Supporting Customized Design Thinking Using a Metamodel-based Approach

Dominik Bork, Dimitris Karagiannis, Igor Hawryszkiewycz

Published in:

20th Australasian Conference on Information Systems (ACIS) 2017, Hobart, Australia

Supporting Customized Design Thinking Using a Metamodel-based Approach

Dominik Bork
Faculty of Compute Science, Research Group Knowledge Engineering
University of Vienna
Vienna, Austria
Email: dominik.bork@univie.ac.at

Dimitris Karagiannis
Faculty of Compute Science, Research Group Knowledge Engineering
University of Vienna
Vienna, Austria
Email: dk@dke.univie.ac.at

Igor Hawryszkiewycz
School of Systems, Management and Leadership
University of Technology Sydney
Sydney, Australia
Email: igor.hawryszkiewycz@uts.edu.au

Abstract

Traditional design methods, based on analytical rationale, often cannot address upcoming challenges e.g., related to the digital business transformation in volatile environments. Analytical rationale assumes a particular result and provides the methods and tools for achieving it. Nowadays, however, the result of a business transformation is often not precisely known nor the ways and means to achieve it. As a result, methods and tools are required that foster creativity while allowing customization to specific requirements or stakeholder needs. This paper proposes customized design thinking processes, realized with a conceptual modelling approach. The approach supports creativity in transformative business design. It shows how numerous design thinking tools can be integrated into a single conceptual modelling approach - supported by a modelling platform. The platform facilitates efficient and flexible design of novel business solutions. The created models moreover serve as a formalized knowledge base that enables knowledge processing and reuse.

Keywords Design Thinking, Conceptual Modelling, Metamodelling, Design Science Research.

1 Introduction

Enterprises are nowadays highly connected and sensitive to multiple external and internal stimuli. Changing customer needs, high-competitive market setting, disruption of established business models, or the digitalization are only a few challenges today's enterprises face. New products, services, or combinations thereof need to be designed in order to remain competitive and to survive (Brentani 2001; Johnson et al. 2008). "There is virtually a consensus that, to remain competitive, firms must continuously develop and adapt their business models. However, relatively little is known about how managers can go about achieving this transformation" (Wirtz et al. 2010, p. 272).

Several authors stress already the necessity to develop a new mindset based on the use of innovative concepts and new tools used to assess competitors and to derive competitive advantage (Hamel et al. 2012; Cooper et al. 2011; Edvardsson et al. 1996). Being innovative is becoming a competitive factor not only for companies like Google and Apple, but also for whole economies and countries (Beckman et al. 2007). This is also the direction that design thinking is targeting, by calling for creativity to generate novel and innovative solutions. Design thinking adds value to knowledge management through providing tools that foster creating new knowledge in the form of new designs.

The challenges in applying design thinking are manifold (cf. Gericke et al. 2016). First, creativity needs to be integrated into a design process that can be customized to continually changing requirements. It is to combine the open and what seems to be a chaotic process of idea generation of design thinking into a formal structure. Second, generic design requirements such as processes that are repeatable must be considered while at the same time focusing on the problem rather than the process. Third, the system needs to be viewed from different perspectives addressing all stakeholders in order to develop imaginative solutions. The emphasis here is on visualization of systems and looking at systems from different perspectives (or frames (Dorst 2011)) to derive solutions. This calls for a multi-disciplinary approach where stakeholders from different disciplines can search for alternative solutions and then, through brainstorming, combine them in consistent ways to realize an innovative proposal.

The paper at hand considers all of the aforementioned and draws on emerging ideas from design thinking and knowledge management (Karagiannis et al. 2017). Following the design science research methodology (Hevner, 2004), it combines them to define an innovative approach referred to as customized design thinking processes. These processes can guide and support enterprises in their business transformation endeavours. Consequently, the paper at hand focuses on the following research question: How can conceptual modelling contribute in business transformation by utilizing customized design thinking processes? Towards an answer to this question, the paper provides two main contributions: First a theoretical basis for customized design thinking processes based on existing works (cf. Buchenau et al. 2000) is presented. Second, the development of a modelling platform called CuTiDe is discussed. CuTiDe supports designers efficiently in applying customized design thinking process in order to design creative solutions. Feasibility of our approach has been evaluated in numerous illustrative scenarios (Peffers et al. 2012).

The rest of the paper is organized as follows. In Section 2, the foundations of design thinking and conceptual modelling are outlined. Section 3 then covers related works. Requirements on customized design thinking processes and their realization in a conceptual modelling method are presented in Section 4. The application of the method with the CuTiDe platform is showcased in Section 5. Finally, the paper concludes with a SWOT analysis and some ideas for future work.

2 Foundations

2.1 Design Thinking

Nonaka (1994) developed the SECI model where knowledge creation passes through four phases - Socialization, Externalization, Combination and Internalization. Recently, the utilization of the SECI process by means of conceptual modelling was reported (Karagiannis et al. 2017). In Cairó and Bork (2017), the authors propose the utilization of conceptual models in order to convert tacit to explicit knowledge. Further research in this area has led to knowledge spaces (Krogh et al. 2014). Such spaces act as a canvas for supporting collaboration that leads to creativity. The focus is on creativity, but at the same time to put creative ideas into practice, using the experience from design thinking. Design Thinking has been successfully applied in companies like PEPSI (Ignatius 2015) and many others (see Yee 2013 and Liedtka et al. 2013 for some examples).

