistas across rooms (PRA-1); F: communal table with acoustic pods (PRA-3); G: kitchen area for social exchange (PRA-1); H: elevated meeting booth (PRA-6); I: wall-mounted tables in hallways (PRA-1).

Collaboration in teams as well as informal knowledge exchange are considered key for creative innovation efforts (Svihla, 2010). The layout of a creative space can enhance such social interactions (Snead & Wycoff, 1999), for example, by providing collaboration furniture (Doorley & Witthoft, 2012) or by placing meeting points, like coffee machines or copiers, in strategically central locations to instigate informal meetings. The studies reported by Waber et al. (2014) experimentally investigated the impact of spatial changes to increase social interactions, for example, by reducing distances or limiting the number coffee stations. Those spatial changes were associated with an increase in the company's sales.

The concept of "open innovation" (Chesbrough, 2006) suggests involving external actors (such as clients or potential users) into the innovation process in order to benefit from new input. The location within the urban context can facilitate such social interactions.

Although the main focus within this category is on increasing interaction, the opposite—reduced social interaction—can also be important. As pointed out by Csikszentmihalyi and Sawyer (2014), a solitary moment is often the cause of creative insight. In a similar vein, Newport (2016) stressed the importance of a place for what he calls "deep work"—focused work with reduced distraction.

Critique of open-plan office spaces has emerged, mainly because of the raised noise levels and increased distractions. Some studies even show that contrary to common expectations, open-plan offices actually decrease social interaction (Bernstein & Turban, 2018). A balanced social dimension that facilitates

both social interaction and personal withdrawal in the workspace seems important. Shielded areas and high-back furniture within collaboration spaces, as shown in our examples present a possible solution to this challenge.

5.4.4. Creative Space as an Indicator of Organizational Culture

Organizational culture is closely related to innovation and creativity. On the one hand, the implementation of innovative work spaces can be used to demonstrate an existing organizational culture, while, on the other hand, such spaces might actually be able to impact people's behavior, work performance, and also the organization's culture itself (Miller, Casey, & Konchar, 2014). This impact can be explained by the psychological concept of priming: the activation of a specific, for example, creative mindset (Sassenberg, Moskowitz, Fetterman, & Kessler, 2017). The question thus arises: How can organizations express or adjust their innovation culture through their spatial environment?

In the analyzed organizations, we found several instances of spatial designs that might impact people's mindset by adding labels to rooms that would suggest a specific creative behavior (Figure 45A and 45C). Other examples of visual signage illustrate work ethics or mission statements (Figure 45B). Some room labels suggest a specific behavior, such as meditating or quiet time (e.g., quiet capsule, Figure 45E). A portrait gallery (Figure 45D) might enhance bonding among employees and, hence, loyalty to a company. A rough, improvised furniture or interior style might further encourage experimentation and creative exploration (Figure 45B, 45F, and 45H). Moreover, examples of previous success stories might enhance the motivation of the employees (Figure 45G).

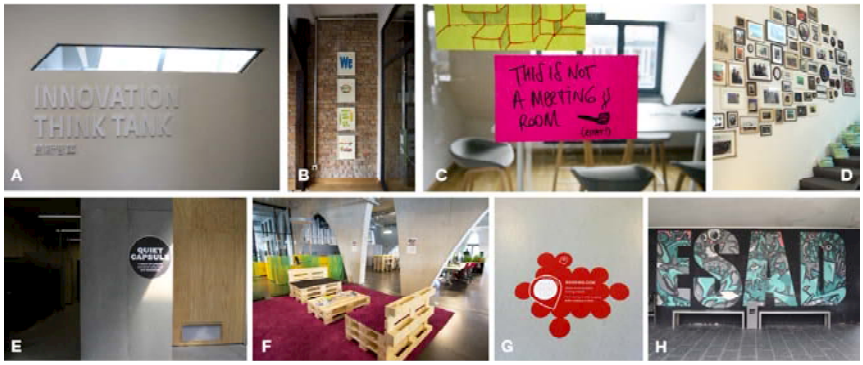


Figure 45. A: room name for innovation (EDU-5); B: visualized mission statement (PRA-5); C: "This is not a meeting room" (PRA-5); D: portrait gallery (PRA-1); E: quiet capsule (EDU-4); F: rough DIY furniture (PRA-3); G: floor sticker presents successful startup (PRA-8); H: graffiti-style logo (EDU-3).

5.4.5. Creative Space as a Process Enabler

The configuration of furniture can facilitate (or hinder) a specific work process. Pair programming workstations enable two people to simultaneously program software code (Figure 46A). Flexible furniture solutions allow for different usage scenarios like switching between play mode and team meeting (Figure 46B). A supply store on the premises enables easy creation of ideas and models (Figure 46C). Available tools have a similar effect (Figure 46D). Shielded work chairs enable focused work (Figure 46E). Many of the companies we visited had differently furnished booths and small meeting rooms for different work activities (Figure 46F). Flexible furniture solutions enable the use of one space for different purposes (Figure 46G), and electrical sockets in hallways allow computer work in transition spaces (Figure 46H).

Figure 46. A: pair programming (PRA-4); B: table tennis can be used for team meetings (PRA-5); C: supply store on site (EDU-4); D: prototyping tools in place (PRA-5); E: secluded single workstation (PRA-2); F: booths for different work modes (PRA-2); G: fold-away plenum seats (EDU-1); H: electrical sockets in hallways (EDU-1).

Workflow optimization has been studied extensively in various contexts. In the twentieth century, research focused on optimizing industrial and, later, office workflows, which can be subsumed under the terms "scientific management" or "Taylorism" (named after its founder Frederick Taylor), as already discussed in Section 2.2.2 on page 42. Both terms describe the attempt to optimize industrial processes, for example, through standardization, strict time-boxing, scheduled breaks, or process documentation. Later, the Japanese concept of Kaizen emerged (Imai, 1986), which refers to continuously improving a business. The Toyota Production System follows the Kaizen philosophy with the main goal of reducing waste in production processes (Kato & Smalley, 2010). For example, Toyota's mass assembly line workers have to stop their assembly line when a problem occurs, in order to solve it together with their supervisors before production can continue. The concept of Kaizen has been developed further and is

now widely known as "lean manufacturing" (Krafcik, 1988). Lean principles were implemented in production processes, for example, by reducing distances between work stations or by installing required tools and machines close to where they were used. The question arises, how *creative* workflows can be optimized through spatial adjustments and what kind of infrastructure is required to facilitate creative processes. Innovation processes such as design thinking or lean startup (Brown, 2008; Mueller & Thoring, 2012; Ries, 2011) suggest a frequent switching between process steps and iterations among teamwork, ideation, prototyping, testing, and so forth. This approach requires different environments than traditional (office) workspaces. The spatial instantiations shown thus far present a first step in this direction.

Another relevant aspect of a space's process enabling qualities is that the environment might be able to affect people's behavior. The concept of "affordance" (Gibson, 1977) suggests that the design of products and environments can indicate how to interact with them. Fokkinga, Hekkert, Desmet, and Özcan (2014) introduced a model of product–human impact. The model suggests that the properties of products are able to influence people's behavior, feelings, and attitude. We suggest that this model also applies to the properties of physical work environments and hence, can directly or indirectly influence people's creative behavior and attitude when working creatively.

5.5. A PATTERN LANGUAGE OF CREATIVE SPACES

The pictures from the 18 selected organizations, presented in the previous section, illustrate some exemplary instantiations of the different creative spaces we analyzed. In the following section, we will convert these instantiations into spatial patterns.

5.5.1. Pattern Formation

As outlined in Section 5.3 on page 117, we identified spatial patterns by merging similar concepts in our case study database. For each emerging pattern, we tried to identify the underlying problem and a related solution principle. In a subsequent conceptual step, we extracted the essence of each solution and formulated an abstracted design principle that would be able to evoke the same solution in a similar situation. We also triangulated the spatial patterns identified in the photographs with field notes from our own observations and the staff members' re-

sponses regarding how the space was used. All of the collected insights were assembled and transformed into 49 design patterns. The entire process was conducted by two researchers (one is the author of this thesis) who independently mapped and categorized the data. Both researchers compared their choices, and any disagreements were discussed until an agreement was reached. The resulting insights from the pattern matching process constitute the nucleus of a pattern language, which is summarized in a total of 49 design patterns.

5.5.2. Inclusion and Exclusion Criteria

Two criteria were applied to select patterns for inclusion into the pattern language of creative spaces. (1) The pattern had to appear in more than one institution; a spatial instantiation that appeared only once, was not considered a pattern. (2) The identified ambient characteristics of a space (noise, light, smell) were only taken into consideration if they were deliberately designed and not a by-product of random circumstances. For example, material smells that were caused by a nearby wood workshop were not considered a pattern of a creative space (even though they might become a creative stimulus), unless the workshop was deliberately placed near other work areas in order to provide stimulation. When in doubt, we consulted the staff members to clarify the intention (or lack thereof) behind ambient characteristics. During several iteration rounds, we winnowed the list of patterns according to the inclusion and exclusion criteria, which left us with the final 49 patterns.

5.5.3. Structure of the Suggested Design Patterns

All 49 developed design patterns follow the same structure and include the following elements: (1) a distinguishable name and number, (2) a problem statement, (3) a solution description, (4) managerial instructions on how to apply the pattern, (5) an explanation for the possible working mechanism of the principle along with justificatory knowledge from related literature (when available), (6) indications of the addressed space types and spatial qualities, (7) cross-links to other related patterns, and (8) an example of the pattern instantiation from one of the 18 analyzed organizations, as a picture and description.

We decided to organize the 49 patterns according to their range of different scales (small items; room layout; architecture; and neighborhood), and not according to the spatial qualities they would address. The reason for this decision is that each spatial instantiation could relate to more than one spatial quality,

and, conversely, a spatial quality could be found in spatial instantiations of different scales. Alexander's pattern language was ordered according to the scale as well, beginning with town planning (large scale) and ending with architectural and furniture details (small scale).

5.5.4. Overview of 49 Patterns for Creative Spaces

Table 11 outlines the full list of all 49 abstracted design patterns for creative spaces. Each pattern is given a distinguishable name that already provides some hints about its possible context and goal. Due to space limitations, we include only selected information about each pattern in Table 11—namely, the number and title, a short version of the solution description, its categorization according to the different space types, and the main spatial qualities that were addressed by that pattern. We included only the space type and quality with the highest number of occurrences in the analyzed institutions. If an additional space type is listed in parentheses, it means that this type occurred less frequently than the main category, but still appeared to be significant. If two space types are listed, it means they occurred in equal number. In those cases where the patterns appeared in all space types, we indicated "any" space type. The spatial qualities were treated equally. To illustrate the appearance of the pattern, we also included the IDs of the organizations where the pattern was found.

Table 11. Overview of 49 design patterns for creative spaces (ordered from small scale to large scale).

#	Title	Description	Found at	Space Types	Qualities
1	Visible Tools	Visible tools provide inspiration and guidance about the process or prototyping possibilities.	EDU-3, EDU-6, EDU-9, EDU-10, PRA-2, PRA-5, PRA-6, PRA-7, PRA-4	Making	Process Enabler
2	The Label	Signs or posters indicate a specific philosophy, mindset, or suggest a creative behavior.	EDU-1, EDU-4, EDU-5, EDU-10, PRA-1, PRA-3, PRA-5, PRA-6, PRA-7, PRA-4, PRA-8	Intermission, (Collaboration)	Culture
3	Visual Inventory	Storage units or rooms that display its content or usage in-	EDU-4, EDU-10, PRA-1, PRA-2, PRA-7, PRA-4, PRA-8	Intermission, any other space type	Knowledge Processor

#	Title	Description	Found at	Space Types	Qualities
		structions through labels, signs or icons, provide helpful information.			
4	The Bulletin Board	Display of people's expertise or informal exchange of supplies.	EDU-2, EDU-8, EDU-9, EDU-10, PRA-1, PRA-7, PRA-8	Intermission	Knowledge Processor
5	Writeable Surface	Paper sheets available for informal, spontaneous notetaking. Surfaces of furniture (tables, boards) or walls can be used for collaborative notetaking.	EDU-2, EDU-4, EDU-10, PRA-1, PRA-2, PRA-5, PRA-7, PRA-4, PRA-8	Collaboration, (Intermission)	Knowledge Processor, (Process Enabler)
6	The Greenhouse	Plants or green areas provide visual stimulation and better air quality.	EDU-1, EDU-5, EDU-7, PRA-2, PRA-3, PRA-5 PRA-6	Intermission	Stimulation
7	Invitation Chair	Small stools next to a workstation invite others to sit down and give feedback. Workstations for two enable pair programming.	EDU-8, EDU-10, PRA-2, PRA-4	Collaboration	Social Dimension
8	High Seat	Elevated seats allow for better views and eye contact with passersby, as well as a more active participation in teamwork.	EDU-3, EDU-10, PRA-3, PRA-6, PRA-7, PRA-4	Collaboration	Process Enabler
9	Seat Variations	Different seats enable varying work postures and different activities.	EDU-2, EDU-6, EDU-8, EDU-10, PRA-2, PRA-3, PRA-4, PRA-8	Collaboration	Process Enabler
10	The Outlook	Views to the exterior or observation points within the building provide visual stimulation and eventually instigate social interaction.	EDU-1, EDU-2, EDU-6, EDU-7, PRA-5	Intermission, Collaboration	Stimulation, (Social Dimension)

#	Title	Description	Found at	Space Types	Qualities
11	The Bean-bag	Unconventional seats allow for temporary withdrawal from work and playful relaxation, and indicate that this is invited by the organization.	EDU-10, PRA-2, PRA-3, PRA-5, PRA-4, PRA-8	Intermission	Culture, (Stimulation)
12	Communal Table	Shared tables in hallways or communal areas instigate collaboration and provide the possibility to work individually but in company.	EDU-2, EDU-4, EDU-8, PRA-1, PRA-2, PRA-5, PRA-8	Intermission	Social Dimension
13	Showcase	Interim work models become an excerpt of the work process and provide practical inspiration. Finished projects incorporate artifact knowledge of successful design, material usage, or construction.	EDU-1, EDU-2, EDU-3, EDU-5, EDU-7, EDU-9, PRA-1, PRA-2, PRA-7	Presentation, Intermission	Stimulation, (Knowledge Processor)
14	The Allrounder	Multi-functional furniture can help to use limited space more efficiently. Two-in-one solutions allow for different usage scenarios at different times.	EDU-4, EDU-9, PRA-1, PRA-5, PRA-4	Collaboration	Process Enabler
15	The Pop-up	Foldable furniture allows temporary usage when needed.	EDU-1, EDU-10, PRA-5, PRA-4, PRA-8	Collaboration	Process Enabler
16	The Movable	Furniture on wheels allows easy moving and rearranging.	EDU-2, EDU-10, PRA-2, PRA-5, PRA-6, PRA-4	Collaboration	Process Enabler
17	The Garage	Handmade appearance and raw materials create an experimental atmosphere; graffiti murals invite artistic self-expression.	EDU-3, EDU-7, PRA-3, PRA-6, PRA-7, PRA-4	Intermission	Culture

#	Title	Description	Found at	Space Types	Qualities
18	The Confessional	Seat arrangements for two allow intimate conversations or consultations.	EDU-2, EDU-6, PRA-1, PRA-2, PRA-5, PRA-7, PRA-4, PRA-8	Collaboration, (Intermission)	Social Dimension
19	The Capsule	Secluded booths facilitate focused work, daydreaming, and personal withdrawal.	EDU-4, EDU-10, PRA-2, PRA-5, PRA-6, PRA-4, PRA-8	Personal, (Intermission)	Stimulation, (Social Dimension)
20	Collectibles	Dedicated space to collect own items/ideas or inspirational material on some sort of "mood board".	EDU-2, EDU-3, PRA-4	Collaboration	Stimulation, Knowledge Processor
21	The Swap Station	Dedicated space to exchange items with own pieces invites interaction and inspires through variation.	EDU-6, PRA-5	Collaboration, Intermission	Stimulation, Culture
22	Cabinet of Curiosities	Collections of materials, techniques, and small toys or gadgets provide inspiration.	EDU-9, EDU-10, PRA-2, PRA-6, PRA-7, PRA-8	Making, (Collaboration)	Stimulation, (Knowledge Processor)
23	Playground	Games, toys, musical instruments, and sports facilities foster experimentation and activity.	EDU-1, EDU-3, EDU-10, PRA-5, PRA-4, PRA-8	Intermission, (Collaboration)	Stimulation
24	The Anchor	Central attractions facilitate chance encounters and meetings across departments, floors, or buildings.	EDU-4, EDU-5, EDU-8, EDU-10, PRA-1, PRA-5 PRA-6, PRA-4	Intermission	Social Dimension
25	The Flexroom	Studios or meeting rooms for varying purposes, available on demand and upon request.	EDU-2, EDU-7, PRA-2, PRA-5, PRA-4	Collaboration	Process Enabler
26	The Lounge	Group arrangements with sofas and lounge chairs invite casual meetings.	EDU-1, EDU-2, EDU-6, EDU-7, EDU-10, PRA-1 PRA-2, PRA-5,	Intermission	Social Dimension

#	Title	Description	Found at	Space Types	Qualities
			PRA-6, PRA-7, PRA-4, PRA-8		
27	Odd Shape	Unusual shapes of common elements can trigger curiosity, play, and interaction; hence, these provide inspiration.	EDU-1, EDU-5, EDU-8, EDU-10, PRA-2, PRA-5, PRA-4, PRA-8	Intermission	Stimulation
28	Mystery	Elements with unclear functions or restricted access instigate curiosity and thus trigger creativity. The lack of instructions or visual affordances instigates experimentation and trial-and-error.	EDU-1, EDU-5, PRA-2, PRA-5, PRA-6	Collaboration, (Intermission)	Stimulation
29	Buzz	Ambient background noise like relaxing music or a certain level of background conversations can set someone into a creative and active mood.	EDU-10, PRA-5	Collaboration, (Intermission)	Stimulation
30	The Silencer	Especially in open plan office environments, a raised noise level causes distraction. This problem can be minimized through integrated (e.g. felt) silencers.	EDU-2, EDU-9, PRA-7, PRA-4	Intermission, Collaboration	Stimulation
31	Access Control	Time-delayed usage distribution and security reasons require digital booking systems and access control	EDU-4, EDU-6, EDU-7, PRA-1, PRA-2	Collaboration, Personal	Process Enabler, Culture
32	The Plugin	Sockets, digital info boards and technical infrastructure enable working anywhere	EDU-1, EDU-2, EDU-7, PRA-5, PRA-4	Collaboration, Intermission	Process Enabler

#	Title	Description	Found at	Space Types	Qualities
33	Leftover Space	Niches and dead corners invite experimentation. People can use them to install exhibitions or set up their own hangout areas.	EDU-5, EDU-8	Intermission	Stimulation
34	Empty Space	White space and emptiness invite implementation of own ideas; the space acts as a stage for people's work. Empty frames invite projection of own ideas. Emptiness prevents fixation.	EDU-1, EDU-5, EDU-7, EDU-8, EDU-9	any	Stimulation, (Process Enabler)
35	Informal Library	Casual areas with books and magazines provide inspiration and facilitate research.	EDU-1, EDU-3, EDU-6, EDU-8, EDU-10, PRA-1, PRA-2, PRA-5, PRA-4	Intermission, (Collaboration)	Knowledge Processor
36	Semi-Privacy	Views across rooms enable eye contact and allow observation of others' activities. Glass walls provide noise protection but keep visual contact.	EDU-1, EDU-2, EDU-3, EDU-8, EDU-9, PRA-2, PRA-3, PRA-5, PRA-4, PRA-8	Collaboration	Stimulation, (Social Dimension)
37	View Variations	Window views are stimulating. This effect can be enhanced through structures and frames that make the view more interesting and varied. Windows in varying sizes and arrangements provide changing views.	EDU-1, EDU-5, PRA-4	any	Stimulation
38	Mixed Lights	A space that is flooded with light is stimulating and facilitates manual work such as sketching or reading. Large windows and additional	EDU-5, PRA-3, PRA-5	any	Stimulation, (Process Enabler)

#	Title	Description	Found at	Space Types	Qualities
		lamps provide extra brightness.			
39	Vertical Distance	Large room height allows large-scale prototyping and "opens the mind".	EDU-2, EDU-4, EDU-5, PRA-1	Making, Collaboration, Intermission	Stimulation, (Process Enabler)
40	Asymmetric Floorplan	Non-rectangular (polygon, concave, or rounded) floorplans create cozy niches and interesting perspectives across interior and exterior areas.	EDU-5, PRA-5	Collaboration	Stimulation
41	Nested Open Plan	Open-plan offices facilitate visual contact and social interaction, but can result in a "factory" atmosphere. Elevated plateaus and nested areas can mitigate this effect.	EDU-2, PRA-1, PRA-3	Collaboration, (Intermission)	Social Dimension, (Stimulation)
42	The Reception	A welcoming reception area can put people in a positive mood and make them receptive for creativity.	EDU-8, PRA-1, PRA-3, PRA-5, PRA-7, PRA-8	Intermission	Social Dimension
43	Visible Structures	Visible construction triggers a "garage" feeling and reveals knowledge of functionality.	EDU-1, EDU-2, EDU-8, PRA-4, PRA-8	Collaboration, Intermission	Stimulation, Knowledge Processor
44	The Plaza	Large staircases or central junction areas are great hangouts or casual work areas. They facilitate chance encounters and serve as observation points.	EDU-1, EDU-2, EDU-7, EDU-9, EDU-10, PRA-2	Intermission	Social Dimension
45	Outer Space	Outdoor access enables casual breaks to get some fresh air and, hence, provide a	EDU-1, EDU-2, EDU-4, EDU-8, EDU-10, PRA-2,	Intermission	Stimulation

#	Title	Description	Found at	Space Types	Qualities
		change of perspective.	PRA-5, PRA-7, PRA-4		
46	The Pavilion	People love to work outdoors, but there is often a lack of equipment, electricity, or shelter. Outdoor work spaces with appropriate infrastructure mitigate this drawback.	EDU-10, PRA-5	Collaboration, Intermission	Stimulation, Process Enabler
47	Genius Loci	Creative neighborhood, heritage, or history can spark off creativity.	EDU-5, EDU-7, EDU-8, PRA-3	any	Culture
48	The Supply Store	On-site availability of resources facilitates prototyping and provides stimulation.	EDU-2, EDU-3, EDU-4, EDU-8	Intermission	Stimulation, Process Enabler
49	Field Access	Central location or easy access to public transport enables easy (user) research.	EDU-7, EDU-8, EDU-10	Intermission	Social Dimension, (Process Enabler)

5.5.5. Exemplary Patterns

In this section we will describe five selected patterns in more detail. In Chapter 8 we will develop the patterns further into a tangible card set.

Table 12. Pattern N° 01: Visible Tools (item).

No. 01	Visible Tools
Problem	A tool that is not visible is often not considered. People might refer to the most obvious tools or familiar equipment for their creative task. If particular tools are not familiar to the designers, they will probably not start searching for it.
Actionable Advice	Instead of storing tools in closed shelves or boxes, they should be made visible at appropriate places of the workspace. Arrange available tools and equipment in a visible way in the workplace. Provide open shelves or boards on walls that display relevant tools and materials in a systematic way.

No. 01	Visible Tools
Explanation	Visible tools might encourage people to start prototyping and to try (new) tools. Tools enable prototyping processes and provide knowledge about possible material treatments. Prototyping might reduce fixation effects. Tangible materials encourage experimentation.
Addresses	Space Type: Making Space, Collaboration Space. Spatial Quality: Process Enabler, Stimulation.
Cross Link	3 Visual Inventory; 13 The Showcase; 20 Collectibles; 22 Cabinet of Curiosities
Examples	At ZOKU Coworking space in Amsterdam, users will find a toolbox on each work desk, containing basic tools and materials like pens, Post-it notes, Scissors, cutters, tape, etc.
Literature	Prototyping might reduce Fixation (Youmans, 2011) Tangible prototyping materials increase collaboration and encourage exploratory processes (Peter, Lotz, McDonnell, & Lloyd, 2013)

Table 13. Pattern N° 05: Writeable Surface (interior, item).

No. 05	Writeable Surface
Problem	The lack of appropriate equipment for spontaneous or deliberate note taking, idea generation, or sketching might lead to a loss of ideas and thoughts. Sometimes ideas emerge during breaks or intermission, when no equipment is present. An insight that is not written down, will probably be forgotten afterwards. Team members need to get access to others' knowledge.
Actionable Advice	Integrate paper note pads, whiteboards, or other writeable surfaces into furniture. Consider whiteboard paint on entire wall surfaces.
Explanation	Allows externalization of tacit knowledge (thoughts and ideas). Provides a physical platform for ideas. Knowledge remains visible and accessible to other team members.
Disadvantage	Retention of ideas might be problematic (archiving paper sheets; pictures of whiteboards). Writeable whiteboard or chalkboard surface on tables can easily smudge.
Addresses	Space Type: Intermission Space, Presentation Space, Collaboration Space Spatial Quality: Process Enabler, Knowledge Processor
Cross Link	1 Visible Tools; 20 Collectibles; 34 Empty Space
Example	The "Campfire Paper Table" by Steelcase provides a pad of round paper sheets integrated into the round table top. Whiteboards are typical elements of creative spaces, either as a piece of furniture or as an entire wall.

No. 05	Writeable Surface
Literature	Externalization: "The Knowledge Creating Company" Nonaka & Takeuchi (1995); Retention of Ideas: (Simonton, 1998, 1999b)

Table 14. Pattern N° 08: High Seat (interior, item).

No. 08	High Seat
Problem	Sitting at normal seating level results in an inconvenient positioning when communicating with people who are passing by or when interacting in a team where one person stands (e.g., working at a whiteboard).
Actionable Advice	Elevated seats allow eye contact with passersby. High stools instigate active participation in teamwork situations. Provide lounge areas or desks on a platform that is elevated around 40 centimeters from ground level. Provide high stools in team spaces.
Explanation	Raising a seated person by approximately 40 centimeters will enable him/her to have convenient eye contact with people who are standing (e.g., passersby).
Addresses	Space Type: Collaboration Space, Intermission Space. Spatial Quality: Social Dimension, Process Enabler.
Cross Link	7 Invitation Chair; 9 Seat Variations; 10 The Outlook; 12 Communal Table
Examples	Standing tables and high stools at SAP and HPI D-School create a dynamic atmosphere and activate participation.
Literature	"A Social Learning Place in Higher Education" (Poutanen, 2013). "Creating Space for Innovation" (Fixson, Seidel, & Bailey, 2015).

Table 15. Pattern N° 37: View Variations (architecture).

No. 37	View Variations
Context	Window views are considered positive for creating an inspiring and stimulating atmosphere.
Problem	However, always looking at the same scene might also result in boredom.
Actionable Advice	Windows arranged in various sizes, angles, and vertical positions provide a multitude of different views and motifs.
Explanation	Surprising views can create inspiring stimuli. Making new connections can lead to flexibility of ideas. Occurring coincidences can lead to serendipity.
Addresses	Space Type: Intermission Space, Collaboration Space, Personal Space Spatial Quality: Stimulation

No. 37	View Variations
Cross Link	10 The Outlook; 28 The Mystery; 41 Nested Open Plan
Example	The Entrance Hall at Umeå School of Architecture provides a wall of variously-sized windows that allow constantly changing views (providing peeks into the sky as well as to the ground); presenting the viewer with motifs such as stray dogs, passers-by, flying birds, etc.
Literature	Surprise: "From Positive Affect to Creativity" (Filipowicz, 2006) Serendipity: "Ubiquitous Serendipity" (Goldschmidt, 2015)

Table 16. Pattern N° 47: Genius Loci (neighborhood).

No. 47	Genius Loci
Context	When looking for a site to establish a creative business or design school (either renting existing premises or building a new one), location is crucial, because it is difficult or impossible to change afterwards.
Problem	Lack of creative and inspiring spirit in an environment might lead to a lack of motivation and awareness of employees or students.
Actionable Advice	Choose a location near to or within any neighborhood that inherits a desired historical or cultural spirit that one wants to transfer to one's own institution.
Explanation	Working or studying within an environment that is historically well-known for creativity and innovation can result in associative (context) priming of students or employees toward a creative mind-set and also increase creative motivation. Also, this 'genius loci' might be able to attract other people to move there, which might raise the level of creative spirit as such.
Addresses	Space Type: Intermission Space; can affect all other space types Spatial Quality: Culture
Cross Link	2 The Label; 17 The Garage; 49 Field Access
Example	The Dessau School of Design is located in direct proximity to the German Bauhaus. The presence of the historic provenance of the design discipline might positively affect students' creative mood and motivation.
Literature	"Understanding Priming Effects in Social Psychology" (Molden, 2014); "The state, not the trait, of nostalgia increases creativity" (Ye, Ngan, & Hui, 2013); "Motivation and Creativity" (Collins & Amabile, 1998); Motivation: "Enhancing Creativity" (Nickerson, 1998, p. 411 ff.); "Design Fixation" (Jansson & Smith, 1991)

These five examples illustrate the potential of the entire set of the 49 spatial design principles. Designers, educators, or spatial planners can use them to identify

any similar context or problems within their own environments and adapt the suggested solution principles accordingly. Each pattern follows the same structure and provides information about the background, an explanation, links to related literature, cross-links to other related patterns, and an example. Designers, educators, or spatial planners can use the patterns to identify any similar contexts or problems within their own environments and adapt the suggested solution principles accordingly.

5.5.6. Pattern Relationships

Alexander et al. (1977; 1979) considered their pattern language to be a collection of individual patterns that are related to each other. Each pattern description lists references to other related patterns. Several individual patterns in combination would form a new pattern language. In that way, they presented several pattern languages for specific purposes, each constituting a selection of several patterns as components for creating specific architectural aspects. For example, to form the pattern language for a "window seat", they suggested a combination of the following patterns: "zen view", "window place", "built-in seat", "frames as thickened edges", "deep reveals", "windows which open wide", "small panes", and "filtered light" (Alexander, 1979, p. 359 ff.). In a similar vein, we also suggest relationships between patterns and provide cross-links to other related patterns that might add a different perspective on a similar problem. Furthermore, we suggest pattern languages that constitute specific aspects of creative environments by combining several individual patterns. We derived these relationships based on their occurrences in the institutions we analyzed.

Table 17. Mapping of spatial design principles to the typology of creative spaces.

	Personal Space	**Collaboration Space**	**Presentation Space**	**Making Space**	**Intermission Space**
Source of Stimulation	19, 6, 11, 36, 37, 1, 13, 15, 18, 9, 38, 35, 22, 34, 40	36, 6, 23, 9, 43, 22, 28, 20, 34, 35, 38, 41, 27, 40, 1, 10, 30, 39, 37, 18, 19, 16, 46, 15, 21, 3	13, 43, 10, 34, 37, 30, 36, 38, 40	22, 1, 43, 37, 39, 38, 34, 40	23, 45, 6, 13, 27, 11, 36, 35, 48, 19, 30, 10, 9, 37, 34, 33, 43, 28, 42, 21, 39, 2, 46, 41, 38, 22, 17, 40
Knowledge Processor	3, 1, 35, 22, 20	5, 35, 3, 4, 1, 43, 22, 20, 28	13, 5, 43, 42, 36	1, 22, 36, 5, 3, 43, 4	35, 5, 4, 3, 13, 43, 32, 1, 42, 36, 22

	Personal Space	Collaboration Space	Presentation Space	Making Space	Intermission Space
Social Dimension	18, 25, 19, 36, 15, 7	18, 26, 7, 36, 12, 23, 10, 41, 8, 25, 9, 39, 19, 21, 15, 42, 4	42, 44, 10, 24, 36	36, 4	26, 24, 44, 18, 42, 12, 23, 49, 19, 45, 41, 25, 10, 36, 7, 8, 4
Indicator of Culture	47, 11, 31, 2, 19, 17	2, 47, 31, 23, 17, 43, 21, 11, 4	47, 13, 2, 43, 27, 33	47, 2, 43, 33, 31	2, 17, 11, 47, 24, 4, 31, 21, 23, 43, 13, 42, 19
Process Enabler	25, 15, 9, 1, 16, 32, 38, 7	1, 16, 9, 25, 14, 5, 15, 32, 7, 8, 46, 38, 22, 12, 31	1, 5, 15, 44, 16, 14, 9, 34	1, 22, 39, 16, 8, 14, 34, 31	9, 5, 48, 32, 12, 31, 49, 3, 1, 39, 15, 25, 19, 14, 34

In Table 17, we have mapped the 49 spatial patterns to the space types and qualities of creative spaces. The allocation of patterns to space types and qualities was derived from our case study database, from which occurring patterns for both categories could be extracted. Each cell of the matrix provides the numbers of the related design patterns that could be used to address the spatial quality of that particular space type. In this way, people who want to design their spaces could refer to the table and identify the relevant criteria they want to change, along with the related spatial design patterns indicated by their identifying numbers. For example, the pattern language for a "social presentation space" could be formed through the patterns 10 ("the outlook"), 24 ("the anchor"), 36 ("semi-privacy"), 42 ("the reception"), and 44 ("the plaza"). Within Table 17, the patterns are ordered according to the frequency of occurrence, which means that the first listed pattern per category is also the one that occurred most often in the studied institutions and, hence, might be the most relevant for that particular combination of space type and quality.

5.5.7. Pattern Distribution

Although the main focus of this chapter was to identify spatial patterns based on a qualitative case study, the collected data from the 18 different organizations also revealed some additional quantitative insights regarding the distribution of patterns, which warrant further investigation. To identify possible differences between the educational and the practice institutions, we compared the occurrences of patterns for both institution types. For all of the analyses, we compared the number of occurrences in relation to the total number of pictures taken per

institution, rather than the absolute numbers, to avoid possible imbalance due to the unequal number of pictures taken.

Figure 47 shows the comparison between the average number of pattern occurrences per space type in the two types of organizations. This comparison reveals that most of the identified patterns addressed either intermission spaces or collaboration spaces. Personal spaces were rarely addressed, especially in the educational institutions, whereas presentation spaces were rarely covered within practice institutions. The potential of intermission spaces seemed to be equally acknowledged by both types of organizations. Collaboration spaces were, however, much more present in practice.

