

# Material innovation: case studies of tangible working material in technology, art and design

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## Abstract

There are still unexplored entrepreneurial potentials for collaboration in design, art and engineering. Heimdal and Rosenquist explored three roles of textiles as tangible working materials in such co-design processes. However, more knowledge of innovative design processes that involve new use of materials is needed. The aim of this study was to identify potentials for sustainable innovation in tangible working materials in design processes. This was analysed in a ‘preservation of diverse cultures’ perspective from Deep Ecology. Case studies were performed on the design and engineering of innovative use of materials for product development and design of the environment. Contexts for the case studies included cement industries, experimental use of cement in design education, 3D printing of plaster-based, clay-based and cement-based composites, public art in a terrazzo floor in a school and concrete art sculptures in a hospital park. The findings were discussed in relation to ecology to contribute to concepts for sustainable collaborative practices between technology, art and design.

*Keywords: artistic research, participatory design, Deep Ecology, chemical products*

## 1 Tangible working materials for innovation

There is a need for more studies on materials, especially in a context of cooperation between industry, academia and education, a cooperation needed to enable innovation (Curaj, 2012). There are unexplored entrepreneurial potentials for collaboration in design, architecture and engineering. Heimdal and Rosenquist explored three roles of textiles as tangible working materials in such co-design processes (Heimdal & Rosenqvist, 2012). Whereas their study focused on textiles, there is a need to expand knowledge systematically about other materials. This study contributes to that aim with a specific focus on materials such as plaster-based, clay-based and cement-based composites, because these were materials to which the participating researchers had access to the field (Hammersley, 2007).

A useful starting point for such a study was the recognition that there were many innovative applications of plaster-, clay- and cement-based composites in different contexts that could be analysed. Such established practices can be seen as the result of tradition and different ways of thinking, according to the art philosopher Varto, who claimed that ways of seeing the world also influence what is regarded as research (Varto, 2009). A certain practice may be seen as having emerged from natural causes and is therefore regarded as the best and maybe even the only way. However, this thinking may result from being unaware of other ontological justifications, other practices, other ways of thinking or other theories. It is therefore valuable to see how concrete is used innovatively in different contexts, ranging from education and research to industry and the public sector, and to see how this can be related to research traditions. Design research is a cross-disciplinary field that should integrate a sustainable and lasting way to contribute to practice. It is therefore important to be aware of the different scientific traditions within which practitioners are working. Thus, cross-disciplinary research can contribute to connect different types of practices and professions.

More knowledge is needed about innovative design processes that involve new use of materials. The aim of this study was to identify potentials for material innovation in tangible working materials in design processes. This was analysed in a ‘preservation of diverse cultures’ perspective from Deep Ecology (Næss, 1993). From a design education perspective and in the context of designers’ making skills and experience with materials, digitalisation has great advantages, but there are also lost opportunities to engage students with tangible/practical issues around sustainability. It is therefore a need to approach fresh learning methodologies and spaces and to observe effects on teaching and learning situations (Stoltenberg & Firth, 2015). Learning spaces are frequently discussed in design research, but there seems to be little focus on how various environments might influence the learning outcomes within the context of teaching sustainable working methodologies and material processes. This justified the research question of how plaster-, clay- and cement-based composites can function as tangible working materials in co-design processes to influence sustainable innovation.

## **2 Case studies in education, industry and public service**

The method was chosen based on existing practices and access to the field through participatory research (Hammersley, 2007). In the Nordic countries, there has been a tradition of cooperation between labour, government and unions which has strengthened a sustainable approach to the labour market through participation and social awareness (Aagaard Nielsen, 2010). Increasingly, government and research practices demand a better interaction between research, teaching and innovation in business and employment (Curaj, 2012). Therefore, a suitable method should generate empirical data from both teaching, industry and public organisations. Case study was chosen as a method (Yin, 2009) based on the nature of the research question and because we had relevant access to the field in various contexts (Hammersley, 2007). This made it possible to do a cross-case analysis adopting a ‘preservation of diverse cultures’ perspective from Deep Ecology (Næss, 1993). Case study was suitable because it was possible to study a topic – plaster-, clay- and cement-based composites as a tangible working materials in co-design that leads to innovation – in various contexts such as cement industries, experimental use of cement in design education, 3D printing of plaster-, clay- and cement-based composites, public art in a terrazzo floor in a school and concrete art sculptures in a hospital park. This was finally discussed in relation to

sustainable perspectives on Deep Ecology, specifically on ‘preservation of diverse cultures’ (Næss, 1993).

