Architects understand and visualize organizations and processes differently from their counterparts in management disciplines. With the increasing complexities of markets and blurring of organizational boundaries, linear models of innovation processes are unable to account for the range of possible interrelations and interdependencies. Design-led disciplines have become of interest in providing frames and ‘design’ structures for fostering innovation. Though it deals specifically with the conceptualization and realization of R&D and innovation centres, architecture has been largely overlooked in this regard. This paper explains how architects’ approach to reframing complexities, focusing on social interactions and shaping invisible patterns prior to building design offers new perspectives for innovation research. It critically reviews the changing context of innovation and relational models in the literature, and outlines the relevance of integrating spatial proximities and time for a constructive 3-dimensional representation. Via two case studies, the basic principles for the development of an integrative approach are sketched out and suggestions made for further research. The specific skill-set and thinking of architects offers a 3rd dimension of innovation processes.

Keywords: innovation process, innovation architecture, design, 3rd dimension, spatial proximities

Leaving the Plan

Architects understand and visualize organizations and processes differently from their counterparts in management disciplines. While management focus on the performance and competitiveness of the company, architects use their analyses and depictions for the purpose of building design (Boland & Collopy, 2004; Schürer & Brandner, 2004; Martin, 2013). They seek to understand the interrelations and interdependencies of processes and workflows, align them to requirements of physical areas and technical equipment, and synthesize a new whole bringing the different and conflicting parts together under one theme (Lawson, 2005; Nelson & Stoltermann, 2012). Especially when assigned to research & development projects (R&D), e.g. the design of a new innovation center, architects seek to map existing workflow patterns and to integrate the new requirements given by the client. Architects can challenge the given demands and create together with client and user an alternative conception of how the organization will work, produce and innovate in the future (Schürer & Brandner, 2004; Shamiyeh, 2007). This systemic architectural approach, prior to the design of a building, has the potential to create new perspectives on the company’s processes, to visualize what was previously invisible and transform it into new ways of working and innovating. Given the increasing complexity in markets, products and services and the growing need for dynamic forms of collaboration and co-operation across departmental and organizational structures, an architectural approach can provide an fresh understanding of today’s and future innovation processes (Boland & Collopy, 2004; Shamiyeh, 2007; Burke & Tierney, 2007; Hidalgo & Albors, 2008; Laloux, 2014). Architecture, as first hypothesis in this paper offers a 3rd
dimension to innovation processes, which leads to future-proof organizational designs. This perspective has so far been obscured by its focus on physical results, and thus inaccessible to both architects and managers.

Management, on the other hand, has started to change its view on innovation and innovation processes by approaching creative fields (Boland & Collopy, 2004; Buchanan, 2008; Martin, 2013). While in the second half of the past century innovation progress was pursued by quality improvement, process optimization and efficiency increase to serve consumer needs, the strong one-directional push altered in the 1980s (Martin, 2009; Trott, 2012). Existing managerial methods, models and tools have become less applicable in coping with complex environments, demands and the transition into a post-industrial era of services, networks and platforms driven by the advances in information technology (Boland & Collopy, 2004; Chesbrough, 2005; Burgelmann, Christensen & Wheelwright, 2009; Trott, 2012). Developed in stable circumstances, linear ways of thinking as well as the focus on decision making as choosing between existing alternatives - instead of the creative generation of entirely new options - have struggled with pivoting strategies for companies and in imagining future markets (Boland & Collopy, 2004; Christensen, 2016). With the growing importance of innovation for remaining competitive, management have turned to design disciplines, which have had to tackle similar problems of complexity and wickedness, but dealt with them in a different, creative and non-linear way (Buchanan, 1992; Rith & Dubberly, 2006; Martin, 2009). Design thinking has thus begun to receive wider attention as means to support creativity, collaboration and to be suitable in dealing with complex challenges. It became integrated in companies as a structured innovation, creativity and collaboration method (Carlsgren, 2013; van der Pijl, Lokitz & Solomon, 2016). Interdisciplinary teams, face-to-face interaction, equal participation of team members, valuing ideas of any kind, forward oriented action using a broad set of tried and tested tools, and continuous visual communication to create a common understanding are vital for the process’ success (Brown, 2008; van der Pijl et al., 2016; Lewrick, Link, Leifer & Langensand, 2017). By outlining prototyping and the focus on user and markets, the design thinking method tests ideas and concepts and iterates them until a promising solution is reached or agreed upon (ibid.). Though it emphasizes collaboration, it does not explain how and where innovation occurs for an entire organization. After years of intense implementation in management challenges across industries, the method in its structured form and emphasis to specific tools is facing criticism for not developing radical new ideas for the market and society (Keeley, Pikkel, Quinn & Walters, 2013; Verganti, 2017).