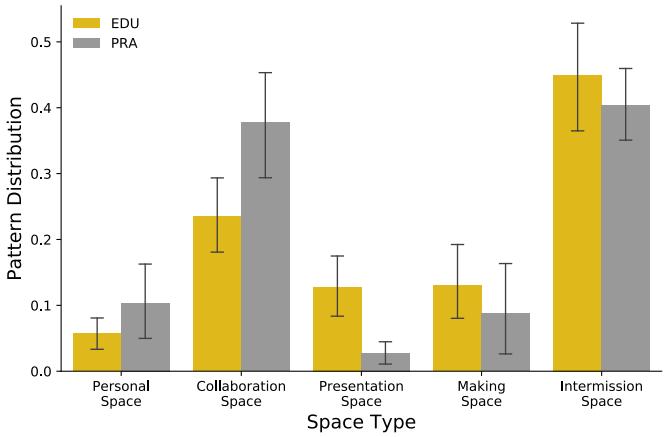


Figure 47. Distribution of patterns according to space types.

Figure 48 shows the comparison between the average number of pattern occurrences per spatial quality in the two types of organizations. It becomes evident that in both organization types most of the patterns addressed stimulation. The difference between educational and practice institutions is not striking; however, patterns for knowledge processing and process enabling were slightly more prominent in educational institutions, whereas patterns addressing culture were more prominent in the practice organizations.

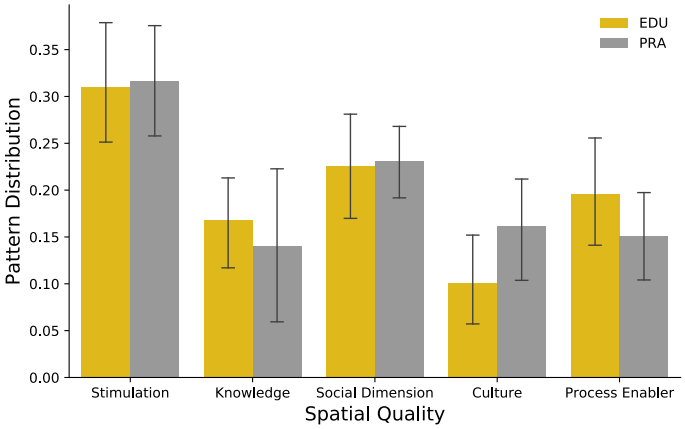


Figure 48. Distribution of patterns according to spatial qualities.

The results of this preliminary pattern distribution cannot be generalized, due to the small sample size, but we argue that they provide first insights that can serve as a foundation for further research.

5.6. DISCUSSION

With this study, we wanted to answer a twofold question: *how do organizations from the creative sector design their workspaces, and what spatial design patterns could be identified?* The results from the multi-case study conducted in 18 organizations yielded insights on two levels. First, the inventory of exemplary creative spaces from these 18 organizations provides rich insight into contemporary workspace design and educational environments in the creative sector. In addition to the theoretical underpinnings provided, this inventory might serve as a source of inspiration and provide practitioners with relevant knowledge about the possible impact of spatial design decisions. Secondly, we systematically derived spatial patterns from the 18 organizations we analyzed. The developed design patterns provide designers, design educators, architects, managers, and spatial planners with a resource for the systematic design or redesign of a creative workspace. Each pattern provides insights into the spatial context, an abstracted solution principle, and an exemplary spatial instantiation from a real-life organization. Moreover, each pattern is abstract enough to be adapted to specific needs and to be integrated into the unique context of the user.

5.6.1. Theoretical Implications

This study constitutes a type-5 theory (Gregor & Jones, 2007), according to the different types of theories outlined on page 55. It aims to provide design patterns, or in other words, abstracted guidelines and examples for how to design creative work environments. The focus of this study is to develop a theory on how to design such creative spaces, not to test the theory. Therefore, a validation of the proposed pattern language is not part of this thesis, but is dedicated to future research.

The statistical analyses provided in Section 5.5.7 provide some insights that warrant further research. Although the results cannot be generalized due to the small sample size, some results are striking. For example, most organizations focused on implementing creative collaboration spaces. Personal spaces were underrepresented in all of the organizations that were analyzed, but particularly in the educational sector. The potential of presentation spaces was given more focus in educational institutions. This focus makes sense for lecture spaces, which are certainly more relevant to universities, but showcasing and other means of presenting work could be given more attention in practice. When looking closer at the data, we can see that the pattern "Showcase" was found in six educational institutions, but only in three practice organizations, which supports this assumption. Future research can build on these insights and investigate such occurrences among a larger sample size.

5.6.2. Practical Implications

The 49 design patterns presented in this chapter suggest abstracted guidelines for designing creative spaces in terms of furniture solutions, room layouts and interiors, the architecture, as well as the neighborhood and city location. We tried to find an appropriate level of abstraction that reduces the number of principles to a minimum and avoids redundancy, but at the same time, leaves the users with enough flexibility to adapt the patterns to their own context and requirements. In that way, the patterns could be used to design or redesign spaces in design education or design practice, but also in other creative areas, such as co-working or maker spaces, as well as start-ups and innovation departments of larger corporations.

Similar to Alexander et al.'s (1977) pattern language, there are various ways for the reader to use our proposed pattern language of creative spaces. The pat-

tern language can be used with co-workers in order to improve an existing workspace; it can be used to design a personal workspace; and it can be used, together with spatial planners, to design a new creative space. The classification of patterns to categories allows the users to identify certain areas of interest, for example, to increase the social dimension in intermission spaces. By browsing the respective intersections in Table 17, users are presented with the appropriate patterns that could address their goal. Furthermore, the pattern language can be used as a lens for analyzing existing workspaces, for example, to identify the strengths and weaknesses of a current space. Hence the pattern language can be used not only as a design tool but also as a research tool.

When designing a creative workspace, one should be careful not to aim for maximizing all patterns. Instead, the focus should be on balance. Otherwise, particular patterns could have contrary effects and hence lead to a cacophony-type of design that may hinder creativity instead of facilitating it. Some patterns are multidimensional by nature. For example, the social dimension of a creative space involves both increasing and reducing interaction. Likewise, stimulation as such is not effective; a particular kind of stimulation and a good balance is required.

The suggested patterns are not meant to provide exact design blueprints but rather exemplary concepts which need to be adapted by the users to match their own context and requirements. Furthermore, the study adds to the existing research on creative spaces by providing a structured schema for spatial analyses and by suggesting a variety of design possibilities. The work presented in this chapter provides users with the required contextual information to determine what kind of spatial configuration would be appropriate for the given situation, and it presents exemplary sets of several patterns for different creative activities.

5.6.3. Correspondence to Alexander et al.'s Pattern Language

We acknowledge that Alexander et al.'s (1977) patterns can also be applied to a large extent to creative workspaces. For example, "indoor sunlight" (N° 128) can improve the overall atmosphere of any space, consequently, also for a workspace. However, since Alexander et al. did not develop their patterns with the particular requirements of *creative* spaces in mind, their suggested intentions and underlying working principles are quite different and address, for example, the general well-being or personal taste of the users. In contrast, we focused on the capabilities of specific spatial patterns to facilitate *creative* work and *creativity* in general. Nevertheless, we can identify some correspondences between the two pattern

languages. For example, Alexander's Pattern N° 251, "different chairs", suggests providing varied seat options for people of different sizes and with different tastes. Our pattern N° 9, "seat variations", suggests the same, but with the intention to provide opportunities for different work modes. Similarly, Alexander's pattern, "window place" (N° 180), suggests a low window sill or alcove to provide comfort and views. This can be compared to our pattern, "the outlook" (N° 10); however, our pattern focuses more on the type of view that would provide creative stimulation. In contrast, some of Alexander's patterns appear to be contrary to ours. For example, Alexander's pattern N° 106, "positive outdoor space", elaborates on problems related to negative "leftover" space. However, such leftover spaces appeared to be conducive to creativity in our study and were given their own pattern in our pattern language (N° 33 "leftover space"). Consequently, we argue that our pattern language of creative spaces uses similar structures and elements as Alexander et al.'s pattern language, but has extended and developed it further to match the specific characteristics of *creative* work environments.

5.7. CONCLUSIONS

In this chapter, we have presented the groundwork of a "pattern language" for designing creative work and study environments. Based on the typology of creative spaces developed in Chapter 4, and on an inductive approach with a multicase study conducted in 18 institutions, we identified emerging patterns of creative spatial designs and developed these into a set of 49 design patterns. The presented pattern language of creative spaces constitutes a novel method for designing work environments for creative activities. The patterns not only provide users with inspirations for their own spatial designs, but also refer users to related studies with empirical data to substantiate their design decisions.

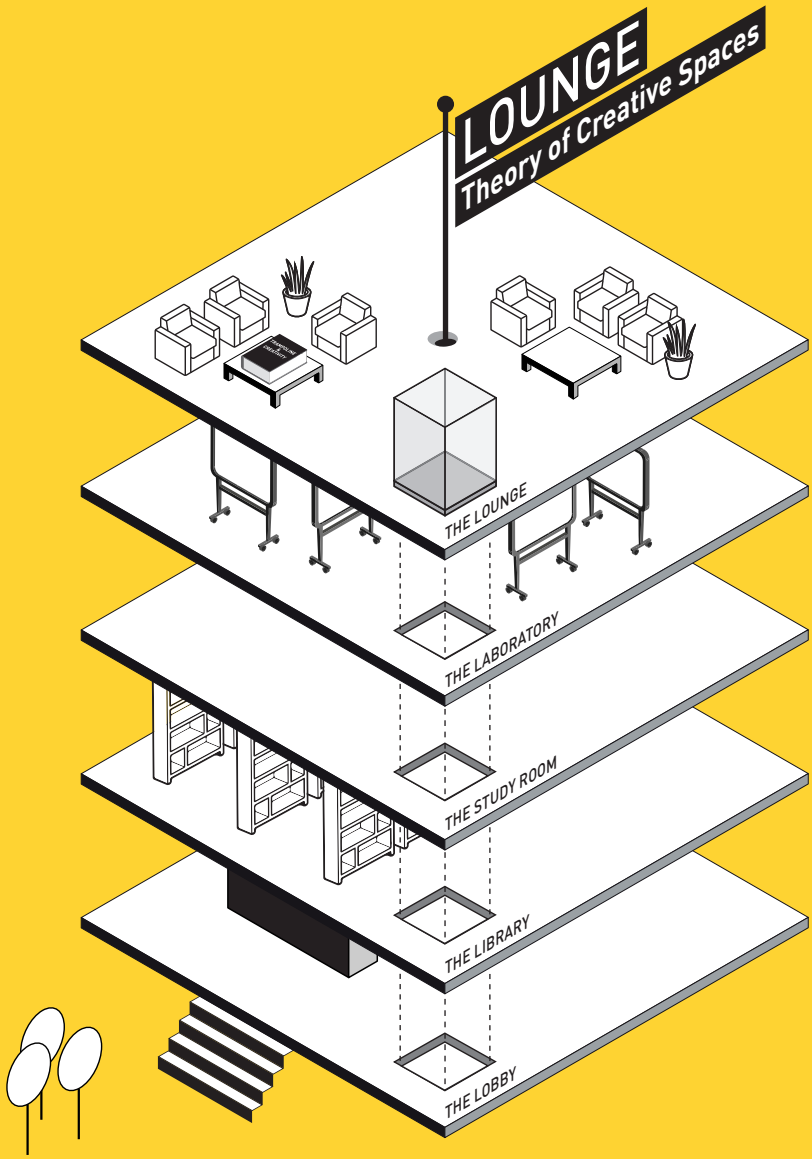
Nevertheless, several limitations apply to our study. First, the sample size of 18 organizations is not sufficient enough to allow for generalizability. However, we argue that the different corner cases that were included in our multicase study were able to provide holistic insights into the topic. Furthermore, we did not systematically evaluate the effectiveness of the identified patterns for facilitating creativity. The work presented in this chapter is focused on developing theory, not testing it. However, whether the space would be considered positive or negative in terms of supporting creativity could be inferred from the staff's responses and from our own observations of people's behavior. Nevertheless, future work will focus on revising the patterns and enriching them through a broader theoretical underpinning.

In Chapter 6, we will enrich the patterns by presenting theoretical propositions about the impact of space on creativity. Mapping the patterns to these propositions will lead to a better understanding of their working mechanisms.

Finally, the patterns should be developed further into a tangible and applicable tool that would facilitate practitioners with designing their workspaces. We envision a card set that could then be used in a threefold manner: (1) as a resource that one can browse in order to find inspiration for one's own creative environments, (2) as an analysis tool that one could apply in an existing environment to identify areas needing improvement, and (3) as a practical tool to identify solutions for specific spatial problems. The development and testing of such a tool are described in Chapter 8.

6TH FLOOR: THE LOUNGE

It's time to think... in the lounge. This is the place to philosophize with some dear colleagues. Have a seat and think about the meaning of your workspace. How does it work and why? And how can you improve it?



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6. TOWARD A CAUSAL THEORY OF CREATIVE SPACE

6.1. RATIONALE

After studying creative spaces in 18 organizations and identifying spatial patterns, the next step is to understand *how* specific spatial configurations might influence creativity and innovation.

This chapter introduces a preliminary causal theory of creative spaces that consists of ten propositions outlining causal relationships between spatial characteristics and creative impact. The propositions were developed based on nine expert interviews that provided insight on the topic from the perspective of different creative fields, namely, urban planning, architecture, interior design, office planning, furniture design, industrial design, design thinking, innovation, and fine arts. We focus on both educational and practice environments within the creative sector. To develop an evidence-based theory, we provide links to relevant literature for each of the suggested propositions. We present a summary of the main insights and visualize the developed theory as a set of causal graphs. The propositions have important implications for both research and practice: on the one hand, they can be regarded as a first step toward a theory of creativity-supporting work environments, and on the other hand, the propositions can serve as a reference when designing or adjusting creative spaces.

> RQ 6: *What are the spatial conditions that facilitate creativity and innovation, and how can these be explained through theory?*

The developed theoretical propositions were mapped to the spatial patterns (presented in Chapter 5) in order to demonstrate the applicability of the suggested propositions.

6.2. RELATED WORK ABOUT CREATIVE SPACE THEORIES

Our literature review, outlined in Chapter 3, yielded only four sources that presented a causal theory of creative spaces that would explain any possible relationships between spatial designs and creativity (Martens, 2011; McCoy, 2005; Meinel et al., 2017; Paoli et al., 2017).

Martens (2008) presented a hypothetical framework based on a case study, outlining how the physical work environment contributes to creativity

and creative work processes. The framework positions creativity, creative work, and an appropriate work environment. The identified critical factors were layout, furniture, color, finishing, and light. More specifically, he identified several aspects as conducive to creativity: open space, spaciousness, unconventional architecture, interim showcases, indoor climate, an adequate noise level, bright colors, and haptic textures.

McCoy (2005) looked into the literature on team creativity in organizations that linked creative team characteristics and social influences to properties and attributes of the physical office environment. Five categories that influence the physical environment and social behavior emerged from this literature review: spatial organization, architectonic detail, view, resources, and ambient conditions. She identified several aspects as positive for creativity: remoteness from the daily work, spaciousness, proximity and short distances, vistas in between and across rooms, face-to-face meeting spaces, informal lounge areas, personalized space, writeable surfaces like whiteboards, and technical infrastructure.

Based on a literature review of 17 articles, Meinel, Maier, Wagner, and Voigt (2017) identified several categories of interest regarding creativity-supporting physical work environments: They defined five aspects regarding spatial layout (privacy, flexibility, office layout, office size, complexity), four space types (relaxing space, disengaged space, doodle space, unusual/fun space), and several tangible office elements (furniture, plants, equipment, window/view, decorative elements, materials) as well as intangible office elements (sound, colors, light, temperature, smell). They summarized the results in a framework. They identified several aspects as supportive for creativity, such as available materials and tools, a good indoor climate, positive smells and sounds, complex shapes and ornaments, decoration and art, and greenery.

Paoli, Sauer, and Ropo (2017) presented a set of certain design characteristics that would be able to facilitate creativity, clustered into five different themes (home, sports and play, technology, nature, and symbolism). Among the aspects they identified as conducive to creativity were: field access, open space, spaciousness, greenery, cozy capsules, toys and games, sports facilities, communal tables, style and atmosphere, ambient light, bright colors, pale colors, and natural materials.

The analyzed literature has shown that although there have been a few attempts to explain the possible causal relationship between workspace and cre-

ativity, the existing sources are scattered. A comprehensive overview of the influence of a creative space in relation to general theories of creativity is lacking. With this study, we are attempting to bridge this knowledge gap. To explore the question further, we will take a closer look at the general theories of creativity in the next section.

6.3. THEORETICAL FOUNDATIONS OF CREATIVITY

Numerous definitions of creativity exist. Most authors distinguish between creativity as an outcome (a creative solution) and creativity as a process. A creative outcome should be novel (both original and unique), meaningful, and useful at the same time (Amabile et al., 1996; Boden, 1996; Sääksjärvi & Gonçalves, 2018; Sarkar & Chakrabarti, 2007; Sawyer, 2006; Stein, 1953; Sternberg, 1988; Weisberg, 2006). Gero (1996) added "unexpectedness" as a further aspect to this definition of creativity, and Simonton (2012) added "surprise," which is similar to unexpectedness. The most widely accepted definition of creativity as a process is still the one developed by Wallas (1926), who proposed a four-step creative problem-solving process. These steps are *preparation* (investigation of the problem in all directions), *incubation* (unconscious processing), *illumination* (sudden insight and creation of a solution), and *verification* (critical elaboration and validation of the idea). Several authors suggested that elaboration needs to be separated from validation, because early critique would kill creativity (Osborn, 1953). Consequently, we add *elaboration* as a separate step that describes the process of developing and detailing an idea further. A summary of the various creativity concepts and the creative process can be found, for example in M. Gonçalves (2016) and Lubart (2001).

Our research interest focuses on the ability of the built environment to facilitate a creative *process*; hence, the definitions of *creativity as a process* are more relevant for our study. Accordingly, our research question centers on the questions if and, if yes, how the environment can provide appropriate spaces for (1) *preparation*, (2) *incubation*, (3) *illumination*, (4) *elaboration,* and (5) *verification*.

In his seminal book, *Creativity*, Csikszentmihalyi (1996, pp. 127–147) presented some thoughts about the relevance of the physical environment to support creativity. He referred mainly to the steps of the creative process as proposed by Wallas (1926). More specifically, he stressed that the environment has different requirements depending on which step of the creative process one is

engaged in. For the preparation phase, he suggested an ordered, familiar environment where one could work and concentrate without being distracted. In the subsequent incubation phase, a different, novel environment with magnificent views and an alien culture would be conducive to making new connections until the illumination phase occurs. After that, a familiar, comfortable, and even humdrum setting would be preferable again in order to elaborate and evaluate an idea. We will further discuss Csikszentmihalyi's views on the spatial aspects of creativity in relation to our own theoretical propositions in the discussion section of this chapter.

Besides Wallas' four-stage model of creativity, other concepts are equally relevant to our theory development. Building on Wallas' definition, Guilford (1950) introduced the concept of divergent and convergent thinking as modes of thought to explain creativity. Divergent thinking means producing a large quantity and variety of ideas, whereas convergent thinking describes the process of narrowing down to one solution—concepts that are also popular in current design thinking (Brown, 2009). Later, Guilford (1967) differentiated divergent thinking further into *flexibility* (the variety of ideas diverging into different directions) and *fluency* (the quantity of ideas produced), which are seen as important elements of a creative process (M. Gonçalves, 2016). These concepts were considered in our theory development as well.

Wallas' model of the creative process did not, however, suggest any deliberate synthesizing of research insights—a concept known as "synthesis" and "point of view" in design thinking (Brown, 2009). Hence, we add *synthesis* to our list of relevant creativity concepts.

To better explain the possible impact of certain spatial designs, some insights from cognitive theory are useful as well. The brain switches frequently between two cognitive modes: focused mode and diffused mode of thinking (Immordino-Yang, Christodoulou, & Singh, 2012; Moussa, Steen, Laurienti, & Hayasaka, 2012; Oakley, 2014; Raichle & Snyder, 2007). The focused mode (also called highly attentive state) is "a direct approach to solving problems using rational, sequential, analytical approaches" (Oakley, 2014, p. 12) and is mostly linked to the prefrontal cortex. In the diffused mode (also called resting state network or default mode network), the mind wanders and connects different areas of the brain in a more relaxed manner (Oakley, 2014). The focused and diffused modes are similar to de Bono's (2009) concepts of vertical and lateral thinking and Guilford's (1950) concepts of convergent and divergent thinking. The

diffused mode is associated with higher creativity, especially when divergent thinking is involved (Takeuchi et al., 2012).

Table 18 summarizes the creativity concepts that were considered for our theory development. We will refer to these concepts throughout this chapter to illustrate the anticipated impact of our propositions.

Table 18. Overview of relevant creativity concepts.

Creativity Concept	Explanation	Source
Priming	Activation of a specific—for example, creative—mindset	Sassenberg et al. (2017)
Preparation	Investigation of the problem in all directions	Wallas (1926)
Serendipity	Unexpected finding of ideas, persons, and things	Goldschmidt (2015)
Incubation	Unconscious processing	Wallas (1926)
Synthesis	Conscious, deliberate processing	Brown (2008)
Illumination	Sudden insight	Wallas (1926)
Fluency	Quantity of ideas (part of divergent thinking)	Simonton (1999b), Guilford (1967)
Flexibility	Variety of ideas (part of divergent thinking)	Guilford (1967)
Fixation	Inappropriate repetition of existing ideas	Purcell & Gero (1996)
Elaboration	Adding detail; narrowing down toward fewer solutions (part of convergent thinking)	Osborn (1953)
Verification	Critical validation and selection	Wallas (1926)

6.4. APPROACH AND METHOD FOR THEORY DEVELOPMENT

6.4.1. Different Types of Theories

As outlined in Section 3.4.1, on page 55, Gregor (2006) distinguished among five types of theories: Theories for analyzing (type-1), interpretative theories for explanation (type-2), theories for prediction (type-3), causal theories for explanation and prediction (type-4), and design theories (type-5).

The current study involves what can be considered a type-4 theory because it aims to explain and predict the possible influence of spatial specifications on the creative process. In this respect, our endeavor to develop a causal theory

for creative spaces differs from the existing theoretical attempts to describe spatial impacts on creativity, as outlined in our literature review, because the analyzed sources do not provide any theoretical explanations on how space impacts creativity.

The presented propositions are testable; however, an actual test is not part of this study. For each of the propositions we provide evidence that is based on expert interviews and related literature. Similar to evidence-based management (Pfeffer & Sutton, 2006), we aim to provide an evidence-based theory for creative spaces that does not subscribe to hype and fashion. Our presented propositions are probabilistic, not deterministic, which means that we have investigated factors that make the outcome in general more likely (Jaccard & Jacoby, 2009). We do not claim that these propositions are valid for everybody under all circumstances. Instead, we are interested in the rich insights related to possible contingencies. Therefore, our main sources for the propositions, apart from the literature, are qualitative interviews and cases. As a consequence, we propose a qualitative probabilistic causal theory (Pearl, 2013) of creative space.

6.4.2. Expert Interviews

We conducted nine semi-structured interviews with experts from the fields of design education, innovation, product design, art, workplace furniture, office planning, urban planning, architecture, and interior design. We chose these experts in order to include corner cases that cover a wide variety of different perspectives on the topic of creative environments. The selected interviews provided insights into the topic from nine different angles:

(1) Urban planning (URB): This expert is a design professor for social and communication design. Her research focus is on the relevance of public and urban spaces for designers.
(2) Architecture (ARC): This expert is an architect with Henning Larsen Architects—an architectural firm specializing in cultural buildings. He was the leading design architect for several architectural projects, including the planning, design, and building of a design school in Umeå, Sweden.
(3) Interior design (INT): This expert is an architect and interior designer who was responsible for the redesign of the interior of the Hasso-Plattner-Institute (HPI) School of Design Thinking in Potsdam, as well as several spatial design projects in industry (e.g., with Google).

(4) Furniture manufacturing (FUR): This expert is a workplace consultant for higher education at Steelcase Furniture Manufacturing who is responsible for the German-speaking European market.
(5) Industrial Design Practice (ID): This expert is a design manager at the leading design consultancy, IDEO. He provides insights from his 15+ years of work experience in IDEO's different design offices around the world.
(6) Office planning (OFP): This expert was part of the "Quickborner Team" office planning consultancy—a company that introduced open-plan offices in Germany in the late 1950s and then influenced the rise of the cubicle in the US (Duffy, 1992; Saval, 2014, pp. 200–205).
(7) Innovation (INN): This expert is a renowned writer who has published several books about creativity and innovation. He provides insights into the innovator's mindset.
(8) Design Thinking (DT): This expert is a professor for strategic design and design thinking, as well as a design thinking consultant for several start-ups and global companies.
(9) Artistic spatial design (ART): This expert works as an artist and spatial designer. Among her broad professional experience is, for example, the design of the Berlin "*grund_schule der künste*", an art education school for children that is associated with the Berlin University of the Arts' Teacher Training Programs for Fine Arts. She provides a perspective on creative spaces that addresses the peculiarities of art education, design, and elementary schools.

The selected experts also represent cultural diversity in terms of their countries of origin and their places of work. The covered nationalities include German, American, Venezuelan, and Swedish, and their places of work include the United States, Germany, Denmark, Switzerland, and Austria. Table 19 shows an overview of the included interviews; Figure 49 illustrates the different expert perspectives on creative space.

Table 19. Overview of expert interviewees.

No.	ID	Experience (years)	Main Expertise
1	URB	20+	Professor for Urban and Social Design, Germany
2	ARC	10+	Architect for Umeå Design School, Sweden
3	INT	10+	Interior Architect for HPI D-School, Potsdam, Germany
4	FUR	15+	Manager for Educational Furniture at Steelcase, Germany, Austria, Switzerland
5	ID	15+	Design Manager at IDEO in the US and Germany
6	DT	20+	Professor for Strategic Design and Design Thinking, Venezuela
7	INN	30+	Writer and Professor for Innovation, US
8	OFP	45+	Sociologist, Office Planner for "Office Landscapes", Quickborner Team, Germany
9	ART	10+	Spatial and Furniture Designer, Germany

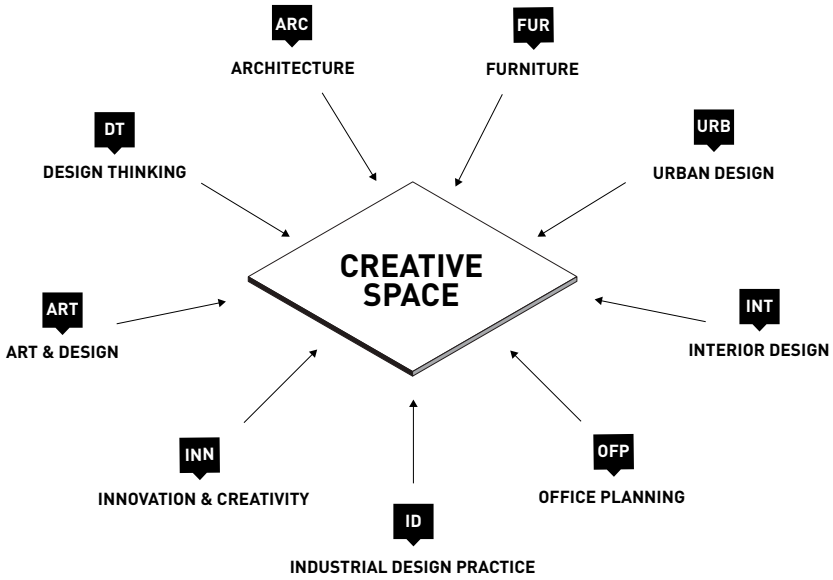


Figure 49. Nine expert interviews as corner case perspectives for creative space.

A set of open questions guided the semi-structured interviews (the complete interview guidelines can be found in Appendix B). We structured the interviews into three categories. First, we asked about experiences or thoughts related to the suggested five space types and five spatial qualities (as outlined in the typology of creative spaces, Chapter 4). The second set of questions was related to general characteristics of a space (materials, colors, furniture, etc.), what impact these might have on creativity, and how important these characteristics are. Finally, we asked the interviewees about their personal experiences and preferences regarding their own work environments. All questions were open-ended and allowed for the sharing of personal insights and stories beyond the prepared questions. The interviews were audio recorded and later transcribed (non-verbatim). The nine interviews totaled 11.4 hours of audio data—an average of 86 minutes per interview (the shortest lasted 53 minutes and the longest 104 minutes). We transcribed and imported the interviews into Atlas.ti for further analysis.

6.4.3. Data Analysis and Proposition Formation

To analyze the data, we iteratively developed a code structure based on the space types and spatial qualities, as suggested by the typology of creative spaces (see Chapter 4 on page 84). Further code groups were added to identify the addressed impact of space on creativity, the prioritization (how important a certain characteristic was for the interviewees), and concrete characteristics of spatial designs (such as materials, colors, or light). The complete code structure can be found in Appendix C.

Two researchers coded the interview data; one is the author of this thesis. We calculated an interrater agreement coefficient (Cohen's Kappa) of 0.70 by analyzing and comparing the codes from one jointly coded interview. For any identified disagreements, both raters discussed their ratings until they came to an agreement.

The first step of the analysis process was to filter all data against the code "creativity" because this study's main objective is to investigate the possible impact space has on creativity. We coded the data with this term in cases where the experts mentioned "creativity" either autonomously or after prompts from the interviewer and where quotes mentioned closely associated aspects such as "innovation" or "idea generation." Thus, we coded 86 text segments with "creativity," which served as the basis for developing the propositions. In a second step, we checked these identified segments against other codes that appeared in close proximity because these aspects might also be of relevance for creativity. We

ranked the resulting 161 adjacent codes according to the frequency with which they appeared in the interview texts. The most frequent occurrences in alignment with "creativity" were the sub-codes around "stimulation" and "atmosphere". Since these aspects might also have an impact on creativity, we cross-checked all of the data for these codes to gain new insights. Using this procedure, we identified additional quotes that appeared to be highly relevant to the spatial impact on creativity.

The quotes were clustered according to emerging categories. In order to identify the underlying concepts, the two researchers grouped, regrouped, split, named, and renamed the emerging categories in several iteration rounds. This procedure was repeated until no further categories emerged, i.e., to the point of theoretical saturation (Corbin & Strauss, 2014).

The thematically clustered interview quotes were used as a starting point for the proposition development. The quotes provided us with ideas and insights on what spatial aspects could be of relevance for facilitating creativity. By comparing these insights with relevant literature, we were able to substantiate and detail the propositions further. The resulting ten propositions are described in detail in the following section.

6.5. TEN PROPOSITIONS ABOUT THE IMPACT OF SPACE ON CREATIVITY

We present a set of ten propositions that suggest an influence of the physical environment on creativity, each of which is based on quotes from the interviews and substantiated by relevant literature. Figure 50 shows an abstracted graph that illustrates the possible cause-and-effect relationship between space and creativity. A spatial element or configuration could facilitate, enable, or activate a particular construct (which gives name to the overall proposition) that might lead to a creativity-supporting event. However, the space could also influence the construct in a negative way by reducing, limiting, or preventing the construct. This abstracted "formula" (depicted in Figure 50) guided the further development of the ten propositions. Each proposition follows the same structure and is illustrated through such a graph.

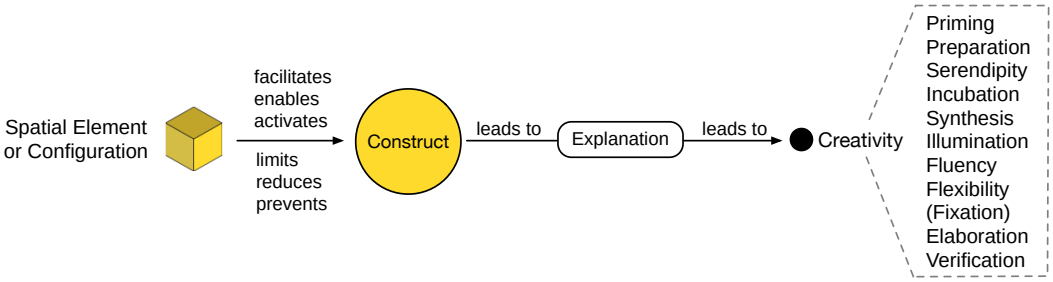


Figure 50. Abstracted "formula" that describes the causal relationship between space and creativity.

In the following subsections, we will describe the ten propositions in detail. For each proposition, we will present some exemplary interview quotes that constitute the initial inspiration for the development of a proposition. Furthermore, we will link each proposition to the creativity concepts (as described earlier in Table 18 on page 157), which provide possible explanations for the working mechanism of each spatial construct. Whenever applicable, we will provide relevant literature that supports (or possibly contradicts) the proposition. We conclude each proposition with an illustrative causal graph and some suggested spatial instantiations that could facilitate the related impact on creativity.

6.5.1. Proposition 1: Sources

P1: Space that provides visible sources is conducive to creativity.

Experts' Input

Designers often rely on visual stimulation for inspiration, which most of the interviews made evident. Such inspiring sources can be graphics and images, but also texts, books, models, materials, as well as toys and gadgets.

> *Quote 1: "It is important to have those things that we find inspiring at hand. We have a collection of old projects to show to new clients. And a material library, books, and project reports." (ART) [translated by author].*
>
> *Quote 2: "And if I start putting things or paintings on the walls and stuff, then I get a little bit distracted. […]. There are moments when distraction really pays off, and I think visual distraction creates ideas." (DT)*
>
> *Quote 3: "Sometimes I bring them [the students] a box of materials with unusual stuff for prototyping (pasta, for example). It is always a surprise moment." (DT)*

Evidence from Literature

This view is extensively supported by literature. M. Gonçalves, Cardoso, and Badke-Schaub (2014) investigated the inspirational approaches of designers and identified a strong preference for visual material, mainly from the internet, but also from magazines and books. This preference seems to pay off at times, as there is a positive correlation between the presence of visual stimuli and the emergence of creativity (Goldschmidt & Smolkov, 2006). However, Goldschmidt and Sever (2011) and M. Gonçalves, Cardoso, and Badke-Schaub (2013) also found that textual stimuli can be equally inspiring for creativity. Furthermore, the exhibition of sketches, either self-generated or created by colleagues, elicits "backtalk", i.e., reinterpretation and reflection of visual material created (Schön, 1983). Backtalk from sketches can then elicit multiple reinterpretations and lead to creativity (Goldschmidt, 2003). Moreover, visible sources also contain knowledge that might be relevant to the creative process. However, an abundance of visible sources can be distracting or even result in "creative chaos," which might hinder an effective workflow. At the same time, such creative chaos could lead to serendipity by providing unexpected findings (Baird et al., 2012). Clark (2007) described chaos and order as two interconnected elements of the creative process that must be in balance.

