PRINCIPLES FOR BUSINESS MODELING WITH NOVICE USERS

ALEXANDER LÜBBE
HASSO-PLATTNER-INSTITUTE
ALEXANDER.LUEBBE@HPI.UNI-POTSDAM.DE

ABSTRACT

Business modeling implies to frame the organizational knowledge using a particular thinking tool. Applying those thinking tools requires education and experience, i.e. expert knowledge. In participatory design sessions most users are novices to the thinking tool that is used.

This paper identifies guiding principles for experts working with novices in participatory design sessions. We illustrate the application of our principles to business modeling approaches by examples.

INTRODUCTION

Business modeling aims to create a shared view on an organization. Various thinking tools are used to frame the knowledge of the organization into concepts such as the organizational structure, processes or product life cycles. Applying those thinking tools requires education and experience. Thus, it is typically done by external experts rather than people within the organization.

But how can we make those expert thinking tools available to the people in the organization to work out solutions in participatory design sessions? We believe experts can use their thinking tools together with those novices. They can facilitate a business model design session by following some principles for application.

In this paper, we first outline the scientific literature that influences our work. From there we derive a set of guiding principles for experts that want to facilitate participatory design sessions. We then show how we used these principles to transform IT-driven business process modeling (Weske 2007) into a participatory approach and we outline how Cradle to Cradle (McDonough & Braungart 2002) lifecycle modeling might be done by following our principles. We conclude that these principles are not complete but a starting point to design participatory business modeling sessions.

RELATED SCIENTIFIC LITERATURE

We get informed by scientific literature from cognitive science, design research and participatory design. We outline theories from these areas that contribute to our goal of using expert thinking tools with novice users. We condense this knowledge in the next section into a set of principles.

COGNITIVE THEORIES

Research in cognitive science investigates the nature of the human mind. It seeks to understand perceiving, thinking, learning, understanding, and other mental phenomena (Stillings 1995). The goal of this research is to find and describe effects that are consistent in human information processes. We use cognitive science research to learn about the effect of information representation on participants.

The *cognitive load theory* refers to the limitation of the human brain as an information processor (Kirschner 2002). In 1956, Miller was one of the first to describe the limitations of the human brain for its ability to process single-dimensional information. He demonstrated that the average person can hold on to "seven, plus or minus two," (Miller 1956) single dimensional stimuli at a time. Miller also showed that the ability to remember and discriminate information can be expanded by adding dimensional stimuli. Dimensions for stimuli can be color, sound, material or space.

Building on this, Sweller and Chandler (1991) proposed a cognitive load theory that describes the mental effort of learners. The capacity of the brain available to process new information is described as the *working memory* which is consumed by three factors, namely intrinsic load, extrinsic load, and germane load (Sweller 2005). Reducing the effort of the learner, e.g. simplifying the interaction interface to reduce extraneous cognitive load, frees working memory available for the other two aspects.

The *cognitive fit theory* postulates that the representation of a problem determines the thinking model applied (Vessey & Galletta 1991). In other words, what we see determines, how we think about it. It was shown that representation impacts the problem solving performance. As one example, Agarwal et. al (1996) measured task performance when process-oriented vs. object-oriented methodologies were applied to process-oriented vs. object-oriented problems. Like others, they found significantly superior task performance when problem and method match, i.e. they emphasize the same information.

The *dimensions of notations* were introduced by Green (1989) and Blackwell et al. (2001) as a framework to describe aspects of visual representations. Originally meant as an approach to understanding programming notation systems, it was extended to examine other notation systems as well including music notation and physical prototypes (Blackwell 2008). From the fourteen cognitive dimensions in the framework, three are most noteworthy for us: viscosity, premature commitment, and provisionality.

Viscosity is the "resistance to change". A highly viscous system requires many actions to change the current state of the system into a consistent new state. "Environments containing suitable abstractions can reduce viscosity" (Blackwell et al. 2001). Premature commitment refers to the constraints imposed on the order in which things can be done. Finally, provisionally is the degree of commitment to a state or action. Provisional action can allow sketching ideas or playing "what-if" games.

