

Jens Krzywinski · Mario Linke · Christian Wölfel (Hrsg.)

ENTWERFEN ENTWICKELN ERLEBEN 2016

Beiträge zum Industrial Design



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Designing a Sustainable Future with Mental Models

Anke Bernotat · Jürgen Bertling · Christiane English · Judith Schanz

Abstract

Inspired by the question of the Club of Rome as to Design could help to translate the ubiquitous knowledge on sustainability into daily practise and Peter Senge's belief on mental models as a limiting factor to implementation of systemic insight (Senge 2006), we explored working with mental models as a sustainable design tool. We propose a definition for design uses. At the 7th Sustainable Summer School we collected general unsustainable mental models and "designed" sustainable ones. These mental models were tested as a part of the briefing to student projects and evaluated by the students. Analysing an existing product portfolio, we tested the ability of mental models to aid the creation of strategic design advice. We argue that mental models in the form of associative thinking and cognitive metaphors have been part of designing all along and overlap in nature with design methodologies to such an extent that they are sublimely suited to be used as a design tool.

We summarize our prototyping exercises with the proposal of a design process using mental models to root sustainability in design practise and thinking beyond present-day eco-design (Liedtke et al 2013, Luttrupp and Lagerstedt 2006, Pigosso and McAlloone 2015).

Background

The Wuppertal Institute and the Club of Rome, German division, approached Industrial Design educators with the question of whether design could help to translate the knowledge on sustainability into daily action. Although the worries about the earth are severe and the reasons, with our own behaviour harming the earth, are fairly well known, the majority of the western world does not live accordingly. Why is there such a gap between theory and practice of sustainable life? Is this a design problem?

Mental Models as a lever for change

The first report to the Club of Rome *Limits to growth* looked at the sustainability crisis from a systems dynamics perspective (Forrester 1993). In *limits to growth* Donella Meadows (1972) explained the role of mental models: “Decision-makers at every level unconsciously use mental models to choose among policies that will shape our future world”. Are these mental models the same ones that designers use to aid users in operating in complex and unfamiliar situations – such as Apple has so famously done when inventing the desktop metaphor for the man-machine interface? (Kay 1990). Could these rather simple mental models be so powerful as to change policies, thinking and acting? Peter Senge (2006) thinks so, when promoting a “discipline of managing mental models” in the business context. He believes that unexamined, unconscious mental models are the reason why “systemic insights never find their way into operating policies” and why we are limited “to familiar ways of thinking and acting”.

Research scope and aim

From these starting points, we set out to develop a new design process that would be able to root sustainability in every day practice beyond present-day eco-design-concepts (Liedtke et al. 2013, Luttrupp and Lagerstedt 2006, Pigozzo and McAlloone 2015). We experimented with mental models and design processes and attempted to:

- Discover mental models of our current unsustainable ways
- Find or invent sustainable mental models
- Design objects, services or behaviours using sustainable mental models
- Discover mental models in existing product portfolios
- Formulate strategic design advice to improve a portfolios sustainability

Grand and Wiedmer (2010) suggested to call “focusing on the world as it could be [...] Design Fiction”. They argue that scientific research starts to consider itself as a constructive and creative practice – put differently: that research is design at times. They call for a “A method toolbox for design research in a complex world”. The way we set out to develop the method could be framed accordingly: research as design or design as research. Our method under development could possibly fit into their toolbox.

When research turns to the future, or more explicitly into a “desirable” future it loses some of the valued objectiveness in favour for an intention. Our research aims to support a sustainable change, hence it could be called

design activism (Fuad-Luke 2013, Markusen 2013). We hope our method will have the hallmark of design methods in terms of design thinking (i.e. Brown 2009) and be useful as an interdisciplinary link between systems dynamics, sustainable design and even business.

What are mental models?

During the 7th Sustainable Summer School, an interdisciplinary group started the process. The first conflict presented itself in understanding what mental models are. The confusing multitude of definitions leads most participants into unfamiliar territory. Doyle and Ford (1998) collected definitions, for example: “a mental image or verbal description in English can form a model of cooperation and its processes. [...] They are models to substitute in our thinking for the real system that is represented.” by Forrester. “Each person carries in his head a mental model as an abstraction of all his perceptions and experiences in the world, which he uses to guide his decisions” by Donella Meadows. And Morecrofts more recent suggestion “It is useful to think of mental models as a dynamic pattern of connections, comprising a core network of “familiar” facts and concepts and a vast matrix of potential connections that are stimulated by thinking and the flow of conversation”. These definitions start out reminiscent of Platon's cave story and end sounding like an attempt to describe a creative process.