> *Quote 4: "For me, messy is really inspiring. Yeah. I make connections when things are really messy. […] What is messy? Messy is not knowing where things are at the moment when you need them. Instead you are finding things you were not looking for. And that is inspiring." (DT)*

The degree of acceptable chaos depends on the project status. Although one may consider an abundance of visual sources to be tolerable during a project (caused by the project's own materials), one may also consider chaos produced by old materials from previous projects to be a hindrance at the beginning of a new project. This could also result in fixation (Cardoso & Badke-Schaub, 2011; Crilly & Cardoso, 2017) because the presence of visible material from earlier projects bears the risk of getting stuck in those old thought patterns. Thus, space should facilitate a good balance of chaos and order.

> *Quote 5: "I could not start a new project when the material from the previous one was still on my desk. No one would stick the new Post-it note on top of the old one. If you want to create something new, you need to start fresh, to create new associations. Otherwise, there's the risk of reproducing the same stuff again and again. During the project, however, it may be chaotic and messy." (INT) [translated by author]*

Possible Spatial Facilitation

Books and other texts provide a resource for research, whereas materials and objects (such as work models) can help with understanding structural or other design principles. In this way, sources can facilitate an exploration of the context in various directions (preparation). In an environment displaying an abundance of sources and materials, unexpected findings, coincidental combinations, or mistakes can occur (serendipity). Visible sources allow individuals to make new connections among them, which leads to a faster and easier development of many ideas (fluency) and can result in a greater variety of ideas (flexibility).

A space that offers an effective degree of visible sources might, for example, be structured through storage facilities to keep order and provide shelves and showcases to display and provide books, materials, work models, or other relevant material. Pin boards allow for the collection of inspirational materials and relevant information, that can be removed and reused according to the project at hand. Figure 51 illustrates Proposition 1 as a causal graph.

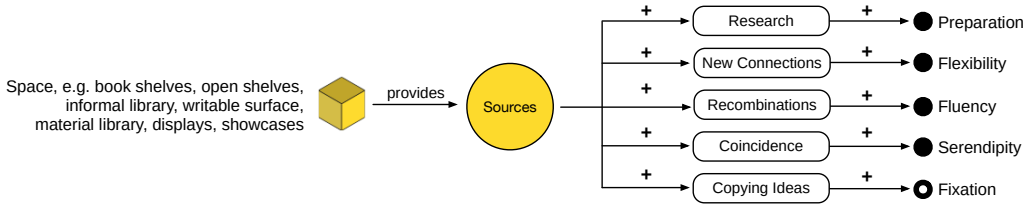


Figure 51. Components of Proposition 1: "Sources".

6.5.2. Proposition 2: Void

P2: Space that provides a void is conducive to creativity.

Experts' Input

Although visual stimulation can act as a source of inspiration, the opposite—reduced stimulation and a lack of visible sources—can also be conducive to creativity, according to our interviewees.

> *Quote 6: "I prefer to have a white space, a white canvas, where I can spread out my thoughts. […] If you would fill everything with inspirational material, that would have to be removed later to leave empty space for the next project." (URB) [translated by author]*

> *Quote 7: "A space should be like a stage to be filled by its users. A room that wants to be the main actor is always a bit bothersome." (ID) [translated by author]*

Evidence from Literature

Empty space (conveyed by reduced stimulation or white walls) might help the mind to lose focus and to wander (Baird et al., 2012). Sometimes, adding constraints can also be conducive to creativity. Research has shown that too many choices can overstrain the user and hence, a limitation of sources is preferable at times (Joyce, 2009; Rosso, 2014).

Moreover, people often express a tendency to fill an empty space to make it look complete, a phenomenon known as the "Zeigarnik effect" in Gestalt psychology (Zeigarnik, 1938). Hence, a provided void might trigger people to fill it with their own ideas, as suggested in the following quote.

> *Quote 8: "I had this picture frame from my grandmother. I left it empty and I really like looking at it. I don't look at the frame; I look at the white space in the middle, and I project the ideas into it." (DT)*

However, what we saw across the board with our interviewees was that this is not a unanimous opinion. Some experts were skeptical about white spaces and expressed their wish for visual structures and stimuli.

> *Quote 9: "A totally white and empty room is awful! If I was a very contemplative person, this might work, but since I'm a communicative person I think this is terrible. It depends on your personality. Even as a contemplative person this would be disturbing, if you look at the wall and there is no visual feedback." (OFP) [translated by author]*

This could be explained by designers' personal preferences: those that require visual stimulation could be considered "inspiration seekers", while those that prefer to rely on their experience and to work in white spaces can be called "inspiration avoiders" (M. Gonçalves, Cardoso, & Badke-Schaub, 2016). Furthermore, the current state of the project might also determine different needs regarding the abundance of sources (or lack thereof). For example, during the research phase, a lot of sources might be conducive, whereas later during synthesis, a lack of sources could help to maintain focus. We will elaborate further on this discrepancy in the discussion section of this chapter.

Possible Spatial Facilitation

White walls or empty rooms with reduced stimuli facilitate the diffused mode, which can trigger an incubation phase. The emptiness can also lead to people projecting their own ideas into the void, i.e., to trigger an illumination effect. And finally, the reduced presence of visible sources might also be able to minimize

fixation effects, especially in people who prefer to work creatively without stimulation and who are wary of fixation effects (M. Gonçalves et al., 2016).

White walls or empty rooms with reduced stimuli facilitate the diffused mode and invite people to project their own ideas onto them. Dedicated empty areas, such as empty walls or showcases, could invite people to express their own ideas even more. Neutral colors and clean walls without decoration could also have the desired effect. A well-organized storage system with closed shelves and drawers might help to keep order and minimize chaos. Figure 52 illustrates Proposition 2 as a causal graph.

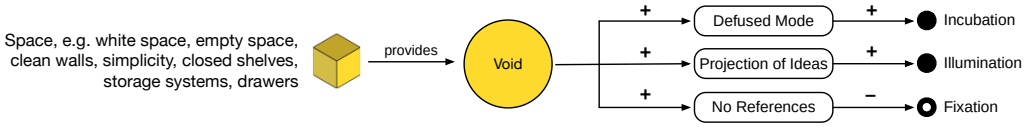


Figure 52. Components of Proposition 2: "Void".

6.5.3. Proposition 3: Encounters

P3: Space that facilitates chance encounters is conducive to creativity.

Experts' Input

Several experts stressed the importance of social interaction with creative people to share ideas and feedback. In fact, they suggested that people are more important than the space. However, a well-designed creative space can facilitate and reinforce such encounters with co-workers, fellow students, or strangers.

> *Quote 10: "I worked in circular offices, I worked in square offices, I worked in dark offices, light offices, and sometimes we'd be sitting in the end of the room or sitting at the center of the room, and I wonder that what triggers my creativity, especially on spaces, is I have to say it's not the space but it's the people inside. I see the people as a trigger of thinking." (DT)*
>
> *Quote 11: "All innovations basically emerge in the smoking corners, these informal spaces where everybody passes by and conversations come up." (URB) [translated by author].*
>
> *Quote 12: "We have designed those small extra stools that we place at each work station. They indicate sort of an invitation… 'Hey, come and sit next to me for a minute and see what I am working on'. It encourages spontaneous feedback." (ART) [translated by author]*
>
> *Quote 13: "Access to citizens is an important factor, for example to do user research and conduct interviews. That's why we set up our space in the city center." (URB) [translated by author].*

Quote 14: "Our old office building was stretched over five floors. You literally would not meet colleagues from the other floors. That's why we moved into this new building that is arranged more horizontally with lots of open-plan spaces." (ID) [translated by author]

Evidence from Literature

McCoy and Evans (2002) found that spaces that promote social interaction have a positive effect on creativity. Amabile (1983); Zuo, Leonard, and MaloneBeach (2010); Shaw (2010); and Le Dantec (2010) also supported this proposition. According to Moenaert and Caeldries (1996), spatial proximity can lead to a higher quality of communication.

Possible Spatial Facilitation

When relating "Encounters" to the creativity theory, several connections can be made. Chance encounters and related new input can lead to coincidences, which might in turn lead to serendipity. Meeting people allows one to make new connections within existing knowledge, which can increase flexibility. Finally, field access to do user research can facilitate preparation. Spatial instantiations that might support these effects are, among others, communal work areas or lounges that facilitate collaboration, proximity through reduced horizontal and vertical distance, open-plan office structures, as well as spare seats or high stools that provide better eye contact with passersby. Space can facilitate social interaction and chance encounters through several means, such as strategically positioned meeting points (e.g., copy machines), lounge furniture, or transparent walls, to name just a few examples. The location within the city determines access to user research. Figure 53 illustrates Proposition 3 as a causal graph.

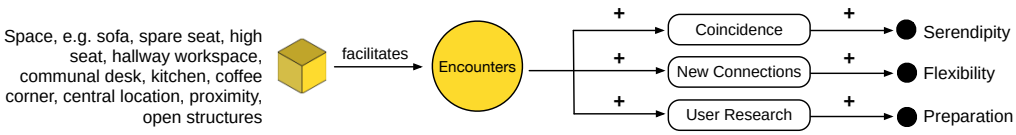


Figure 53. Components of Proposition 3: "Encounters".

6.5.4. Proposition 4: Seclusion

P4: Space that provides seclusion and reduced social interaction is conducive to creativity.

Experts' Input

Although creativity can benefit from interactions and collaboration, there are phases in the creative process that require individual work (Paulus, 2000). In those occasions, the opposite of personal encounters—seclusion and privacy—seems to have a positive effect on creativity.

> *Quote 15: "If you need to think conceptually or be creative by yourself, you sometimes need this withdrawal space which is secluded – almost hermetically. You would have to exclude any distractions then. Maybe it could be with another person, but not more." (INT) [translated by author]*

> *Quote 16: "Because of our open-plan office concept, we do not have many options for personal withdrawal. Sometimes when people need to think or just work intensively on a task, they go into one of these phone booths, or they use those large headphones that indicate 'do not disturb me'." (ID) [translated by author]*

> *Quote 17: "You need a place where you could be alone with your ideas and that is one of the things a lot of people forget when they are building creative spaces, either at schools or agencies." (INN)*

Evidence from Literature

The possibility to withdraw from frequent interruptions can help the mind to enter the focused mode (Immordino-Yang et al., 2012; Oakley, 2014). The focused mode (also called highly attentive state) is "a direct approach to solving problems using rational, sequential, analytical approaches" (Oakley, 2014, p. 12) and is mostly linked to the prefrontal cortex. Csikszentmihalyi (1990) introduced the term "flow", which is a state of mind characterized by intense and focused concentration and can be compared to the focused mode. The state of flow can also be conducive to creativity (Csikszentmihalyi, 1996, p. 107 ff.).

Newport (2016) proposed privacy and reduced social interaction to allow efficient and focused work; a state of work that he called "deep work." This view corroborates the concept of flow, although flow can also occur in social groups and does not necessarily require privacy. Both concepts do, however, propagate an elimination of distractions.

Possible Spatial Facilitation

This focused or high-attentive state of mind allows one to critically elaborate and flesh out ideas, which would support elaboration and verification of ideas. Spatial instantiations that might support these effects are, among others, booths or other capsules, high-back furniture, shields, partition walls or curtains, and private rooms. Sometimes, other means of avoiding disturbances might also be useful, such as providing large headphones or temporarily blocking one's availability in social media or disconnecting email and phones. Also, the possibility for personal withdrawal, for example, through outdoor work facilities, can be useful to provide seclusion. Figure 54 illustrates Proposition 4 as a causal graph.

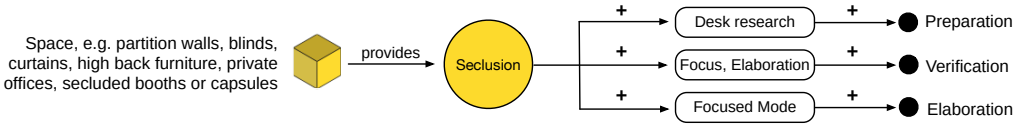


Figure 54. Components of Proposition 4: "Seclusion".

6.5.5. Proposition 5: Ambiance

P5: Space that provides a balanced ambiance is conducive to creativity.

Experts' Input

In addition to visual stimuli, other senses can also be stimulated, which can influence creativity—for example, through sounds, smells, or tactility.

> *Quote 18: "I think materials are hugely important; I'm a very tactile person. And I think in terms of representing and promoting creativity; I think material surroundings are very important. It's stimulating." (INN)*

> *Quote 19: "Basically, every creative person is able to be creative anywhere. But sometimes the space does not allow that. Either I do not feel comfortable in there, or the light, the air, the atmosphere is not right […] in a way space can hinder creativity." (FUR) [translated by author]*

Evidence from Literature

According to Sarkar and Chakrabarti (2008), a stimulation is a "trigger" that activates one or more senses and, hence, initiates the creative search and exploration process. Consequently, triggers can occur through visual, auditory, olfactory, tactile, or gustatory stimulation of the senses (Ludden, Schifferstein, & Hekkert, 2012). Such stimuli create a certain ambiance in the workspace.

Mehta, Zhu, and Cheema (2012, p. 785) suggested that "a moderate (vs. low) level of ambient noise is likely to induce processing disfluency or processing difficulty, which activates abstract cognition and consequently enhances creative performance." Other research has shown that an ambient sound level can even increase creativity in highly creative individuals (Toplyn & Maguire, 1991). Olfactory cues might be able to enhance creativity, as shown by F. Gonçalves, Cabral, Campos, and Schöning (2017). Furthermore, tactile structures might add to the creativity-facilitation capabilities of a space. McCoy and Evans (2002) demonstrated the importance of using materials in creativity. Natural materials, such as wood, were considered important to creativity. In addition, plants can add to the ambiance of a space. According to Plambech and Konijnendijk van den Bosch (2015), a natural environment can enhance creativity by facilitating the first two phases of a creative process, namely, preparation and incubation. The beneficial effects of plants and flowers in the workplace were suggested by several sources (Ceylan et al., 2008; McCoy & Evans, 2005).

Possible Spatial Facilitation

Sensorial stimuli, such as textures, comfortable light, the smell of coffee, or certain material smells (such as from woodworking), can set people into a creative mood. However, other stimuli, like loud noises or unpleasant smells, can quickly become annoying or distracting. A well-balanced composition with appropriate incongruities between stimuli, can be crucial to the constitution of a creative space. If present to an appropriate degree, the stimuli creating the ambiance of a space might be able to facilitate the incubation phase by stimulating unconscious processing of prior information. For example, a moderate level of relaxing background music can direct the mind toward the diffused mode. Also, a close proximity of certain stimuli (e.g., wood workshops or coffee stations) can provide for pleasant smells in the workspace. The abundance of lights, in addition to natural daylight, can improve the ambiance of a space. Providing means to get fresh air, such as outdoor access (e.g., balconies) or outdoor work areas, can be beneficial as well. Moreover, the presence of indoor plants to provide stimulation might also be considered. Figure 55 illustrates Proposition 5 as a causal graph.

Figure 55. Components of Proposition 5: "Ambiance".

6.5.6. Proposition 6: Views

P6: Space that provides views is conducive to creativity.

Experts' Input

Windows providing an open view of nature or an urban environment, as well as vistas within buildings seem to have a positive effect on creativity and inspiration.

> *Quote 20: "If I'm trying to write here and I'm trying to look for a creative idea, I always look outside the window." (DT)*
>
> *Quote 21: "… people passing by outside the window might distract me, but also could provide new input at the same time." (FUR) [translated by author]*
>
> *Quote 22: "There is a small couch near the [office] entrance. Sometimes I just go there for a 5 minutes break maybe just to look in the newspaper or just clear my mind. There you have this very nice overview; you don't see the whole thing but you see a lot of space there. You see the door where people go in and out which is fundamental that you can see who is coming in and leaving. That's one of my favorite spots." (ARC)*
>
> *Quote 23: "Vistas and window views are extremely important for me. Even if that reduces my privacy. I like to be connected to the sky. It lets the mind expand." (ART) [translated by author]*

Evidence from Literature

McCoy and Evans (2002) suggested that looking into a natural environment would foster creativity. The positive effect of window views is also suggested by several authors (Ceylan et al., 2008; Dul & Ceylan, 2011, 2014; Dul et al., 2011). Conversely, Farley and Veitch (2001) could not confirm this hypothesis in their studies. Students in windowless rooms showed the same creative performance as those in rooms with a view. However, study participants confirmed a higher level of well-being when they were in rooms that provided a window view.

Possible Spatial Facilitation

The expansion of the mind into the outside world could activate a diffused mode of thinking and, hence, facilitate the incubation effect. Moreover, views across rooms can also provide visual stimuli and foster social interaction, which could lead to serendipity.

Large windows to the exterior, as well as window seats elevated to the sill, can enhance outdoor views. Vistas across rooms can be provided through nested open-plan offices with elevated platforms, transparent divider walls and glass doors, or other open structures, such as open shelves. Figure 56 illustrates Proposition 6 as a causal graph.

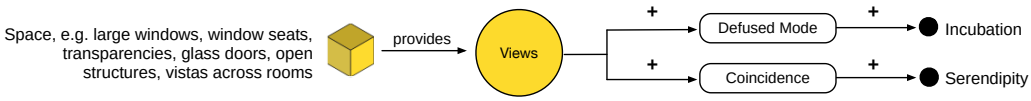


Figure 56. Components of Proposition 6: "Views".

6.5.7. Proposition 7: Visual Cues

P7: Space that provides visual cues is conducive to creativity.

Experts' Input

According to some experts, space can convey the feeling of being a "safe area" where people can experiment, try things out, and are not afraid to fail.

> *Quote 24: A design school needs to have a protected space, a safe space in which you can act as you want, say what you want, design what you want, and where you do not feel embarrassed. Criticism from others helps to connect the dots and establish associations. (INT) [translated by author].*

> *Quote 25: "I hope that it expresses this freedom of unfolding yourself like feeling like here I'm allowed to do my studies the way I believe is interesting and not saying, 'oh, you should design this way' or it should have this generosity towards each individual that they feel that they can develop in their own direction." (ARC)*

Sometimes, just calling a space a "creative space" or an "innovation lab" can put someone in a mood that is receptive to creativity.

> *Quote 26: "And, of course, there is the 'Innovation Lab' and it [just the name] worked – it spread really fast like everybody was talking about it. Suddenly, everybody wanted to use it […]. But now, all of a sudden, everything is about innovation. Yeah." (DT)*

This effect is not exclusive to literal labelling; the historic atmospheres of creative surroundings seem to have a similar effect. People can be inspired to mimic historic role models from art and design who are still omnipresent through stories and discussions.

> *Quote 27: "Well, the fact that Parsons is down in the Village, which has traditionally been the center of creativity in this city, is really important. I mean Jackson Pollock lived a block from here. The whole movement, abstract movement, they all lived here." (INN)*

Furthermore, objects, style, and atmospheres that indicate that playful and experimental behaviors are valued by the organization can have a similar result.

> *Quote 28: "Especially when it is about creativity, it is important to get rid of pressure and high expectations. I would say 70% of our team plays table tennis. We also like to play soccer in the afternoon. […]. Frequently, some toys and gadgets show up here. We had a drone and such nonsense." (INT) [translated by author]*

Evidence from Literature

Bhagwatwar, Massey, and Dennis (2013) studied brainstorming performance in virtual environments. Their results indicated that people perform more creatively in spaces that are labeled for creative activities.

Berretta and Privette (1990) studied the influence of play on creative performance and were able to confirm an outcome of significantly greater creative thinking skills in children who practiced flexible play. Lieberman (2014, p. 30) suggested that the concept of play can instigate creativity by increasing spontaneity and supporting divergent thinking. Playfulness and games can also increase people's happiness. A possible correlation between happiness and creativity has been suggested by several authors (Csikszentmihalyi, 1997; Desmet, 2015; Desmet & Pohlmeyer, 2013).

Possible Spatial Facilitation

The labeling of a space as specifically designated for creative activities can result in people being motivated for this type of task and adopting a creative mindset (priming). The encouragement of experimental behavior can increase the number of ideas being developed (fluency) and might also facilitate experimentation and trial-and-error (verification).

Space can provide visual cues—for example, by providing posters, labels, and signs that visually represent mission statements and creative work ethics, or that suggest a specific creative behavior. Moreover, the playful or experimental design style of a space—for example, the presence of rough materials or graffiti wall paintings—can indicate that creative experimentation would be appreciated there. Specific pieces of furniture, such as beanbags or hammocks, or a playful atmosphere with games and toys indicate that the organization values play and

experimentation, and it also sends an inviting signal to take an occasional creative break. Figure 57 illustrates Proposition 7 as a causal graph.

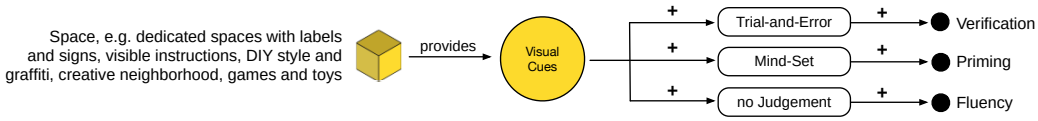


Figure 57. Components of Proposition 7: "Visual Cues".

6.5.8. Proposition 8: Activator

P8: Space that activates bodily movement and activity is conducive to creativity.

Experts' Input

Several experts remarked on the positive effect of bodily activities, such as walking or performing sports.

> *Quote 29: "Personally, I think the more you move the more you learn. There is a connection between your physical activity and your mind work, so to speak. There was always this old idea of when you walk, you think very well and you discuss very well when you walk. I don't know if it's fixed to everyone, but I can sense that importance of physical activity while thinking or doing some intellectual work." (ARC)*
>
> *Quote 30: "I feel very much creative when I'm moving in the space; for example, my best ideas I have when I'm walking […]. Somehow, movement triggers me a lot." (DT)*
>
> *Quote 31: "I cannot be creative without exercising two times a week." (ID) [translated by author]*

However, not only sport-like activities can have an impact on creativity. Manual work with your hands and active participation in the creative process might also be helpful. Instead of thinking about a problem, manually working on something can be conducive to creativity.

> *Quote 32: "Somehow, you think differently when you touch things or when you try to build. You really come up with ideas that you cannot have come up by sketching or by looking out the window. You think different when you're making." (DT)*
>
> *Quote 33: "Yes, changing position of work is part of this, definitely. […] I do believe that our brain works very well when we switch in between different thoughts like using your hands or your body doing something physically and using just your mind, so to speak, writing something or drawing; then, of course, you use your hands still, but*

it's in less extent than building something or doing something physically. This interplay in between activities is quite important." (ARC)

Evidence from Literature

In Ancient Greece, the Peripatetic School (Furley, 2003), founded by Aristotle, cultivated the habit that one should "think while walking" (Csikszentmihalyi, 1996, p. 137). Since then, bodily movement has been believed to be conducive to creative or intellectual thinking.

Oppezzo and Schwartz (2014) experimentally demonstrated that walking boosts creative ideation. Also, Gondola (1986), Steinberg et al. (1997), and Colzato, Szapora Ozturk, Pannekoek, and Hommel (2013) provided evidence that physical exercise positively affects creative performance.

Possible Spatial Facilitation

Active movement (e.g., when walking or exercising) can set the brain into the relaxed state of mind, or diffused mode, in which the mind wanders and connects different areas of the brain in more relaxed ways (Oakley, 2014). A space can induce this relaxed state of mind by providing, for example, transition spaces that require walking between buildings to get from A to B, thus, facilitating the incubation phase. Furthermore, vertical distances, such as layered floor plans with stairs, could have a similar effect. Outdoor access that motivates people to get away from their computers could also be considered.

More deliberate inclusion of facilities for exercising and sports could be beneficial as well—for example, by providing a gym or other infrastructure for exercising and team sports (table tennis, climbing walls, etc.). Moveable (swivel) chairs or furniture that allows or enforces different work positions might have a similar effect. Figure 58 illustrates Proposition 8 as a causal graph.

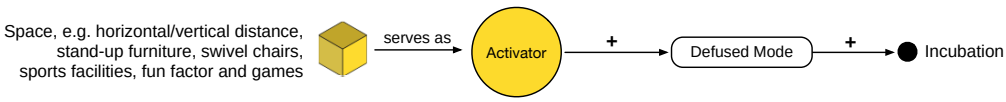


Figure 58. Components of Proposition 8: "Activator".

6.5.9. Proposition 9: Platform for Ideas

P9: Space that provides a platform for ideas is conducive to creativity.

Experts' Input

When working creatively, one needs some space to manifest one's ideas. This space can range from a Post-it note or a whiteboard to a writeable wall or a large studio to build things in.

> *Quote 34: "The size of the space is extremely important. I had a smaller studio before and all my designs were smaller as well. A large space allows you to think bigger, create bigger ideas, and build bigger models." (ART) [translated by author]*
>
> *Quote 35: "Ideas manifest creativity, and that manifestation must be part of the process, and you manifest in different ways: workshop, studio, even if you are acting things out, you need a sort of stage." (INN)*
>
> *Quote 36: "One of my favorite pieces of furniture is this table with the integrated sheets of paper. It allows you to spontaneously capture ideas." (FUR) [translated by author]*
>
> *Quote 37: "Within this School of Architecture, there were some spaces that are very tall; they're over ten meters and only maybe one meter in wideness, and they're not accessible, of course. These started to be used by the students; they hang things there, and for example, they study how sound is being transported within such a room, and they try to visualize that with the installations. Very inspiring how they attack the space." (ARC)*

Evidence from Literature

Typical examples of such platforms for idea generation are innovation templates. Helminen, Ainoa, and Mäkinen (2016) presented three different toolkits and showed how altering the design of these toolkits also changed the creative performance of the users. Similarly, Sadler, Shluzas, and Blikstein (2017) presented evidence of the correlation between the modularity of a prototyping toolkit and the quality and quantity of users' ideas. We argue that the concept of boundary objects can explain these phenomena. Boundary objects (Star & Griesemer, 1989), such as sketches, canvases, or prototypes, are plastic enough for different communities to adapt and interpret information differently but robust enough to maintain informational integrity. They support distributed cognition by eliciting and capturing tacit knowledge through interactions with the boundary objects (Henderson, 1991). Boundary objects support social and individual creativ-

ity in several ways: by moving from vague ideas to more concrete representations; by producing records of mental thought outside of the individual memory; by providing means for others to critique, interact with, and build upon the ideas; and by establishing a common language of understanding (Fischer, Giaccardi, Eden, Sugimoto, & Ye, 2005). Space can establish a platform for these boundary objects and act as a boundary object itself; a sort of boundary space.

Moreover, space as a platform for ideas invites the manifestation of an idea, for example, as a prototype. Youmans (2011) investigated the influence of prototyping and material use on fixation. Although he did not necessarily relate prototyping to creativity, one can argue that if fixation is reduced when working with physical materials, then prototyping can potentially support creativity. Fonseca, Jorge, Gomes, D. Gonçalves, and Vala (2009) established a connection between prototyping and creativity within the domain of human-computer interaction in a computer engineering course.

Possible Spatial Facilitation

A large (studio or workshop) space enables the creation of more or literally bigger ideas (e.g., building larger models). The larger the platform, the more possibilities one has for manifesting ideas, which can generate many solutions (fluency). When an idea appears suddenly during the incubation phase, it is helpful to have a platform available to represent the emerging idea (e.g., writeable surfaces throughout the workspace), which is useful to facilitate any possible illumination that may occur. Workshop facilities, tinker desks, and tools allow people to add details to ideas and develop them further (elaboration). The idea manifestations also allow people to visualize, discuss, and validate ideas, either together with others or as a testable prototype (verification). Moreover, empty spaces (as outlined in Proposition 2, the "Void"), such as dead corners, can serve as a platform for new ideas. Figure 59 illustrates Proposition 9 as a causal graph.

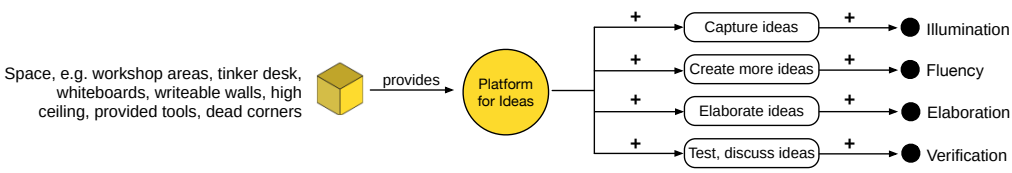


Figure 59. Components of Proposition 9: "Platform for Ideas".

6.5.10. Proposition 10: Variation

P10: Space that provides variation and change is conducive to creativity.

Experts' Input

Several experts mentioned the positive effects achieved through varying work environments, change, and the related possibility of getting new input and new perspectives.

> *Quote 38: "Flex desks and room-sharing, where you have a new desk every morning, allow you to meet new people every day and gain new perspectives." (OFP) [translated by author]*
>
> *Quote 39: "I like to look at an environment that is not static but constantly changing and provides visible movement." (OFP) [translated by author]*
>
> *Quote 40: "As you can see, we have those chalkboards here where everybody can post some messages. We don't have any fixed signs that appear unchangeable. With this, we want to express constant change. Our office changes every day." (ID) [translated by author]*
>
> *Quote 41: "It is important to break proportions. The room itself can be rectangular, but this alone becomes boring; it needs some variations to loosen it up, such as small niches or parts with rounded shapes… this makes it livelier." (OFP) [translated by author]*
>
> *Quote 42: "I prefer a view to busy street views that provide new perspectives." (INN)*

While most experts stressed the positive effects of a changing, unusual, and even surprising work environment, also some negative thoughts were mentioned.

> *Quote 43: "When I was working in this Frank Gehry building, you would think round fosters creativity and so on, but it was quite the opposite. There was no way of placing the tables inside that room. And when your space is constantly invaded because it's round and you have people walking behind you and so on, it just doesn't help you connect with the space." (DT)*

Consequently, spaces that are too impractical for the intended activity might be impedimental to creativity.

Evidence from Literature

Csikszentmihalyi (1996, p. 128) reports on various artists and poets who have traveled away from their homes in order to see new perspectives and get new

input. The possibility of gaining new perspectives by switching spaces and moving into new surroundings can have a positive effect on creativity. Nicolai, Klooker, Panayotova, Hüsam, and Weinberg (2016) found indications where students had their breakthrough ideas when they moved out of their normal workspace. The positive effect of innovation labs that are located remotely from the everyday work has been investigated by numerous authors (McCoy, 2005; O'Hare, Hansen, Turner, & Dekoninck, 2008; S. Schmidt et al., 2015).

According to Flipowicz (2006), surprise can cause a cognitive shift which very likely fosters creativity. This view is also supported by Grace and Maher (2015) and Becattini, Borgianni, Cascini, and Rotini (2017).

Possible spatial facilitation

A good balance between variation and change on the one hand, and functionality on the other, seems to be ideal. Strange or unexpected spaces that have unusual shapes resulting in "dead" or unused corners or that reveal surprising interiors or views can have a positive effect on creativity. Such surprising, unfamiliar, unexpected, or changing spaces trigger curiosity, provide new perspectives, and, hence, allow people to make new connections. This effect can result in an increased variety of ideas by establishing connections between different concepts (flexibility), or it can provide coincidences (serendipity).

Space might be able to provide variation and new perspectives—for example, through so-called flex desks, where people would choose a new work desk and thus meet new neighbors every day. Also, external work locations, such as outdoor pavilions or remote innovation hubs can provide stimulating new perspectives. Varying sizes of windows or views of busy and changing environments might also be conducive to creativity. Moreover, frequently updating exhibitions, as well as having the possibility to change workspaces (e.g., by providing mobile equipment) can provide new insights. Figure 60 illustrates Proposition 10 as a causal graph.

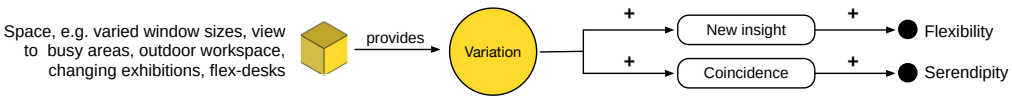


Figure 60. Components of Proposition 10: "Variation".

6.6. DISCUSSION

6.6.1. Propositions in Relation to the Spatial Qualities

To illustrate the possible impact of the suggested propositions in a conceptual way, we have aligned them to the typology of creative spaces (see Chapter 4, page 71). Figure 61 shows the five spatial qualities with the ten propositions that are considered relevant for fostering creativity. Each proposition is placed within one spatial quality (process enabling, knowledge processing, social dimension, stimulation, or culture) or within an intersection of several areas.

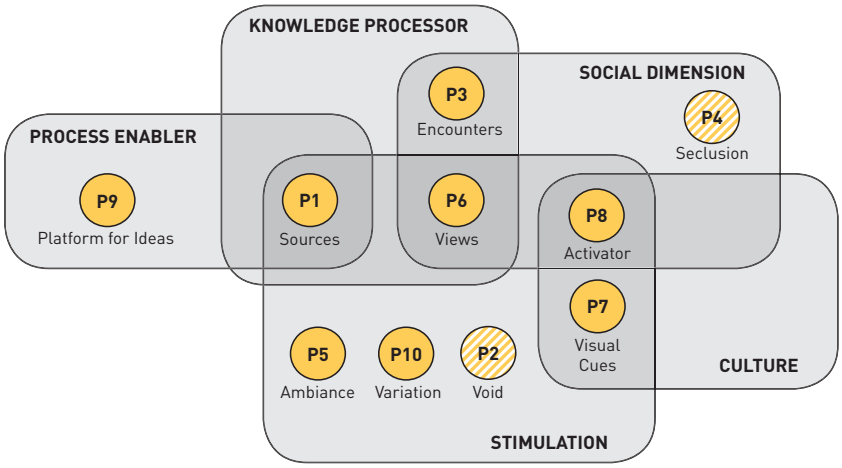


Figure 61. Five spatial qualities and how they are addressed by the ten propositions.

For example, Proposition 9 ("Platform for Ideas") suggests enabling the creative process by providing a space and equipment for developing ideas and is, hence, considered a "process enabler". P1 ("Sources"), however, is placed at the intersection of three areas: they might act as a "process enabler" by providing research information (e.g., texts from magazines), they contain "knowledge" (e.g., books or technical drawings), and they become "stimulation" (e.g., pictures or color material swatches). In a similar vein, P8 ("Activator") can indicate the organization's "culture", instigate "social interaction", and provide "stimulation", and is, therefore, placed within these three qualities.

Certain propositions decrease the respective quality: P4 (Seclusion) reduces social interactions and P2 ("Void") reduces stimulation. This is indicated through a striped proposition symbol.