Innovation as a social process depends on the interaction, the understanding, perception and acting of people (Fagerberg, Mowery & Nelson, 2005; Fichter, 2014; Godin, 2017). Despite current distance-shrinking technologies and advances in digitization, face-to-face communication still is of the highest importance for successful teams and employees (Waber, Magnolfi & Lindsay, 2014). The engagement of a team is equally important for its success in creating something new, as is the exploration, i.e. moving outside the group for contrarian views and inspirational thoughts (Pentland, 2015). Awareness for social interaction has risen in recent years (Groves & Marlow, 2016). Despite the research on the correlation of direct social interaction with creativity and innovation, management disciplines have hardly integrated human or social factors in organizational approaches or models of innovation. Management, as second hypothesis put forward in this paper, has to leave its two-dimensional understanding as descriptive plan or graph over time and consider the complexity, simultaneity and parallelism of social interactions between involved people in space for sustainable innovation processes.

The paper is an excerpt of a currently running doctoral project on the architecture and design of innovation processes applying the thinking and tools of architects. Firstly, the changing context of innovation and their processes to express the need for alternative approaches is explained. This 1st dimension of innovation, retrieved from the text and literature review, is followed by an outline of the 2nd dimension: the management of innovation over time, based on linear descriptive and normative models. The 3rd dimension of innovation turns its view to an alternative conception of architecture beyond building design. The characteristics of architectural thinking are described in their applicability to innovation research and management. To underpin the approach, two case studies from architecture are presented, which deal with the analysis and creation of innovation processes for small-and-medium-sized engineering companies in Germany. The paper closes with an outlook on the next steps of research within the doctoral project.

The 1st Dimension - Describing the Changing Context of Innovation as Text

Literature on innovation has grown significantly in the past two decades (Chesbrough, van Haverbeke & West, 2014; Goffin & Mitchell, 2017). With the ongoing technological advances and growing digitization, new
business models have appeared, new forms of organization have evolved, and new approaches to innovation have been developed (Chesbrough et al., 2014). As the capability and potentials to innovate have become core to a company’s competitiveness, the interest in how to innovate faster, more radically or disruptively has risen across industries (Chesbrough et al., 2014; Christensen, 2016). With the creative turn of management towards design thinking, agile methods and open frameworks have become more widely used (Martin 2009, 2013). Alternative definitions of innovation are leaving the industry-bound context of technological innovation with its reliance on quantifiable and trackable improvements (Keeley et al. 2013). Design manuals, playbooks and toolboxes are published to guide companies into becoming open, agile, adaptive and resilient (Keeley et al., 2013; Uebernickel, Brenner, Pukall, Naef & Schindlholzer, 2015; Lewrick et al., 2016). Though the recent publications for practitioners use graphical elements, diagrams and pictures for formulation and explanation, the greater part is text-based (ibid.). The changing context in which innovation happens is described in verbal analyses, case study descriptions, lists of insights or principles of action (ibid.; Hidalgo & Albors, 2008). Among the multiple aspects innovation has to deal with, three are currently receiving much attention, which the same time relates to the field of architecture, and are relevant for the above-stated hypothesis.

Innovation deals with current and future forms of complexities, what has to be captured, challenged and reframed: the complexity of the environment, the complexity of the problem formulation, and the complexity of the process itself (Rith & Dubberly, 2006; Martin, 2009). Through all these levels, dealing with complexity implies actively working with and accepting uncertainty, in order to observe, understand, interpret the specific characteristics of innovation tasks as open, wicked problems, and to acknowledge that in future the solution to a task will be less scalable for market penetration (Conklin, 2006; Prahalad & Krishnan, 2008; Martin, 2009; KPMG, 2011). Prototypes may become the final state of a product, which means that innovation will lose scalability and diffusion as an element of its definition (ibid.). Complexity theory besides being a field of research in its own right seems to “fight complexity with complexity” as Senge puts it, questioning existing analytic tools, thereby forecasting techniques and strategic plans in their applicability to dynamic complexities (Senge, 2006, p. 72). In his view, analysing, modelling and forecasting detailed complexity prevents us “seeing patterns and major interrelationships” for the creation of “dramatic breakthroughs in managing a business” and requires the fifth discipline of systems thinking (ibid., pp. 71-72.). Simon et al. (1986) point in a similar direction by valuing alternative tools – absent from linear management thinking – to cope with complex problems in business:

"Most corporate strategy problems and governmental policy problems are at least as ill structured as problems of architectural or engineering design. The tools now being forged for aiding architectural design will provide a basis for building tools that can aid in formulating, assessing, and monitoring public energy or environmental policies, or in guiding corporate product and investment strategies." (Simon et al., 1986, p. 29)

Secondly, for innovation, social interaction is becoming the focal point on multiple levels and scales, as who interacts with whom matters (Lundberg, Sutherland, Blazek, Habicht & Penzenstadler, 2014; Groves & Marlow, 2016; Sørensen & Mattsson, 2016). The inner workings of a novel idea coming into existence depends on the behaviour of various people interacting with each other, their involvement, engagement, and labour. They exchange thoughts and tacit knowledge, they contribute to or are part of the development of an invention and its implementation (Fagerberg et al., 2005; Nasiri, Alleyne, Yihui & Nisar, 2016). An organization relies on its organizational structure, culture and the capacity and skills of its employees and networks to innovate (Chesbrough, 2006; Laloux, 2014). Social interactions which drive innovation are characterized by creativity at individual, team, and organizational level (Mumford, Hester & Robledo, 2012). The people involved share a deep understanding or empathy for complex processes, systems, and meanings; they evaluate and interpret, immerse themselves in requirements and needs to imagine preferred states which ought to be (Verganti, 2009; Nelson & Stolterman, 2012; Fichter, 2014). They show proximity in collaboration and co-creation, spatially and relationally, for the exchange of ideas and their further progress (Waber et al., 2014; Groves & Marlow, 2016). The importance of who is interacting and when needs to be linked to the dimension of where – in both the physical and virtual realms. When dealing with innovation, it is becoming important to consider how people act creatively, empathically and relationally as well as in spatial proximity to each other, regardless of their function or departmental belonging (Fichter, 2014; Groves & Marlow, 2016).

Thirdly, to foster innovation, the activity is shifting from process management to process design (Verganti, 2009; Martin, 2009; Lockwood & Papke, 2018). Designing a process implies a synthesizing approach, where different elements and often conflicting parts are integrated into a new whole (Nelson & Stolterman, 2012). It requires to think of organizations, their people and physical assets as a system where the parts interact with
Design does not simply turn existing situations into preferred ones; it adds meaning and purpose to the new whole, which is then accessible to the people within (Simon, 1996; Verganti, 2009, Nelson & Stolterman, 2012). It escapes the linearity of process and allows for simultaneity and real-time interaction on multiple levels. Innovation processes designed as systems show an emergent property allowing ideas to evolve into innovations over time beyond a project schedule (Allen & Henn, 2007; Groves & Marlow, 2016). The awareness of process and emergence can be achieved by being visual and comprehensible, and connecting the involved, interested or unrelated actors by depicting their location and proximity spatially in a model (Allen & Henn, 2007; Lockwood & Papke, 2018). Design aims for changes in behaviour and the appropriate design of an innovation process may lead to or foster innovative behaviour (Buchanan, 2015). A systemic view of the process design helps becoming aware of the complexities and considering the dimension of time and emergence in an iterative way. It needs to be visual for awareness, communication, and engagement (Fichter, 2014; de Mozota, 2013).

**Figure 1:** Changing context for innovation processes: dealing with complexity, focusing on social interactions and designing processes. Author’s own representation.