Design thinking gains more and more attraction recently. Leading universities comprise design thinking in their engineering (Dym et al. 2005) and information science (Fichman et al. 2014;

Hawryszkiewycz et al. 2015) curriculum. Fast changing environments, fierce market competition, and the digitalization are only a few forces that require enterprises to continuously question their business models, adapt, or even fundamentally change them. So what is design thinking? There exist plenty of different definitions of it. According to Cox (2005, p. 2), design is "what links creativity and innovation. It shapes ideas to become practical and attractive propositions for users or customers. Design may be described as creativity deployed to a specific end". Design, "at its heart it is about the process of translating ideas into reality, making abstract thoughts tangible and concrete. Whether it's for a new service, a piece of graphics or an innovative product, a number of key attributes underpin every design-led project" (Davies et al. 2013, p. 3).

One vital aspect of design thinking is creativity and co-creation (Dorst 2001). Multi-disciplinary teams need to be created that collaboratively work on defining an innovative solution to a complex problem. It is essential that these teams are not limited by organizational structures or contextual circumstances. Ideas need to be pitched without considering side-effects in the first place.

We now want to emphasize on a more pragmatic way of defining design thinking by comparing it to traditional design. In traditional design, most designers follow a structured process:

We know what to do → we know what method to use → to produce specific results.

Solutions in complex environments comprising wicked problems are most often unique and call for a creative and innovative ways to construct them (Hawryszkiewycz 2014). They might require imaginative use of knowledge that can in Nonaka's terms externalize and combine knowledge elements into unique solutions.

We don't know what to do → we don't know what method to use → to create emerging value.

In design thinking, knowledge needs to be developed not only on how to create a solution but also on what is a good solution. It requires the ability to choose a design method that matches value that is to be created. Eventually, flexible tools are required that: i) can be customized to specific design thinking projects, ii) address specific stakeholder skills and needs, and iii) enable documentation and analysis of the project's progress.

2.2 Domain-specific Conceptual Modelling

Conceptual modelling refers to the representations of selected real world phenomena by applying abstraction. It serves the purposes of human understanding by reducing the complexity of the real world and using a more abstract language - the modelling language – to describe it. Conceptual modelling can be distinguished from other applications of modelling by its addressee, human beings. Conceptual models are created by humans and serve the purpose of understanding by human beings (Mylopoulos 1992).

According to Karagiannis and Kühn (2002), conceptual modelling methods comprise: A *modelling language*, a *modelling procedure*, and *mechanisms & algorithms*. All domain concepts of a modelling method are specified in its modelling language (i.e., classes and relationships between classes). For each class and relation, semantics (the meaning), syntax (the grammar), and notation (the visualization) need to be specified. The utilization of a modelling language is then specified in the modelling procedure. Here, steps, and results of these steps, to be performed by the modeller are defined. Mechanisms and algorithms make sure the created models serve not only means on themselves. By contrast, using e.g., model queries, model simulation, model transformation, validation and other techniques, increases the value of models and enhances the utility of a modelling tool. The more mechanisms and algorithms are given, the more useful a modelling tool will be. Recently, modelling methods are applied in numerous domains (cf. how conceptual models have been utilized in the mobile maintenance domain (Buchmann 2014) or Karagiannis et al. 2016 for an overview of domain-specific conceptual modelling methods), not only limited to software engineering with UML or process modelling with BPMN. In such domain-specific applications, conceptual models enable diagrammatic representation of formalized domain-specific knowledge that is intersubjectively understandable and machine processable (Bork and Fill 2014).

2.3 Conceptual Modelling in Design Thinking

Knowledge acquisition involves eliciting, analysing, and interpreting the knowledge that human experts use when solving a particular problem and the transformation of this knowledge into a suitable machine representation (Kidd 1987). The design thinking process is by nature a very knowledge-intensive process. All participants contribute with their specific knowledge, targeting at identifying an innovative solution for a complex problem. Using a modelling method ensures that all participants use the same (modelling) language. This fosters communication by enabling comparability of different proposals and contributes to a common understanding among the project participants.

Conceptual models can help designers to: i) formally specify ideas, ii) analyse ideas thoroughly, and iii) synthesize different ideas efficiently. Hence, conceptual modelling is perceived a facilitator in the analysis-synthesis spectrum (Tovey 1986) of design thinking. Similar thoughts on applying design thinking in the business process modelling domain deem convincing (Luebbe et al. 2011).

3 Related Work

Before proposing customized design thinking processes, it is mandatory to refer to existing works in the domain by first introducing commonly applied design thinking processes and then analysing existing tool support for designers.

3.1 Design Thinking Processes

Albeit not a core design thinking process, Nonaka's (1994) SECI method on organizational learning is also related as making tacit knowledge explicit is the first step towards the design thinking project's success. Hence, knowledge conversion and knowledge sharing are essential to successful design thinking. According to Nonaka, knowledge conversion follows four stages: Socialization, Externalization, Combination, and Internalization.