DESIGN RESEARCH

Design Research is the scientific investigation of the design process through cognitive, qualitative or ethnographic methods (Laurel 2003). Theories built from this research aim to explain the design process, the roles involved and the objects used. We focus on the latter ones.

Media describes the external embodiment of information, e.g. in language, software or hardware. The embodiment determines the affordances. By *affordance* we refer to the work of the perceptual psychologist J.J. Gibson (1977), who coined the term as a way of discussing perceptual cues of an environment or object that indicate possibilities for action.

Boujut and Blanco (2003) describe shared media as intermediary objects that afford distributed cognition. Shared models may be considered as enlistment devices, either allowing or baring access to collaborative participation (Blanco et al. 2007).

Media Models Framework is built on top of these theories by Edelman (2009a). The main idea is that media models steer the conversation in design. A media model is an artifact that represents the design of a product or service. He identifies the dimensions resolution and abstraction to impact the conversation. Abstraction is defined as the highlighting and isolation of specific qualities and properties of an object, such as color, size or functions. Fewer represented properties indicate a greater abstraction. Resolution refers to the fidelity with which an object is defined with respect to its final form.

Similar to the cognitive fit theory, resolution and abstraction impact the way designers think about the model. However, Edelman describes the framing and steering effect that the media choice has on design conversations. As an example, discussions about CAD models are different to those provoked by a plasticine model. In general, less abstract and highly resolved media models focus the discussion on parametric changes while highly abstract and less resolved media models afford paradigm changes. The interplay of both dimensions leads to the "ease of change" (Edelman 2009a) which is the effort required to make consistent changes analogue to Blackwell's viscosity dimension (Blackwell et al. 2001).

Tangibility as a quality for interaction is studied in multiple disciplines such as HCI (Ishii & Ullmer 1997) or industrial design (van den Hoven et al. 2007). Tangibility is typically referred to as the physical experience of information. In the words of Miller (1956) it is information with multi-dimensional stimuli. In design research, tangible prototyping is used to get extensive feedback fast. It is therefore seen as a key enabler to collect feedback and iterate in early design stages (Buxton 2007). Similarly, Clark (2008) suggests that thinking doesn't happen only in our heads but that "certain forms of human cognizing include inextricable tangles of feedback, feed-forward and feed-around loops: loops that promiscuously criss-cross the boundaries of brain, body and world".

PARTICIPATORY DESIGN

Participatory design is an approach to organizational change which acknowledges that workers are in the best position to determine improvements in their environment. The body of research describes approaches to enable people within the organization to take part in the creation of improvement ideas (Schuler & Namioka 1993). From participatory design literature, we learn about frameworks for group facilitation.

The system theorist Russell Ackoff (1974) describes three success factors for "design-by-playing" as an approach to participatory design. In particular, Ackoff proposes to (1) make a difference for the participants, (2) have likely implementation of results (3) make it fun to participate.

Ehn and Sjogren (1991) investigated the aspect of fun in participation and describe the principle of a language game. By playing a game the participants conduct a learning process that helps them to "create a common language, to discuss the existing reality, [and] to investigate future visions". In one sample case, she introduces a game kit with cards of different color and shape, "easy to move around in the common playground". When using the cards, people have to agree on their meaning and the rules for their use. By doing so, they establish the common ground for discussion.

Finally, Hornecker and Buur (2006) propose four qualities to improve group interaction. They call for (1) tactile manipulation of information as well as (2) spatial interaction, which is the movement in space. The (3) group facilitation should be embodied in the material used to direct group behavior and (4) the representation should be expressive with respect to the information that is to be embodied. The last quality is analogue to the cognitive fit theory (Vessey & Galletta 1991) and the media models framework (Edelman 2009a) from design research. They all suggest that representation steers the thinking and conversation about an issue.

In summary, these three research areas have similar ideas, which we condense into a smaller set of principles that can be used when working with novice users of a tool.

SEVEN PRINCIPLES FOR USING EXPERT TOOLS WITH NOVICE USERS

Members in participatory design sessions are typically novice users of the thinking framework applied. They need facilitation to work out a solution together. The following principles shall guide experts of a tool that facilitate participatory design session.