**The 2nd Dimension - Management of Innovation over Time**

Innovation research and management focus on the characteristics of innovation, which are different from business operation. Innovation research explains how innovations occur and what the drivers are, while innovation management provides the framework to manage and foster the processes (Fagerberg et al., 2005; Hauschildt, Salomo, Schultz & Kock, 2016). While it is an interdisciplinary field integrating perspectives and approaches from other areas as sociology and psychology, management is the leading domain (Fagerberg et al., 2005; Burr, 2014; Godin, 2017). In its beginnings, research and development centres shaped an era of technology-push, bringing advances in sciences and technologies from the corporate side to the market (Godin, 2017). This phase described as first generation of management of innovation processes, linear and sequential; the second generation focused on market demands and developed innovations by a close analysis of needs; the third generation pursued a combination of the two paradigms as iterative model; innovation occurred by technology-push, from companies to demands, and by market-pull, from users to companies. In its current fourth generation, the management of innovation has opened towards “a network of partners designing an integrated innovation system” (van der Duin, Ortt & Aarts, 2014, p. 489). The shift from a closed innovation paradigm, characteristic of the preceding generations, towards an open innovation paradigm has altered the relation between companies and external actors (Chesbrough, 2005). The mind-set on innovative activities has shifted from a company centric view to a dynamic network view, where people, technologies and
ideas were sourced and aligned across and outside the company’s boundaries. The open innovation paradigm changed the attitude towards internally developed ideas beyond the core scope of services or products.

Innovation management in German innovation research is defined as conscious design of an innovation system, consisting of the single processes and institutions in which these processes occur (Hauschildt et al., 2016). It requires an integrative approach of leadership, resources and diffusion, distinct from R&D Management, and favours a dynamic approach and culture, in which innovation teams are encouraged to proceed for radical innovations without specified or SMART goals, which tend to be inhibitors (Hauschildt et al., 2016).

Models of innovation have tried to explain the processes behind it. In the 1960s, models started to be used and were multiplied in subsequent decades (Godin, 2017). Analytical models put “a conceptualization or theorization [...] into a schema, graph or diagram.” (ibid., p. 2). The process models later evolved into system models, considering the whole and parts, relations, factors, and causes. Their basic function is of a rhetorical nature; it gives form to reality or a theory, acts transcursively, advertises a conception and pretends a scientificity with a synthesizing virtue, attractiveness, abstraction and promise of success (Godin, 2017, pp. 213-215). In his analysis of models of innovation, Godin (2017, p. 181) deduces their meanings: models are simplified conceptualization of reality, a narrative of sequence of events, a paradigmatic perspective or a graphical figure in the form of chart, diagram, scheme or cycle. In its fifth meaning as a tool, models of innovation are a theoretical structuring device or a practical guide to become pragmatic, decide, check, teach and highlight important points. In contrast to other disciplines, including architecture, the innovation model in innovation research “is not an instrument to explore, manipulate, and experiment with a theory, to stimulate the world and get better theories.” (Godin, 2017, p. 208). Models are used in a prescriptive and descriptive way, instead of being constructive or prospective and so creating an alternative reality (Cross 2007a). The process models show a step, phase or stage thinking of a sequence over time; systems model thus display the structure of a process, than a conception of interacting parts (Godin, 2017).

Another classification of relevance for relating architecture to innovation research, groups models in voluntaristic, contextual and interactive models. Until the turn of the millennium the prevailing understanding of voluntaristic models emphasized the individual actor (e.g. persons, organizations, R&D departments) in a linear way; contextual models outlined innovation as responses to changed circumstances and markets depending on organisational structures and industry sectors (Fichter, 2014). With increasingly dynamic markets, growing collaboration and complexity, interactive models gained in importance. They focused on holistic-systemic, process and interactive points of view, where the non-linearity and non-directed creative dynamism of the innovation process could be explained more accurately (ibid.).

In a review of innovation process design methods, 63 different approaches were mapped and analysed according concept, inner structure, and applicability (vanPatter & Pastor, 2016). As findings, graphic depictions of models started in the 1950s, but are lacking a visual clarity in respect of time and duration of each of the executed step. Roles within a process are visually not indicated nor is the human factor. The process models are ordered in six groups: creative problem solving, design, product design, service design, organizational innovation and societal innovation (ibid.). They are text-based as principle steps in acting or graphically representing the phases to be undertaken. A third dimension showing the involved actors or institutions is not included. As mentioned, models in innovation research and management are directed to prescriptive, actionable steps and processes rather than explaining the inner workings of an organization as a whole. They do not design innovation processes in a constructive way oriented towards a future innovation system of self-organized interacting parts. Though social elements have been taken into consideration since the beginnings of innovation research, the models and principles applied in practice rarely entail a dynamic, emergent, or human element. “It would be more interesting if models could be dynamic. It will make them more human” (Larry Leifer quoted in de Mozota, 2013, p. 288).