6.6.2. Propositions in Relation to the Creative Process

As discussed in Section 6.3 on page 155 and throughout the proposition descriptions, we identified several creativity concepts as relevant for explaining the developed theory. Figure 62 summarizes in a graphical diagram how we suggest the propositions are related to the creativity concepts.

Fixation effects have to be considered carefully, because they can become a hindrance to creativity by inducing people to repeat existing ideas. This is the reason why fixation has been marked in gray. The striped proposition (P2, Void) indicates an impact on decreasing the strength of fixation, which in turn might be beneficial for creativity.

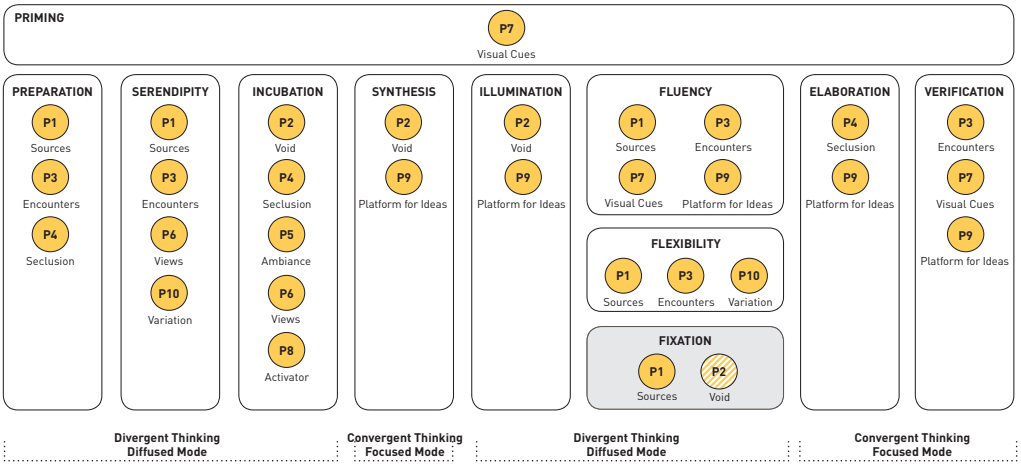


Figure 62. Propositions relevant to the creativity concepts.

Interested readers can refer to this overview to identify which proposition could influence the related creativity concept, which can help them to better understand the possible impact of spatial design decisions. The overview presented in Figure 62 also resembles the creative process, with roughly ordered steps proceeding from left to right. Although this is not supposed to be a rigid, linear process but instead, could be passed iteratively, it becomes evident that certain phases require different approaches. Psychological priming, which would put people in a mood receptive for creativity, is relevant throughout the entire process. Priming can mainly be addressed through visual cues (P7). In the preparation (or research) phase, sources (P1) are the most important aspect. Depending on the type of preparation, both encounters (P3) and seclusion (P4) can be beneficial—encounters during user research and seclusion during desk research.

Serendipity occurs when unexpected insights show up during the research process. Those unexpected insights can be found either through sources (P1), encounters with people (P3), surprising views (P6), or variation (P10). Incubation requires a diffused mode, which is facilitated by unrelated tasks, such as sports or walking (P8), a relaxing ambiance (P5), and views (P6). Reduced stimulation (P4) and lack of sources (void, P2) are also beneficial.

Synthesis requires a focused mode, which can be supported by a void (P2) to eliminate distractions and by providing a platform for ideas (P9) to structure thoughts and insights. The illumination and incubation phases require similar environments because the insight typically happens suddenly during incubation and, consequently, marks the end of this phase. We argue that illumination as such is difficult to trigger. Providing a void (P2) could be conducive to illumination because it might trigger people to project their ideas and to fill the void. Moreover, the environment can "prepare" for this moment of sudden insight, by providing an appropriate platform (P9) to capture this sudden idea, such as writable walls or whiteboards. During idea development, encounters (P3) are useful to develop a greater number of ideas that are also more flexible. Sources (P1) can have the same positive effect on idea development, but these can also lead to fixation. This fixation effect could be reduced by providing a void (P2), instead. Variation (P10) can facilitate the flexibility of ideas by providing varying input, whereas visual cues (P7), through deferring judgment and encouraging risk-taking, can increase the number of ideas. The elaboration phase needs an environment that allows focused work. Seclusion (P4) is important, as well as a platform for ideas (P9) to flesh out concepts and add detail to the solution. Finally, during the verification phase the platform for ideas (P9) is again important in order to build, present, and discuss the idea. Here, it is also beneficial to provide encounters with others (P3) in order to obtain feedback.

It can be concluded that phases of focused mode and convergent thinking, such as synthesis, elaboration, and verification, would require a work environment with reduced stimulation and fewer distractions, as well as appropriate infrastructure to capture and manifest ideas. In contrast, phases of diffused mode and divergent thinking, such as preparation and incubation, as well as the process of idea development, would require more stimulation (e.g., visible sources, variation, and activation), ambiance, and social interaction.

Csikszentmihalyi (1996) also expressed some thoughts about the appropriate environment for facilitating creativity in relation to the phase of the creative process. He suggested that familiar or even humdrum environments would

be better suited to the phase of preparation, while a different environment with novel stimuli and views might be more conducive to making new connections during incubation. Toward the end of the process, for elaboration and evaluation, one would need the familiar, ordered environment again to be able to finish the idea in a focused manner (Csikszentmihalyi, 1996, pp. 139, 145).

Csikszentmihalyi's position partly corroborates our suggested theory. We also acknowledge that focused and diffused modes of thinking alternate in the creative process and that both require different environments. We agree that elaboration and verification require a focused mode of thinking and, hence, an undisturbed environment. However, we consider the preparation phase as the process of collecting insights and information on a specific topic, where stimulating sources (and possibly encounters) are crucial. Although we agree that preparation is focused and should not be interrupted by distractions from real life, as suggested by Csikszentmihalyi (1996, p. 145), we advocate the presence of sources and social interaction during this stage of the creative process. One possible explanation for this apparent mismatch between Csikszentmihalyi's view and our own might be that he is mainly focusing on traditional artistic fields (such as music, poetry, or fine arts) that consider the creative person as a lone genius, whereas we focus more on contemporary design and innovation processes that usually involve user research and team collaboration. Moreover, we added more detail to our model, both in terms of the creative process and the suggested environments, which allows us to be more specific with our suggested propositions.

6.6.3. Identified Proposition Dependencies and Contradictions

The ten suggested propositions were developed based on the clustering of relevant interview quotes until theoretical saturation emerged. We tried to limit the propositions to a minimum and avoid redundancies, while at the same time providing enough detail to address all relevant phases of the creative process. Nevertheless, a few clarifications might be necessary.

(1) Some propositions appear to be contradictory. P1 (sources) and P2 (void) address opposite scenarios, i.e. the presence or absence of visual sources. We argue that both concepts are relevant for creativity in different situations. The stimulation and knowledge provided through visual and other sources (P1) can facilitate research, provide new connections, allow for recombinations, and lead to coincidence. These aspects might be conducive to creativity for preparation, increase flexibility and fluency of ideas, and may result in serendipity. The

opposite—reduced stimulation and a lack of sources (P2)—can also be conducive to creativity by setting the mind into a diffused mode. Moreover, the lack of references could lead to more original ideas. Hence, this proposition can facilitate incubation and illumination, and it reduces the risk of fixation. Consequently, both constructs can have a positive impact on creativity, but at different process steps and using different mechanisms. In a similar vein, P3 (encounters) describes spatially initiated social interactions, whereas P4 (seclusion) refers to the opposite notion of spatial separation from such interactions. For these two instances, we decided not to use one single construct with different poles, but rather to define two different propositions with unique names for each construct. In this way, it is possible to also distinguish among different working mechanisms, creativity concepts, and design suggestions for each construct.

(2) There are several interrelationships among the propositions. For example, a void (P2), such as a dead corner or an empty wall, can become a platform for ideas (P9) where people can install their own work. Furthermore, an activator (P8), such as an outdoor workspace or a sports facility, can lead to encounters (P3) and provide variation (P10).

We argue that these relations and interdependencies between propositions allow for a better understanding of creativity-supporting work environments and enable in-depths discussions of the possible spatial impact on creativity.

6.6.4. Mapping the Propositions to the Pattern Language of Creative Spaces

In the previous chapter, we presented a pattern language of creative spaces; a collection of 49 design patterns identified in 18 creative organizations. By mapping these 49 patterns of creative spaces to the ten developed theoretical propositions, we are able to provide more concrete examples on how to facilitate the theoretical propositions through spatial designs. Moreover, this mapping provides a comprehensive theoretical underpinning to the pattern language we previously developed. Table 20 outlines the conceptual mapping of patterns to propositions. Each pattern is reflected at least once by one or more of the theoretical propositions.

Table 20. Mapping of the pattern language to the ten theoretical propositions.

P#	Proposition	Patterns
P1	SOURCES	(1) Visible Tools, (4) Bulletin Board, (13) Showcase, (20) Collectibles. (22) Cabinet of Curiosities, (35) Informal Library, (48) The Supply Store
P2	VOID	(33) Leftover Space, (34) Empty Space
P3	ENCOUNTERS	(4) Bulletin Board, (7) Invitation Chair, (12) Communal Table, (18) The Confessional, (24) The Anchor, (26) The Lounge, (41) Nested Open Plan, (42) The Reception, (44) The Plaza, (49) Field Access
P4	SECLUSION	(19) The Capsule, (25) The Flexroom, (36) Semi-Privacy, (45) Outer Space
P5	AMBIANCE	(6) The Greenhouse, (29) Buzz, (38) Mixed Lights, (45) Outer Space
P6	VIEWS	(8) High Seat, (10) The Outlook, (36) Semi-Privacy, (37) View Variations, (39) Vertical Distance, (40) Asymmetric Floorplan, (41) Nested Open Plan
P7	VISUAL CUES	(1) Visible Tools, (2) The Label, (3) Visual Inventory, (7) Invitation Chair, (11) The Beanbag, (17) The Garage, (21) The Swap Station, (23) Playground, (43) Visible Structures, (47) Genius Loci
P8	ACTIVITATOR	(8) High Seat, (9) Seat Variations, (16) The Moveable, (23) Playground, (39) Vertical Distance, (45) Outer Space, (46) The Pavilion
P9	PLATFORM FOR IDEAS	(5) Writeable Surface, (33) Leftover Space, (34) Empty Space. (39) Vertical Distance
P10	VARIATION	(9) Seat Variations, (14) The Allrounder, (15) The Pop-Up, (21) The Swap Station, (27) Odd Shape, (28) The Mystery, (37) View Variations, (40) Asymmetric Floorplan, (46) The Pavilion

6.6.5. Implications

The ten propositions presented in this chapter constitute the nucleus of a theoretical investigation about the impact of physical workspace design on creativity. With this preliminary theory of creative space, we have provided a piece that might help to complete the bigger picture of a fundamental theory of design creativity. We provide propositions and evidence for possible direct or indirect causal relationships between space (such as furniture, interior design, and architecture) and creativity. The presented insights can be useful to designers, educators, architects, spatial planners, and managers who want to design their work environments to maximize creativity and innovation among co-workers.

The work presented in this chapter is considered a starting point for further research. The ten developed propositions are testable; however, an actual test was not part of this study. Researchers might find the propositions a valuable resource to investigate this field further.

6.7. CONCLUSIONS

In this chapter, we presented a collection of ten propositions that form a preliminary theory regarding the impact of spatial design on creativity. We have developed the propositions empirically through the clustering of relevant quotes from nine expert interviews. Relevant literature of related studies was added to provide theoretical underpinning.

The ten propositions are presented and discussed according to (a) their relation to five spatial qualities (stimulation, knowledge processing, culture, social dimension, and process enabling) and (b) their possible impact on relevant creativity concepts related to the creative process (priming, preparation, serendipity, incubation, synthesis, illumination, fluency, flexibility, fixation, convergent thinking, and verification).

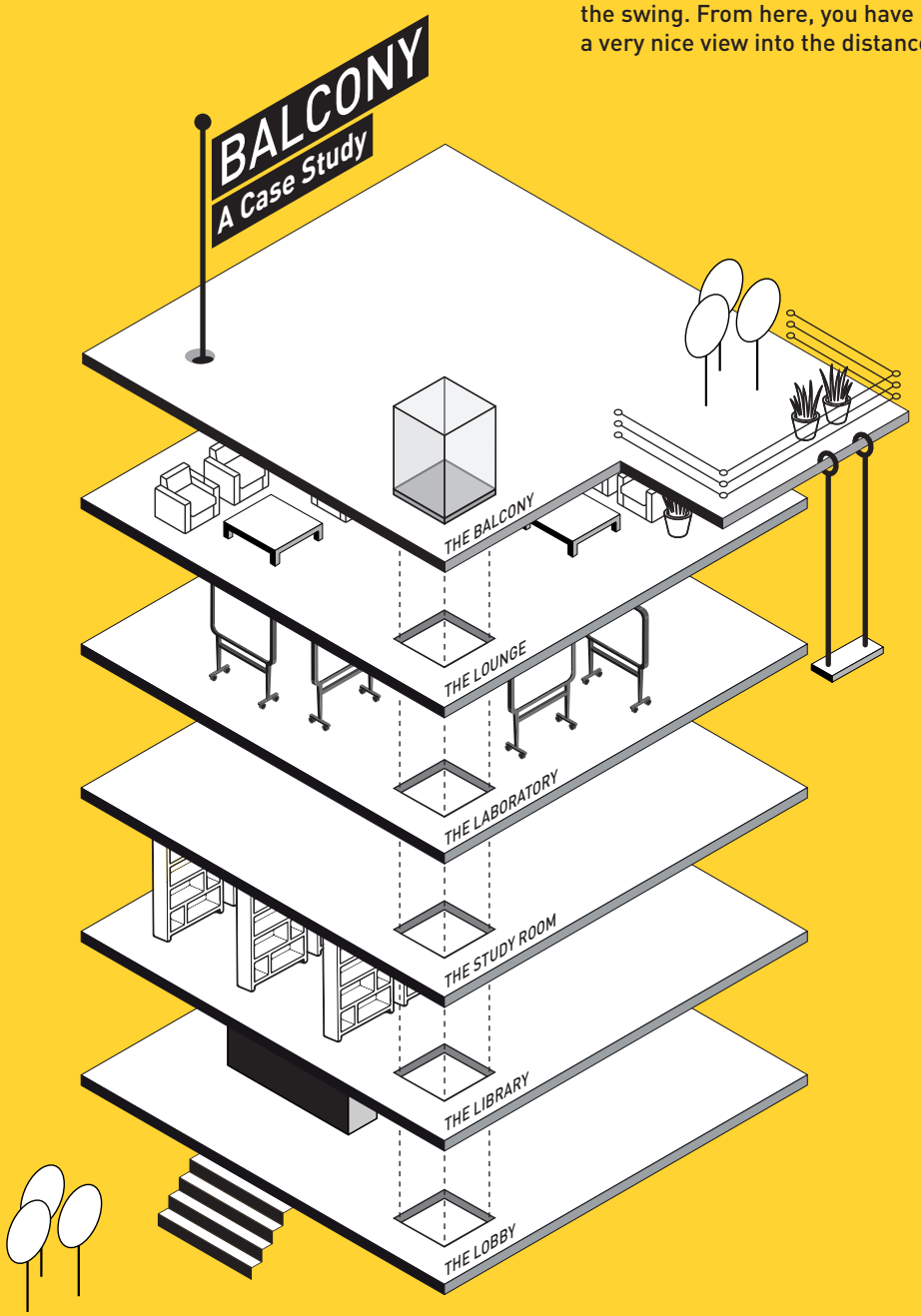
As the propositions were developed empirically through expert interviews and supported by theoretical evidence, further research will have to provide practical evidence for the applicability and actual impact of the propositions.

In conclusion, we argue that the preliminary causal theory of creative space presented in this chapter is of relevance to design education and practice because it will contribute to a better understanding of the influence of spatial design aspects on creativity. Furthermore, traditional assumptions (such as "chaos is creative") that are actually myths in the layperson's understanding of creativity and which have never been empirically tested can now be empirically investigated in a specific context, which is something that adds to a broader understanding of the impact of creative spaces on the creative process and on design output. Although this study's primary aim is to provide insights that can support improving the work environments in the creative industries and design education, the propositions we presented would also be useful for practitioners in any other area that deals with creativity and innovation as well as for educators from other disciplines who want to design creative environments.

In the next chapter, we will take a look at an organizational spatial planning project before we to continue to consolidate the findings from all of the previous studies into a creative space development toolkit in Chapter 8.

7TH FLOOR: THE BALCONY

Take a step outside. It is always a good idea to get some fresh air and new perspectives. Maybe you would also like to take a break and relax on the swing. From here, you have a very nice view into the distance.



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Thoring, K., Luippold, C., Mueller, R. M., & Badke-Schaub, P. (2015). 'Workspaces for Design Education and Practice'. In Proceedings of the 3rd International Conference for Design Education Researchers (pp. 330–346). Chicago, USA. https://doi.org/10.13140/RG.2.1.1200.7520

7. LONIGUTIDINAL CASE STUDY OF AN IDEA LAB

7.1. RATIONALE

Before we continue with our endeavor to develop tangible tools for people who want to design creative spaces (which will be presented in Chapter 8), we will first take an in-depth look at an exemplary case study. In this chapter we will present a longitudinal case study on the planning and realization process of a real-life creative space. Through this in-depth look at a realistic project we were able to gain insights into a spatial planning process and the spatial requirements of different stakeholders, and to identify any potential for improving the co-creation process.

> *RQ 7: What can we learn from an organizational creative space implementation project?*

The study presented in this chapter was actually conducted earlier in the PhD process, and was originally designed to validate the typology of creative spaces in a practitioner's context (see Section 4.6, page 99). However, as a by-product, the study yielded rich insights about the spatial requirements of different stakeholders and the spatial planning and implementation process of the organization that was studied. These insights partly informed the development of our toolkit for designing creative spaces, which will be presented in the subsequent Chapter 8. Therefore, we decided to present the study in more detail at this point in the thesis, in order to establish the foundation for the toolkit development. In the following sections, we focus on the requirements we identified and the problems revealed within the planning and implementation process. The typology validation has already been discussed in Section 4.6 and was, therefore, not included in this chapter.

7.2. RELATED WORK ABOUT IDEA AND INNOVATION LABS

The concept of "open innovation" (Chesbrough, 2003; Von Hippel, 2010) promotes the involvement of external actors and sources into the innovation process in order to benefit from new input. Lahr (2013) introduced the term "creative

lab" for a space that would provide a meeting environment for internal and external actors. According to his literature search, the term "idea lab" was used less often but described the same concept.

In contrast to incubators, creative labs are not permanently rented to start-ups, but rather used as encounter spaces to conduct workshops and idea generation sessions for a short period of time. Schmidt and Brinks (2017) discussed the emergence of new spatial settings for innovation that they summarized under the term "open creative labs". They distinguished among four lab types: (1) experimentation labs (grassroots initiatives run by interest groups or non-profit associations), (2) working labs (organized as private enterprises that primarily attract freelancers, micro-entrepreneurs, and start-ups), (3) open innovation labs (initiated by firms, academic institutions, or research and development organizations with the aim to enrich internal processes with external knowledge), and (4) investor-driven labs (e.g. incubators). According to Narayanan (2017, p. 27) "idea labs are deliberately established locations, where individuals and teams with new product ideas can work together for concentrated bursts of time, sharpening and focusing their product concept, embedding the voice of the customer in product design and charting alternative progression paths for their ideas to be developed into potentially profitable offerings by units of the business that will nurture them. […] In addition, they offer technology tools, bring together people with diverse perspectives and provide links to information networks that facilitate the migration of product ideas".

The idea lab, which is the subject of our study, is very suitable for these definitions given. It was initially meant as an encounter space for students, university's staff, and external companies to work together in workshop settings. Following the categorization suggested by Schmidt and Brinks (2017), it can be defined as an "open innovation lab".

In order to better understand the concept of idea labs, we refer to our systematic literature review presented in Chapter 3 on page 51, where we used both search terms "idea lab" and "innovation lab". The 13 sources identified as relevant for the topic are discussed in more detail in the next section.

Eight papers focused on different aspects of creative labs. Berger and Brem (2016) discussed "innovation hubs" in the Silicon Valley, such as Xerox PARC, and stressed the importance of installing such labs at a remote location, for instance, away from the headquarters and day-to-day work life, in order for the employees to freely develop their ideas without interference from the company's management.

Schmidt, Brinks and Brinkhoff (2015) studied innovation labs in Berlin, Germany. They determined that there are different objectives of a creative lab (purposes, target group, operators, and innovation practices), and identified location patterns (accessibility, industry focus). They identified 53 creative and innovation labs in Berlin and mapped their locations according to these criteria.

Schmidt and Brinks (2017) focused on the impact of "open creative labs" on the community and the respective organization. In a workshop study, they identified three main criteria for such labs: (1) openness (spaces that are open to a diverse user group), (2) flexibility (labs provide access for various temporalities and can be used for a short time), and (3) collaboration (labs offer instruments that foster serendipitous encounters, such as workshops or hackathons). However, they did not provide any insights on the spatial configurations of such labs.

Tõnurist, Kattel and Lember (2017) presented a study of 11 innovation labs ("i-labs") in the public sector. Based on their interviews within the selected institutions, they derived possible explanations for creating such new organizational structures and mapped these to existing theoretical concepts. One of their main findings suggested that those i-labs were created to enable cross-disciplinary and citizen-driven approaches. Similar to Berger and Brem (2016), they stressed the need for autonomy of the units in the sense that i-labs should allow the users to pursue their innovations without interference from traditional organizational structures.

McGann, Blomkamp and Lewis (2018) studied public-sector innovation labs and presented several classifications according to different criteria, such as the type of funding or the methods employed in the studied labs. Based on a literature review,

Timeus and Gascó (2018) suggested that public innovation labs would allow for overcoming traditional administration's bureaucracy, encourage experimentation, facilitate idea generation and knowledge exchange, introduce new technologies, and hence, increase an institution's innovation capacity.

Lewis and Moultrie (2005) conducted three case studies in innovation laboratories. They outlined possible benefits for an organization and discussed potential drawbacks. Among the benefits are the dislocation from day-to-day activities and the possible elimination of hierarchies. Furthermore, they identified innovation labs as a reinforcement factor for employees' commitment to innovation.

Narayanan (2017) discussed four characteristics of idea labs: (1) positioning in the firm's innovation value chain, (2) tasks (generate, develop, and migrate

product ideas), (3) processes (bonding, bridging, experimentation, protection, and learning), and (4) structure (system, facility, and technology enabler).

Three papers analyzed the role of the physical environment in general, but addressed creative labs only marginally. Dul, Ceylan, and Jaspers (2011) used questionnaires to examine the effect of the physical work environment on the creativity of knowledge workers in Dutch small and medium-sized enterprises (SMEs). They developed a theory about the possible influences of the work environment on creativity. They distinguished between the social-organizational work environment and the physical work environment and presented a list of 12 spatial aspects (furniture, plants, calming colors, inspiring colors, privacy, window view to nature, any window view, quantity of light, natural light, indoor climate, sound, and smell) that would influence creativity positively. Waber, Magnolfi, and Lindsay (2014) presented examples of new spatial approaches used by companies like Facebook, Yahoo, and Samsung and their focus to enhance social interaction. They suggested that particular changes in the work environment, such as reducing the number of coffee stations, would force more people from different departments into casual meetings. This spatial change correlated with an increase in the company's sales by 20%. Kristensen (2004) analyzed a space's impact on organizations across different phases in the creative process. He suggested that the preparation and elaboration stages require a combination of communal and private space, while the incubation and insights stages require more private space.

Only two papers addressed the intersections of both aspects, namely, the possible creative impact of the physical space in the context of creative labs. Moultrie et al. (2007) proposed a framework to better understand the design, role, and goals of innovation labs in a practitioner's context. They distinguished between strategic intent, process of creation, process of use, and physical embodiment of intent. The authors presented 10 categories within the physical embodiment category: geographic location, scale, real/virtual, flexibility, design values and imagery, IT resources, data and information, modelling and visualization resources, constraints, and evolution. However, these categories were not detailed further or illustrated with examples. Haner (2005) looked at two cases of innovation laboratories and analyzed how both cases supported the divergent and convergent thinking of teams and individuals. He suggested three categories of spatial characteristics: location (which also includes virtuality), style (which includes soft factors such as color and materials), and building and layout (which includes, e.g. visibility, proximity, and privacy).

None of the discussed sources presented an in-depth, longitudinal case study of an idea lab from the first planning phase to the evaluation of the implemented space and its use. Also, most of the sources did not analyze the design requirements of a creative lab's physical environment, both of which are presented in our study. Understanding such aspects is important because an analysis of the complete use cycle of creative spaces in general, and idea labs in particular, provides insights on the impact and limits of co-creation processes and about actual user needs in this emerging field.

7.3. APPROACH AND METHOD FOR THE LONGITUDINAL CASE STUDY

7.3.1. Background

When the German city of Kassel and the local university were planning a complex of innovation spaces, we were involved in the design process as external consultants, assessing the requirements for particular sections. The building complex, which comprises over 6,000 square meters of creative space, was devised as a meeting place and innovation center for students, start-ups, regional companies, and university spin-offs. It includes several co-working spaces, ateliers and laboratories, traditional offices, meeting rooms, incubators, a canteen, and an idea lab. The idea lab is the focus of this study. Its aim was to provide a large flexible space for up to 50 people to be used as an ideation or co-creation lab or to house special events such as talks or meet-ups. Figure 63 shows a floor plan of the entire building and the location of the idea lab within this complex.

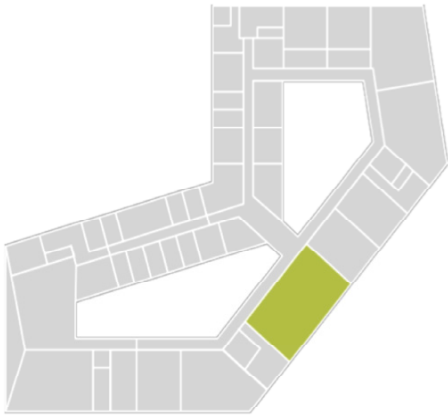


Figure 63. Floor plan of the building, indicating the location of the idea lab within the innovation center (image: Science Park Kassel, with permission).

Consistently with the concept of open innovation (Chesbrough, 2003; Von Hippel, 2010) idea labs are being established in many institutions, either affiliated with universities or as private enterprises, to promote the involvement of external actors and sources into the innovation process and, thus, benefit from diversified inputs. However, the research about the actual spatial requirements of such spaces is still in its beginnings. Moreover, there is limited research on the spatial planning processes of such creative spaces. With this study we want to fill this gap in order to gain insights on the requirements of different stakeholders, as well as on the exemplary design and development process of a creative space.

Our research approach can be differentiated in two phases. Phase 1: the co-creation process for defining the spatial criteria includes a pre-study using a combination of cultural probes, a visual canvas, and a focus group workshop. Phase 2: the evaluation of the finished space after it has been in use for two years, includes a follow-up interview with the idea lab manager, a questionnaire with a regular user, and on-site observations to evaluate the implementation of the space.

7.3.2. Phase 1: Co-creation and development process

As already outlined in Section 4.4 on page 76, cultural probes are a self-documentation method in which selected participants are equipped with a pre-designed set of questions and tasks meant to be independently completed (Gaver et al., 1999; Mattelmäki, 2006; Thoring, Luippold, & Mueller, 2013). We chose this particular approach, because it allowed us to collect qualitative, rich data from the target users, without having to visit them in person. This reduced the time and effort for the researchers and also allowed the participants to reveal private and possibly sensitive information.

We provided nine selected participants with a canvas-based cultural probes set (see Figure 64 and Figure 65). We chose the participants to address a wide range of backgrounds and employment positions. We invited four practitioners (one start-up founder, one self-employed designer, and two employees of global companies), one student, and four research associates from different departments. Unfortunately, the future architects of the space were not able to participate in the study. Two of the nine participants had prior experience with working in idea labs but had not been previously involved in any deliberate spatial planning processes.

Figure 64. Overview of cultural probes set. Contents: canvas poster, pictures of exemplary creative spaces, colored pens, snack with questionnaire inside, USB stick for digital files, and return envelope.

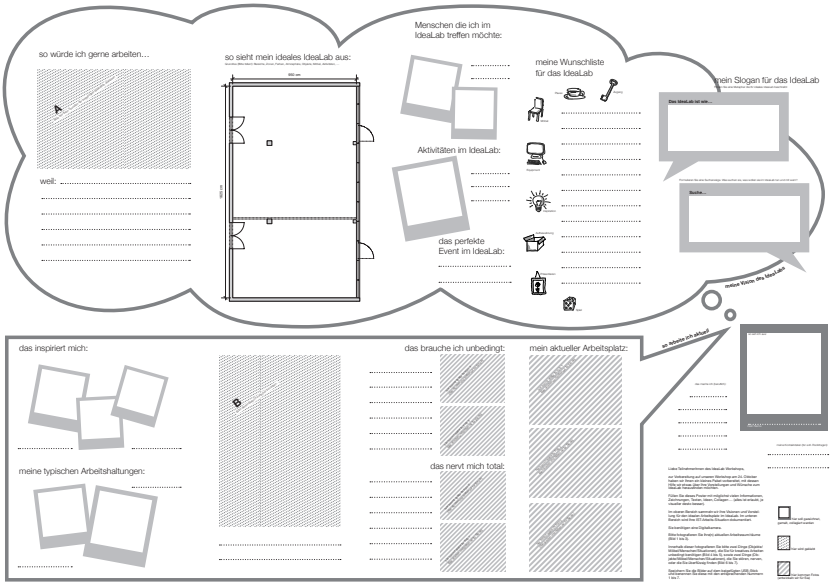


Figure 65. Visual canvas used for individual self-documentation and reflection prior to the workshop.

The canvas and the resulting data were structured as follows: The lower part of the canvas (placed inside an abstracted speech bubble) was dedicated to the documentation of the *status quo*, i.e. the existing workspaces the participants were working in. The upper part of the poster (placed into an abstracted thought

bubble) was dedicated to the participants' *vision*. Here they provided ideas and thoughts about their desired idea lab with a sketch of a floor plan of the envisioned space (Figure 65). The participants had three weeks to complete and return the cultural probes set. Figure 66 shows an exemplary poster created by one participant.

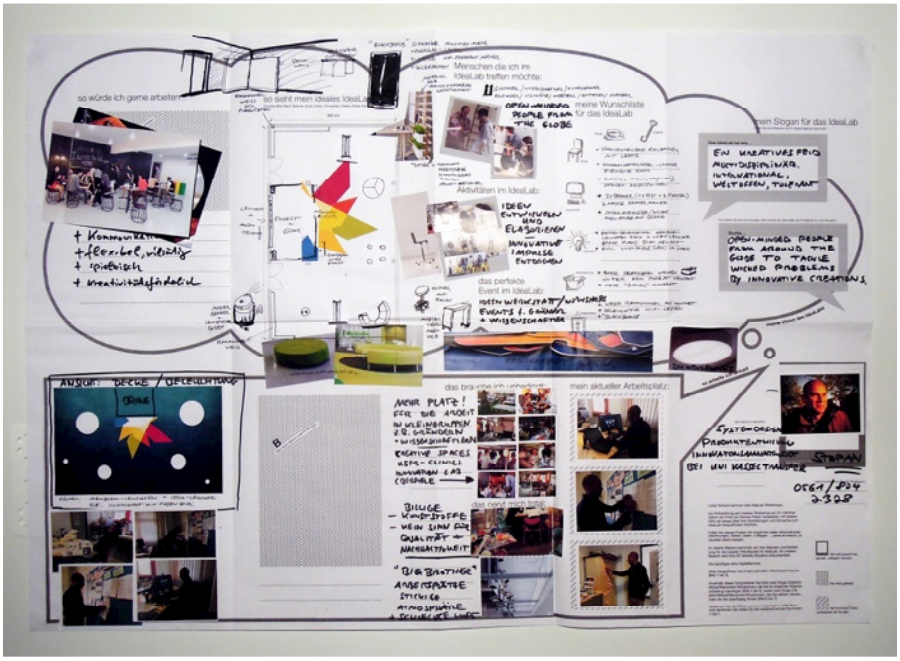


Figure 66. Exemplary canvas of one participant.

In preparation for the workshop, two researchers (one is the author of this thesis) evaluated the returned data from each poster by extracting and writing down the main insights. The notes were clustered to the point of theoretical saturation (Corbin & Strauss, 2014) until 15 themes emerged.

After completing the cultural probes tasks, all nine participants were invited to a focus group workshop to discuss their insights and to co-create ideas for the future idea lab. During the one-day workshop, the participants jointly analyzed and discussed their posters, clustered the notes and ideas, and then prioritized the most relevant aspects. In summary, the individually prepared posters yielded 15 themes of relevance, which were then detailed into 39 spatial characteristics during the workshop. The resulting 15 themes and 39 spatial requirements are described in detail in Section 7.4.

7.3.3. Phase 2: Follow-up Evaluation

After the idea lab had been created and in use for two years, we conducted a follow-up evaluation study. On-site observers checked the actual implementation of the suggested designs, by using a checklist containing the 39 spatial recommendations. The idea lab's secretary was asked to inform us about any non-visible aspects (e.g. offered events, booking processes) by using the same checklist. A follow-up interview with the idea lab manager and a questionnaire with a current idea lab user (who had also participated in the phase 1-study) were conducted to gain insights on the success of the initial concept.

The interview with the idea lab manager was conducted via telephone. It lasted 45 minutes and was audio-recorded and transcribed. We consulted the user via email with a set of ten open-ended questions, which were grouped under three categories: (1) usage of the idea lab, (2) satisfaction with the idea lab, and (3) comparison with the initial workshop requirements. We coded the interview and the questionnaire answers to extract relevant quotes related to positive and negative aspects of the space and to detect coherences and inconsistencies. Although the limited number of data sources from the phase 2-study (one interview, one questionnaire, and on-site observations) does not allow for generalistic inferences, the triangulation of the three perspectives (manager, user, and researcher) yielded several rich insights that are summarized in the next section.