The Stanford Design School (dSchool) has developed a design thinking process that is used to develop creative solutions. It comprises the following phases:

- EMPATHIZE: Work to fully understand the experience of the user for whom you are designing. Do this through observation, interaction, and immersing yourself in their experiences.
- DEFINE: Process and synthesize the findings from your empathy work in order to form a user point of view that you will address with your design.
- IDEATE: Explore a wide variety of possible solutions through generating a large quantity of diverse possible solutions, allowing you to step beyond the obvious and explore a range of ideas.
- PROTOTYPE: Transform your ideas into a physical form so that you can experience and interact with them and, in the process, learn and develop more empathy.
- TEST: Try out high-resolution products and use observations and feedback to refine prototypes, learn more about the user, and refine your original point of view.

Another design thinking process was introduced by Liedtka et al. (2013), comprising four questions aiming to guide designers during their task of identifying innovative solutions: *what is?*, explores the current reality by using e.g., *journey mapping*, *value chain analysis* or *mind mapping*; *what if?*, envisions alternative futures but applying *brainstorming* or *concept development* techniques; *what wows?*, gets users to help make tough choices by applying *assumption testing* or *rapid prototyping*; and *what works?*, makes it work in markets and as a business by using e.g., *customer co-creation* or *learning launch* techniques.

One recently published design thinking process is the Double Diamond approach (visualized in Figure 2) that was proposed by the British Design Council in 2013 (Davies et al. 2013). The approach intends to be generically applicable. It comprises the steps discover, define, develop, and deliver. For every step of the approach, a selection of tools and techniques is proposed.

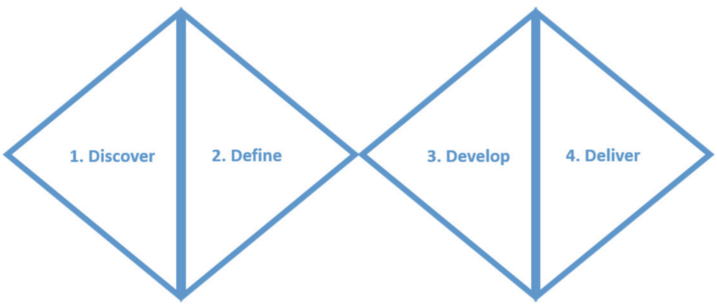

Figure 1: Double Diamond design thinking process (from Edvardsson et al. 1996)

1. DISCOVER. Identify the problem, opportunity or needs to be addressed through design; Define the solution space; Build a rich knowledge resource with inspiration and insights.
2. DEFINE. Analyse the outputs of the Discover phase; Synthesize the findings into a reduced number of opportunities; Define a clear brief for sign off by all stakeholders.
3. DEVELOP. Develop the initial brief into a product or service for implementation; Design service components in detail and as part of a holistic experience; Iteratively test with end users.
4. DELIVER. Taking product or service to launch; Ensure customer feedback mechanisms are in place; Share lessons from development process back into the organization.

3.2 Design Thinking Tools: From Graphical Representations towards a Modeling Platform

One of the most comprehensive set of design thinking tools and techniques can be found on the Do it Yourself (DIY) homepage[1]. The goal of DIY is to enable engineers to solve design thinking tasks with a considerable set of independent tools. The toolkit incorporates a multitude of approaches along the categories: look ahead, develop a clear plan, clarify my priorities, collect inputs from others, know the people I'm working with, generate new ideas, test and improve, and sustain and implement. Similar but limited toolkits are provided by Design Kit[2], the Design Sprint of Google Ventures[3], and Toolkit 100 Open[4]. We Thinq[5] is a platform that aims at establishing a community of innovators. It provides a software platform that supports design thinking. However, the platform is commercial and, as such, excludes a lot of potential users.

Collective Action Toolkit (CAT)[6] combines tools and methods with an educational approach, fostering a broader understanding of design thinking. Ultimately, the goal is to educate people in problem solving by applying design thinking with a focus on third world countries. As a consequence, the approach tries to rely on a minimal set of requirements and preconditions for application as in such countries internet connection and computers cannot be assumed to be available. All steps described by the approach are therefore not supported by any software - they solely rely on paper and pen.

What can be learnt from the previous investigation is, that flexibility and genericity are vital for acceptance and utilization of the approaches. Some approaches define or recommend a set of tools and techniques to be used while others stay on a conceptual and theoretical level. These tools and techniques are sometimes specifically meant to be used in one particular process step, while others suggest to use them in multiple steps, depending on the current situation.

Another result of the previous investigation is, that most approaches limit the use of technology. Mostly, very basic set of templates are provided, e.g., as a printed a4 page or an Excel sheet. Different tools are isolated and reuse is impossible. Knowledge gained during one project/step can hardly be reused in other projects or linked to the outcome of other steps. Moreover, revision of premature proposal is costly, as changes to a physical piece of paper or even an Excel sheet are time-consuming and error prone.