### **3 Sustainable innovation and Deep Ecology**

Innovation has different meanings in various traditions, such as in design, where corporate social responsibility (CSR) is enhanced (Melles, de Vere, & Mistic, 2011); in social anthropology, where change of practices is relevant (Barnett, 1953); and in technology and business (Chesbrough, 2003). In this study, a hermeneutic approach was chosen in which the aim was to describe the meaning of the different innovative practices using plaster-, clay- and cement-based materials as tangible working materials in co-design processes, described in such a way that it would be understandable and meaningful both for the practitioners represented in the study with their various fore-understandings and for others from the cross-disciplinary field of design practice (Gadamer, 2004).

The sustainable values in the study can be made more visible through perspectives from Deep Ecology, developed by the philosopher Arne Næss (Naess, 1973). Ecosophy was an appropriate perspective to adopt because it seeks to discuss fundamental ethical and knowledge-related issues (Næss, Rothenberg, & Næss, 1989). Næss stated that there are two ecology movements which are competing for our attention. Ecosophy is not the same as eco-philosophy, according to Naess. *Eco-philosophy* is an academic discipline that does not take a position on moral and political issues; it is descriptive and analytical, whereas *Ecosophy* has a clearly normative character. Næss states that ‘Ecosophy is a philosophical worldview, total view or system inspired by the living conditions in the biosphere, especially as they appear in ecology including ecologically oriented social anthropology.’ As a philosophical system, Ecosophy emphasises the coherence between all subsystems.

According to Næss, Eco-philosophy is concerned mostly with pollution, resource depletion and the usefulness of the Earth to humans. Ecosophy is concerned with the diversity, richness and intrinsic value of all the Earth. This is the Deep Ecology movement. Deep Ecology is a philosophical system with holistic thinking and a worldview based on an ecological understanding of the world and humans’ place within this world. It emphasises a positive coherence between all living things and a set of general guidelines for thinking and action. In 1984, together with George Sessions, Næss developed eight basic principles of Deep Ecology. Throughout his career, he developed his theories further, and Næss’ theory is currently viewed as one of the most important philosophies on environmental issues (Næss et al., 1989). In his book, *Ecology, Community and Lifestyle: Outline of an Ecosophy*, Næss presented his Ecosophy T theory and outlined an 18-point list to be used as a tool for a sustainable discourse. One of these 18 points, ‘preservation of diverse cultures’, was chosen as a perspective for the case studies to see how preservation of diverse cultures can be relevant to a study in tangible working materials in various co-design processes. The aim was to develop the understanding of concepts that connect technology, art and design.

### **4 Findings**

The results from the methods show different qualities of tangible working materials in various co-design processes.

#### 4.1 Case 1: Material innovation in concrete industries

Founded in Milan in 1937, Mapei is one of the leading companies in the production of adhesives and chemical products for building. Mapei claims on their website that the company's 'longstanding commitment to the environment extends to our facilities, products and processes – from minimizing waste to maximizing use of recycled materials. In addition, the focus of our Research & Development efforts is to formulate ecologically sustainable products and systems which do not include solvents or pollutants.' They aim to use local raw materials to minimise pollution. Mapei claims to be an innovator of environmentally responsible solutions, and they manufacture more than 150 LEED-compliant eco-friendly products. As one example of the company's research, Mapei Norway in Odalen chemically tests their products to make sure of their qualities in use. These quality tests are related to temperature-responsive contraction, aggregation, dynamic light scattering, aqueous solution, copolymer microgels and chlorides (Al-Manasir, Zhu, Kjoniksen, Knudsen, & Nystrom, 2012): 'From the zeta potential measurements, it is observed that the charge density of PNIPAAM microgels in the presence of an ionic surfactant is significantly affected by temperature and the attachment of the negatively charged PAA groups. The turbidity measurements clearly indicate that the interaction between PNIPAAM and SDS is more pronounced than that of the cationic surfactant.' Illustration (Figure 1) by TU May 10 2015. A sustainable aspect is to develop materials that support the Nordic climate and to use local materials to reduce pollution.