Mental models are first mentioned by Craik in his book *The Nature of Explanation* (Craik cited in Johnson-Laird 2004). In user interface design, mental models are bound to their functional aspect of explaining one thing in the terms of another. Metaphors from the analogue world are commonly used to explain complex digital tools and processes in interface design (i.e. Blackwell 2006, Saffer 2005 or Cooper 1995).

Lacking a usable definition, we looked in approximation for something like mottos, slogans or metaphors guiding behaviour. We searched for mental models of the unsustainable world. The list, compiled with tentative commitment did nothing less but shock us. From the childhood truth: that *the cow is there to give milk* to the seemingly descriptive term of *1st and 3rd world*, the implication on entitlement of use and abuse of nature and fellow being were obvious. These “nuggets” had some power, and presented some condensed confronting insights.

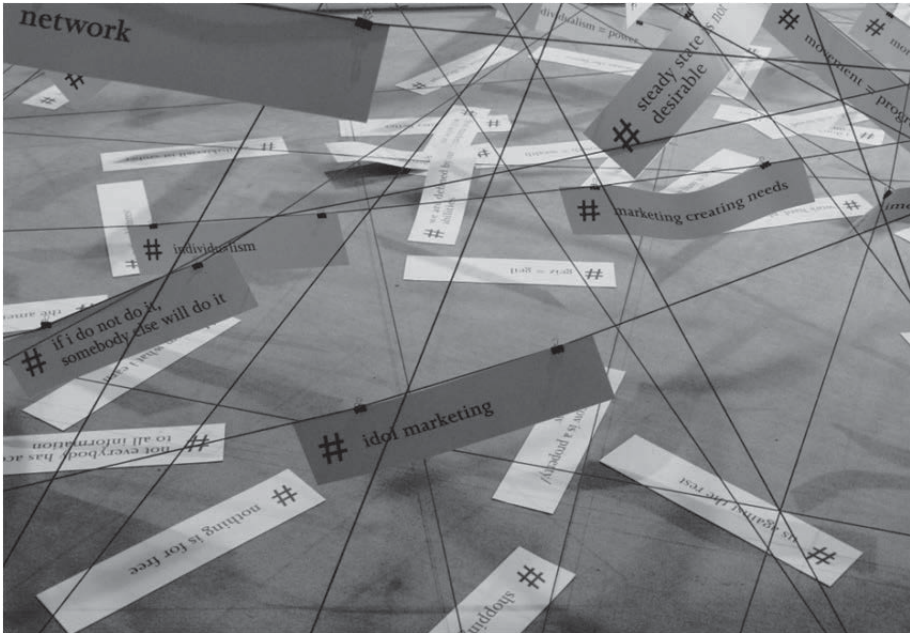


Figure 1: Impression of mental model presentation at the exhibition Zwanzig52, Folkwang University of the Arts, March 2016

Mental Models – A definition for design uses

Doyle and Ford (1998) carefully compiled this definition: “A mental model of a dynamic system is a relatively enduring and accessible but limited internal conceptual representation of an external system whose structure maintains the perceived structure of that system.” They quote Frankfort-Nachmias and Nachmias statement “A conceptual definition is neither true nor false. Conceptual definitions are either useful for communication and research or they are not.” To be useful in a design context, a definition of mental models should be short, use common language and syntax and require little or no expert knowledge on the subject. We propose to condense Doyle and Fords (1998) definition into the following sentence:

“Mental models are little theories of how the world works.”

We can assume some prior knowledge of the design community on what a “model” is and how it is used to visualise concepts and how a model and the reality may relate in structure and detail. Designers are very familiar with the diversity of models in shape, content, scope and quality. But they hardly ever consider models as “theories of how the world works”. We use the

word “theories” as a non-technical word for hypotheses, something believed to be true. Doyle and Ford (1998, p17) worried that “theory” might sound too complete and coherent, adding the attribute of “little” to address this worry. At the same time the word “little” suggests some form of being “accessible and limited”. Broadening the “external system” to the all-encompassing word “world”, does indeed make the definition less precise. “[...] how the world works” implies the purpose of the engagement with mental models, which brings our definition closer to the functional definitions used in practical fields. For designers, examples may be even more important than the text itself, hence we include examples in our definition, noting the extreme diversity in appearances and scope.

Example 1 Archetype

The chocolate brand Milka uses the “lilac cow” to position themselves and their chocolate. The “lilac cow” is a mental model defined in contradiction to an archetypal cow. Using the lilac cow, they explain how their product is different from others on the market.

Example 2 Illustration/Scheme

Vosniadou and Brewer (1992) studied the mental models that young children form, when trying to reconcile the experience of a flat world with the information that the world is round. The “hollow world” is spherical on the outside; people live on a flat cross-section within the earth. The researchers drew this and other mental models schematically.

Example 3 Metaphor

The desktop metaphor for the computer interface is the best known metaphor used to explain a digital process or tools in terms of an analogue comparison. Many other examples exist: the lasso tool, the scissors tool or a shop web site.