P1: Map out the information

People have limited information processing capacity (Miller 1956, Kirschner 2002). Mapping information can help to reduce the cognitive load and extend capacity to hold on to details by adding new stimuli to the information.

P2: Make it intuitive to use

The available working memory is consumed with different types of load (Sweller & Chandler 1991). Reducing distracting noise (external load) frees capacity for other concerns (Schweller 2005).

P3: Choose an expressive representation

The representation impacts the task performance (Vessey & Galletta 1991). Therefore a representation should fit the problem domain (Agarwal et al. 1996; Hornecker & Buur 2006).

P4: Choose a small set of concepts

Participants have to agree on the set of concepts to be used (Ehn & Sjogren 1991). Less concepts and less resolution of details can help to make the agreement process easier (Edelman 2009a). The further apart the participants' disciplines, the smaller the set of concepts that they may share.

P5: Choose easily changeable media

Low viscosity, high provisionally, and low premature commitment all reduce the overhead associated with changes (Blackwell et al. 2001). From a different perspective, the media chosen implies the ease of change, characterized by the abstraction and resolution of the representation (Edelman 2009a).

P6: Play a game

Games are fun to participate (Ackoff 1974). While playing, explicit rules are set that help to build a common understanding about the concepts and terminology (Ehn & Sjogren 1991). A game is an artificial problem to be used with the thinking tool while deferring arguments about the real case.

P7: Make it tangible

Tangibility is physical embodiment of information that enables haptic manipulation and spatial interaction (Hornecker & Buur 2006). A physical embodiment makes the idea accessible for others and provokes feedback (Buxton 2007). Physicality also stimulates different thinking styles (Clark 2008).

APPLICATION TO BUSINESS PROCESS MODELING (BPM)

THE CURRENT SITUATION IN BPM

Business process modeling (BPM) is the act of visualizing work flowing in organizations (Grosskopf et al. 2009a). It implies mapping the as-is situation but also designing the to-be process. BPM is a business modeling approach that focuses on tasks, their routing order, assignment of responsibilities, and required data in that context (Weske 2007). Taking the process frame to analyze and improve organizations has increasingly been influenced by the use of software systems (Smith & Fingar 2003). Thus, this approach is also very popular to communicate requirements and possibilities between business and IT departments.

At present, business process modeling is a special skill for business process consultants. They elicit processes during interviews and classical workshops. The consultant subsequently transforms the information into a process diagram. The quality of process models, the basis for discussions, heavily relies on input and feedback from domain experts, people within the organization that carry out the process on a daily basis. Often enough, the domain experts are left behind (Grosskopf et al. 2009a). They do not sufficiently understand the notation to assess implications or correct mistakes.

TANGIBLE BUSINESS PROCESS MODELING (T.BPM)

We created a haptic toolkit for business process modeling (Edelman et al. 2009b; Grosskopf et al. 2009b). It consists of acrylic shapes that reflect the basic

BPMN (OMG 2009) iconography, a well adopted process modeling notation (*P3*). The toolkit (see Figure 1) is used in process elicitation and design sessions with people from the business and IT departments to facilitate the immediate discussion. Business users can directly map out (*P1*) their daily experiences with the process. IT users can better understand business needs and illustrate the options offered by technology. The t.BPM tool can be used with no new interaction knowledge beyond kindergarten (*P2*).

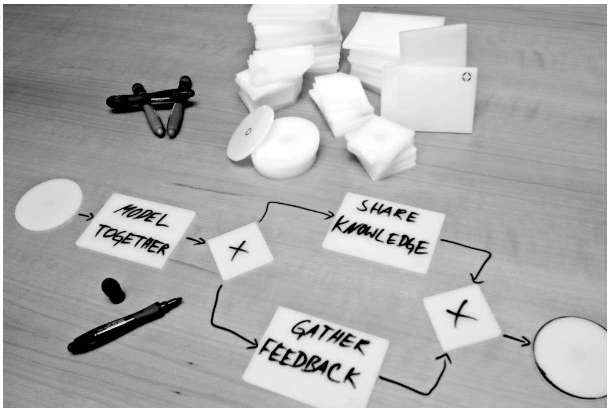

Figure 1: t.BPM approach - processes modeled with acrylic shapes

The immediate mapping eases the cognitive burden and fosters instant feedback. The haptic and spatial interaction (*P7*) at the table engages participants, hence the name tangible BPM (t.BPM). The intuitive interaction concept enables everybody to participate. The inscriptions are done with whiteboard markers and can be changed easily (*P5*).