7.4. RECOMMENDATIONS FOR THE IDEA LAB DEVELOPMENT

Based on the evaluation of the cultural probes canvases we identified 15 themes of importance for most of the participants. These identified themes (ordered according to the number of mentions) include: (1) working zones, (2) physical activities, (3) lighting, (4) style and atmosphere, (5) flexibility, (6) open space, (7) break areas, (8) electronic infrastructure, (9) knowledge storage, (10) access to materials, (11) outdoor access, (12) storage, (13) privacy, (14) layers and platforms, and (15) serviced facilitation. In the focus group workshop, the 15 themes were discussed with the participants and detailed with concrete spatial characteristics and additional services. After the voting and selection process, a list of 39 recommendations for the future idea lab was defined. We kept these recommendations abstract and conceptual for a later adjustment by the external architects. We consolidated the findings in a document that was handed to the organization's management. Table 21 outlines the 39 recommendations, along with an

indication of whether or not they were implemented in the final idea lab. We will elaborate on the degree of implementation in the subsequent section.

Table 21. Overview of recommendations and resulting implementations.

	Initial Recommendations	**Implemented**
1	Individual, mass-tailored furniture line	Yes
2	Movable, flexible furniture on wheels	Yes
3	Room layout without a designated front or direction	No
4	Flexible configuration of the space, (e.g., through mobile workstations)	Yes
5	Room-in-a-room concepts or zoning through mobile dividers	Partly (only dividers)
6	Writeable surfaces or pinboards	Yes
7	Storage facilities	No
8	Lockers and cabinets for materials and personal stuff	No
9	Various seating options (chairs, stools, stand-up furniture, comfortable seats, and sofas)	Partly (no sofas)
10	Mobile writeable walls and dividers	Yes
11	Tables with various sizes (optional: adjustable height)	Partly (not adjustable)
12	Lounge area (also outside the idea lab possible)	Canteen outside
13	Flexible, adjustable furniture that does not require lots of assembly	No
14	Optional: flexible stage or platforms with additional storage	No (fixed stage)
15	Outdoor areas for recreation and outdoor work	No (access to parking lot)
16	Meeting points or withdrawal areas in hallways and outdoor areas	Yes
17	Events, specific content-based services, and thematic activities, such as networking events	Yes
18	A regular newsletter for interested parties and tenants	Yes
19	Rules for using the space without over-regulation	No (only formal contract)
20	Designation of a responsible contact person and a facilitator for maintaining the idea lab	Yes (secretary)
21	24/7 access to the space	No
22	Booking facilities (e.g., through web portal)	No (only by phone)
23	Different pricing models and discounts for long-term tenants	Yes
24	Furniture configurations for different usage scenarios (e.g., small groups, large groups, lectures)	Upon request

	Initial Recommendations	Implemented
25	Use of natural, sustainable, and local materials	Partly
26	A timeless, clean, and modest design	Yes
27	Robust and sturdy materials that do not wear off quickly	Yes
28	Blinds on windows	Yes
29	Audio, video conferencing, projection facilities, and good Internet connection	Partly
30	1 or 2 mobile presentation units	No
31	1 to 3 computer-based workstations with printer and scanner	No
32	Optional: Smartboard	No
33	Adjustable light system that allows different temperatures and styles of lighting	No
34	Basic work materials (e.g., paper, Post-It notes, pins, timer)	Partly
35	Flat screen display or iPad in each unit to share data	No
36	Installation of a small on-site library	No
37	Material supply for prototyping	No
38	Selection of sports and games facilities (e.g. table soccer and table tennis)	Partly (outside)
39	Plants and flowers (if care is assured)	No

7.5. FOLLOW-UP EVALUATION OF THE IMPLEMENTED IDEA LAB

After the first two years of implementation, the space is well-received and regularly rented. In the following section, we will present our concluding evaluation.

7.5.1. On-Site Observations

Table 21 outlines our 39 recommendations and indicates which of them have been implemented. Our on-site evaluation revealed that more than half of the recommended specifications had been implemented fully or partially (21 out of 39). Additionally, several measures that have not been implemented directly in the lab are now available in other areas of the complex; for example, video conferencing systems are located in co-working spaces next door. Similarly, lounge areas and games can be found on each floor. Nevertheless, some requirements that the workshop participants emphasized in the planning phase have not been implemented at all. Examples include adjustable light systems, outdoor access (which is possible but leads to a parking lot), and specific equipment (e.g., desktop computers, printers, and prototyping material). Other requirements were

implemented as recommended; for example, an individual furniture line was designed through a design contest. Figure 67, Figure 68, and Figure 69 show impressions of the final idea lab space and the customized furniture concept.

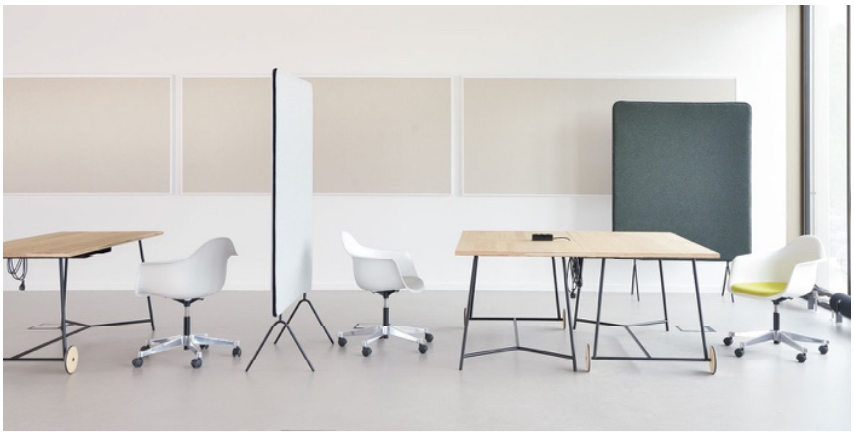


Figure 67. Final furniture concept: tables and pin boards (photo ©Minu Lee, used with permission from design studio Aust Amelung).

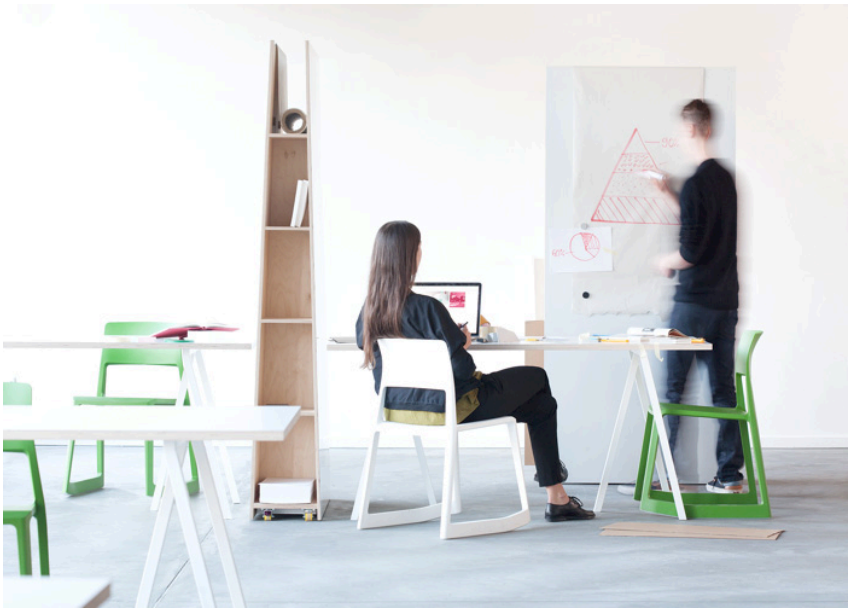


Figure 68. Final furniture concept: storage-whiteboards (photo ©Robin Stummvoll, used with permission from Tim Mackerodt Studio).

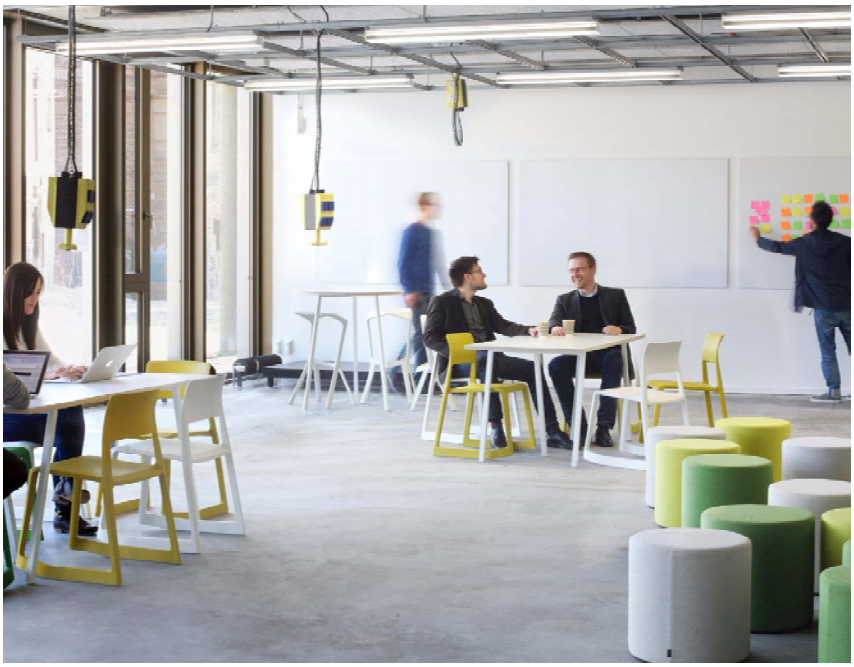


Figure 69. Final idea lab in use (photo ©Eibe Sönnecken, used with permission from Birk Heilmeyer und Frenzel Architects).

7.5.2. Interview and Questionnaire

The interview with the idea lab manager and the questionnaire with a frequent user of the idea lab resulted in the following insights.

The idea lab was originally planned as a meeting and co-creation space mainly for educational purposes. However, it has transformed into a space mostly used by local SMEs, who seem to have a higher demand for "unusual" spaces to get away from their normal day-to-day routines. The additionally planned permanent co-working spaces have not proven to be as successful as the idea lab because the need for these kinds of spaces was not as great as expected. By contrast, the manager indicated that the idea lab, devised as a temporary workshop space, is regularly rented. Although this success can certainly not be reduced to the spatial design alone, the manager regarded the space to facilitate experimentation and creative work processes as some sort of "third teacher" (Cannon Design, VS Furniture, & Bruce Mau Design, 2010). He speculated that this might be due to the relatively scarce and reduced, yet flexible interior, which invites people to adjust and transform it to create new situations. This is what makes it what he called a "pedagogical space". The only problem with the space

was its size, in the sense that it could be made larger and be given its own building.

The questionnaire, however, also revealed some negative feedback concerning the light system that would not allow adjustable work modes, and the rather low quality of the idea lab's interior, specifically the standard plastic chairs, the ceiling-mounted electrical connection hubs, and the relatively scarce and lifeless design. Moreover, the limited access to external recreation facilities (especially outdoor access) was mentioned as unsatisfactory. According to the consulted user, some of these issues could be attributed to the different ideas between the workshop participants and the architects concerning the concept of the idea lab. However, both the manager and the user had positive evaluations regarding the customized furniture concept, consisting of work tables on wheels and moveable whiteboard-storage boards (Figure 67 and Figure 68). Furthermore, the adaptable layout and the flexibility of the space due to the different working zones with moveable dividers were perceived positively. According to both informants, the playful design and flexible configurations allowed for any activity or event, ranging from only 12 to almost 300 participants.

7.6. DISCUSSION

The contribution of this study is twofold. First, we identified spatial requirements for an idea lab. The 15 themes and 39 spatial recommendations presented in this chapter can act as a guideline for others who want to implement an idea lab. The evaluation of the final space revealed several positive insights that can act as best practice examples, as well as negative issues that should be considered when designing similar creative spaces. In order to provide further insights on these aspects, future research directions should include experimental studies within engineering and user-driven environments. Of particular interest is the fact that in the end the idea lab was mainly used by external SMEs, and rarely as the envisioned encounter space for students, staff, and external practitioners. The apparent need for SMEs to occasionally move away from their daily routines would support the hypothesis raised by several authors that innovation would flourish when creatives performed away from their headquarters and without interference from superiors (Berger & Brem, 2016; Timeus & Gascó, 2018; Tõnurist et al., 2017).

Besides these findings about the creative space itself, we gained several insights regarding the spatial planning process. The multi-methods approach we used in this study had several advantages. The cultural probes task allowed the

participants to prepare for the workshop in due time and to freely express their own experiences and wants regarding a creative workspace without being influenced by the other participants. The same visual canvas could then be used for the co-creation workshop to discuss each other's insights. It served as a shared mental model (Bierhals, Schuster, Kohler, & Badke-Schaub, 2007), as well as an extended knowledge repository and a platform to develop ideas. Hence, the workshop did prove to be effective in terms of the requirement assessment for the spatial planning process. One problem we identified was a discrepancy of expectations between the workshop participants and the architects who implemented the space. This reinforces our suggestion that all stakeholders should be involved in such a co-creation approach to ensure that all requirements are met.

The presented study relies on insights from only one single case. Hence, it remains unclear whether the results can be transferred to other contexts and institutions. However, the triangulation of different data sources and perspectives, as well as the longitudinal study over several years generated qualitatively rich insights and provided a deep understanding of the spatial requirements of idea labs and the related planning process.

Given that new spatial concepts (such as idea labs, incubators, co-creation spaces, or makerspaces) are established in many organizations to facilitate their innovation capabilities, future research will have to continue to explore this emerging field.

7.7. CONCLUSIONS

This chapter has presented a longitudinal case study of an idea lab, from the initial planning phase to the evaluation of the implemented space after two years. The gained insights provided us with knowledge that is necessary to understand users' possible motivations for working in a creative space, as well as their spatial requirements. The following insights could be derived from this study:

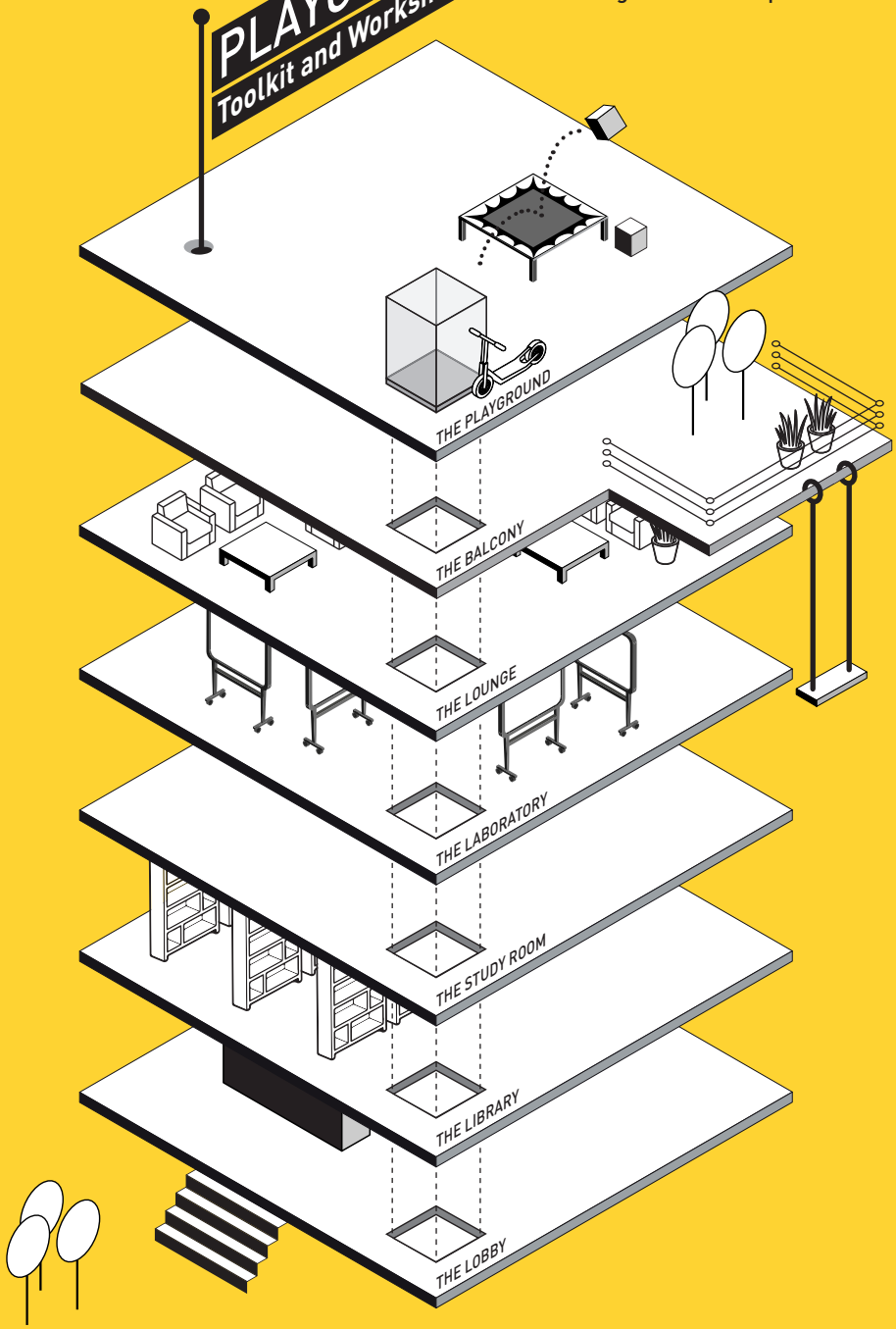
(1) Developing creative spaces requires a co-creation approach that involves all stakeholders; including users, decision makers, architects, and spatial planners.
(2) Stakeholders need to be equipped with the required theoretical knowledge about the possible impacts of spatial design decisions, in a tangible and accessible way.
(3) Stakeholders are inspired by real-life examples.

These insights will inform our next process step, which includes the development and evaluation of a toolkit for designing creative spaces.

PLAYGROUND
Toolkit and Workshop

8TH FLOOR: THE PLAYGROUND

Here you can try out some tools or participate in a workshop on how to design a creative space. Have fun.



Parts of this chapter have been published in:

Thoring, K., Mueller, R. M., Badke-Schaub, P., & Desmet, P. (2016). 'Design the Campus: Introducing a Toolkit for Developing Creative Learning Spaces'. *Proceeding of the International Cumulus Association Conference*, 358 – 368. Nottingham, UK.

Thoring, K., Mueller, R. M., Badke-Schaub, P., & Desmet, P. (2017). 'A creative learning space development toolkit: empirical evaluation of a novel design method'. *Proceedings of the 21st International Conference on Engineering Design (ICED17)*, 245–254. Vancouver, Canada.

8. A CREATIVE SPACE DEVELOPMENT TOOLKIT

8.1. RATIONALE

In the previous chapter, we conducted a longitudinal case-study of a real-life creative space development project. Based on the insights drawn from this study, we now seek to explore how such a design process could be facilitated and improved. Our approach includes not only the design of various facilitation tools, but also their subsequent evaluation. Hence, the following research questions guided our next steps:

> *RQ 8: How can we support the process of designing creative spaces by providing appropriate tools?*
>
> *RQ 9: Are the developed tools applicable to a real project?*

Our goal is to develop a workshop concept and a set of tools that consolidate all the knowledge that we acquired throughout this PhD project (as presented in the previous chapters), and to make this knowledge available to practitioners in a tangible and accessible way.

8.2. RELATED WORK ABOUT CREATIVE SPACE DEVELOPMENT TOOLS

As shown in our systematic literature review (Chapter 3, page 51), we did not find any academic sources that presented tangible artifacts or other tools for designing creative spaces. Therefore, we expanded our search further toward non-scientific databases. Through a snowball search within the Google search engine, we identified two more sources of relevance.

The "New Workspace Playbook" (Dark Horse Innovation, 2018, German only) presented a comprehensive set of frameworks for designing a creative workspace by following six steps: (1) "setup" (preparation and distribution of roles), (2) "understand" (definition of requirements), (3) "inspire" (developing ideas), (4) "concept" (developing a floor plan and concepts, (5) "communicate" (feedback, iteration, and presentation for decision makers), and (6) "work" (adapt to the new workspace after implementation). For steps 2 to 4, canvases (called "boards") are provided for download. Additionally, the book provides several templates and a diary, where participants can individually document

their own ideas and requirements, as well as identified problem areas in the existing space. A printable floor plan can be adjusted to the available space and filled with provided standardized seating configurations. All of the provided tools are available for self-printout. Additional workshops are offered to facilitate the design process further. More information can be found at new-workspace-playbook.de.

The tools provided appear to be very elaborate, but are also rather complex. Their main purpose is to guide the spatial design process by asking questions and providing templates for people to fill in their ideas. There are no spatial recommendations and theoretical underpinning is lacking. The inspirational examples (only provided in the book) are not linked to any theory nor do they explain the possible impact on creativity or productivity. Nevertheless, the book with the print-out templates, is the most comprehensive tool for developing creative workspaces, that we have found.

Mosaic (SAP AppHaus, n.d.) is an innovation tool for co-creating a creative work environment. It mainly consists of a set of hexagonal cards that address different categories of a creative space, which are indicated by a color-code and specific icons. The cards are two-sided and the reverse side provides additional information orthogonal to the (color-coded) category. Some pieces include an additional layer that can be rotated in order to specify a particular emphasis. The cards are used to identify and discuss the team members' requirements for the future work environment. A canvas is not provided as such, but has to be drawn on brown paper by all team members together, which will then form the floorplan of the envisioned workspace. The cards can be purchased as a kit, or self-printed from the do-it-yourself-version, which is also provided for download. The downloadable version is accompanied by a brief pdf with instructions and additional workshops are offered to guide the spatial design process. More information is available at experience.sap.com/designservices/approach/mosaic.

The discussed examples demonstrate that there seems to be a need among practitioners for creative space facilitation tools. It appears striking that a global software company like SAP has created their own tools for this purpose, which warrants the assumption that there is a need for such tools that is currently not being satisfied.

Both sources did not provide any theoretical underpinning, and we could not find any evidence of a rigorous development nor of an evaluation process (we acknowledge, however, that the lack of a proper publication does not necessarily mean that this step did not happen).

We argue that the findings from our literature search justified our own endeavor to create a toolkit for designing creative spaces that is scientifically developed and evaluated, yet tangible and accessible for practitioners. In order to develop such a toolkit, we will take a detailed look at the literature on co-creation tools in general.

8.3. THEORETICAL FOUNDATIONS OF CO-CREATION TOOLS

There is a large body of literature about co-creation approaches with end-users in different contexts that we adapted for the context of creative spaces. For example, Sanders (2005) has outlined the development of co-creation over the past thirty years. Among other aspects, she suggested to provide generative tools for co-designing that enable and facilitate collaborative thinking, mapping, dreaming and storytelling (Sanders, 2000). According to her, a toolkit usually contains a background on which to work, together with a large number of simple and ambiguous components that can be arranged and juxtaposed in a variety of ways.

Ali and Liem (2015) provided a classification of different types of co-creation toolkits, consisting of probes, generative toolkits, or prototyping toolkits that they put in alignment to the different phases of the design process (pre-design, design research and discovery, design, marketing and sales, and after sales).

We refer to the approach suggested by Sanders (2000) and hence, created a toolkit that incorporates the findings from our previous research and consolidates them into a tangible, accessible, and manageable form. Our toolkit is devised as a combination of (1) a card set containing relevant knowledge and inspiration, (2) a set of visual canvases to facilitate group work, and (3) a co-creation workshop concept.

To learn more about these three components, we will look into the related literature and discuss possible choices in the following sections.

8.3.1. Card-Based Tools

In the design field there are several card sets available for different purposes (see e.g. Wölfel & Merritt, 2013, for an overview). These card sets span a wide range of topics from design method cards (IDEO, 2003), ideation cards (Golembewski & Selby, 2010; Lucero & Arrasvuori, 2012), elicitation of human values in the design process (B. Friedman & Hendry, 2012), design heuristics (Daly, Christian, Yilmaz, Seifert, & Gonzalez, 2012), task analysis (Tschudy, Dykstra-Erickson, & Holloway, 1996), Biomimicry (Lynch-Caris, Weaver, & Kleinke, 2012), and data

privacy (Luger, Urquhart, Rodden, & Golembewski, 2015). As a design tool, cards have the advantage of making a problem or design process tangible (Lafrenière, Dayton, & Muller, 1999; Lucero & Arrasvuori, 2012) and of enabling better communication between designers and users (E. Beck, Obrist, Bernhaupt, & Tscheligi, 2008; Wölfel & Merritt, 2013). Yoon, Desmet, and Pohlmeyer (2016) developed suggestions regarding how to integrate instructions into card sets. Wölfel and Merritt (2013) identified three main card categories: general purpose/repository cards, customizable cards, and context specific cards. The card set we want to develop can be classified as context specific cards because it focuses on the topic of creative space.

The decision to develop a card set as the main component of the toolkit was based on several considerations: (1) Analogue cards are not dependent on a specific (technical) infrastructure, as it is the case, for example, with digital tools. (2) Cards are mobile and can be used anywhere at any time, and can also be used by a larger group of people. (3) Cards allow for flexible usage. Different aspects can be aligned or clustered in order to define hierarchies, priorities, or thematic groups. Finally, (4) a card set is a tool that is familiar within the creative sector, which can be inferred from the popularity of card sets, such as the IDEO Method Cards (IDEO, 2003), for example.

8.3.2. Canvas-Based Tools

In addition to a card set, our toolkit will also include poster-based canvases to facilitate groupwork and co-creation.

A canvas has become a popular innovation tool since the introduction of the Business Model Canvas (Osterwalder & Pigneur, 2010). Typically, a canvas is a large, two-dimensional poster with a graphical framework that deconstructs a complex topic into smaller components in order to simplify it (Thoring, Mueller, & Badke-Schaub, 2019). Avdiji, Elikan, Missonier and Pigneur (2018) suggested three design principles for developing a canvas: (1) ontology-creation, (2) a shared visualization, and (3) collaboration possibilities. Thoring et al. (2019) presented a theoretical framework of the expected working mechanisms of a canvas. Among the suggested working mechanisms there are five that we consider particularly relevant and conducive for facilitating teamwork and co-creation workshops: (1) A canvas can motivate and encourage group participation. (2) A canvas can function as a boundary object (Star & Griesemer, 1989) that would establish a common language of understanding (Fischer et al., 2005). (3) A canvas can serve as a communication and presentation tool. (4) A canvas

can help to create a shared mental model (Badke-Schaub, Neumann, Lauche, & Mohammed, 2007), and (5) the canvas can become a platform for ideas, where people could fill in their thoughts. Moreover, the structure of the canvas might be able to guide the participants, as, for example, suggested by Liedtka (2018) who pointed out that structure and linearity might help people to try and adjust to new behaviors.

8.3.3. Co-Creation Workshops

The awareness that it is important to involve the end users of a project into the design process has already reached most design disciplines. Sanders and Stappers (2014, p. 7) state that "there is growing interest in and support for this mind-set that the end-users are the experts of their future lives and that designers/design teams can design with the people. It is a growing recognition of and skill at involving end-users in design processes as 'experts of their experience'." However, according to Outram (2013), many architects do not talk to the future users of the spaces they are going to build. Many architectural buildings are planned and built by architects that do not involve the users of the space: in this case, the employees, staff, students, and teachers.

Rochelle and Penuel (2006) presented a 7-step process for co-design projects in classroom contexts. Among these steps they emphasize the need for a flexible tool, as well as the importance of conducting a bootstrapping event to catalyze the team's work, for example, in a workshop. Also Sanders (2000, p. 9) stretched the idea of so-called "strategic visioning workshops" as the next step of co-creation approaches: "in these workshops we use an assortment of large toolkits to enable a group of people to work together to express their ideas and dreams."

A workshop setting that would bring all stakeholders of a creative space together at one table, as well as to systematically define requirements, wants, and needs for the space to-be-build, appears to be of high relevance and was also one of the main insights gained from our previous case study (Chapter 7).

8.4. TOOLKIT REQUIREMENTS

The design of the toolkit is based on the agglomeration of the research from the four studies that have been presented in the previous Chapters 4, 5, 6, and 7.

While the results from Chapters 4, 5, and 6 mainly guided the development of the tools (canvases and card set), the insights from Chapter 7 have informed the development of the workshop concept. Accordingly, our toolkit and workshop concept should (1) involve all stakeholders, (2) provide theoretical knowledge in a tangible and accessible way, and (3) present inspiring real-life examples. More specifically, the goal of the toolkit is to engage current and future users, spatial planners, architects, and management. Moreover, it should provide these stakeholders with the necessary information to come up with appropriate design decisions for their creative workspaces. Finally, it should allow them to collectively develop ideas, define and phrase requirements, discuss possible problems and solutions, and decide on certain strategies for their spatial concept. Hence, it should allow group work. Table 22 summarizes how the insights from the previous chapters informed our toolkit design process. Additionally, Figure 5 on page 33 can be consulted for a graphical overview of how the different studies relate to the toolkit development.

Table 22. Overview of previous chapters and how they informed the toolkit development.

Study	Chapter	Results/Insights	Applied to
3	Chapter 4: Typology	5 space types 5 spatial qualities	Canvases
5	Chapter 5: Pattern language	49 Patterns for creative spaces	Card Set
5	Chapter 5: Pattern language	Examples from 18 creative organizations	Card Set
6	Chapter 6: Theory of creative space	10 propositions about spatial impact on creativity	Card Set
7	Chapter 7: Longitudinal case study of an idea lab	(1) Involve all stakeholders (2) provide theoretical knowledge (3) inspire through real examples	Workshop Concept

We define eleven requirements to be fulfilled with our toolkit:

(1) It is tangible and easy to use (beyond just a textbook) and tailored to practitioners.

(2) It can be used individually without facilitation.

(3) At the same time, it facilitates groupwork.
(4) It involves a (properly guided) co-creation workshop that involves all of the stakeholders.
(5) It includes analysis and evaluation features for existing spaces.
(6) It provides dedicated areas for designing ideas.
(7) It includes concrete design recommendations (yet, flexible enough to be adapted to individual contexts).
(8) It provides inspiration from best-practice examples.
(9) It provides knowledge and theory about the possible impact of design decisions.
(10) It is scientifically developed, e.g. based on empirical data or a design science approach.
(11) It is scientifically evaluated, e.g. through an action research workshop.

The development, testing, and iteration of this toolkit is described in the subsequent sections. Beforehand, we will present details about our methodological approach.

8.5. APPROACH AND METHOD FOR TOOLKIT DEVELOPMENT

The developed toolkit is considered a design artifact, because it constitutes a system of designed elements: a card set, several canvases, a workshop concept, and additional supporting materials, such as stickers. The design field suggests several approaches for a scientifically sound development of such a design artifact. However, there seems to be no such thing as a consistent and established standard. Several concepts do exist, but they use various names and do not provide any formalized procedures and requirements. For example, Christopher Frayling (1993) introduced the concept of "research-through-design" (sometimes also called "research-by-design"), but without providing sufficient explanations as to how to achieve this goal. Among a few examples of what research-through-design might be, he mentioned action research. Later, Ken Friedman argued that "the phrase 'research-by-design' is widely used, but it has not yet been defined." (K. Friedman, 2008, p. 157). He further elaborated on the concept of research-by-design and suggested to consider explicit ways in which to build design theory. Practice-based design research is another term for a similar approach. However, Friedman points out that "many designers confuse practice with research. Rather than developing theory from practice through articulation and inductive inquiry, some designers mistakenly argue that practice is research. From this,

they claim that practice-based research is itself a form of theory construction". (K. Friedman, 2008, p. 154). Finally, Koskinen, Zimmerman, Binder, Redstrom, and Wensveen (2011) suggested another new term for the same concept: "constructive design research", to "keep discussion open" (Koskinen et al., 2011, p. 6). This apparent lack of a consistent definition and related guidelines on how to conduct scientific, practice-based design research has led to the decision to refer to the concept of Design Science instead.

8.5.1. Design Science

Design Science has been widely adapted in the Information Systems field (and only to a lesser degree in the design field). Design Science is a research method proposed by Herbert Simon in his seminal book *The Sciences of the Artificial* (1996), first published in 1969, as a method to scientifically study a designed artifact, as opposed to studying the natural. "The natural sciences are concerned with how things are […] design on the other hand is concerned with how things ought to be." (Simon, 1996, p. 114). Nigel Cross summarized the concept as follows: „design science refers to an explicitly organized, rational, and wholly systematic approach to design; not just the utilization of scientific knowledge of artifacts, but design in some sense as a scientific activity itself." (Cross, 2001, p. 53). Hevner et al. presented a 7-step guideline for design science approaches in Information Systems (Hevner, 2007; Hevner et al., 2004), which we adapted to the context of design. Table 23 outlines these seven principles and our corresponding approach.

We refer to this approach (a) because it suggests a formalized, systematic approach on how to conduct a scientifically guided design process, and (b) because we consider a creative space development toolkit as a complex system rather than a designed product in itself, and hence the systemic view that is offered by the Information Systems field appears to be most appropriate.

Table 23. Seven guidelines for design science research by Hevner et al. (2004), and our corresponding approach.

No.	Guideline	Explanation	Our Contribution
1	Design as an Artifact	"Design Science research should produce a viable artifact in the form of a construct, a model, a method, or an instantiation."	Our toolkit consists of several tangible tools, including canvases and a card set.
2	Problem Relevance	"The objective of design-science research is to develop solutions to important and relevant business problems."	Creative spaces are being implemented in design practice but often without involving all stakeholders (especially the future users of the space) and without a proper understanding of the possible impact of design decisions.
3	Design Evaluation	"The utility, quality, and efficacy of a design artifact must be rigorously demonstrated via well-executed evaluation methods."	The toolkit elements were evaluated in two workshops; the first involving researchers and practitioners interested in the topic and the second in a real problem context of an institutional spatial planning project. Evaluation was based on video observation and follow-up questionnaires.
4	Research Contributions	"Provide clear and verifiable contributions in the areas of the design artifact."	The insights from the action research workshops expand the body of knowledge on visual innovation and co-creation tools, as well as the research on creative spaces.
5	Research Rigor	"Application of rigorous methods in both the construction and evaluation of the design artifact."	The design process of the toolkit is based on the extensive prior research presented in the previous chapters. The foundation for the toolkit is grounded in the typology of creative spaces (Chapter 4) and the design principles for creative spaces (Chapter 5). Insights from the previous studies (cultural probes, expert interviews and 18 institution visits) were consolidated and visually mapped within the developed tools.
6	Design as a Search Process	"Generate and evaluate alternative solutions."	The development process of the toolkit lasted for over two years. The toolkit has been modified several times and is now in its third edition. Particularly the inspiration cards are considered a "living" tool that is constantly being updated and extended.