Example 4 Folk wisdom/ saying

Mental models are embedded in most sayings. 'Don't count your chickens before they are hatched', explains the danger of confusing possibility with reality in terms of chicken farming, but is applicable to many areas of life.

Example 5 Cognitive Metaphors

When we say, “I feel down”, the metaphoric meaning is clear to us immediately from our own bodily experiences. Tired, ill, old or dead people are

lying – they are “down”. Johnson and Lakoff (1980) have shown that language is full of such metaphors. These cognitive metaphors explain the world and allow us to reason about it.

Example 6 Slogan/Motto

Nike's slogan “Just do it” expresses an attitude towards sports. It explains how to achieve your sporting goals – or any other goals for that matter. The mental model is nested in all kinds of popular ideas on success, life and enjoyment.

Example 7 Shared understanding

In shared mental model research, the view (interpretation or understanding) that a team has about their task or role is seen as a mental model. Those shared mental models are extracted by questionnaires, discussion or use of images. With the market research tool ZETMET, mental models can be metaphorically extracted by use of images and the results are represented as a conceptual map.

Example 8 Design concept

Christopher Alexander and colleagues (1977) used the word *pattern* to refer to concepts like the “holy ground” or the “outdoor room”. In the book 'A pattern language', the purpose, need and principal design guidelines to many *patterns* are suggested. Such patterns/design concepts are mental models.

Finding and inventing Mental Models to induce sustainable behaviour

As mental models appeared to be powerful – albeit unconsciously at work, the Summer School participants wanted to ensure a respectful and non-manipulative use of mental models. They agreed on criteria of what a 'good' mental model would be:

1. Experiential – people should be able to recognise it from their daily life
2. Meaningful and commonly understood, but allowing for individual interpretation
4. Visible, tangible, emotional or in some other way catchy
5. Should trigger a re-evaluation of behaviour or thought
6. Inspire sustainable practices.

Considering that the topic of sustainability is both complex and broad, a more narrow focus was necessary. We selected three fields that impact our daily life: personal hygiene, comfort and e-communication.

The Zaltman metaphor-elicitation technique (ZETMET) extracts “a mental model shared by a market segment or group” (Zaltman and Coulter 1995) using images. Analogue or digital analysis of text or spoken language as has been proposed as a means to extract shared mental models (i. e. Carley 1997). Argyris and Schoen's (1974) mental model method deducts from negative consequences in a series of steps back to the governing values. Peter Senge (1990) regards working with mental models a discipline, which needs “regular practise”, something similar to drawing. In line with Senge's understanding, we decided not to use any formal method other than design methods commonly known to design practise and thinking. We do not feel the need for any digital database support (Kolb et al. 2008) or guided procedures (Madson 1994). Using divergent creativity techniques, we collected and developed mental models. We analysed expert presentations and extracted mental models used. Finally a simple convergent voting resulted in a list of “best positive mental models”.

Comfort #THE BEST THINGS IN LIFE ARE FOR FREE #SIMPLIFY YOUR
 LIFE #ALL MY TIME IS QUALITY TIME # I MADE IT, SO I LIKE IT #PRO-
 PERTY IS BURDEN Ecommunication #WORLD WIDE WASTE #1 COFFEE
 = 35 EMAIL #WHO PAYS THE BILL? #MIND THE WEB! #ARE YOU
 STILL CONNECTED WITH YOURSELF? Personal hygiene #GRANDMA WAS
 CLEAN TOO #LESS IS THE NEW SEXY #MY BODY IS A MOUNTAIN LAKE
 #GEIZ IS GEIL #ALLE FLIEGEN AUF AXE(L), ABER ICH STEH AUF PAUL

Figure 2: Collection of Sustainable mental models created in our workshop at 7th Sustainable Summer School 2015.

Mental models in design

We cannot know with certainty if the chair called *Ant* by Arne Jacobsen (1952) was named or designed after the ant. However the metaphoric likening is not superficial: ants move in rows, are small but strong, have tiny thin exposed legs, work a lot and have a remarkably narrow waist. Casakin and Goldschmidt (1999, 2000) found that designers at all levels of expertise use metaphors and analogies to frame problems and inspire solutions. Associative thinking is part of many creativity techniques such as TRIZ

(Altshuller et al 1999), lateral thinking (de Bono 1970), associative problem-solving (i.e. Casakin 2007) and programme for biomimetic design.

Mental models in user interface design are understood as metaphors, explaining a digital process or tool in terms of an analogue comparison. We see metaphors in architecture and products design sometimes with formal influence, but often resulting in just conceptual structuring of a solution. Kim Leung and colleagues (2012) have shown that cognitive metaphors especially embodied metaphors activate creativity.