The 3rd Dimension – Architecture of Innovation Processes in Space

The growing interest by management in creative approaches for innovation processes has been focussed on disciplines such as industrial design. Architects acting at the forefront of design thinking in the past century have remained mostly unnoticed by management studies (Rowe, 1987; Dorst, 2011; Shamiyeh, 2016). The work of Schön (1983), Cross (2007b, 2013), Lawson (2005) and Lawson and Dorst (2009) refer to a large extent to architectural ways of design thinking or observe architects as case group. It is important to focus on the special characteristics of architects, trained and practiced in synthesizing a new whole out of often conflicting
and contradicting parts (Lawson 2005, Lawson & Dorst, 2009). Architecture as a profession has been intensively linked to the rise and development of different industries (Nerdinger, 2012; Rumpfhuber, 2013). The diverse field of projects architects are involved in stand in close relation to areas of management and innovation. The design and planning of a research facility require an intense deal with the underlying, projected, or yet-to-be defined processes. This creative thinking and structured work conducted to understand, design, and realize new processes, which precede the planning, have been underestimated in their value for organizational challenges, and as yet barely discussed in the scientific literature (Shamiyeh, 2007; Awan, Schneider & Till, 2011, pp. 27; Samuel, 2018). To access architecture in its relevance for innovation research and management an alternative conception is framed in the doctoral project: firstly, architectural design thinking is applicable to structuring innovation along with other design thinking approaches; secondly, the architect-client interaction contains information on vision, processes, and requirements important for redesigning an entire organization and its innovation paths. Thirdly, the focus on buildings needs to be shifted to the focus on systems and system design (Koolhaas 2004; Hyde, 2013; Luebkeman 2015). The changing context in which innovation processes are embedded – i.e. rising complexity, relevance of social interactions, and the call for design – can also be traced in the thinking and work of architects and this entails the addition of a 3rd dimension.

Architects embrace complexity and reframe it to a workable degree (Venturi, 1992; Lawson, 2005; Noennig, 2006; Gänshirt, 2012; Bachman, 2012). They exclude and include information and iterate different points of view. With parallel lines of thought they alternate between paths until a new meaning and solution unfolds (Lawson, 2005). Architecture copes with complex surroundings without simplifying and withholds contradictions inherent in conflicting goals or the contrarian requirements of clients, stakeholders, and users (Noennig, 2006; Bachman, 2012). To create a coherent whole by integrating different aspects and requirements, architecture gives order and at the same time allows disorder (Lawson & Dorst, 2009). “Simplicity” in art and architecture “is at bottom complexity” (Pallasmaa, 2014, p. 40). “To present complexity in simple ways is the designer’s noblest aspiration” (Norman 2016, p. 174). In contrast to management disciplines, architects use a 3rd dimension to cope with complex structures, relations, and interdependencies, and consider qualitative as well as quantitative information. Social interactions of people are thought together with physical area requirements and technological equipment, the form of organization – its architecture and design – is the medium to communicate meaning (HENN & WITTENSTEIN, 2016). Though the physical is dominant in the conception of built architecture, the value lies in the (invisible) art of arrangement. Applied to innovation research, this approach to complexity offers a new approach to the innovation processes of a company, integrating different parts in a multidimensional way while making its complex structure comprehensible to the actors involved. Embracing complexity is one of the core pieces of advice in innovation management literature – something for which architects may be well prepared (Schoeneberg, 2014; Lewrick et al., 2016).