No.	Guideline	Explanation	Our Contribution
7	Communication of Research	"Design Science Research must be presented effectively to the target audiences."	Interim steps of the toolkit were published in several conference papers (Thoring, Mueller, Badke-Schaub, & Desmet, 2016, 2017); parts of the toolkit were presented at conference workshops (DRS 2018); a commercially available version of the toolkit is planned for future work.

8.5.2. Action Research

Following the design science approach for developing the toolkit, we included action research, which has been proven to be a valuable method to evaluate design artifacts and design methods in a qualitative way (Lewin, 1946; Oosthuizen & Williamson, 2002). Participants are part of a real case that they are actually interested in, which results in better feedback than, for example, a laboratory experiment would generate.

Action research is a known as a method to implement a designed artifact into a real context (such as an organization) and to study the impact this intervention has on the system, similar to a case study research (Yin, 2003). According to Kemmis, McTaggart, and Nixon (2013) action research should be conducted as a spiraling sequence of four consecutive steps: Plan, Act, Observe, and Reflect.

8.5.3. Action Design Research

We have combined the two approaches; design science for designing the toolkit and action research for evaluating it as suggested by Sein et al. (2011).

Sein et al. (2011) suggested to combine action research with design science in order to provide a formalized and systematic design approach that includes several iteration cycles within a real organizational context. Following the guidelines as outlined by Hevner et al. (2004) and Sein et al. (2011) our toolkit development and evaluation process adheres to both concepts. Figure 70 depicts the action design research cycle that we followed for designing and evaluating our toolkit.

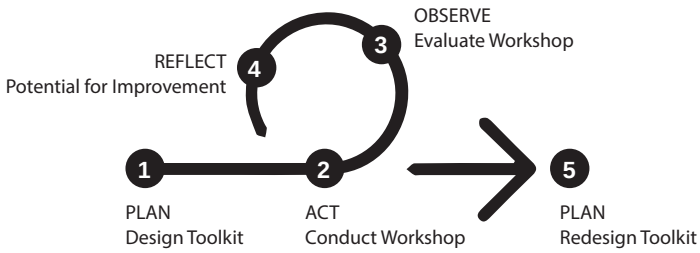


Figure 70. Action design research process, adapted from Kemmis et al. (2013) and Sein et al. (2011).

The following sections present our development process and the subsequent evaluation study in more detail.

8.6. PASSING THROUGH THE ACTION DESIGN RESEARCH CYCLE

The development and iteration process of our toolkit follows the four steps of the action design research cycle suggested by Kemmis et al. (2013) and Sein et al. (2011). First, we designed the toolkit, secondly, we conducted an evaluation workshop, thirdly, we evaluated the workshop, and finally, we reflected on the results and improve the toolkit. These four steps are presented in the following subsections. The last step, redesign of the toolkit, is presented in Section 8.7.

8.6.1. Plan: Designing the Toolkit

This step represents the first step ("Plan") of the action design research cycle, as outlined in Figure 70. We developed three elements as part of our creative space development toolkit: (1) an inspirational card set, (2) several canvases for group-work, and (3) a workshop concept.

Card Sets

We developed a set of inspirational cards that are based on the results of three of our previous studies. More specifically, we created 49 cards that each represent a pattern from our pattern language, where each card depicts one exemplary creative space from the inventory of creative spaces (Chapter 5). The cards are categorized according to the identified space types and qualities from the typology of creative spaces (Chapter 4). Additional theoretical underpinning and related literature is added from the developed theory of creative spaces (Chapter 6). Consequently, the cards consolidate the main insights from these studies in a compressed and accessible form. They provide inspiring best-practice examples,

abstracted patterns for how to design a creative space, and knowledge about possible effects of the spatial design. For the first version of the toolkit, the cards were designed in landscape format in A6 size. On the front side a black and white picture of the spatial example was shown, while on the reverse side the involved space types and qualities for the shown example were indicated by symbols and explained through texts. Additional blank cards were developed to provide space for sketching ideas and to take notes on any problems that were identified.

Canvases

The canvases and trigger questions were developed based on the cultural probes study that yielded the typology of creative spaces (presented in Chapter 4). Based on the results of this study, relevant constructs could be identified, which would influence the effectiveness of a space. These constructs are (1) five different space types, (2) the location of the space types within the room, building, or campus, (3) five different qualities of a space that determine the creative impact, (4) the users of a space, and (5) their activities in the space. The spatial configuration, as well as the activities with them, might cause some problems (6), for which solutions (7) need to be developed.

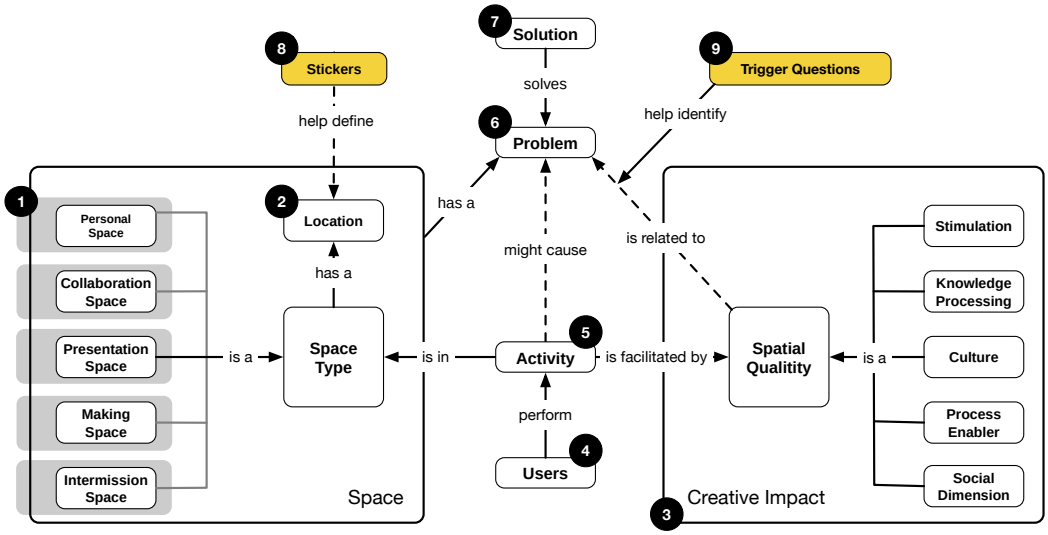


Figure 71. Ontology of creative space canvases.

Through systematic mapping, we developed a framework of relationships among these constructs that can be compared to an ontology, as suggested by Avdiji et al. (2018). Figure 71 illustrates this conceptual mapping. The canvases

were then designed based on the identified concepts of creative spaces and the relationships among them. These elements are numbered in the ontology (Figure 71), as follows:

(1) A total of five canvases; one for each space type
(2) Area for a floorplan to indicate the location of the respective space type within the given area (provided on each canvas (1), but also given its own large poster printout)
(3) Creative impact determined by the degree and presence of spatial qualities
(4) Users, of the space, who perform a specific activity
(5) Activity within the space, performed by the users
(6) Identified problems related to the space that could be either caused by the respective activity, or by the respective spatial quality (or the lack thereof)
(7) Solutions, to be developed by the stakeholders (workshop participants)

It became evident, that additional materials were necessary to facilitate the localization of space types within floorplans, and the identification problems associated with the spatial qualities. Hence, the following materials were added to the list.

(8) Stickers that are used to identify space types within the floorplan (additional material).
(9) Trigger questions that help to identify problems of the space which are related to the spatial qualities (additional material).

The constructs were then arranged on five canvases (one for each space type) and given a coherent graphic design. A customized floorplan was printed separately on a large poster. Stickers depicting symbols of the space types were printed on sticker paper, and trigger questions were printed as a list on A4 paper sheets; one list per spatial quality.

Workshop Concept

The workshop concept was developed based on our longitudinal case study (Chapter 7), which yielded several insights on problems that occurred during that particular spatial planning process. Moreover, we referred to Sanders (2000), who suggested to facilitate co-creation workshops with providing additional tools, such as canvases to work on and additional cards or stickers. Consequently,

the workshop was designed in interplay with the developed tools (card set and canvases).

The workshop was conceptualized to facilitate four goals. (1) Within the given space, participants should define areas for specific activities (i.e., to locate space types within the respective building, floor, or room). (2) Participants should then give these space types a more distinct shape (i.e., to develop ideas for spatial designs). Here, the problems and benefits associated with spatial qualities should be considered. (3) The results of the previous steps should be discussed. And finally, (4) the developed ideas and gained insights should be retained and reflected beyond the workshop duration. The process is depicted in Figure 72.

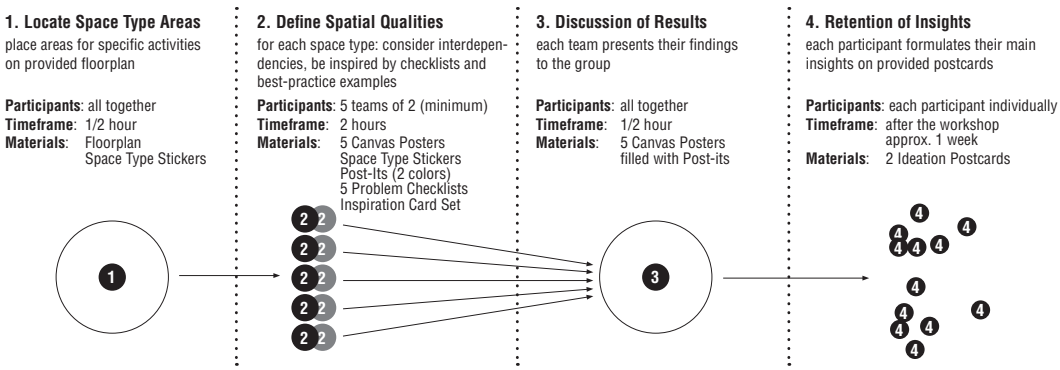


Figure 72. Process sequence of the spatial planning workshop.

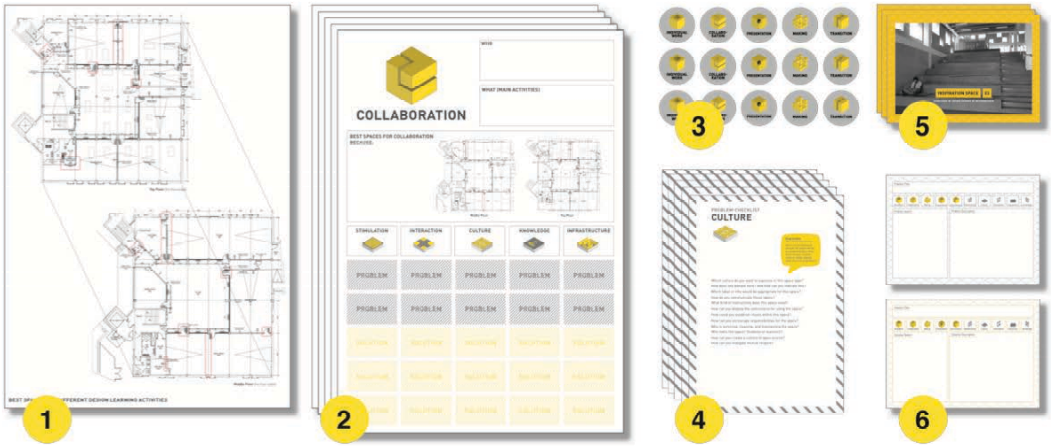


Figure 73. Overview of the first version of the toolkit

The Toolkit Elements

The tangible elements of the toolkit's first version are shown as an overview in Figure 73. The six elements are: (1) A large, poster-based floorplan of the given space (needs to be customized for each project), (2) five canvases for each space type, (3) stickers, (4) trigger questions, (5) inspiration cards, and (6) blank cards for problems and solutions. This overview shows the first version of the toolkit, which was later iterated and optimized after the evaluation workshop.

8.6.2. Act: Conducting an Evaluation Workshop

The fashion and communication design departments of Nottingham Trent University (NTU) had to move their teaching and staff spaces into a new building within a very short timeframe of a few months. The new space was located in a former office building, built approximately in the 1980s or 1990s, spread over two floors. The core of the entire building was being removed in order to install new partitions and rooms. The people from the design school were not entirely happy about the move, because the new building seemed to be worse than their old one (e.g. lower ceilings and smaller windows). However, the move was necessary to create new space for the two departments that were being merged. Some major decisions about the design and layout of the new space had already been made. The department head recruited twelve workshop participants with the goal to cover all three relevant stakeholder groups: (1) students, (2) teachers and staff, and (3) spatial planners, architects and decision makers. There were three students from the second and third year of fashion design. The group of seven staff members was composed of one administrator and six teachers from different sections of the school. Additionally, there was an external spatial planner, an architect, and a representative from the university's administration. The half-day workshop was conducted on-site at NTU's School of Art and Design.

The workshop was organized by two researchers (one is the author of this thesis). To prepare for the workshop, a floorplan and some pictures with the current state of the floors were sent to the workshop organizers. At the beginning of the workshop, a 30-minute input was given to the participants, which explained the typology of creative spaces and presented a selection of spatial examples from other institutions. Afterwards, the entire group inspected the target space, which was located across the street. It consisted of two floors that would be transformed into the future teaching space of the two departments. At that time the floors were a construction site, but the participants were able to get an idea of the size and the proportions, as well as the window situation of the space. The toolkit

materials were then introduced and the workshop was conducted according to the four steps depicted in Figure 72.

The workshop was devised to follow three consecutive steps. (1) In a warm-up session with all the involved stakeholders, the entire group was instructed to discuss and allocate space types within the given area. For this purpose, a canvas with the customized floorplan was provided with a set of stickers with icons representing the five space types. The participants could then jointly place the stickers on the areas they would agree on for a particular space type. In addition to the card set and the canvases, we also provided a set of stickers to allocate space types on the floorplans, and a set of trigger questions to identify possible problem areas. (2) Then the group was split in five smaller teams of two or three. Each team was given one of the canvases to define one space type. Again, the location was marked on the integrated floorplan on the canvas with a sticker. The teams then had a total of two hours to go through the trigger questions and identify possible problems and come up with solutions. Problems and solutions were written on Post-it notes, and then placed on the defined canvas areas. The inspiration cards were provided, so the participants could refer to them as possible best-practice examples. (3) Finally, each team presented their identified problems and developed ideas, and all the results were discussed among all participants.

8.6.3. Observe: Evaluating the Workshop

The workshop was observed and evaluated in five ways: (1) Three cameras video recorded the entire workshop. These cameras were not able to capture all of the activities, because five groups were working simultaneously on different tasks, but one camera was constantly recording one group as well as the plenum sessions, while the other two cameras were switching between groups and hence recording everything else that was going on at least in parts. After the workshop, it was possible to recall specific activities and group dynamics by watching the videos. (2) The workshop was conducted by two researchers who took notes about their observations during and immediately after the workshop. (3) The resulting artifacts, i.e. the filled canvases, were analyzed after the workshop and they yielded insights on how people used the canvases and what problems emerged. (4) A follow-up survey was sent online to all twelve participants (shown in Appendix D). (5) A follow-up inquiry with the staff manager was conducted one year after the workshop in order to learn which of the ideas that were developed at the workshop had been actually implemented.

While the evaluations done through (1) video data and (2) researchers' observations mainly yielded insights on the usability and comprehensibility of the tools, (3) the artifact analyses, (4) the follow-up surveys, and (5) the personal inquiry with the staff manager provided additional insights on the actual impact of the workshop and the tools that we provided.

The following sections describe the main insights that emerged from the workshop evaluation.

Insights from the Observations and Video Data

The two researchers, who participated in the workshop, took notes on their observations. Moreover, the data from the three video cameras was reviewed after the workshop and differences in behavior among the different teams were identified and noted as well. Through triangulation of the observation notes with the video data, we extracted several insights:

(1) The inspiration cards were used differently by different teams. Some teams spent about an hour, browsing through the cards, without touching the canvas. Only after they had thoroughly read all the cards, they started to fill the canvas. Other teams started immediately to fill the canvas, and only when they encountered a lack of ideas or got stuck in some way, did they consult the cards, which seemed to help them to continue. Despite those different approaches, all of the teams managed to present a completed canvas after the given time of two hours. This behavior indicates that the inspiration cards played a major role in the workshops and were used at different times and in different ways. In the end, they seemed flexible enough to allow for different procedures, yet they still led to a satisfactory end result.

(2) The list format of the trigger questions seemed to have a negative effect on the teams' workflow. At some point, all the questions were read out by one participant, which resulted in an interruption of the process, rather than in a stimulating input.

(3) The toolkit clearly served as a communication facilitator and motivational element. It engaged people to have in-depth discussions about the spatial requirements for more than two hours. The high level of participant engagement was visible. All of the stakeholders were discussing at eye-level. Specifically, the introductory session engaged all of the participants when they were placing stickers on floorplans and there were no hierarchies visible.

(4) The portrait format of the canvases was not ideal for the teamwork. Teams of two could work perfectly together with the canvas, but teams with more

than two people had difficulties to operate on the relatively narrow canvas. Also, the positioning of the upper areas of the canvas was difficult to reach for shorter people. In the teams with more than two people, usually only one person was filling in the canvas while the others remained seated. In contrast, in teams of only two people, both were standing and working on the canvas together. The poster size for the floorplan seemed to be limiting, as people tried to extend the canvas to include other (e.g. outdoor) areas.

(5) One participant spontaneously acted as a moderator for the group discussions. However, that person had to ask the workshop conductors several times to clarify questions that came up. Apparently, the moderator would have needed either a proper briefing or some written instructions.

Figure 74 depicts some selected workshop impressions, extracted from the video data.

Figure 74. Impressions from the evaluation workshop (selected video stills).

Insights from the Artifact Analysis

After the workshop, it was possible to infer some insights by analyzing the processed posters and canvases.

Figure 75 (left) shows the floorplan that was used to allocate space types on the two floors of the building and the canvas to define collaboration spaces. The floorplan revealed two insights: (1) The stickers that were provided were placed arbitrarily all over the entire poster. Apparently, there was no prioritizing of areas and space types, but instead almost every available sticker was placed somewhere. This demonstrates, on the one hand, that providing too many stickers was not effective, however, on the other hand, it also demonstrated that the

tools motivated a very lively and engaged discussion, which could also be confirmed by triangulating this assumption with the video data. Nevertheless, a limited number of stickers should be preferred in order to enforce prioritization.

(2) The provided floorplan was extended toward additional exterior areas, such as an envisioned rooftop garden or a remotely located library. This behavior was possible because, coincidently, some spare paper was left next to the actual floorplans. The insight derived from this observation was that a pre-designed floorplan might not be able to cover all of the areas that are relevant to the participants and, hence, some flexibility should be considered to allow for adding more spaces.

Figure 75 (right) shows one of the five canvases to define a space type. The canvas for specifying the collaboration space shows where the participants would allocate collaboration spaces on the top floor of the building (indicated by the placed stickers). The areas for identified problems (orange post-it notes) and solution ideas (yellow post-it notes) were completely filled.

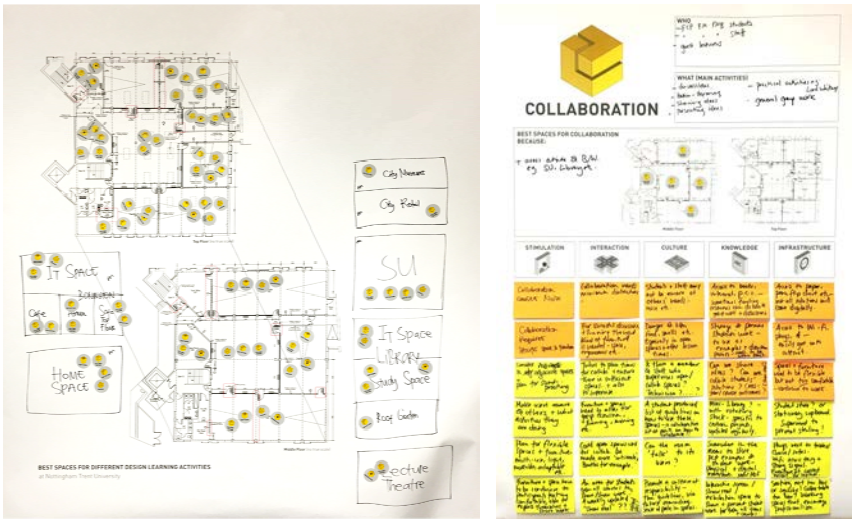


Figure 75. Selected toolkit elements processed by the participants (floorplan, collaboration canvas).

While a systematic analysis regarding the quality of these ideas was not part of our evaluation workshop, we could still extract some relevant insights regarding the usefulness and impact of the tools:

(1) The problem statements and solution ideas the participants developed clearly showed that the participants had gained a deep understanding of the

problem context and the possible dependencies between spatial designs and resulting impact. This could be inferred, for example, from hand-sketched arrows on the canvases that indicated causal dependencies between different ideas, for instance, where one solution would cause another problem to rise.

(2) While some of the ideas were very concrete, such as "providing a library with rotation shelves", some other ideas still remained on a very abstract level, for example, to "provide furniture that enables group discussions"; this suggestion resembles more a requirement than an actual idea. Moreover, the trigger questions they were given were reflected in the formulated problems, but also in the solutions the participants came up with. For example, one trigger question was phrased as "What kind of noise will occur due to the activities in the space?". As a response to this, several of the ideas then proposed something like "provide noise cancelling furniture". We consider such ideas to be a result of an arbitrary or too open formulation of some of the trigger questions. Therefore, in order to evoke more precise and constructive ideas the trigger questions had to be re-phrased accordingly.

Insights from the Survey Data

The survey contained a mixture of multiple-choice questions with a 5-point Likert scale and open-ended questions that allowed for free-text responses. A picture of each toolkit element was presented as part of the survey as a reminder for the participants. Three questions were related to the purpose and the expected outcome of the workshop; three questions were related to each set of the five workshop materials (15 questions in total), prompting the usefulness of the material and possible improvements; three questions were targeted to find out to what degree the self-explanatory aspect of the toolkit was effective; and five questions were focusing on the overall experience and usefulness of the toolkit and workshop for the university's specific case. The survey questions can be found in Appendix D.

The link to the survey was sent ten days after the workshop by e-mail. After several rounds of follow-up e-mails requesting the participants to fill out the questionnaire, finally eleven out of the twelve participants completed the survey (one member of the staff group did not respond), which equates a response rate of 92%.

The main goal of the survey was (1) to see whether the toolkit was useful for the three stakeholder groups, and (2) how the toolkit could be improved. We

were particularly interested in any diverging opinions between the three stakeholder groups. Another question that was of particular interest was what the participants expected from the workshop and whether or not these expectations were met. The survey provided a selection of six possible answers (multiple answers were allowed). The main purpose of the workshop for the participants was manifold: Ten participants (91% of the respondents) declared they wanted to "identify the user requirements for the space". Six participants (55%) expressed their wish to "co-create ideas for the spatial design". Five participants (46%) selected either the option to "detect possible problems before actually building the space", and the same number (five people) said they wanted "to be inspired from the toolkit for future projects". The following quotes demonstrate exemplarily the participants' main purpose: to involve the students, and to get into discussions.

> *Quote 44: "It was incredibly helpful in that we got to really think about how students would be using the space and the best way to make the most of this space to ensure that students were not only inhabiting an aesthetically beautiful space, but that it was also a space that functioned as a point on inspiration, which is very important for a creative school."*

> *Quote 45: "It was very useful to see how the tools worked in prompting discussions."*

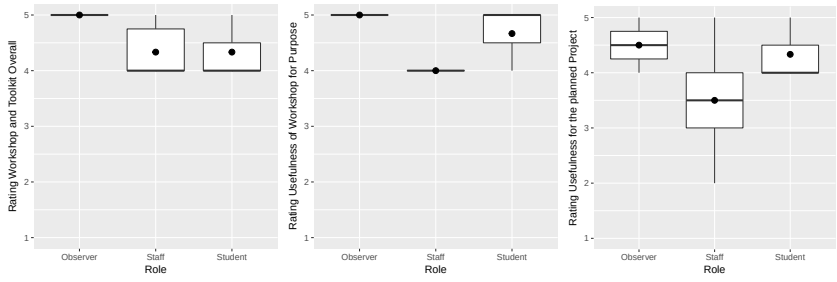


Figure 76. Ratings of the different user groups for the overall workshop and materials (left), the personal usefulness (center), and usefulness for the university's project (right), (n=11).

Figure 76 illustrates the different perspectives of the three user groups on the purposefulness of the toolkit and workshop regarding the overall impression (left), the usefulness according to the respective purpose (center), and the usefulness for the planned project at the university (right). The box plots show that the observers (spatial planner and management) rate the toolkit and workshop best for all three questions. This could be either explained by the fact that they were not actually working with the tools and hence could not experience any

difficulties, or a possibility might be that they were more objective in terms of the overall insights they gained from observing the group. The students were more positive than the group of staff members, which can be explained by some of the students' quotes that indicate their pleasure about being involved in the process at all. The staff members assessed the usefulness of the toolkit and the workshop lower than the other two groups did. In their written responses some of them explained their dissatisfaction with the timing of the workshop as most decisions were already made (which is, however, not a problem with the toolkit).

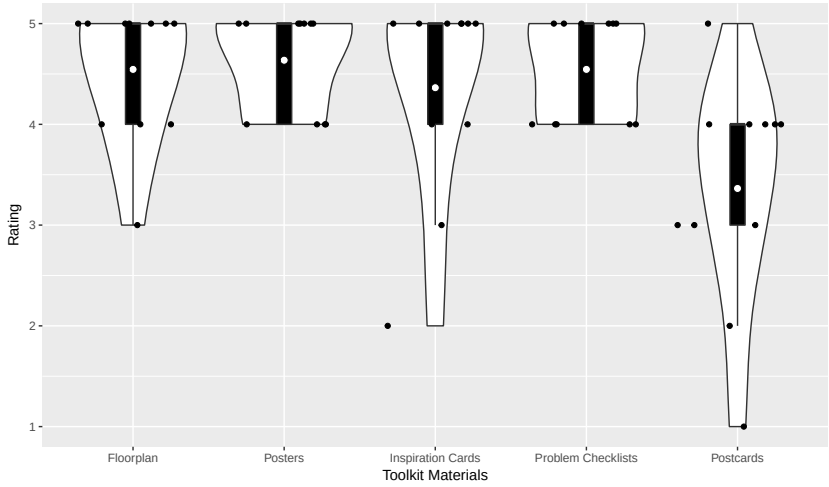


Figure 77. Ratings for the different toolkit materials (n=11).

Figure 77 shows a violin plot of the participants' ratings of the different toolkit materials. A violin plot is a combination of a box plot and a kernel (or probability) density plot. The black dots additionally show the individual answers and the white dots indicate the mean. The results indicate that the space-type canvases and the trigger questions were rated highest by all respondents, while the postcards had the lowest ratings. From the following free-text answers it was possible to deduce possible reasons for the low ratings of the postcards:

> *Quote 46: "I did not use these [postcards] and […] I do not remember these."*
>
> *Quote 47: "Our discussions didn't really continue beyond the session, but I can see that they would be useful for other projects."*
>
> *Quote 48: "Just timing really, nobody has returned their cards […], so maybe they could be sent in advance or time given in the workshop to complete them."*

Four respondents said that the inspiration cards were their favorite item, but there were also some suggestions for improvement:

> *Quote 49: "Make these [inspiration cards] available before the workshop so that people could research, discuss with wider group and have more opinions on them."*

> *Quote 50: "Maybe have more 'problematic' spaces where innovative solutions were found."*

The floorplan with the stickers was mentioned by most participants (five respondents; equals 46%) as their favorite item from the toolkit. Almost everyone mentioned in their responses that this tool helped to keep the discussions focused.

> *Quote 51: "It brought everything together in one place and helped give a focus to our discussions."*

However, also some problems were mentioned:

> *Quote 52: "Some groups I noticed almost put all the stickers in each area rather than really prioritizing."*

> *Quote 53: "It might be useful to have prompt sheets with definitions of the qualities and types of spaces as I think some people were forgetting these".*

Of particular interest is the question, what impact the toolkit and workshop actually had on the spatial planning project of NTU, because any method is only as good as its respective usefulness.

> *Quote 54: „It allowed for more attention to the finer detail."*

> *Quote 55: „It certainly changed the usability of the existing space they'd already laid out; how we might change the materials of the walls, breakout spaces etc."*

> *Quote 56: „It was a great way to force them [management] to pause for a moment and consider how we [the students] actually use the space*

> *Quote 57: "If we were planning a space from scratch it would have more impact."*

> *Quote 58: "The toolkit made us think about the varied types of work taking place in the space and specific requirements for each of these."*

> *Quote 59: "In an ideal world the workshop and materials would be used to plan a building or space that has not already to a certain extent been defined."*

Insights from the Follow-Up Inquiry after one Year

An informal e-mail inquiry with the staff manager from NTU was conducted approximately one year after the workshop. According to her the ideas that developed during the workshop were highly relevant and several of them were actually implemented in the final space.

> *Quote 60: "We did implement a couple of the ideas from the workshop, […] for example, we have movable walls dividing rooms and glass walls, which have integrated blinds to let more light into the space. We also have information screens on each floor."*

However, she stated again that many ideas could not be implemented because it was too late for that.

> *Quote 61: "It was hard to implement very many of the ideas as they [the spatial planners] had decided so much already."*

8.6.4. Reflect: Toolkit Evaluation

In this section the insights from the workshop are recapped, triangulated, and interpreted. A summary of the identified strengths of the toolkit, as well as the weaknesses and potentials for improvement is presented.

Identified Strengths and Weaknesses of the Toolkit:

Overall, the toolkit and workshop were assessed as helpful for the particular spatial planning case at NTU. The combination of several tools, such as a floorplan, posters, trigger questions, and inspirational cards, allowed for a mix of group discussions and individual focused work on parts of the design case. The floorplan was able to engage a vivid group discussion, while the posters allowed in-depth discussions and idea development in smaller teams. The toolkit involved all three stakeholder groups, and particularly the students were pleased to be involved in the decision process, which seemingly is not often the case. The inspiration card set was perceived positively, because it showed what was possible, while the trigger questions helped to focus the work process.

In general, the different tools were able to guide the design process in a structured way. In its present state, the toolkit would not work without a trained moderator and a proper introduction to the space typology and there are no written instructions. Since the participants were not yet familiar with the presented typology (the space types and qualities) they were difficult for them to define. The postcards had not been used at all. The idea to keep the discussion going after the end of the workshop apparently did not work out.

Placing stickers on the floorplan was very engaging, but as a result, some participants placed stickers on every available space of the floor plan, without focus and without any clear reflection (we assume the number of stickers we provided was too high).

Regarding the actual impact, we infer that the toolkit and the workshop yielded numerous relevant ideas that reflected the requirements of the different stakeholder groups. The fact that only a few of them were implemented was attributed to the late timing of the workshop, as many decisions had already been made. However, this is not a problem with the toolkit.

Potential for Improvement:
Through an evaluation of the workshop, we were able to identify several potentials for improvement. The toolkit could be made more self-explanatory, for example by providing a detailed written description of the definitions of space types and qualities. A smaller floorplan on the poster or an empty grid to be filled by the users would leave more space on the canvas to include external areas. Fewer stickers might force people to focus and prioritize. The postcards did not work in the workshop setting but could be considered as a tool for self-use at home or could be integrated into the other workshop elements. The checklists with trigger questions could be given a more flexible format (e.g. a card set), because the one-page lists were limiting the discussions. The inspiration card set, which turned out to be one of the most used elements during the workshop, could be given more emphasis, for example by adding more detail in the images and in the text.

8.7. FINAL TOOLKIT

Based on the results from the spatial planning workshop at Nottingham Trent University, the toolkit for developing creative spaces and the related workshop concept were substantially updated. The following subsection presents the iterated toolkit elements in more detail.

8.7.1. Updated Inspiration Card Set

The inspiration cards were given more emphasis. In addition to the pictures of exemplary spaces from the creative organizations (presented in Chapter 5), we also included more theoretical underpinning for each pattern card that explains the expected working mechanism. The previously used symbols for indicating related space types and qualities were limited only to the spatial qualities in order

to add clarity and focus. The exemplary spaces are now shown in color print, and the overall design of the cards has been given more structure, which was possible by changing the layout from landscape to portrait format. In order to avoid becoming fixated on the examples shown, we have described alternative solutions in text form. Cross-references to related patterns were added at the bottom of each card, to invite browsing.

One introductory card shows additional information about the aspired spatial qualities and a reference matrix of potential solution patterns for specific space type/quality requirements (Figure 78). This matrix, along with the additional instructions, would also allow people to use the cards individually without participating in a workshop. Therefore, the tool will also be useful for smaller groups and individuals, who want to improve their work environment.

Figure 78 shows the introductory card, which describes the spatial qualities on the front side. The reverse side shows the pattern language matrix, indicating which pattern numbers could be consulted to improve a specific spatial quality in a specific space type.

A PATTERN LANGUAGE OF CREATIVE SPACES

	Personal Space	Collaboration Space	Presentation Space	Making Space	Intermission Space
Desired Quality	Suggested Pattern				
Source of Stimulation	1, 6, 9, 13, 18, 19, 20, 22, 34, 35, 36, 37, 38	1, 3, 6, 9, 10, 15, 16, 18, 19, 20, 21, 22, 23, 27, 28, 29, 30, 35, 36, 37, 38, 39, 40, 41, 46	10, 13, 30, 36, 37	1, 8, 13, 17, 22, 29, 31 33, 34, 39	2, 6, 9, 10, 13, 17, 19, 21, 22, 23, 27, 28, 29, 30, 35, 37, 38, 39, 40, 41, 42, 43, 45, 46, 48
Social Dimension	7, 18, 19, 25, 36	4, 7, 8, 9, 10, 12, 18, 19, 21, 23, 25, 26, 36, 39, 41, 42	10, 36, 42, 44	4, 36, 42	4, 8, 10, 12, 18, 19, 23, 24, 25, 26, 36, 41, 42, 44, 45, 49
Knowledge Processor	1, 3, 20, 22, 32, 35	1, 3, 4, 5, 20, 22, 35, 43	5, 13, 36	1, 3, 22, 43	3, 4, 5, 13, 22, 32, 35, 36, 42, 43
Culture Indicator	2, 7, 11, 17, 19, 36, 47	2, 7, 11, 17, 21, 23, 31, 47	2, 10, 13, 33, 42, 47	2, 10, 31, 33, 47	2, 11, 13, 17, 19, 21, 23, 42, 47
Process Enabler	1, 9, 14, 15, 16, 32, 38	1, 5, 7, 8, 9, 12, 14, 15, 16, 25, 31, 32, 38, 46	5, 9, 10, 14, 15, 16, 34, 36, 44	1, 3, 8, 14, 15, 16, 31, 34, 39	1, 3, 5, 9, 12, 14, 15, 16, 19, 25, 32, 34, 39, 46, 48, 49

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Figure 78. Updated card set with additional information on spatial qualities (left) and pattern matrix (right).