So why do we need CuTiDe? The answer is multi-faceted. Design thinking is a cooperative task, involving different people who have diverse backgrounds, e.g., designers, domain experts, financial advisors, marketing experts, CxO's among others. Moreover, as creativity is vital for developing new solutions, guidance is necessary to keep the whole team focused. In reusing tools and best practices from successful projects, one can build on existing knowledge and omit common mistakes. Design thinking processes, in this regard, amplify the project progress by providing basic guidelines and fostering usage of existing creativity techniques and design thinking tools.

The related work showed, that there is no common understanding on the appropriate set of steps to be performed in design thinking and on the set of tools and techniques to use. Even more serious, most of the presented tools are theoretical guidelines or pure templates. If at least some minimal form of

[1] Do It Xourself homepage [online], http://diytoolkit.org, last checked: 02.12.2016
[2] Design Kit [online], http://www.designkit.org/, last checked, 02.12.2016
[3] Google Ventures Design Sprint [online], http://www.gv.com/sprint/, last checked: 02.12.2016
[4] Toolkit 100 Open [online], http://www.toolkit.100open.com/, last checked: 02.12.2016
[5] We Thinq [online], https://www.wethinq.com, last checked: 02.12.2016
[6] Collective Action Toolkit [online], http://www.frogdesign.com/work/frog-collective-action-toolkit.html, last checked: 02.12.2016

tooling is provided, these tools are closed source, proprietary or not customizable. These tools are moreover isolated, making it impossible for designers to semantically link related artefacts.

CuTiDe, in contrast, targets also at experienced designers who know already the available tools but need support in efficiently execute their tasks and want to reuse existing artefacts. It aims at an integration of engineering design and cognitive psychology (Howard et al. 2008) by providing a platform that efficiently supports collaboration and reuse. “In practice, creative designing seems to proceed by oscillating between sub-solution and sub-problem areas, as well as by decomposing the problem and combining sub-solutions” (Cross 1997, p. 438). Our approach aims at customization in all aspects of the design thinking process. Not only the tools and techniques applied but also e.g., the graphical visualization of the results can be customized to the designer’s needs. CuTiDe is realized as an open platform that can be adapted, extended, and customized to specific needs. This implies that new tools can be added as the design thinking field emerges.

4 A Conceptual Modelling Approach for Customized Design Thinking Processes

The proposed conceptual modelling platform for Customized Design Thinking (CuTiDe), comprises four major benefits and unique characteristics compared to existing works: i) it is customizable (efficiency), ii) it integrates numerous tools & techniques (utility), iii) it codifies results of the design thinking process in a formalized manner (processing), and iv) it is open source (extension). Following the modelling method components as proposed by Karagiannis and Kühn (2002), the following sections will introduce the modelling language, the modelling procedure, and the mechanisms & algorithms of CuTiDe, respectively.

4.1 CuTiDe Modelling Language

In respect of the identified requirements, CuTiDe supports a rich set of 18 established and commonly used design thinking tools. Moreover, a Knowledge Creation Space tool serves as a high-level specification of the process performed while creating a solution. The Knowledge Creation Space tool enables the modeller to semantically link existing sub-solutions and subparts to identify an overarching specification of the solution. This way, e.g., the categorization of brainstorming post-its into theme issues, or the combination of theme issues into service blueprints can be documented in a comprehensible and reproducible way. Every tool in CuTiDe is realized as a modeltype on the ADOxx tool development platform (www.adoxx.org). The modeller selects one modeltype (i.e., design thinking tool) and creates a model adhering to the specification.

CuTiDe is a platform for customized design thinking processes. Designers choose a tool and follow a procedure of their definition based on suitability, knowledge, experience, or the appropriateness to the task at hand. Table 1 provides an overview of the design thinking tools realized in CuTiDe, while clustering them along the Double Diamond phases. Some tools are available in multiple phases, as experience in design projects suggests that it is meaningful to have different evolutionary states of some artefacts depending on the current design phase and the design thinking project.

1. Discover	2. Define	3. Develop	4. Deliver
Company Map	Brainstorming	Business Model Canvas	Business Model Canvas
Design Scenario	Business Solution	Business Solution	Business Solution
Journey Map	Design Brief	Experience Prototyping	Design Scenario
Persona Map	Design Scenario	Joint Value Proposition	Document Model
Service Safari	Lotus Blossom	Lotus Blossom	Knowledge Creation Space
User Diary	Persona Map	Persona Map	Lotus Blossom
User Shadowing	Theme Circle	Service Blueprint	Persona Map
Theme Issues		Theme Issues	

Table 1. CuTiDe tools mapped to the Double Diamond phases

4.2 Modelling Procedure

CuTiDe does not impose a pre-defined procedure for conducting design thinking. Hence, CuTiDe is realized in the most supportive way while being customizable to the needs of the designer. Albeit not providing a low-level sequence of modelling steps the, CuTiDe still provides guidance for novelists in design thinking. In this regard, all design thinking tools of the platform are visually categorized into the Double Diamond phases. Having such a top-level procedure for conducting design thinking is very important as it also enables rather unexperienced designers to start investigating and brainstorming on novel designs. Independently of the specific design thinking tools chosen by the modeller, it is to the best of our knowledge advisable to first create isolated sub-solutions which can be later integrated in the Knowledge Creation Space towards an overarching solution specification. Having the sub-solutions codified in the modelling environments enables intuitive reflection and revision towards a mature and generally agreed solution design among the team members. Figure 3 visualizes the generic modelling procedure advertised by CuTiDe.