Relations have a spatial dimension for architects. The question of who interacts with whom about what is connected to the question of when and where. Architects develop a deep understanding of people, their interrelations and interactions, their pathways and movements, and depict their proximity spatially and relationally (Pallasmaa, 2016). Organizational systems understood by architects fundamentally differ from the organizational charts in management or innovation theory. The visual and non-linear thinking of architects combined with their specific use of models provide three-dimensional access to a problem, process, or organization. Architects add a 3rd dimension to setting, organizing and transforming relations and dependencies. They graphically externalize thoughts, ideas, and knowledge in order to start a communication between the sketch, diagram, drawing, or model and the practitioner themself or other involved parties (Gänshirt, 2012; Schubert, 2014). It is less a picture of a finished idea which appears than the process of formation of an idea using a tangible medium. It is “the demonstration of an idea as well as its advent” (Leatherbarrow, 2001, p. 91). This reflection-in-action process reveals new possibilities and options, which could not be detected or observed up-front, and underline the prospective mode architects work in to transform the existing and to imagine as well as to construct a future state (Schön 1983; Lawson, 2005; Boschung & Jachelmann, 2013). While innovation management works descriptively or prescriptively, formulating a process to follow, architecture creates a frame of possibilities for the entire organization, empathically confronting people with transformation. As futurists, they are inherently optimistic that a better state can be thought of, created, realized, and operationalized (Dator, 2016; Gänshirt, 2012). This visual and spatial construction may help to broaden the view of innovation design for a company as a whole with its human actors.
Making the invisible visible is central to architecture. The architects’ ability for synthesis relates to the real (world) and seeks for application in the end. This means that architects use their developed frames of complexities and their understanding of social interactions to finally design a coherent new whole (Lawson, 2005; Nönnig, 2007; Nelson & Stolterman, 2012). They abstract, represent, integrate, relate, and synthesize continuously by sketching, diagramming, planning, modelling, and prototyping: the tools they use, are tools to think and to design (Lawson, 2005; Lawson & Dorst, 2009; Gänshirt, 2012). These tools are at the same time analytical and constructive. “The ability to design,” Cross (2008, p. 9) points out, depends not only on the internal depiction of an idea in the individual’s mind, but “even more on being able to make external visualizations.” Besides sketching as primary tool, diagrams and models are important means for designing a system (Gänshirt, 2012; Boschung & Jachelmann, 2013). In a diagram, the holistic and systems thinking of architecture becomes visible: it depicts an organization as socio-technical system by combining functional aspects of areas and processes with people, flows, interactions, and relations while not determining its final form (Boschung & Jachelmann, 2013). Diagrams reveal ‘a hidden or invisible reality,’ information and relations (Hnilica, 2013, p. 243). In this philosophical realm, diagrams in architecture can contain a narrative and story: they merge quantitative and qualitative information without having to be scientifically correct and extrude a metaphor in a vertical direction (Boschung & Jachelmann, 2013). The diagram stands as a concept and ‘template of possibilities’ which does not necessarily anticipate the building design and offers in this state valuable perspectives on organizational structures (ibid.; Dördvinlioglu, 2018). It is “architecture’s best means to engage the complexity of the real” (Allen, 1998, p. 17). At this abstract, yet constructive level, the diagram can serve as general scheme or outline for activities at the overlap of the visible and invisible. To capture and design the fuzziness of innovation processes, this may be a valuable tool.

![Diagram of design tools](image)

**Figure 2:** Design tools of architects, with interrelation and interdependencies between the tools. Author’s own representation.

Models are used and understood differently in architecture than in management (Boland & Collopy, 2004). While in management the descriptive and prescriptive character in 2-D prevail, models in architecture are 3-dimensional and generative. They are used for experimenting or testing and serve as a boundary object or shared system image for communication, participation, co-creation, and presentation, both internally and externally (Doll, 2009; Gänshirt, 2012). In working models the “ephemerality of assemblies” is what allows us to add, take away, shuffle, and re-arrange parts or the entire model, while reflecting on and evaluating the conducted actions and their consequences (Wagner, 2000, p. 385). As persuasive artefacts they offer a special kind of openness, immediacy, and interpretive flexibility (Wagner, 2000, p. 388). The models also represent the prototyping mind-set of architects and show the relational and spatial proximities as well as the parallelly
and simultaneously performing parts of a whole (Gänshirt, 2012). They are abstractions and representations of the constructed real, not the final product itself, which requires the architect to continuously imagine, foresee, and think of the implications and consequences when a design is going to be built (Rittel & Webber, 1984). It speaks for a holistic approach with a long-term perspective beyond current client, user, or market demands (Maescher 2018).

Reframing complexity, understanding interactions and designing a system in an architectural way leads to a 3-dimensional conception of an organization. If this kind of thinking and tools could be applied to the design of innovation processes, new models could evolve as unique solution for a specific company. To underline this argument, two case studies will be presented, where architects have worked on architecting and designing innovation processes for small-and-medium sized companies (SMEs).