Figure 79 shows one exemplary card with content. Each card follows the same structure: The front page shows one example of the solution principle, the pattern number, pattern name and descriptive sub-title, and a short description.

The reverse side repeats the pattern name, number, and sub-title, and provides further information about the working mechanism, the addressed space types, and the real-life example depicted on the front. Figure 80 pictures the complete card set.

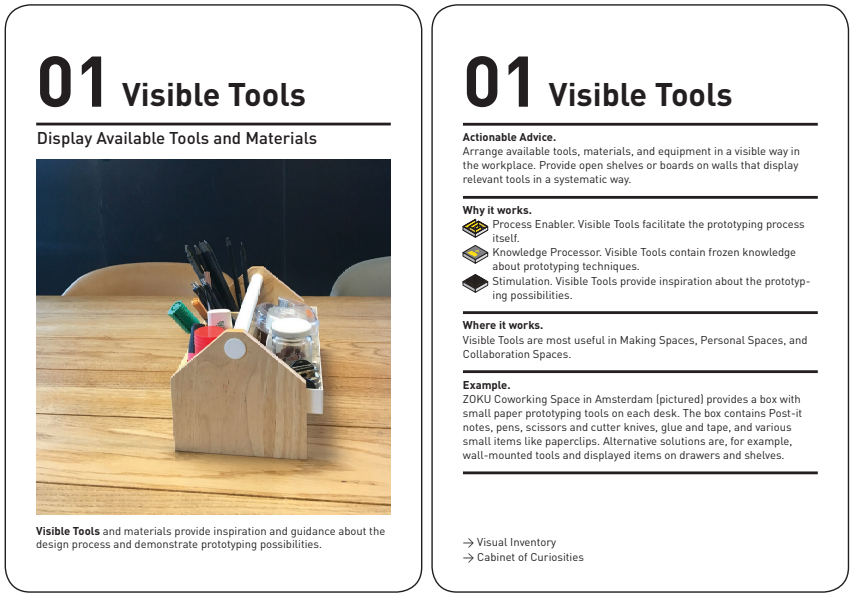


Figure 79. Exemplary card with content. Each of the 49 cards follows the same structure.

Figure 80. Complete set of 49 pattern cards.

8.7.2. Updated Canvases

The canvases were redesigned in various ways: The floorplan canvas was given a dedicated area with a facilitating grid to sketch or mount a floorplan. Instructions and a legend were added. Empty space was deliberately integrated for extending the floorplan toward exterior areas. The layout of all canvases was changed from portrait to landscape format. This new layout allowed for more fields on the space type canvases to fill in ideas (previously there were 3 boxes per spatial quality; now there are 4). Instructions were also added to the five space type canvases. Figure 81 depicts one of the five new space type canvases. Each canvas follows the same structure. Figure 82 shows the updated floorplan canvas.

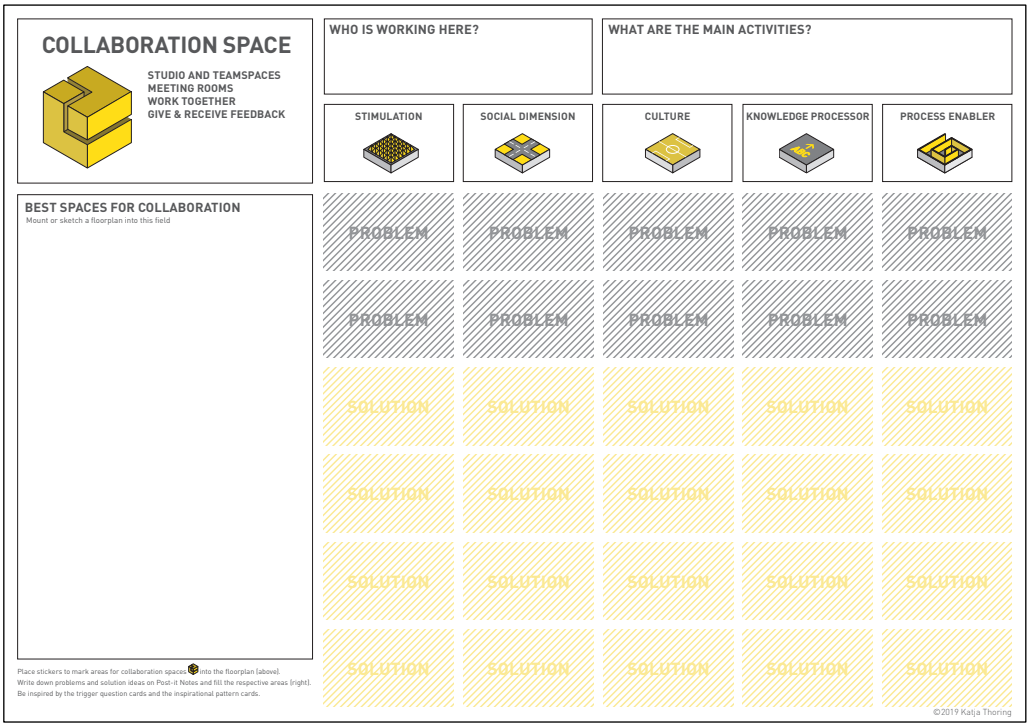


Figure 81. Canvas poster for defining the collaboration space (one out of five canvases).

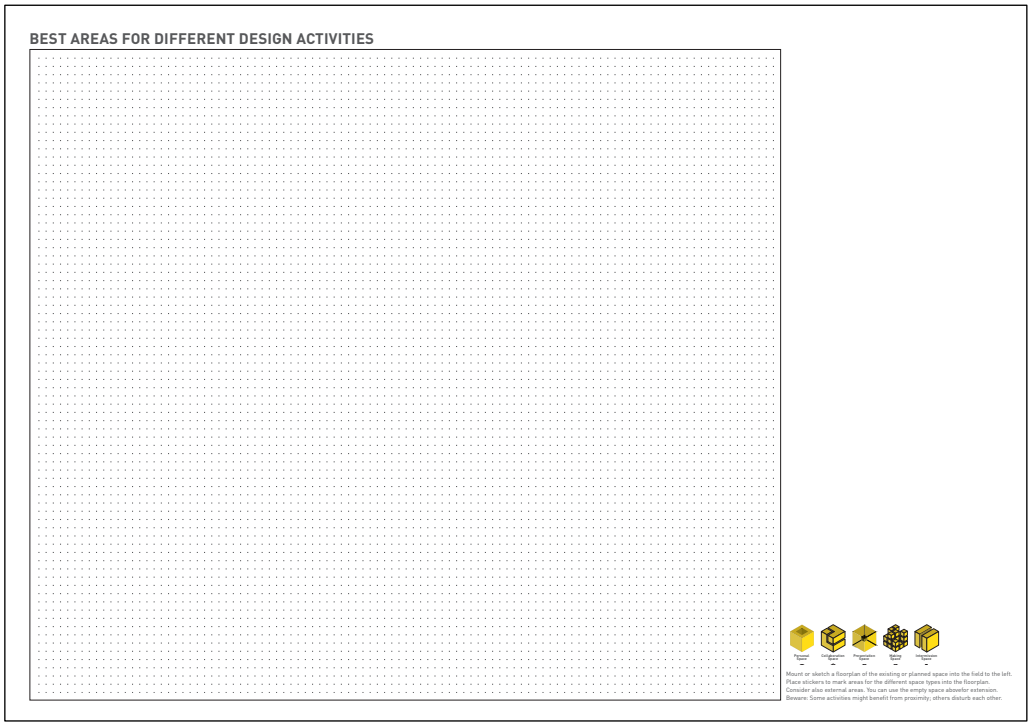


Figure 82. Floorplan canvas with grid for collaboratively defining and sketching a workspace layout.

8.7.3. Updated Trigger Questions

The trigger questions were given a more flexible format and hence, were also transformed into a set of smaller cards (standard card deck size). For each category (namely, the five spatial qualities), a different color was chosen. The participants could pick random cards when working with the respective canvases and align them according to their responses, which would make the process more playful and flexible.

To make it even more playful, we named the card set "Creative Space Clinic". This name reflects a gamification approach and should provoke the idea of a workspace being a "patient" that needs to be diagnosed in order to receive the appropriate treatment. Figure 83 shows the "Creative Space Clinic" card set.

Figure 83. "Creative Space Clinic" assessment card set.

According to Deterding, Dixon, Khaled, and Nacke (2011) gamification refers to the use of game design elements (such as leaderboards, meaningful stories, and points) in non-game contexts. Building on this definition, Huotari and Hamari (2012) defined gamification as a process of enhancing an activity or service with affordances for gameful experiences. Such a gameful experience can result in a higher user engagement and motivation (Robson, Plangger, Kietzmann, McCarthy, & Pitt, 2015). Robson et al. (2015) established three different dimensions of gamification: (1) mechanics (in this case the card set and specific rules on how to play with them), (2) dynamics (the way participants interact with the game and with each other, which is typically hard to control), and (3) emotions that the players experience (which in this case are triggered by the story of a space being a patient). We focused on the aspect of a meaningful story rather than integrating incentives (like points, leaderboards, or other rewards), to get people into the mindset of being a doctor and diagnosing the space; a role that would trigger them to deeply investigate the space and find its "defect".

The updated questions are phrased in such a way that the response would indicate whether or not an existing space was conducive or problematic regarding the respective category. When responding to the questions, people can place those cards with a positive response in one pile, and those with a negative response in another pile. Optionally, they can also align the

cards alongside a scale in order to indicate intermediate steps or neutral assessments.

Figure 84. Trigger question cards aligned to a scale of positive and negative responses; the color code allows to identify problematic areas.

The color code of the cards would then lead to emerging patterns, for example, if most questions regarding knowledge processing were given a negative response, this would become evident through an accumulation of light yellow cards on the negative side of the scale (Figure 84). Those aspects that are identified as "problematic" through this procedure could then be addressed through the suggested patterns shown in the respective cell of the space type/quality requirements matrix (as pictured earlier in Figure 78).

Figure 85 shows one exemplary card for each spatial quality. Each of the five categories contains between ten and 15 cards and each card has a trigger question. People can randomly select cards from each category to diagnose existing spaces and to develop ideas for new spatial designs.

Figure 85. Updated trigger questions; card set with five categories for assessing a creative workspace (only one question shown per category).

8.7.4. Further Changes to the Toolkit and Workshop

Several smaller changes have been implemented to the additional materials and the workshop concepts. Instructions and additional explanations with selected symbols were added to all canvases. The number of provided stickers per workshop was reduced significantly. Only ten stickers per category should force the participants to prioritize and hinder them from randomly placing all the stickers everywhere. The additional postcards were discarded, because they have not been proven to be very useful to the participants. Instead, more space was added on the canvases to develop ideas using standardized Post-it notes, which could then be placed onto the respective canvas.

8.8. DISCUSSION

This chapter introduced an action design research study for developing and evaluating a creative space co-creation workshop and toolkit. The development of this toolkit has been conducted with an evidence-based method, which was based on the extensive prior research presented in the previous chapters. The action design research cycle resulted in positive feedback from the participants of the evaluation workshop, but at the same time revealed many insights on how to further improve the toolkit. In a second loop of iteration, the final version of the toolkit has been developed, where the several elements were better integrated and interconnected. However, the final version still needs to be tested and evaluated by conducting additional workshops.

8.8.1. Comparison with the Initially Defined Requirements

Table 24 refers back to the list of requirements for our toolkit as outlined in Section 8.4, and compares it with the two analyzed tools (Dark Horse Innovation, 2018; SAP AppHaus, n.d.). It becomes evident that all three toolkits are suitable for practitioners, because they provide information in a manageable and accessible way, for example, through the use of tangible tools or canvases. However, Mosaic and the Workspace Playbook both do not include theoretical knowledge about possible consequences of spatial designs, as we do in our spatial pattern cards. Moreover, there is no evidence that Mosaic and the Workspace Playbook were developed or tested scientifically (we acknowledge, however, that this might still be the case, even if such evidence has not been published). Moreover, Mosaic does not provide any best-practice examples with their toolkit.

Table 24. List of toolkit requirements, in comparison with the identified tools (* indicates lack of evidence).

No.	Requirements	Our Toolkit	SAP Mosaic	Workspace Playbook
1	Tangible	yes	yes	self-print only
2	Tailored to practitioners	yes	yes	yes
3	Engaging setting to motivate participation at eye-level	yes	yes	*
4	Include knowledge and theory about possible impact	yes	no	no
5	Provide inspiration from best-practice examples	yes	no	yes, in book (but not linked to the tools)
6	Scientifically developed	yes	*	*
7	Evaluated in realistic context	yes	*	*

8.8.2. Facilitation of the Co-Creation Process

Feedback from the participants indicated that they would like to be able to conduct the workshop by themselves, without having to involve the external researchers as moderators. However, as Rochelle and Penuel (2006) pointed out, one of the seven crucial factors for successful co-design projects is a "strong facilitation with well-defined roles". We argue that a co-creation workshop as suggested in the toolkit we have presented needs a well-trained facilitator and cannot be easily conducted without any experience in co-creation methodologies. Hence, the toolkit does not only consist of the "hardware" materials, but also the trained facilitators. Nevertheless, we have decided to make the inspiration cards independent from the rest of the tools. The card set is considered the heart of the toolkit, because it consolidates our entire research into one tangible and accessible tool. It can become a valuable source for any creative person to improve their workspace, even without attending a guided workshop.

8.8.3. Limitations of the Evaluation Workshop

Several limitations apply to this study. We conducted our evaluation workshop in an educational context. Although the case represented a realistic spatial planning project, it is not clear if the insights are transferable to other contexts. Future work will have to include further evaluation studies in corporate environments.

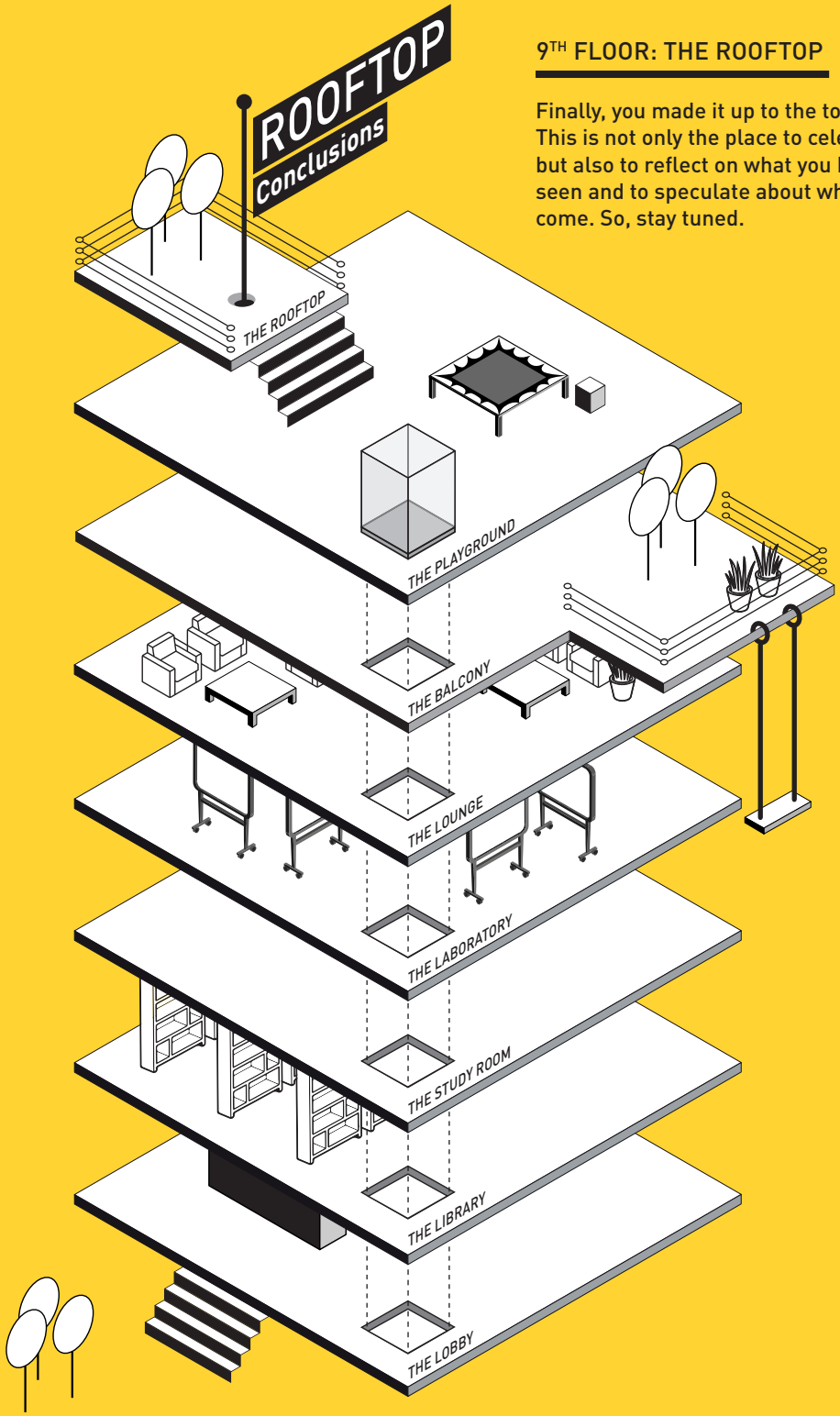
Moreover, the actual quality of the ideas that were developed have not been systematically evaluated. The final analysis of these ideas, the decision for or against one idea, and the implementation of the insights and ideas generated at the workshop was in the hands of the institution's decision makers; we had no influence on this process.

The updated toolkit still needs to be evaluated. We are planning to continue to conduct workshops and to apply the toolkit in realistic projects, in order to test its usefulness for assessing and designing creative spaces.

8.9. CONCLUSIONS

This chapter consolidates the findings and insights from the previous four chapters into a set of different tools for developing creative spaces. The resulting toolkit constitutes the nucleus of our insights on creative workspace design and hence can guide practitioners with the process or designing or improving creative workspaces.

In contrast to existing tools, our proposed solution combines a guided workshop concept with tangible tools, inspirational best-practice examples, and theoretical knowledge about the possible consequences of spatial design decisions.



9TH FLOOR: THE ROOFTOP

Finally, you made it up to the top floor. This is not only the place to celebrate, but also to reflect on what you have seen and to speculate about what will come. So, stay tuned.

9. CONCLUSIONS AND OUTLOOK

9.1. SUMMARY AND MAIN FINDINGS

This PhD project is centered around the question of how the physical work environment is able to facilitate creativity and innovation in organizations from the creative sector, which includes corporate and educational contexts.

In the first part of this thesis, we investigated the topic through theoretical and empirical studies to better understand different aspects of creative environments. These studies are presented in Chapters 1 through 7. The second part of this thesis describes an action design research approach, where several artifacts have been developed that consolidate the findings from the previous studies and are expected to facilitate creative space development processes in organizations (Chapter 8). The entire thesis is structured in nine chapters.

9.1.1. Summary

Introduction.
Chapter 1 introduces the topic of creative work environments by providing a definition and various examples. Moreover, we outlined the aim of this research and provided an overview of this thesis' structure.

The History of Creative Spaces.
Chapter 2 presents a brief overview of the history of creative workspaces. We begin with the first historical records from the 16th century, continue by describing the developments of general office designs in the 20th century, and conclude with examples from today's workspaces.

Related Work About Creative Spaces.
Chapter 3 presents a structured literature review of creative workspaces in design education and practice. Our systematic search process yielded a total of 42 sources that addressed the topic of creative workspaces from different angles.

A Typology of Creative Spaces.
Chapter 4 describes the development of a classification system of creative spaces. Based on a cultural probes study (Gaver et al., 1999; Mattelmäki, 2006) in two different creative organizations, we were able to extract rich qualitative insights about types and qualities of creative spaces. The proposed typology consists of five space types that are necessary for design activities: personal spaces, collaboration spaces, presentation spaces, making spaces, and intermission spaces. At the same time, a creative space can have various qualities: it can serve as a knowledge processor, it can provide stimulation, it can provide a social dimension, it can enable work processes, and it can express a certain organizational culture.

A Pattern Language of Creative Spaces.
Chapter 5 introduces examples of creative spaces from 18 creative organizations around the world. We mapped the instantiations of creative work environments we found to the typology of creative spaces. Based on these real-life examples, we identified a total of 49 design patterns of creative spaces. The patterns range from small scale, such as, individual pieces of furniture and the interior, to large scale, such as architectural buildings and the location within a larger urban context. Each pattern provides actionable guidelines for developing specific creative space elements, yet they are abstract enough to be adapted by the users and adjusted to individual requirements and needs.

A Theory of Creative Spaces
Chapter 6 presents ten propositions about the causal relationship between space and creativity. Through interviews with nine experts from different creative contexts, we gained insights on the possible impact of spatial designs on creativity. These insights were underpinned by related literature and transformed into a causal theory of creative spaces.

A Longitudinal Case Study of a Creative Space Development Process.
Chapter 7 presents a longitudinal case study of the development and implementation process of an idea lab. The study lasted over two years and yielded insights on the requirements and challenges related to such a creative space development project.

A Creative Space Development Toolkit.
Chapter 8 introduces a toolkit for designing creative spaces. The toolkit consists of a set of inspirational cards, several canvases, trigger questions, and stickers. The tools are accompanied by a workshop concept for co-creating a creative space together with the relevant stakeholders. The toolkit has been developed, tested, and iterated by following an action design research approach.

Conclusions and Outlook.
Chapter 9 summarizes the findings and implications of this study and presents an outlook to future work.

9.1.2. Contributions

We have demonstrated throughout this thesis that the design of the work environment can have a substantial impact on people's creativity. We identified direct relationships between space and creativity, for example, that the space could provide inspiration or facilitate prototyping. However, we also identified indirect relationships, for example, that the space can set people into a mood receptive for creativity, instigate playful behavior, or facilitate chance encounters. The main contributions of this PhD project are as follows:

(1) The typology of creative spaces provides a framework for analyzing and adjusting creative workspaces. The developed requirements list for space types and spatial qualities can be used to evaluate an existing work environment and to identify possible problems or potentials for improvement.

(2) The 49 developed design patterns constitute the heart of our research. Each pattern presents an example from existing creative spaces that can be utilized to inspire the design of one's own creative work environment. Moreover, each pattern presents an abstracted principle of how the space could be designed in order to have a desired effect on creative work. The patterns were enriched by theoretical underpinnings and constitute the main findings of this PhD research.

(3) The theory of creative spaces provides theoretical propositions about why a specific design might have a certain effect on creativity. With this knowledge, users are empowered to base their design decisions on an evidence-based theoretical foundation.

(4) The toolkit conglomerates the findings from the previous studies in a set of tangible tools and a co-creation workshop concept.

9.2. IMPLICATIONS

9.2.1. Theoretical Implications

Academic interest in creative workspace design has been increasing. As we have outlined in our systematic literature review in Chapter 3 (starting on page 51), there is a multitude of individual studies on the topic. However, these studies are not linked to each other and do not present a bigger picture regarding the entire system of creative spaces. With this PhD project, we have provided a holistic and systemic investigation of the topic from various angles. All of the conducted studies are supported by existing literature and are embedded in a bigger network of different components inherent in creative spaces (see Figure 5 on page 33 for an overview of the interrelationships of our main studies). The initially developed typology of creative spaces (Chapter 4, starting on page 71) presents a classification system that connects the different parts of this PhD project and gives structure to the subsequently developed pattern language, the causal theory, and the toolkit for creative spaces.

In summary, this PhD project provides several theoretical contributions to various fields. First, it contributes to the field of design creativity. We have presented an explanatory causal model of the influence of the built environment on creativity. We argue that with this preliminary theory of creative space (presented in Chapter 6), and the underlying design patterns for creative spaces (presented in Chapter 5) we contribute to the bigger picture of a fundamental theory on design creativity.

Secondly, this PhD project contributes to the co-design and participatory design fields. Through the longitudinal case study concerning the development process of an idea lab (presented in Chapter 7), we have provided first-hand insights on a typical co-creation design process. We have identified the strengths and problems of this approach and have developed suggestions for improving such a process. The tools and the workshop concept we developed (presented in Chapter 8) consolidate these findings. Both, the toolkit and the workshop concept have been applied to and validated through a real-life spatial planning project that yielded further insights on, for example, design requirements for co-creation tools.

Finally, this PhD project contributes to the fields of office planning and architecture. The inventory of creative spaces (presented in Section 5.4 on page 121) constitutes a rich picture of contemporary workspace design. The derived pattern language of creative spaces (Chapter 5) combines these best practice examples with the required theoretical underpinning to enable architects and office planners to implement creative spaces and to possibly validate the suggested impact.

9.2.2. Practical Implications

Creativity becomes more important, not only within the design discipline, but also in neighboring fields, such as business or IT, where the awareness of the relevance of creative behavior has increased. Start-ups have always been dependent upon innovative ideas and creative approaches, but global companies are now implementing design and innovation departments and are hiring Chief Design Officers (CDOs) throughout their organizations. In educational contexts major interest is being shown in the facilitation of creativity.

Consequently, a work or study environment that supports creativity, can have a major impact on a company's success or a pupil's creative development. Conversely, an environment that is not optimized for creative work, can have the opposite effect. It might hinder workflows, distract people from their creative work, or prevent them from meeting with coworkers. It is crucial for an organization to know about the possible consequences of spatial design decisions, so that they can optimize their workspaces for maximum innovation impact. The findings presented in this thesis not only provide this relevant knowledge about the relationship of space and creativity; they also provide tangible tools for facilitating creative space design processes.

Providing creative workspaces has become some sort of quasi-standard for organizations that consider themselves to be creative. In a similar vein, creative workspaces have become a major attractor, maybe even a decisive factor for employees to choose a particular company as their future employer. According to Garland (2013) a "well-designed and thoughtful office space […] can aid in recruiting and retaining talent." Or, in other words, creative space can act as an attractor for current and future employees.

However, appropriate tools that would facilitate spatial design processes and provide relevant knowledge about the possible impact of design decisions, are rare. To the best of our knowledge, a systematic method to facilitate the design processes of creative spaces that is underpinned by theory, does not yet exist.

Hence, we argue that the toolkit presented here is highly relevant for practitioners and organizations. It provides spatial planners and decision makers of creative organizations with the required knowledge to consider all of the relevant parameters to design creative spaces, and it also provides a platform to involve all of the relevant stakeholders with a guided co-creation workshop.

In conclusion, we argue that the results presented in this thesis are highly relevant for practice, because they present theoretical knowledge in a tangible and accessible way that is suited to practitioners.

9.3. REFLECTION ON METHODS

9.3.1. Qualitative Approach

We chose a qualitative approach for this research project for the following reasons: Creative space is regarded a complex system with various relevant parameters and interdependencies. We aimed at developing a deep understanding of this system in order to develop theories about why specific spatial designs would have a particular effect. Therefore, an interpretative, exploratory approach seemed most appropriate.

Through employing the user-centered cultural probes study, we were able to gain rich insights from a user's perspective. The participants' self-documentation allowed us to understand the underlying needs and wants of the users of the space.

The multi-case study conducted in 18 organizations in five different countries provided us with first-hand insights on the current state of workspace design. Through observations of users in theses spaces, we were able to gain a deep understanding of how the spaces were actually used by the people. These first-hand insights were only possible through a qualitative approach.

The nine expert interviews provided us with different perspectives on the topic and each one resulted in valuable insights on creative spaces that informed our theoretical propositions.

The longitudinal case study helped us to understand (a) user requirements of different stakeholders, (b) problems regarding the planning and design process of a realistic project, and (c) insights on the final success of the project after the implementation and after two years of use. These insights helped us to better understand such design processes and to develop a set of facilitation tools. The action design research approach for developing the toolkit provided us with

a realistic problem context. The participants were actually in the process of designing a creative space and hence, the feasibility of the developed tools could be tested with realistic requirements. This would not have been possible with a laboratory experiment.

In summary, the qualitative approach proved to be useful and adequate for developing the different types of theories. Only now, after we have developed these theories, can we start to test parts of them through quantitative and experimental studies.

We can particularly recommend the cultural probes method to anyone who is interested in conducting user self-studies in an independent unobtrusive way. However, one should bear in mind that this method is very time-consuming, not only for researchers but also for the participants. Details about the time and effort to develop, conduct, and analyze the cultural probes study (presented in Chapter 4) are summarized in Thoring, Luippold, and Mueller (2013).

9.3.2. Research Validity

Throughout this PhD research, we have tried to establish a high level of research validity. We followed the guidelines suggested by Yin (2003) and Lee and Baskerville (2003) in order to maintain a thorough and accurate degree of qualitative research rigor.

Construct Validity

Through the triangulation of different research sources, different researchers, and different research methods, we were able to keep construct validity at a high degree. Moreover, we used multiple sources of evidence, such as interviews, case study data, and literature, and we tried to establish a chain of evidence at all times. All the conducted studies inform each other and build upon the respective previous one.

Triangulation was conducted at three levels: (1) Triangulation of research methods was applied for the typology development (cultural probes and focus group), for the toolkit development (design science and action research), and for the longitudinal case study (cultural probes study, focus group workshop, interviews, and on-site observations). (2) Triangulation of research data sources was ensured for the pattern language development, where we analyzed 18 different organizations, and for the theory development, which was based on 9 expert interviews. Finally, (3) triangulation of researchers was applied for the typology development, for the theory development, for the pattern development, and for

the longitudinal case study. In these four studies, two researchers collected the data and the analysis results were always doublechecked by a second researcher.

External Validity

According to Yin (2003) and Lee and Baskerville (2003) analytical generalization in qualitative research (as opposed to statistical generalization in quantitative research) does not need a significant sample size. Instead, the "generalization to theory" can be achieved through theoretical sampling of selected corner cases that will provide different perspectives. Consequently, theoretical sampling was the method chosen for selecting the nine experts for our interviews and the 18 organizations for the pattern development. The selected corner cases provided us with rich data that gave us a deep understanding of the topic from different perspectives. Moreover, the real-life cases provided us with real problems for real users in real contexts. This scenario was deemed appropriate for our theory-development and was preferred over a laboratory experiment in an artificial context.

Internal Validity.

According to the nature of qualitative research, internal validity is lower than in quantitative-experimental studies. We cannot rule-out any other possible causes for creative results, apart from the spatial designs. It might be possible that (1) a third construct exists that influences creativity (for example, monetary or other forms of incentives), (2) that there exists a so-called confounding variable, which influences both constructs (for example, a successful company has the financial resources to implement creative workspace designs and to hire creative people), or (3) a reverse causal relationship exists between space and creativity, which means that a peculiar workspace design is the result of the existing creative performance of the organization, and not vice-versa.

However, we pursued an evidence-based approach to increase internal validity. We mapped any occurrences of peculiar spatial designs with possible explanations from existing theories. Those theories (that had already been validated in other areas) were used as a foundation to explain possible working mechanisms of the spatial designs. Through this procedure we were able to increase the internal validity of our studies.

Reliability.
In our research procedures we ensured a rigorous research design to maintain reliability. We collected all our qualitative raw data in several case study databases. (1) The interview data were collected and analyzed using Atlas.ti software. (2) The data from the cultural probes studies were transcribed, summarized, and digitalized. (3) The photos from the 18 case studies were collected in an Excel table along with field notes and annotations from staff members that served as our case study database. Moreover, (4) the analyzed literature was also organized in an Excel table along with annotations and notes.

For all studies we followed a strict case study protocol that defined the same process for each individual case within one study. Therefore, the data collection process is replicable and transparent for any possible follow-up studies. Details regarding the individual study materials can be found in the Appendix.

9.4. FUTURE WORK

The findings of this PhD project yielded several opportunities for future research. The next step would be that the theories we developed are investigated further and possibly validated through experimental and quantitative studies. The focus of future work will be on measuring the creative performance of users according to the spatial adjustments done to the work environment. The redesigned toolkit shall be tested and validated as well, by applying it to further organizational spatial planning projects.

Besides these further investigations of creative spaces, three new areas of interest emerged that will be tackled in future work: (1) quantified creative spaces, (2) creative space personalities, and (3) the future of creative space in general.

9.4.1. Quantified Creative Spaces

In light of new technologies that are becoming smaller, cheaper, and more mobile, also new research approaches emerge that could be used to measure the impact of the work environment on creativity. For example, mobile EEG headsets that measure changes in brainwave activity could be utilized to identify the impact of particular work environments on the brain. Moreover, indoor positioning technologies can be installed to track people's movements within a space, and hence deliver insights about work preferences regarding the spatial design. Social media channels and crowdsourcing provide access to creative spaces worldwide.

"Netnography" (Kozinets, 2010), describes the utilization of the internet for ethnographic research, which enables a large number of pictures from creative spaces worldwide to be collected. Also crowd-based systems such as Amazon Mechanical Turk (Kittur, Chi, & Suh, 2008), could be utilized to have people rate pictures of creative spaces, worldwide. Moreover, text mining and data mining (Hand, Mannila, & Smyth, 2001) would allow for the automated analysis of large amounts of qualitative research data, for example, the automatic extraction of insights from design companies' websites. Finally, experience sampling applications (Christensen, Barrett, Bliss-Moreau, & Lebo, 2003; Hektner, Schmidt, & Csikszentmihalyi, 2007) will provide study participants with a digital application on their phones, through which researchers could send them prompts and surveys. This procedure would allow, for example, to have people photograph their work environments and report on their self-perceived creativity within these environments. Such a study can be compared with our cultural probes study presented in Chapter 4, but on a digital basis and, hence, would allow user research on a larger scale and in different countries.

Moreover, sensor-based measurements could be utilized to investigate people's behavior in a creative work environment. A first step in this direction was presented by Bernstein and Turban (2018), who measured co-workers personal interactions in an open-plan office structure based on wearable sensors.

Also, design science approaches could be enhanced through new technologies. Creative spaces could be designed virtually, or existing spaces could be altered through augmented reality (AR) or virtual reality (VR) systems, and subsequently users would be able to give feedback on such spaces, even before they are built. Giunta, Dekoninck, Gopsill, and O'Hare (2018) presented an overview of augmented reality (AR) technologies for design research. Thoring, Mueller, and Badke-Schaub (2015) presented a general overview of the potentials of new technologies for design research.