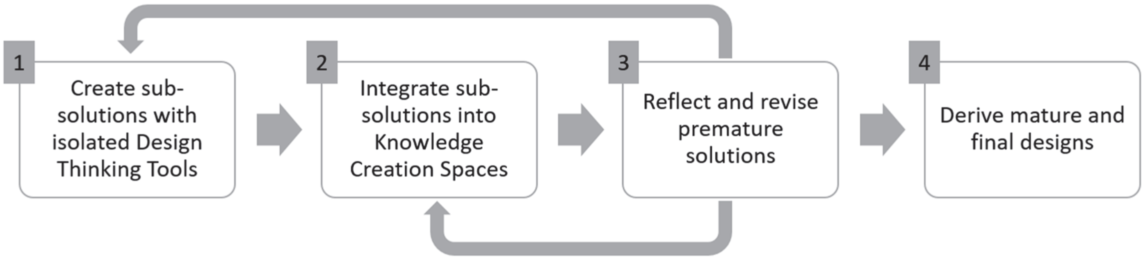

Figure 2: CuTiDe Modelling Procedure

4.3 Mechanisms & Algorithms

In order to increase efficiency and utility of the CuTiDe, semantic linkages between different design thinking tools (i.e., models in the modelling platform) is supported. In some cases, artefacts of one model can be linked to other models or artefacts in different models, e.g., a blossom in a top-level Lotus Blossom model can be linked to a complete Lotus Blossom that provides a detailed specification of that single topic. Designers can explore these semantic links and therefore gain an overview, or, during the design process, use this semantic links as a way to hierarchically organize complex theme structures for reflection and revision see Figure 3).

A different mechanism is to use model transformations between comparable models. Designer may transform any Lotus Blossom model into an equivalent Circle Diagram. As the semantic information of both models is equivalent but the graphical means of visualization differs, such transformations contribute to stakeholder-specific customizations of designs. Moreover, CuTiDe enables the customization of almost any realized design thinking tool to the specific requirements of the current situation. In this regard, font sizes, font colours, background colours and the amount of visualized information can be configured and customized by the designer.

We are currently working on extending the platform functionality to realize further model transformations and semantic links. Having this information codified in the models enables further model processing functionality like model validation, impact analysis, or model queries.

5 Applying Customized Design Thinking with the CuTiDe Modelling Platform

In order to efficiently apply design thinking it is inevitable to provide modelling tool support. Modelling tools have three major benefits: First, they enable efficient creation of the different design artefacts; Second, easy exchange and discussion of ideas (i.e., models) between designers as they share the same methods and tools; Third, codification of the design artefacts in a formal representation enables reuse and machine-processing of the knowledge (Bork and Fill 2014). Following the argumentation of Studer (1998), it is meaningful to combine informal specifications, e.g., using natural language, with the formalized specification enabled by conceptual models. This ensures creativity whilst enabling analysis and processing of knowledge.

Figure 4 visualizes the home screen of the CuTiDe modelling platform. It has been realized with ADOxx (www.adoxx.org), a meta modelling platform that proved its feasibility in the development of numerous industrial and research tools (Efendioglu et al. (2016)). Figure 4 (left) shows previews of a set of existing design thinking models created during case study applications. This overview shall serve as a documentation of the flexibility, customizability, and expressiveness of CuTiDe. Due to limited space, we cannot show the 19 modeltypes provided by CuTiDe in all details. Most of them are commonly known in design thinking. Figure 4 on the right side show the modeltype selection dialog. Here is where the designer first selects the Double Diamond phase, the corresponding design thinking tools are then shown for selection on the right.

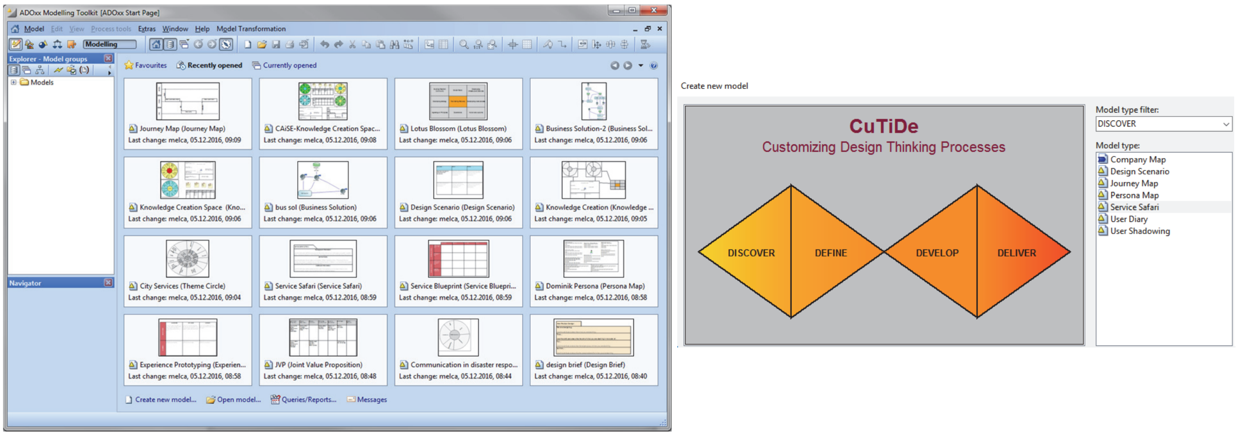

Figure 3: Start-up screen of the CuTiDe modelling platform (left) and tool selection (right)