**From Random and Structure to Network – 2 Case Studies**

The goal in both cases was to analyse and understand the client’s requirements, processes, culture, and vision and to synthesize a concept model of the future organization as the basis for a subsequent building design phase. Two SMEs were facing a major transformation and development in their structure. In the first case, an innovation factory, a successful company in mechatronics needed to enter a higher level of complexity by leveraging its innovation processes from linear to network. In the second case, a nanotechnology R&D headquarters, the successful growth of a start-up required a new state for its processes turning from random to network. Both companies were approached by an architectural consulting service called architectural programming in 2009 and in 2015, conducted with and by the author (WITTENSTEIN & HENN, 2009; attocube & HENN, 2015). Initially serving as brief for a satisfying building design, the architectural programming can be viewed as a ‘research and decision-making process’, which could be applied to problems detached from a physical solution (Cherry, 1999, pp. 3, 229-230). It is one goal of the doctoral project to re-direct the principles applied in architectural programming and early phases of architectural projects for the development of new organizational designs.

**Mechatronics Innovation Factory / 2009**

As a leading company in the fields of mechatronic technologies, the capacity and competence to permanently create new ideas, develop innovative technologies, and apply them to markets has been vital. By the time of the case study in 2009, the employees were responsible for around 80% of innovation projects, while 20% were initiated by customers outside the firm. The questions were how to maintain the speed of innovation, how to achieve a share of 50% in-house and 50% externally initiated innovation projects, how to foster an innovative mindset and self-organization among employees, and, finally, how to attract international talent and expertise. The vision was to create an innovation center, where engineers, developers, and clients work together and follow the process of idea generation, development and dissemination in production.

The progress towards a 3-dimensional innovation process within the architectural consulting service consisted of six phases: information collection, linear process mapping, 3-d process visualization, sections, diagrammatic sections, and systems modelling.

![Figure 3: 3-dimensional diagram of the organizational process in new product development and innovation. Author’s own representation.](image)

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1 The sources for the case study description and analysis are based on the author’s notes and reports, presentations and models handed over by the consulted companies for research. The author was team consultant during the project in 2009, sources from internal documents released for publication are quoted with ‘WITTENSTEIN & HENN, 2009.’
In the information collection phase reports and data-sheets were reframed and visualized graphically. The image of the organization changed by using different forms of visualization, which were discussed and refined in workshops. The illustrations served as boundary objects, leaving textual dependencies for visual simultaneity, and dissolving personal contributions towards commonly visible information (Boland & Collopy, 2004; Henn 2004; Peña & Parshall 2012). With an increase in information level, the visualizations were shifted from two-dimensional to a three-dimensional view, co-locating people and functions in three directions, while maintaining visibility and awareness.

The linear process mapping started from intangible elements (thoughts, ideas, knowledge) towards the physical manifestation of a finished prototype or product. It was conducted for each department and business unit, as well as for the movements of employees, customers and visitors, and for the new product development process. In a second step, each line of the processes were overlaid at the required point of interaction. As some processes needed to intersect multiple times at different stages, the 2-dimensional linear depiction reached its limits. By bending the lines in space, the architectural consulting developed a 3-D process visualization, where the joint points of intersection could be detected while not interrupting the flow line of each process. The visualization revealed a multidimensional organizational system where processes interacted in centres while remaining visible and open in-between. It led the linear thought models of organization towards an emergent system approach, where self-organization, freedom of flow, and exploration could be imagined.

The developed diagram was interpreted in a spatial dimension. By adding the elaborated information from the previous visualizations, the architects created a horizontal and vertical section through the diagram to explain the situations at intersection points. Through the 3-D arrangement of spines, the created diagrammatic section was modelled physically to show all aspects of work processes, flows, and organization of units, as well as the required spatial, technical and site requirements. It depicted for the company the future way of working and innovating in a multi-dimensional, integrative and simultaneous way. By extruding the conceptional section in different directions, the potential of the new organizational structure became visible. What formerly was depicted in a two-dimensional, linear and determined way was visible as 3-dimensional system.

Figure 4: 3-dimensional diagram of the organizational process in new product development and innovation. Source and copyright: HENN & WITTENSTEIN AG, 2016, pp. 10-11.