We reduce the concepts of process modeling to a minimal set (*P4*) and introduce more as needed during the session. However, we stay within the frame of processes to foster process thinking. This is exercised by a playful mini sample example (*P6*) that we use to introduce this thinking tool to all participants.

APPLICATION TO CRADLE TO CRADLE LIFECYCLE DESIGN

DESSO: A COMPANY IN C2C TRANSFORMATION

Desso, a Dutch based multinational company, is in transition to re-design their business based on Cradle to Cradle (C2C) philosophy (McDonough & Braungart 2002). This approach classifies each product ingredient to belong either to a biological or a technical lifecycle (see Figure 2). Product ingredients in the biological cycle must be fully processable by the environment. Product ingredients in the technical cycle must be fully recyclable for reuse. The overall goal is to produce goods in balance with the natural ecosystem.

The implementation of C2C effects the entire organization and its ecosystem, including key partners, customers and supplier. To holistically transform a large organization, management has to define and monitor intermediary goals towards the long-term vision. Supplementary, small teams of domain experts have to work out and implement new manufacturing approaches on the operational level. These teams should be setup in projects that work out one particular aspect and are guided by a C2C expert. Finally, there needs to be coordination between the different teams working in parallel.

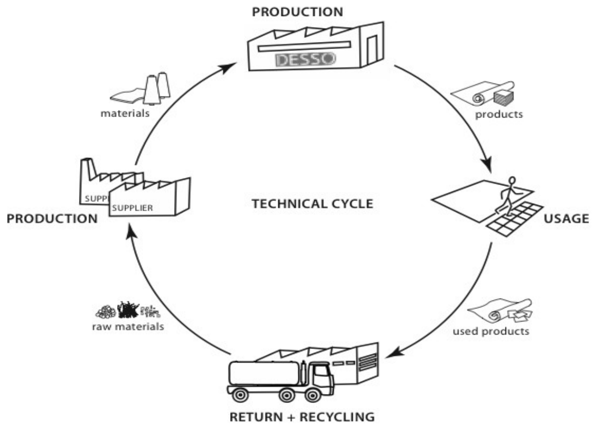

Figure 2: Technical C2C lifecycle taken from http://www.desso.com

FACILITATION OF C2C PROJECT TEAMS

We propose to facilitate team meetings with a Cradle to Cradle (C2C) expert using the principles presented in this paper. In particular, a game should be played (*P6*) that illustrates the principles of C2C to the novice applicants of the tool. Materials used in these workshops should be easily changeable (*P5*) and intuitive to use (*P2*). Moreover, these materials should be C2C conform to function as a role model and make C2C production tangible (*P7*).

Existing lifecycles and new ideas should be mapped out (*P1*) to reduce cognitive load on the participants and allow them to (mentally) drop in and out of discussions. The main visualization must be a lifecycle (*P3*) as this is the thinking framework applied. However, value chains or process models might be applied to frame aspects of the overall solution. Here, approaches like t.BPM can be used to facilitate parts of the discussion. The thinking tool should be reduced to the minimal set of concepts needed to solve a particular task (*P4*). The goal of the workshop is not to make the domain experts C2C experts, but to empower them to reach their project goal.

CONCLUSION

This paper proposes seven principles for experts of a thinking framework working with groups of novice users. These principles are derived from literature in the field of cognitive science, design theory and participatory design. We show how the principles can be applied to the area of business process modeling and Cradle to Cradle lifecycle design. We think the principles discussed here can be transported to more cases of participatory business modeling. We do not propose that the framework is complete. It rather offers a starting point to think about the setup of participatory design sessions.

REFERENCES

Ackoff, R.L., 1974. *Redesigning the future*, Wiley New York.

Blackwell, A.F. and others, 2001. Cognitive dimensions of notations: Design tools for cognitive technology. *Cognitive Technology: Instruments of Mind*, 2117, p.325–341.