Figure 5 visualizes a Knowledge Creation Space model for a disaster recovery system in CuTiDe. The designer has the possibility to reuse existing knowledge, i.e., models already created, to codify not only the several steps performed in the design process but also the relationships between them. Hence, relations can be modelled between post-its and theme issues, or joint value propositions, between theme circles and theme issues etc. The set of combinations is not constrained. In the example above, the Community Member in the Journey Map (lowest lifeline in the model on the lower right part) has a semantic link to the Persona Map of the Community Member visualized on the lower left part. We are currently working on using this codified information to realize model analysis functionality that could answer questions like *'Are all post-its considered in the final value proposition?'*, and on utilizing mechanisms that enable consistent modelling with the multiple models. Moreover, we want to focus on keeping the multiple models consistent (Bork et al., 2015, Karagiannis et al., 2016b).

Figure 5 illustrates from top to bottom, left to right: Theme Circles, Post-Its, Joint Value Propositions, Theme Issues, Persona Maps, and Customer Journey Maps. It also exemplifies the range of visual customization of all artefacts that enables visual encoding of semantic relationships between design thinking tools, e.g. between post-it notes and theme circles.

6 Discussion

We evaluated the CuTiDe modelling approach in several courses with Master and PhD students at an European university and at an Australian university. Moreover, we received feedback from experienced design thinking practitioners. The following SWOT analysis comprehends the received feedback and critically reflects on our lessons learned.

One major strength of CuTiDe is its flexibility which acknowledges the specific requirements of design thinking. General purpose modelling languages or tools cannot provide such a level of adequacy. Moreover, enabling the designer to select the tool that is most suitable for him/her in the current situation certainly increases usability and efficiency of the design process.

Weaknesses are in the limitation of approaches that have been considered in the tool. As there is no norm for design thinking processes, designers use their very own set of tools. Moreover, some of the highly context-sensitive tasks in the process, e.g., interactions between designer and customer. "Designers look to understand the needs and desires of the people who will use a product or service by spending time with them" (Davies et al. 2013, p. 3). While these aspects are vital for the success of the design process, they cannot be supported directly by CuTiDe. CuTiDe compensates this deficit by acting as a journal, enabling the designer to formalize and store experiences.

One threat of the approach is that it integrates many tools, possibly overwhelming unexperienced designers. Moreover, a certain level of knowledge and experience in design thinking is a prerequisite for using the tool. As one last threat we want to emphasize, that design thinking requires an "organizational culture which must be led and nurtured by the focal firm's top leadership" (Chew 2015).

Realized as an open platform, CuTiDe provides tremendous opportunities for future enhancements, further customizations, and unconstrained applications. As design thinking is currently making its way into the curriculum of universities, the tool has the opportunity to becoming part in regular university teaching. This would enable to teach design thinking not only from a theoretical perspective, it would also enable practical application of the theory.