In the future, we are planning to continue our research on creative spaces by expanding into these directions. We want to dive deeper into the topic and tackle some of these possibilities that unfold themselves as novel research opportunities.

9.4.2. Creative Space Personalities

Our research on creative spaces has not yet addressed the question whether different spatial requirements apply for different creative personalities. Within the design field, several creative roles can be distinguished (Kelley & Littman, 2005)

that each might require a different type of work environment. Also, beyond the creative role, differences in character or personal taste might impact how people perceive a creative work environment. Models, such as the big five personality traits (Kwang & Rodrigues, 2002; Rothmann & Coetzer, 2003), or Hofstede's Cultural Dimensions (Hofstede, 1980) could be consulted to explain preferences for specific spatial designs. We have already pursued a step in this direction by investigating the possible impact of national culture on various aspects of the design thinking process, which also included the physical work environment (Thoring, Luippold, & Mueller, 2014). Moreover, the question of how organizational culture can be influenced through the workspace design warrants further research. We have already conducted two workshops at two design conferences about the possibilities of the workspace to act as a catalyst for organizational change processes. Future work will include a deeper investigation of the possible relationships between creative personalities, organizational culture, and creative workspace designs.

9.4.3. The Future of Creative Space

The design profession is changing. New developments, such as design thinking or Agile Software Development (K. Beck et al., 2001), require new work environments. Just as the Taylorism movement in the early 20th century, led to a change in office space design (as discussed in Section 2.2.2. on page 42), current developments in managerial practice and organizational culture will also have an impact on the physical work environment.

Moreover, new technological possibilities will have an impact on how and where design will be practiced in the future. For example, parametric design that is based on algorithmic rules, is already standard practice in the design field. With the rise of artificial intelligence, the human designers might need to adjust their role within the design process, which will also have an impact on the requirements of their work environments.

In the educational sector, new forms of teaching concepts have been developed, for example, Massive Open Online Courses (MOOCs) that focus on distant learning via Web tutorials, videos, and user forums. These new forms of education offer many opportunities, such as, teaching an almost unlimited numbers of students. However, such learning environments that are literally without a physical space also bear some challenges, especially with regard to design education, where physical prototyping and teamwork are an integral part of the learning process. Also, in practice contexts virtual collaboration and teamwork

across geographic locations and across time-zones have become an essential part of work. Consequently, the research interest in such virtual environments regarding their capabilities to facilitate teamwork and collaboration has also grown (Elias, Chamakiotis, Howard, Dekoninck, & Culley, 2011; Jones & Lloyd, 2013; Lloyd, 2013).

The questions how such developments will be reflected by and have an impact on the workspace, provide a fascinating field for future research. For example, the question arises, how a physical creative space could be enhanced and augmented through digital and virtual features. Blending virtual and physical spaces could result in even greater support of creativity than both constructs alone. Future research will try to answer the question, how such augmented creative spaces need to be designed in order to facilitate collaboration, to manage design knowledge, to enable process workflows, to create an atmosphere of innovation culture, and to provide stimulation.

9.5. FINAL THOUGHTS

Does space matter at all? In her article "How to Kill Creativity?" Amabile (1998) regards physical space as one of the least relevant factors:

> *"Another resource that is misunderstood when it comes to creativity is physical space. It is almost conventional wisdom that creative teams need open, comfortable offices. Such an atmosphere won't hurt creativity, and it may even help, but it is not nearly as important as other managerial initiatives that influence creativity. Indeed, a problem we have seen time and time again is managers paying attention to creating the 'right' physical space at the expense of more high-impact actions, such as matching people to the right assignments and granting freedom around work processes." (Amabile, 1998, p. 82).*

As we have demonstrated in the previous chapters, space can indeed make a difference. Therefore, we argue that Amabile's statement above is not showing the full picture. We acknowledge, that space alone is not sufficient for guaranteeing a creative outcome. Without the right people with the right creative mindset, even a well-designed creative workspace is not enough. However, the space could make it *easier* for those people to perform creatively. Creative space can provide an environment that supports a creative person or a good team in such a way that they can focus on *being creative*, rather than dealing with distracting noise, lacking infrastructure, or uncomfortable chairs. Moreover, a space can *inspire* people. They might even surpass themselves creatively, when the environment makes them feel welcomed, relaxed, encouraged, or entertained. And finally, the

space might provide them with opportunities and facilities to meet other creative people.

We would like to stress the relevance of a well-designed workspace for facilitating all of these aspects and encourage the readers to spend a little of their time on improving their own workspace. This thesis hopefully contributes to raising awareness on this relevant and fascinating topic.

We conclude with a wonderful quote by philosopher Alain de Botton.

> *"One of the great, but often unmentioned, causes of both happiness and misery is the quality of our environment: the kind of walls, chairs, buildings and streets we're surrounded by."*
>
> *Alain de Botton (2008)*

So, let us design inspiring, stimulating, knowledge creating, cultural, social, more creative, and — simply better workspaces.

THE LIBRARY

On your way out, stop again at the library and take a closer look at all the books and papers that have informed this thesis.

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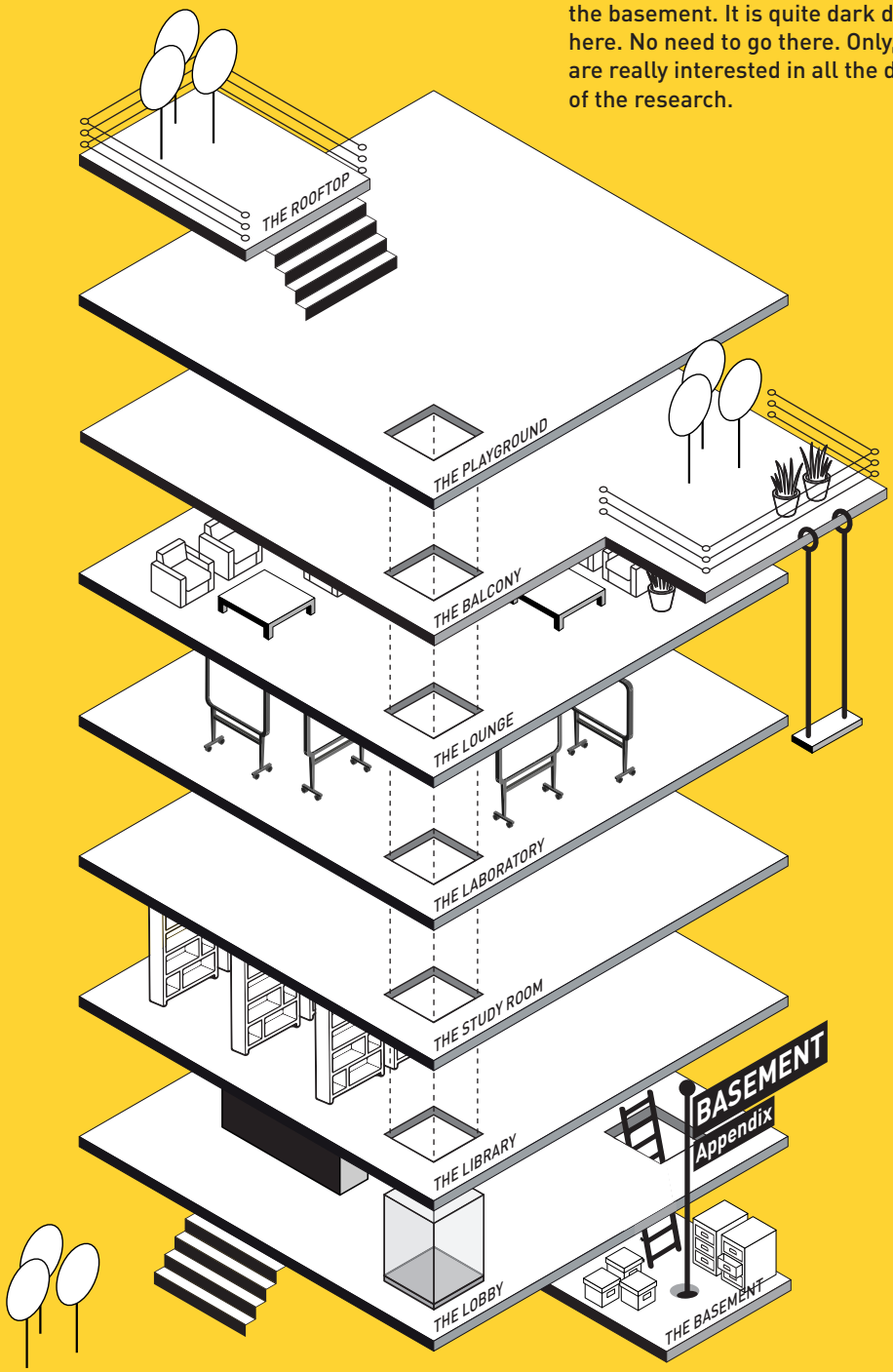
THE BASEMENT

Just to let you know ... there is also the basement. It is quite dark down here. No need to go there. Only, if you are really interested in all the details of the research.



APPENDICES

The following pages present those materials that did not find their place in the main body of this thesis.

Appendix A shows the items of the cultural probes box, presented in Chapter 4, on page 76. The items were prepared in both, English and German and distributed to the participants according to their native language. The Appendix shows only the English versions.

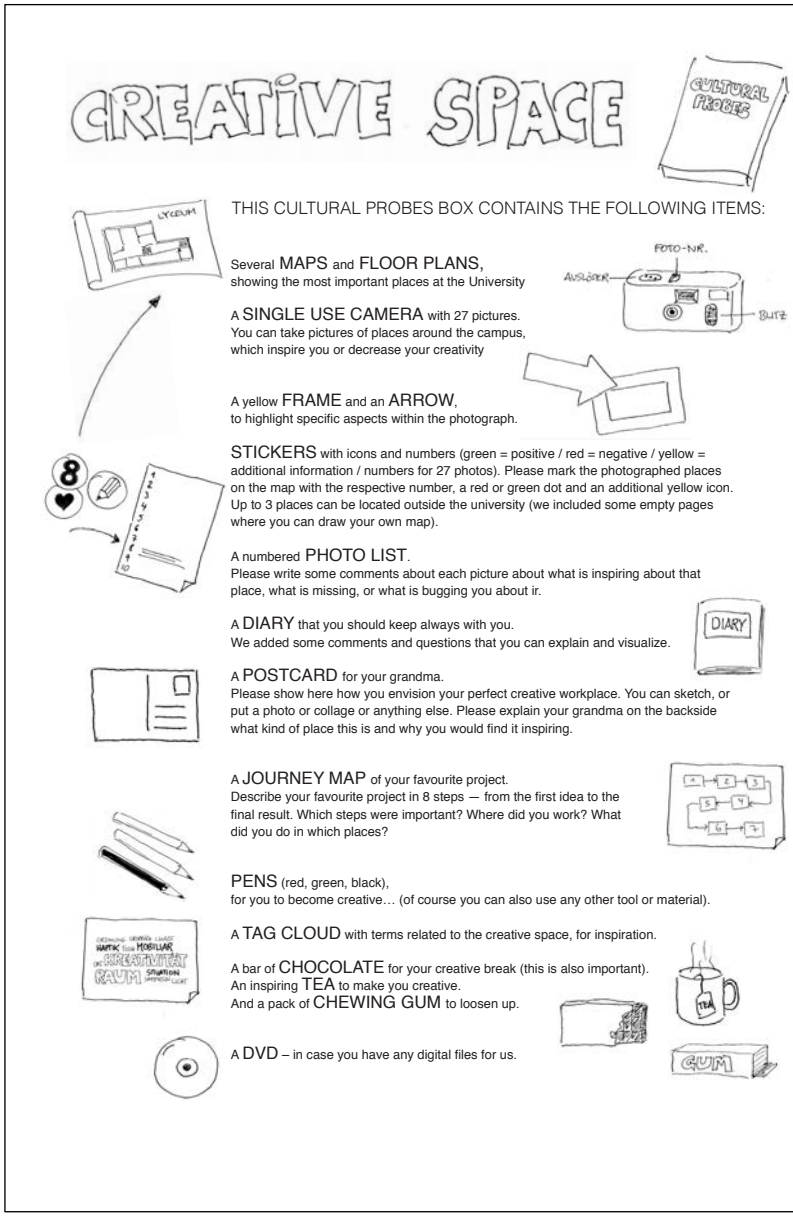
Appendix B presents the open-ended questionnaire that guided the expert interviews (Chapter 6, page 158). This questionnaire was prepared in English and German as well, because different languages were spoken by different interviewees. Only the English version is included in the Appendix.

Appendix C outlines the coding structure that was used to code the transcribed interview data and to develop the causal theory of creative spaces (Chapter 6, page 161).

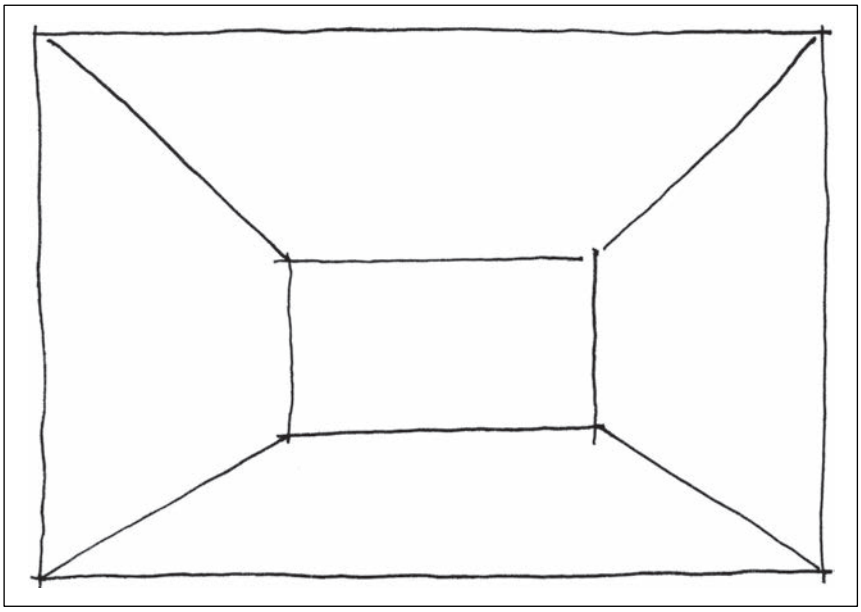
Appendix D shows the questionnaire used to inquire feedback on the toolkit (Chapter 8, page 213).

The remaining appendices outline the author's Curriculum Vitae and the acknowledgements.

APPENDIX A: CULTURAL PROBES ITEMS (FOR TYPOLOGY DEVELOPMENT)



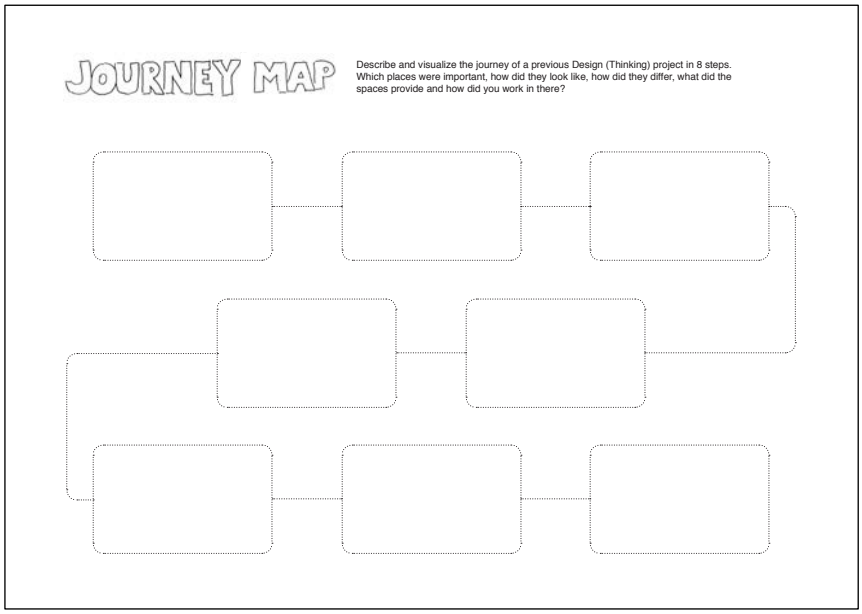
Appendix A.1: Instructions page (A4 format)



Dear Grandma!
Being a Designer is not easy. You have to be creative all the time. I was thinking about the perfect creative place where I could work on my ideas.
I'm sending you my vision as well as some comments about this ideal workplace. It should be…

The personal dream workplace of: ..... (your Name)

Appendix A.2: “Postcard to Grandma” to describe a perfect workspace (A6 format)



Appendix A.3: Journey map “My Project in 8 Steps” (A3 format)

Appendix A.4: Set of round stickers (printed on self-adhesive labels)

photo-no.	description of the place	what is inspiring?	what is missing?	what disturbs?
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
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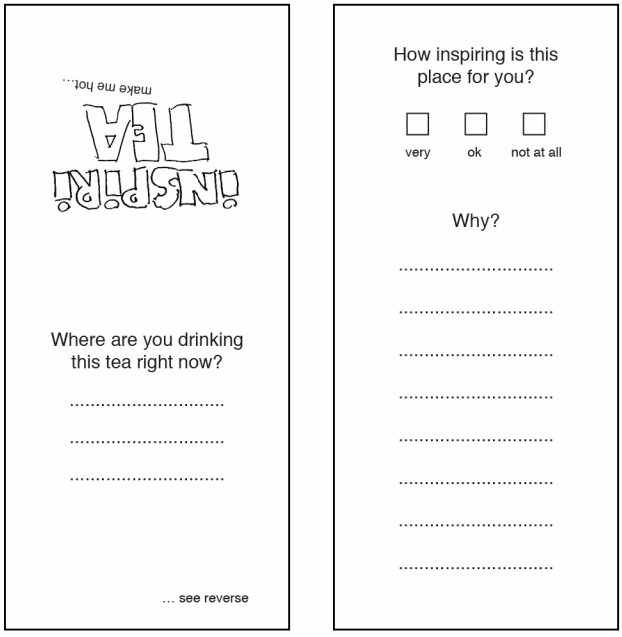
26				
27				
28				
29				
30				

Appendix A.5: Photo list (A4 format)

Appendix A.6: Tag cloud for inspiration



Appendix A.7: Teabag wrapping for random probing.

Appendix A.8: Chocolate wrapping for random probing.

APPENDIX B: INTERVIEW GUIDELINE (FOR THEORY DEVELOPMENT)

1. Thank the participant; explain the research project and its goal.
   Ask for consent to audio record the participant and to mention his/her name.
2. Please introduce yourself, state what your position, role, expertise is.

Introduction and Formalities

3. What kind of space do you usually work in?
4. Do you think that the physical environment has an influence on creative work? If so in what ways?
5. What kind of activities need to be considered in creative work spaces? Are there different types of creative activities?
6. Do you think these activities should be physically separated or close to each other? Explain.
7. Please describe [your / an exemplary] creative work space.
   - What do you find positive? Why?
   - Are there any problems regarding the environment? Which ones? Is something missing, distracting, or annoying?
   - Do you have a favorite spot (within this environment) for creative activities? What and Why?
   - Is there a spot (within this environment) that you don't like? Why not?

Warmup
Opener to the Topic
Personal Preferences

8. Types of Spaces:
   - Are there spaces for personal withdrawal? Do you think this is important?
   - Are there spaces dedicated for teamwork, meetings, collaboration? What do these look like?
   - Are there spaces dedicated to presentations (things, verbally)? Please describe them.
   - Are there spaces dedicated to tinkering, where one can make noise and dirt? Please describe them.
   - Are there other relevant zones (In between/Transition Zones)? Please describe these and their role. Spaces in between others, hallways, outside, distances, etc. do these play any role?

Space Types

9. Spatial Qualities:
   - What kind of stimulation and inspiration can the space provide (in a positive and negative sense)?
   - How can space facilitate social interactions?
   - How can space store (and display) information and knowledge?
   - Do you promote a specific (company) culture regarding the spatial environment? How can space express such a culture?
   - Can the space somehow guide the creative workflow (enforce or prevent specific process steps or activities)?

Spatial Qualities

10. Characteristics of Space

- What role does light play?
- What role does a view of something play? (Windows, adjacing rooms). What kind of view supports creative work?
- What role do colors play? Please name 3 colors you think are positive for creative work, and why.
- What about walls, floors, textures, structures, wallpapers, etc. Can you name positive or negative examples?
- What role do materials play? Please name 3 materials you think are positive for creative work, and why.
- What about noise and sound in general?
- What about smells ?
- What role do plants and flowers play?
- What about the general climate? (temperature, air quality)
- What role does furniture play? How should it be designed?
- What role do spatial proportions play? (room size—furnishing ratio, ceiling heights, squared/rectangular/round floorplan)
- What do you think about interior style?
- Is there any other spatial equipment or infrastructure that is important?
- What about access rights? Who should have access and what kind of access?
- What about the customization of spaces?
- What about flexibility?
- What do you think about games and toys within the space?
- Can the environment enhance or reduce stress? Are there any health issues related to the space?
- What about the facilitation of the space? Who is responsible?
- What role does the location play (in relation to ... city center, campus, home...)?

Spatial Characteristics and Instantiations

11. Can you rank the previously mentioned characteristics according to their relevance for creative work? Please name your personal Top 3.

Prioritization

12. Do you know any interesting stories/anecdotes related to the space?
13. Is there anything more you find important or you would like to mention?

Additional Thoughts

APPENDIX C: INTERVIEW CODING STRUCTURE (FOR THEORY DEVELOPMENT)

IMPACT (ON)	• Learning • Creativity • Wellbeing
EVALUATION	• Positive Perception • Negative Perception • High Priority • Low Priority
SPACE TYPES	• **Personal Space** – Empty rooms – Individual public space (Headphones, Library,) – Individual Booths – Private space – Individual Workstations • **Collaboration Space** – Classroom – Studio – Outside – Cafeteria – Kitchen – Feedback Space (Meeting Space, Critique) – Meeting Room • **Presentation Space** – Auditorium – Exhibitions – Showcases, Wall-Posters, Shelves – Classrooms – Studios – Meeting Room • **Making Space** – Workshop – Tinker Desk • **Intermission Spaces** – Cafeterias – Kitchen – Hallways – Restrooms – Stairs – Elevators – Exterior (Parks, Yards, ...)

SPATIAL QUALITIES	• **Stimulation** – Inspiration – Distraction – Surprise – Disturbance • **Social Dimension** – Coincidence – Separating – Enforced • **Knowledge Processor** – Accessibility – Visibility – Tacit – Codified – Embedded in Artifacts • **Culture** – Rules – Rituals – Responsibilities – Rights – Tolerance • **Process Enabler** – Flexible – Fixed – (Forced) Behavior – Workflow (Facilitation)
SPATIAL CHARACTERISTICS	• **Colors** – Neutral – Absence of Colors – Bright – Color–Accents – Warm Colors – Cold Colors • **Flexibility** – Moveable – Foldable – Adjustable

SPATIAL CHARACTERISTICS	• **Furniture** – Chairs – Tables – Stools – Storage – (White)Boards – Divider, Paravent – Sofas • **Health Issues** – Ergonomics – Relaxation – Stressfulness – Movement • **Light** – Natural – Artificial – Warm Light – Cold Light – Lamps • **Location** – Accessibility – Central, Busy, Crowded – Context (Historic) – Remote (Rural) – Suburbs (Peripheric) – Integrated Buildings – Separated Buildings • **Materials** – Wood – Metal – Concrete – Textile (Felt) – Plastic – Sustainability – Glass • **Objects** – Books – Materials (Prototyping Material, Post-its) – Gadgets, Toys, Games – Models / Prototypes – Tools

SPATIAL CHARACTERISTICS	• **Plants and Flowers** – Inside – outside • **Room-Layout** – Proportion – Heights – Size (related to people/furniture) – Open Space • **Smells** – Food – Coffee – Workshop Materials Smell • **Sound** – City Environment – Nature Environment – Conversations – Music – Workshop Environment – Noise • **Structural Characteristics** – Textures – Walls – Floors – Transparency • **Style** – Improvised / DIY – Clean – Office-style – Chaotic – NoStyle • **Technology** – Screens, Projection – Sockets – Computers – High-Tech Furniture – Internet, Wireless Connection – Video Conferencing Equipment • **View** – Windows – Across-Rooms – Urban View – Nature View

APPENDIX D: SURVEY QUESTIONS (FOR TOOLKIT EVALUATION)

Creative Space Workshop Evaluation

Dear Participant.
With the following questionnaire I want to hear you opinions about the Spatial Planning Workshop conducted at NTU on Monday July 4th. Your responses will contribute a lot to my research and help me to improve the toolkit. I very much appreciate your help and collaboration. Thank you very much for taking the time!

* Required

1. **Your role in the workshop was:** *
   Mark only one oval.

   ◯ Student
   ◯ Staff
   ◯ Observer (only check this if you did not actively participate in the workshop tasks)

Skip to question 2.

Purpose of the Workshop

2. **What was the main purpose of the workshop for you? (multiple answers allowed)** *
   Check all that apply.

   ☐ to detect possible problems before actually building the space
   ☐ to test user acceptance of the planned spatial design
   ☐ to co-create ideas for the spatial design
   ☐ to identify user requirements for the space
   ☐ to express my concerns about problems in the existing spaces
   ☐ to be inspired by (or learn from) the toolkit for future projects
   ☐ Other: _____

3. **How useful was the workshop in general for the purpose(s) specified above?** *
   Mark only one oval.

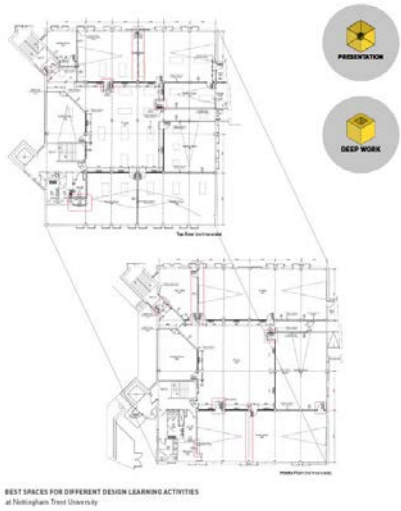
	1	2	3	4	5	
not useful	◯	◯	◯	◯	◯	very useful

4. **If the workshop was purposeful to you, can you describe in your own words in what way?**

Workshop Materials (the "Toolkit")

In the following, I would like to hear about your thoughts of the different workshop materials.

1. The Floorplan with Stickers



5. **How useful were the provided NTU Floorplan and Stickers for the purpose(s) you specified in Section 1?** *

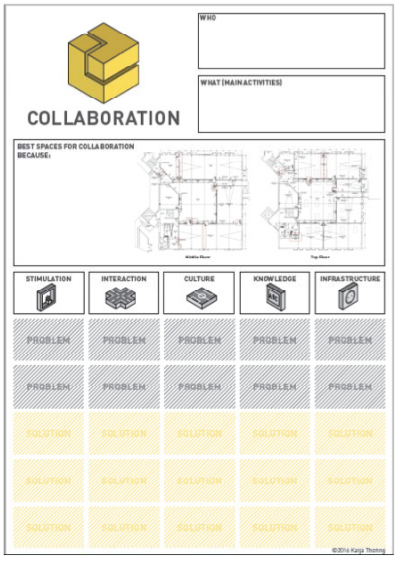
Mark only one oval.

	1	2	3	4	5	
not useful	◯	◯	◯	◯	◯	very useful

6. **What changes or improvements would you suggest to the Floorplan and/or Stickers?**

7. **If any, what qualities or value did the Floorplan and Stickers bring to the workshop?**

2. The Posters for the five Space Types



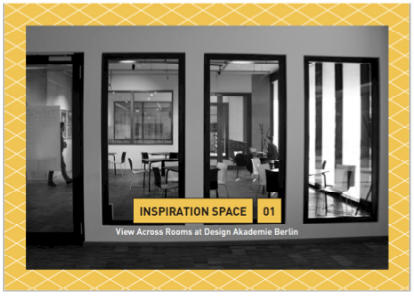
8. **How useful were the Posters for the purpose(s) you specified in Section 1?** *
Mark only one oval.

	1	2	3	4	5	
not useful	◯	◯	◯	◯	◯	very useful

9. **What changes or improvements would you suggest to the Posters?**

10. **If any, what qualities or value did the Posters bring to the workshop?**

3. The Inspiration Card Set with Examples



11. **How useful were the Inspiration Cards for the purpose(s) you specified in Section 1?** *
Mark only one oval.

	1	2	3	4	5	
not useful	◯	◯	◯	◯	◯	very useful

12. **What changes or improvements would you suggest to the Inspiration Cards?**

13. **If any, what qualities or value did the Inspiration Cards bring to the workshop?**

4. The Problem Checklist with Trigger Questions

14. **How useful were the Problem Checklists (with the Trigger Questions) for the purpose(s) you specified in Section 1?** *

Mark only one oval.

	1	2	3	4	5	
not useful	◯	◯	◯	◯	◯	very useful

15. **What changes or improvements would you suggest to the Problem Checklists?**

16. **If any, what qualities or value did the Problem Checklists bring to the workshop?**

5. The Postcards (Problem and Solution Space) to take home

17. **How useful were the Postcards for the purpose(s) you specified in Section 1?** *
Mark only one oval.

	1	2	3	4	5	
not useful	◯	◯	◯	◯	◯	very useful

18. **What changes or improvements would you suggest to the Postcards?**

19. **If any, what qualities or value did the Postcards bring to the workshop?**

20. **How likely would you use the materials/toolkit again for future projects or different aspects of the current project?** *
Mark only one oval.

	1	2	3	4	5	
not likely	◯	◯	◯	◯	◯	very likely

21. **If you would use the materials/toolkit again, for what purpose would you use it?**

22. **Which one was your favorite item from the provided materials?**
Mark only one oval.

- ◯ Floorplan with Stickers
- ◯ Posters for Space Types
- ◯ Inspiration Card Set
- ◯ Problem Checklist (with Trigger Questions)
- ◯ Postcards to take home

23. **Please explain your answer**

Degree of Self-Explanation

24. **How self-explanatory was the provided material?** *
Mark only one oval.

	1	2	3	4	5	
not self-explanatory	◯	◯	◯	◯	◯	very self-explanatory

25. **If any, what aspects or elements required explanation?**

26. **How well would the workshop have worked without the provided input/presentation in the beginning?**
Mark only one oval.

	1	2	3	4	5	
not well	◯	◯	◯	◯	◯	very well

27. **Please explain your answer**

28. **What medium would be appropriate to explain the usage of the toolkit if there was no input/presentation in the beginning?**
Check all that apply.

- [ ] Video summary of input/presentation
- [ ] Animation
- [ ] Brochure or printed instructions
- [ ] Other: _____

Overall Experience

29. **How would you rate the workshop and the toolkit overall?** *
Mark only one oval.

	1	2	3	4	5	
not good	◯	◯	◯	◯	◯	very good

30. **Please explain your answer**

_____

_____

_____

_____

_____

31. **How useful were the workshop and toolkit for the planned spatial design project at NTU?**
Mark only one oval.

	1	2	3	4	5	
not useful	◯	◯	◯	◯	◯	very useful

32. **Please explain your answer**

_____

_____

_____

_____

_____

33. **Did the workshop and the toolkit change any previously existing plans for the spatial design of NTU?**
Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Maybe

34. **Please explain your answer**

35. **How likely would you attend another workshop again for future projects or different aspects of the current project?**
Mark only one oval.

	1	2	3	4	5	
not likely	◯	◯	◯	◯	◯	very likely

36. **Please explain your answer**

37. **How likely would you recommend the workshop for others who are planning a similar project?**
Mark only one oval.

	1	2	3	4	5	
not likely	◯	◯	◯	◯	◯	very likely

38. **Please explain your answer**

ABOUT THE AUTHOR

Katja Thoring was born on January 9, 1971 in Berlin, Germany. She studied Industrial Design at the University of the Arts Berlin (UdK) and spent one year studying abroad at the California College of the Arts (CCA) in San Francisco. She obtained her Master's Degree in Industrial Design from the UdK Berlin in 2002. After running her own multidisciplinary design agency for several years, she started as a research associate for design foundations at the UdK Berlin. In 2009 she was appointed full professor for practice in integrated design at Anhalt University of Applied Sciences in Dessau, Germany, where ever since her appointment she has been teaching design foundation courses. In addition, Katja worked as a part time coach at the HPI School of Design Thinking in Potsdam, Germany. Here, she taught design thinking to multidisciplinary project teams for more than five years.

Katja discovered her passion for research and academic writing in 2012. Her various research interests center around the topics of design thinking, design education, creativity, new technologies, research methods, and innovation management. She has presented her research at numerous conferences; the range includes ICED, DRS, IASDR, DESIGN, E&PDE, Design & Emotion, and ICDC in the design field; DMI, and ADIM in the field of design management; and CHI, AMCIS, and HICSS in the fields of Computer Sciences and Information Systems. In total, she has published three journal papers and 30 conference papers. She was awarded the *best paper award* at the ADIM conference 2017 in Hong Kong, and was nominated for the best paper at the AMCIS conference 2010 in Peru. At the ICED conference 2015 in Milan, her paper was rated among the best 10%. At the ADIM conference 2019 in London, she was honored as one of the top three "Upcoming Early Career Researchers." Besides presenting research papers, she has also conducted several conference workshops, for example, about experimenting with new technologies for design research, or analyzing work environments regarding the organizational culture. She is also a frequent reviewer for various journals, including *Design Studies*, *Design Science*, and *Creativity and Innovation Management*, as well as for E&PDE, ICDC, HICSS, and CHI conferences.

In 2014 Katja became an external PhD Candidate at Delft University of Technology. She pursued her doctoral research on the influence of the physical work environment on creativity and innovation.

In 2016, Katja organized and chaired the annual conference of the German Society for Design Theory and Research (DGTF) in Dessau. The conference was held in the historic Bauhaus building and hosted almost 250 delegates, presented two keynote speakers, eight workshops, six panel discussions, and numerous paper presentations. A concurrent exhibition showcased the Design faculty's current design research. Katja has also consulted numerous companies regarding design thinking and how to improve their work environments. She regularly holds guest lectures and is a keynote speaker at various practitioner's events.

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… So, by now I am "married to science." Fortunately, my other marriage is not a very jealous one. Actually, science has always been part of our relationship (we even got married during a scientific conference). Roland, thank you for encouraging me to undertake this endeavor of doing my PhD, for countless breakfast discussions about research methods and citation styles, and for believing that I can do this. I dedicate this piece of work to you.

This is where the real
creative work happens.

TU Delft
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