Blackwell, A.F., 2008. Cognitive Dimensions of Notations: Understanding the Ergonomics of Diagram Use. *Diagrammatic Representation and Inference,*5223, P. 5-8.

Blanco, E., Grebici, K. & Rieu, D., 2007. A unified framework to manage information maturity in design process. *International Journal of Product Development*, 4(3), P.255–279.

Boujut, J.F. & Blanco, E., 2003. Intermediary objects as a means to foster co-operation in engineering design. *Computer Supported Cooperative Work (CSCW)*, 12(2), P.205–219.

Buxton, W., 2007. *Sketching user experiences: getting the design right and the right design*, Morgan Kaufmann.

Clark, A., 2008. *Supersizing the mind: Embodiment, action, and cognitive extension*, Oxford University Press, USA.

Edelman, J., 2009. Hidden in Plain Sight: Affordances of Shared Models in Team Based Design. *Proceedings of the 17th International Conference on Engineering Design, ICED'09*.

Edelman, J., Grosskopf, A. & Weske, M., 2009. Tangible Business Process Modeling: A New Approach. *Proceedings of the 17th International Conference on Engineering Design, ICED'09*.

Ehn, P. & Sjogren, D., 1991. From system descriptions to scripts for action. *Design at work: Cooperative design of computer systems*, CRC Press, P.241–268.

Gibson, J.J., 1977. The theory of affordances. *Perceiving, acting and knowing: toward an ecological psychology*, P.67–82.

Green, T.R.G., 1989. Cognitive dimensions of notations. In *People and computers V: proceedings of the fifth conference of the British Computer Society Human-Computer Interaction Specialist Group, University of Nottingham,* P. 443ff.

Grosskopf, A., Decker, G. & Weske, M., 2009. *The Process: Business Process Modeling using BPMN*, Meghan Kiffer Press.

Grosskopf, A., Edelman, J. & Weske, M., 2009. Tangible Business Process Modeling - Methodology and Experiment Design. *Lecture Notes in Business Information Processing, 43(1)*. P. 53-64.

Hornecker, E. & Buur, J., 2006. Getting a grip on tangible interaction: a framework on physical space and social interaction. In *Proceedings of the SIGCHI conference on Human Factors in computing systems,* P. 437-446.

van den Hoven, E. and others, 2007. Design research & tangible interaction. In *TEI '07: Proceedings of the 1st international conference on Tangible and embedded interaction*, P. 109–115.

Ishii, H. & Ullmer, B., 1997. Tangible bits: towards seamless interfaces between people, bits and atoms. In *Proceedings of the SIGCHI conference on Human factors in computing systems*. P. 234–241.

Kirschner, P.A., 2002. Cognitive load theory: Implications of cognitive load theory on the design of learning. *Learning and instruction*, 12(1), P.1–10.

Laurel, B., 2003. *Design research: Methods and perspectives*, The MIT press.

McDonough, W. & Braungart, M., 2002. *Cradle to cradle*, North Point Press New York.

Miller, G.A., 1956. The magical number seven, plus or minus two. *Psychological review*, 63, P.81–97.

OMG, 2009. *Business Process Modeling Notation (BPMN) 1.2*, OMG.

Schuler, D. & Namioka, A., 1993. *Participatory design: Principles and practices*, CRC Press.

Smith, H. & Fingar, P., 2003. *Business Process Management: the third wave*, Meghan Kiffer Press.

Sweller, J., 2005. Implications of cognitive load theory for multimedia learning. In *The Cambridge handbook of multimedia learning*. Cambridge University Press, P. 19–30.

Sweller, J. & Chandler, P., 1991. Evidence for cognitive load theory. *Cognition and Instruction*, P.351–362.

Stillings, N.A., 1995. *Cognitive science: introduction*, Bradford Books.

Vessey, I. & Galletta, D., 1991. Cognitive fit: An empirical study of information acquisition. *Information Systems Research*, 2(1), P.63–84.

Weske, M., 2007. *Business Process Management: Concepts, Languages, Architectures*, Springer-Verlag New York Inc.