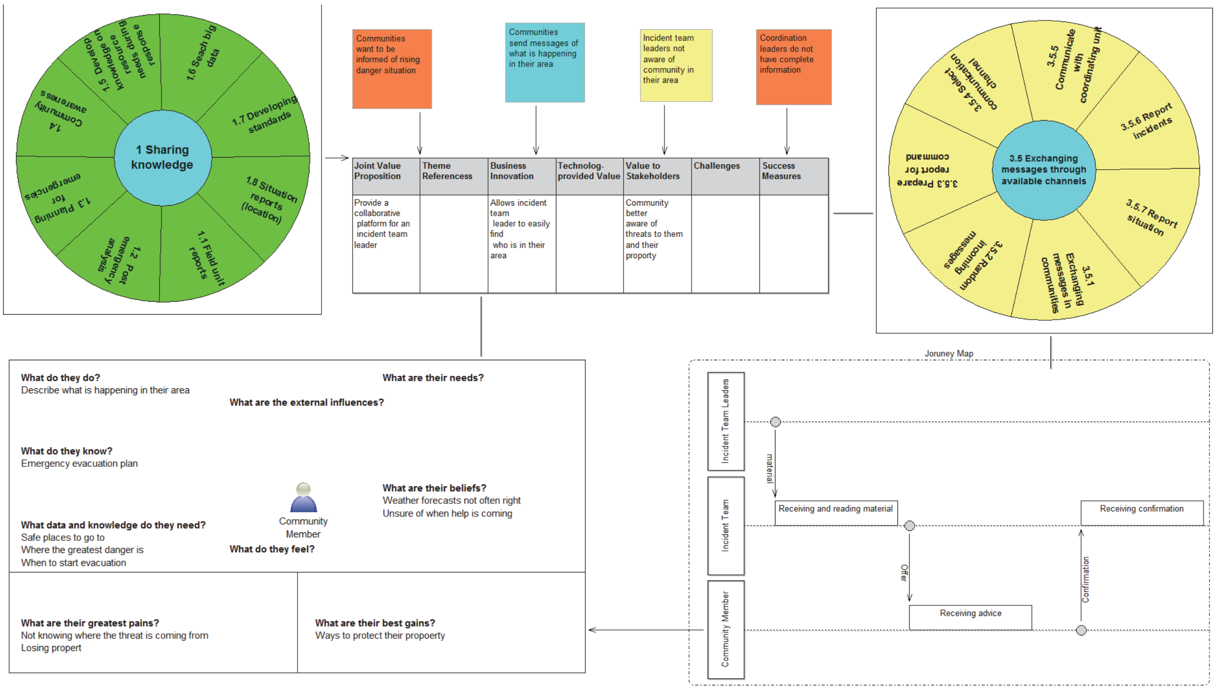

Figure 4: Sample Knowledge Creation Space in CuTiDe

7 Conclusion

Digital transformation is a challenge that traditional and emerging industries face. The pace in which new technologies arise, become mature and de-facto market standards inevitably leads to the requirement of enterprises to continuously adopt their business models. Design thinking tries to tackle this challenge by introducing creativity techniques to create new solutions for complex problems.

The paper at hand first introduced customized design thinking processes as a way of bridging between the creative process employed by designers and the benefits of conceptual modelling methods. It then introduced CuTiDe, a modelling platform for customized design thinking. CuTiDe comprises tools and techniques predominately used in design thinking practice. The strengths of CuTiDe are in its customizability, knowledge processing, and reuse. The generic design thinking procedure leaves flexibility to the designer. Lastly, CuTiDe models serve as a machine-processable knowledge base.

The CuTiDe platform is freely available within the Open Models Laboratory[7] (OMiLAB) for utilization, customization, and revision. OMiLAB is a collaborative world-wide community of modelling enthusiasts and modelling method engineers (Bork and Miron, 2017) following openness in information science research (Bichler and Heinzl, 2016). Future work will concentrate on using CuTiDe in real design thinking workshops to gain more feedback and extend the approach to address practitioners' needs.

8 References

Beckman, S.L., Barry, M. 2007. "Innovation as a Learning Process: Embedding Design Thinking," *California Management Review* (50), pp. 25–56.

[7] CuTiDe Tool Download within the Open Models Laboratory [online], http://austria.omilab.org/psm/content/melca/download, last checked: 11.10.2017

Bichler, M., Heinzl, A. 2016. "Open research in business and information systems engineering," *Business & Information Systems Engineering* (58:6), pp. 375—379.

Bork, D., Fill, H.G. 2014. "Formal aspects of enterprise modeling methods: A comparison framework," *Hawaii International Conference on System Sciences*, pp. 3400–3409.

Bork, D., Buchmann, R., Karagiannis, D. 2015. „Preserving multi-view consistency in diagrammatic knowledge representation," In *International Conference on Knowledge Science, Engineering and Management*, pp. 177-182, Springer, Cham.

Bork, D., Miron, E. T. 2017, "OMiLAB - An Open Innovation Community for Modeling Method Engineering, In *8th International Conference of Management and Industrial Engineering (ICMIE 2017)*, in press, Bucharest, Romania

Cairó Battistutti, O., Bork, D. 2017. "Tacit to explicit knowledge conversion," *Cogn Process* (2017). https://doi.org/10.1007/s10339-017-0825-6

Brentani, U. 2001. "Innovative versus incremental new business services: Different keys for achieving success," *J. Prod. Innov. Manag.* (18), pp. 169–187.

Buchenau, M., Suri, J. 2000. "Experience prototyping," *Proceedings of the 3rd conference on Designing interactive systems: processes, practices, methods, and techniques*, ACM, pp. 424–433.

Buchmann, R.A. 2014. "Conceptual modeling for mobile maintenance: the ComVantage case," *Proceedings of the Hawaii International Conference on System Sciences*, pp. 3390-3399.

Chew, E.K. 2015. "i SIM : An integrated design method for commercializing service innovation," *Information Systems Frontiers* (18:3), pp. 457–478.

Cooper, R.G., Kleinschmidt, E.J. 2011. *New products: The key factors in success*, Marketing Classics Press.

Cox, G. 2005. "Cox review of creativity in business: Building on the UK's strengths," HM Treasury, London.

Cross, N. 1997. "Descriptive models of creative design: application to an example," *Design Studies* (18:4), pp. 427-440.

Davies, U., Wilson, K. 2013. "Design methods for developing services - An introduction to service design and a selection of service design tools, http://www.designcouncil.org.uk/sites/default/files/asset/document/Design methods for developing services.pdf, last accessed: 07.09.2016.

Dorst, K., Cross, N. 2001. "Creativity in the design process: Co-evolution of problem-solution," *Design Studies* (22:5), pp. 425–437.