**Figure 1. Research and development for additives quality testing and cement projects at MAPEI.**

#### 4.2 Case 2: Material innovation in design education

In product design education at Oslo and Akershus University College, an experimental, aesthetic approach was encouraged in the 10 ECTS module 'Experimental use of materials and techniques' in the first year bachelor study, where design learning was based on each student's motivation and creativity was enhanced. The topic was to explore how to make concrete look more like a soft, warm and lightweight material. The study sought to transfer the qualities of a textile material into concrete as a way of preserving an aesthetic expression in another material. One student wrote about her experiments in concrete:

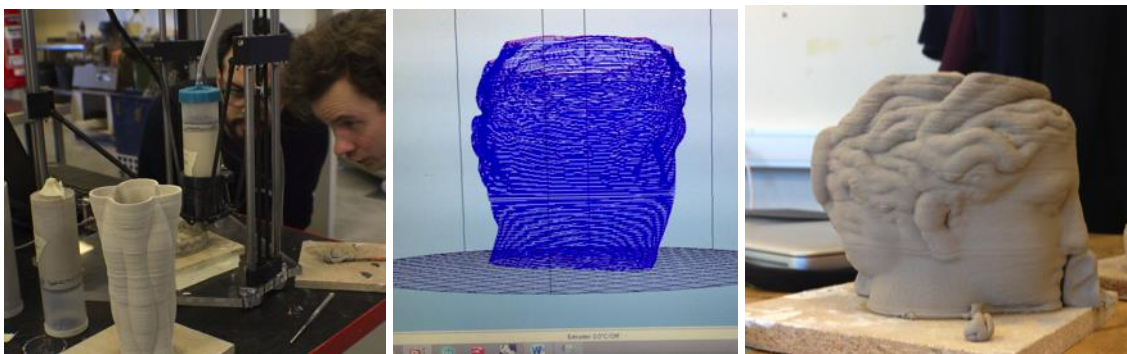
Wool aggregates: I used yarn aggregates as well as sand and stone in the cement mixture. Sample 1A: I cut up the wool yarn and put it into the mix before casting. I witnessed yarn pieces dissolving in the solution, and the effect was less dramatic than I had thought beforehand. Sample 1B: castings in the mould before I strewed yarn bits on. For Sample 2, I greased the mould with release agent, attached nets on the release agent and then poured in premixed white cement. It was a little difficult to keep the

yarn in place because it almost dissolved into the cement. This gave a somewhat random pattern, which can also be quite fine. I polished the sample, and the result was that the yarn stood out more clearly; the grains of sand and stones in the cement became clearer as well. To think of examples of products where you use some of these techniques, one could make stools or benches where one casts the fabric or yarn on its surface. For outdoor use, one could use material that does not absorb water and moisture.



**Figure 2. Experiments from product design student Anne Gerd Eira: How to make concrete look more like a soft, warm and lightweight material.**

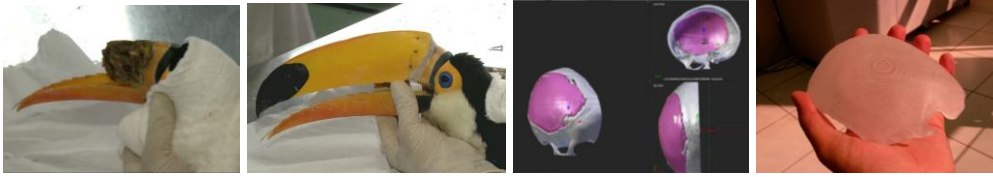
### 4.3 Case 3: Material innovation in clay-based 3D printing