The developed diagram was interpreted in a spatial dimension. By adding the elaborated information from the previous visualizations, the architects created a horizontal and vertical section through the diagram to explain the situations at intersection points. Through the 3-D arrangement of spines, the created diagrammatic section was modelled physically to show all aspects of work processes, flows, and organization of units, as well as the required spatial, technical and site requirements. It depicted for the company the future way of working and innovating in a multi-dimensional, integrative and simultaneous way. By extruding the conceptional section in different directions, the potential of the new organizational structure became visible. What formerly was depicted in a two-dimensional, linear and determined way was visible as 3-dimensional system.
The start-up, founded in 2001, was in a transition phase from a grown structure of 90 people to a company of more than 175 employees. While the mechatronic company was leaving ‘linearity’ in processes and organization, the nanotech start-up was leaving ‘dispersion.’ Through the consulting of architects their vision, values and processes were reflected. The main questions in 2015 were, how to grow as company while maintaining a spirit of a community and start-up; how to achieve a share of 50% industry products and research projects (coming from 25%/75%); how to integrate management departments with innovation, research and highest-precision production; how to communicating mind-set, values, and remain attractive for researchers and high-potentials in engineering and natural sciences.

With modifications to the first case study, the process also followed six steps: information collection, process section, 3-D process visualization, section, diagrammatic sections, and systems modelling.

The available reports and documents on the company were processed visually and enriched with the information gained through workshops and interviews with members of the board, researchers, developers and administrative staff. The process for the research and industry business were mapped in plan views and sections. The materialization of an idea was represented in plan/top view from left to right, and in section from top to bottom. The two perspectives were brought together in a 3-dimensional diagram of the organization. Employees, distance, and proximity as well as process allocation and spatial functions were considered in the model. The digitally rendered visualization was then viewed from different angles, and revised until it matched the perspectives of the board and employees.

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2 The sources for the case study description and analysis are based on the author’s notes and reports, presentations and models handed over by the consulted companies for research. The author conducted the project as architect in 2015, sources from internal documents released for publication are quoted ‘attocube & HENN, 2015.’
Figure 7: 3-dimensional model of employees, relation and spatial organization. Source and copyright: attocube systems & HENN, 2015.

Applying the prior elaborated process from plan view and section to the 3-D model, made the flows of interaction visible to client and architects. By cutting through the model a principle section of the entire company structure was created, which additionally displayed the values and mind-set of the company. The diagrammatic section served as intermediate structure between narrative and organization. In extruding the section in different directions, the innovation process space evolved, balancing out awareness, functions, and project flows of the company.
Further Research

As the consulting process of architects prior to a building design has not been scientifically analysed, the case studies serve as an important source in two respects. Firstly, to develop a separate view of the principles applied detached from a building focus. Secondly, to develop suitable principles and tools for implementing architectural thinking in a management and organizational design context. The visual representations of the organizations in the architectural programming are difficult to access by managerial understanding and constrained by the image of a physical building design. Though the presented works resulted in physical output, they were able to change managerial perspectives on the future organization and innovation processes. For the ongoing research it will be relevant to compare the visual and spatial approach of architects with related works from other disciplines and industries. Despite the existing text-based examples for innovation process design, new digital tools are applied in innovation management and research. Software and applications such as innotrace or innosabi foster agile innovation across companies (Lundberg et al., 2014; Innosabi, 2019). So far, a spatial-dynamic dimension for an organization as a whole has not been detected as this will be pursued in the doctoral project. By comparing existing principles and tools with architecture, is the intention is to develop an architectural approach to innovation research and management, and outline a conception of architecture as an innovation design discipline. This extended field of architecture working at a
systemic, organizational level could integrate the relational and process understanding of management with a spatial system of dynamic flows.

Figure 9: Re-positioning from architecture as tool to architecture as management for innovation. Architecture of innovation creates a relational-spatial system of innovation processes. Author’s own representation.

To bridge communication between the two disciplines, the tools and working modes of architects need to be explicitly shown and explained. The development of further digital tools based on architects’ understanding and perspectives on organizations and their innovation processes will provide additional support. An interdisciplinary project with students from information technology has recently been started to create an integrative, easy-to-use, and adaptive application. It will serve as first prototype towards creating a 3-dimensional interactive process design tool from architecture for management.

References