We suspect that designing is intrinsically a creative engagement with mental models. Nigel Cross (2006) contrasted the culture of design opposed to science or humanities as studies of the “artificial world” with “methods of modelling, pattern-formation, (and) synthesis”. A mental model is a synthesis of information; it is a model and describes or forms patterns. The overlap is obvious – mental models might be very well suited to evolve into a distinct design method.

Designing using sustainable mental models

We tested designing with mental models as method in our product design course at the Folkwang University of the Arts. 3rd and 5th semester students and two Bachelor thesis students participated in the course. 18 students designed 17 objects. The task was to bring sustainability into our daily life through the design of sustainable products and services using mental models.

Student feedback

The students experienced working with mental models as positive. Some benefited most from the mental models in framing their problem; others felt inspired to come faster to relevant solutions. Many students reported that the mental models helped them as a guideline and kept them on track while working. Overall we saw a positive effect to the fluidity design process.

The students themselves did not dare to judge, if mental models helped them to more original, elaborated or sustainable results. This is probably related to the lack of a benchmark; more research would be needed to evaluate the effect of the method on the results. All students reported some initial confusion on what mental models are. Working with mental models was new to all students and they needed time to get used to the new way of looking at things. The students reported to look forward to using the method again. We suspect they see some yet unused potential, which would suggest that mental model work can be practised as a skill.

Mental models in existing product portfolios

All artefacts like products, journals or architecture are embodiments of our “little theories of how the world works”. We suggest searching for the unconsciously ubiquitous mental models in the artefacts surrounding us.

Manufactum is a German warehouse selling items of high quality and often-high price. Their slogan is “the good things in life still exist”. They operate with three guiding principles: reliable, functional aesthetics and sustainable use of material (Manufactum 2016). We wondered if a mental model analysis would allow us to give strategic advice on how to strengthen their sustainable focus. It was easy to identify 62 mental models to Manufactums guiding principles. 42 more mental models relating to the kind of products sold, the user benefits of the products, the attitude of the customers emerged effortlessly. The company seems to be *#committed to perfection*. We felt the diversity in age and origin of their portfolio is assembled, almost as a *#time travellers collection* of artefacts to name just two examples.

Strategic design advise after mm analysis

Our imaginary task was to give design advise on how to strengthen the sustainability of Manufactum. The mental model a *#time travellers collection* offers plenty of opportunities to celebrate the joy and adventure of a sustainable lifestyle. This would be something quiet unique, as sustainability in general is experienced as somewhat overly serious and joyless. Working with the mental models on the product portfolio was surprisingly easy, pleasurable and effective. The mental model can facilitate communication about those otherwise difficult to address and often-emotional topics. The mental model analysis changes the participant’s interpretation, challenges their theories and is therefore in itself a change agent. Dahl (1999) explored ‘visual mental imagery’ as a tool to align customer expectation and company vision.

A design method using mental models

The mental model framework needs some getting used to and aids the fluency of the design process only after some practise, much like many other methods. In our limited experience we felt that once practised it facilitates a dialog about sustainable solutions and allowed a person or group to work efficiently. Working with them is a skill or a “discipline” as Senge (1990, p186) calls it.

The mental model work has the ability to change a person's viewpoint – somewhat permanently. That change is an individual one, which cannot and

should not be imposed on people. The five steps of our method are a loosely knitted framework, welcoming variation and individualization. We enrol common design methods in favour of any specialized ones.

- Step 1 Introduction: A short but comprehensive account of the methods intentions, scope and effects is given. Such an introduction should be more than informative or scientifically sound. We imagine it to have some inspirational attitude and narrative quality. It would include a definition with examples and the four criteria of good mental models defined earlier.
- Step 2 Reflect current mental models: We suggest to deducted mental models from art factual evidence. Preferably this is introspection. Becoming aware of your own mental models is in itself a change promoting activity.
- Step 3 Create positive mental models: Creating or discovering mental models is understood as a design task, any number of divergent creativity technics can be used.
- Step 4 Apply positive mental models: Converging design methods will lead to an appropriate amount of selected mental models, which can be used as part of a design brief or as selection criteria to decisions in on-going activities. Mental models should remain suggestive rather than demanding, and remain open to improvement during their time of use.
- Step 5 Evaluation: Evaluate the effectiveness of the applied mental models involving users.

Conclusions

Deducting mental models from artefacts enriches both design analysis and strategic insight. Using mental models to guide design development aids the fluidity of the design process and combines seamlessly with design methods. Mental models as a design tool could link design to system dynamics, business management and reasoning: our design process can used as an interdisciplinary tool. We feel that working with mental models is a very promising way to root sustainability into design and talk about otherwise difficult to address aspects of products and their implication to the world. We look forward to practitioners and researcher to test and improve the suggested process.

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