Dorst, K. 2011. "The core of "design thinking" and its application," *Design Studies* (32:6), pp. 521–532.

Dym, C.L., Agogino, A., Eris, O., Frey, D.D., Leifer, L.J. 2005. "Engineering Design Thinking, Teaching, and Learning," *Journal of Engineering Education* (94:1), pp. 103–120.

Edvardsson, B., Olsson, J. 1996. "Key concepts for new service development," *Service Industries Journal* (16), pp. 140–164.

Efendioglu, N., Woitsch, R., Utz, W. 2016. „A Toolbox Supporting Agile Modelling Method Engineering: ADOxx. org Modelling Method Conceptualization Environment," In *IFIP Working Conference on The Practice of Enterprise Modeling,* pp. 317-325, Springer International Publishing.

Fichman, R.G., Dos Santos, B.L., Zheng, Z. 2014. „Digital Innovation as a Fundamental and Powerful Concept in the Information Systems Curriculum," *MISQ* (38:2), pp. 329–353.

Gericke, K., Kramer, J., Roschuni, C. 2016. "An exploratory study of the discovery and selection of design methods in practice," *Journal of Mechanical Design* (138:10).

Hamel, G., Prahalad, C. 2012. "Creating global strategic capability," *Strategies in Global Competition: Selected Paper from the Prince Bertil Symposium at the Institute of International Business*, Routledge, pp. 5-39.

Hawryszkiewycz, I. 2014. "Visualizations for Addressing Wicked Problems using Design Thinking," *European Conference on Information Systems 2014.*

Hawryszkiewycz, I., Pradhan, S., Agarwal, R. 2015. "Design Thinking as a Framework for Fostering Creativity in Management and Information Systems Teaching Programs," *Pacific Asia Conference on Information Systems 2015*, 97.

Hevner, A.R., March, S. T., Park, J., Ram, S. 2004. "Design Science in Information Systems Research," *MIS Quarterly* (28:1), pp. 75-105.

Howard, T.J., Culley, S.J., Dekoninck, E. 2008. "Describing the creative design process by the integration of engineering design and cognitive psychology literature," *Design Studies* (29:2), pp. 160–180.

Ignatius, A. 2015. "How Indra Nooyi Turned Design Thinking Into Strategy: An Interview with PepsiCo's CEO," *Harvard Busienss Review*, pp. 81-85.

Johnson, M.W., Christensen, C.M., Kagermann, H. 2008. "Reinventing Your Business Model," *Harvard Business Review* (86), pp. 57–68.

Karagiannis, D., Kühn, H. 2002. "Metamodelling Platforms," *Third International Conference EC-Web*, pp. 182.

Karagiannis, D., Mayr, H.C., Mylopoulos, J. 2016. *Domain- Specific Conceptual Modeling*, Springer Berlin Heidelberg.

Karagiannis, D., Buchmann, R. A., Bork, D. 2016b, "Managing Consistency in Multi-View Enterprise Models: an Approach based on Semantic Queries. In *Europpean Conferenc on Information Systems*, ResearchPaper 53.

Karagiannis, D., Buchmann, R., Walch, M. 2017. "How Can Diagrammatic Conceptual Modelling Support Knowledge Management?," *Proceedings of the 25th European Conference on Information Systems*, pp. 1568-1583.

Kidd, A.L. 1987. *Knowledge Acquisition for Expert Systems*, Plenum Press, New York.

Krogh, G. Von, Geilinger, N. 2014. „Knowledge creation in the eco-system: Research imperatives," *European Management Journal* (32), pp. 155–163.

Liedtka, J., King, A., Bennett, K. 2013. *Solving Problems with Design Thinking: Ten stories of what works*, Columbia University Press.

Luebbe, A., Weske, M. 2011. "Bringing Design Thinking to Business Process Modeling," *Design Thinking: Understand – Improve – Apply*, Springer Berlin Heidelberg , pp. 181–195.

Mylopoulos, J. 1992. "Conceptual Modelling and Telos," *Conceptual Modelling, Databases, and CASE: an Integrated View of Information System Development*, John Wiley & Sons, pp. 49-68.

Nonaka, I., Nonaka, I. 1994. "A Dynamic Theory of Organizational Knowledge Creation," *Organization Science* (5), pp. 14–37.

Peffers, K., Rothenberger, M., Tuunanen, T., Vaezi, R. 2012. "Design science research evaluation," *Design science research in information systems. Advances in theory and practice*, pp. 398-410.

Studer, R., Benjamins, V.R., Fensel, D. 1998. "Knowledge engineering: Principles and methods," *Data & Knowledge Engineering* (25:1-2), pp. 161–197.

Tovey, M. 1986. "Thinking styles and modelling systems," *Design Studies* (7:1), pp. 20-30.

Wirtz, B.W., Schilke, O., Ullrich, S. 2010. „Strategic Development of Business Models Implications of the Web 2.0 for Creating Value on the Internet," *Long Range Planning* (43), pp. 272–290.

Yee, J., Jefferies, E., Tan, L., Brown, T. 2013. *Design transitions*, BIS Publishers Amsterdam.

Copyright