**Figure 3. Workshop in 3D printing of clay-based materials and cement composites.**

The project on workshop learning, led by a research group at the Product Design Department at Oslo and Akershus University College of Applied Sciences, is about design and technology competence in 3D printing. The aim of the project is to expand understanding of how learning occurs and how users gain experience in new 3D prototyping and production techniques applied in materials such as clay-based materials, polypropylene and cement composites. Digital production techniques are being increasingly integrated into the labour market. The basis for the project was the realization that there is continuous development of 3D printers (rapid prototyping) for prototypes and products, yet there is little research on how learning occurs through workshop practice (Mjelde, 2006) in clay-based materials, polypropylene and cement composites in relation to creative and artistic production techniques in 3D printing. A workshop was organised in collaboration with the Estonian Academy of the Arts (Figure 3). By developing existing expertise with recently acquired 3D printers, this competence can contribute to the development of students who can eventually become leaders in future ceramic production techniques. The project will connect research in product design and research in vocational teaching by focussing on workshop learning in practice in various professional contexts (Brevik, 2014). The aim is to provide insight into how action research, participatory design and case studies can be used as a strategy to develop professional knowledge and experience in research-based development and change processes (Berg, 2014).

#### 4.4 Case 4: Material innovation in plaster-based 3D printing



**Figure 4A: Case study from São Paulo State University: Missing upper part of toucan's bill. Figure 4B: Missing part of human skull. Figure 4C: Toucan's bill prosthesis in resin. Figure 4D: Human skull prosthesis in acrylic.**

Design provides societal innovation far beyond industrial applications; it fulfils needs from a much broader range of areas of knowledge. Examples include problems and needs in medical and veterinary areas, prostheses and implants in particular. This case show how it is possible to fulfil these specific and sometimes challenging needs by adopting experimental design processes that combine various conventional modelling techniques with rapid prototyping or 3D printing technologies. It is challenging to replace the original upper part of a toucan's (*Ramphastos toco*) bill (Figure 4A) or part of a human skull (Figure 4C) in a cranioplasty procedure using prostheses that have similar physical characteristics (dimensions, weight, shape and strength).

The first challenge for both cases was the fact that there was no single shape or dimension from the original part as a starting point for the project. As a reference for the toucan's bill, the project used a dissected bill 3D scanned (optical 3D digitalization system GOM ATOS I 2M) from another bird and plaster moulds of the remaining parts. For the skull part, it was possible in this case to use the undamaged side of the skull as a reference directly from the Computerized Tomography Image (CTI) of the patient. After editing and treating the mathematics as a result of the 3D scanning and the CTI, 3D virtual models were generated using software such as Rhinoceros, Grasshopper and Blender. The prototypes for both were based on ZP150 powder, which is predominantly a plaster powder, and were produced by a ZCorp Z650 3D Printer, allowing for all the necessary dimensional and shape corrections and final adjustments. The prosthesis for the toucan's bill was produced by an Envisiontec Ultra 3D Printer using photopolymeric SI 500 resin, and it was implanted using dental cement 3M RelyX Unicem and six tiny (5mm long) bolts (Figure 4B). The prosthesis for the skull part was cast in PMMA (Polymethyl methacrylate, also known as acrylic) and then properly sanded (Figure 4D).

This case shows that even without the part to be replaced as a starting point, it is possible to produce a high quality and accurate prosthesis, literally bringing animals and human beings back to life. In these particular cases, it was clearly possible to minimise all of the negative and collateral effects faced by the injured bird (he started eating and socializing just two days after the procedure) and the six-year-old male patient (he is now able to do what he likes best – play soccer – which he had not been able to do since suffering an accident at two years of age). It also points out and confirms the possibility of producing accurate prostheses, facing all of the most common challenges of the task by means of procedures such as 1) 3D scanning of similar parts as a reference instead of the original parts; 2) 3D scanning of the area that could accommodate the prosthesis as a starting point; 3) different technologies as tools to deal with dimensional differences between a CAD model of a similar part and real dimension needs; and 4) production of moulds to produce prostheses using more appropriate materials than those offered by 3D printing technologies.

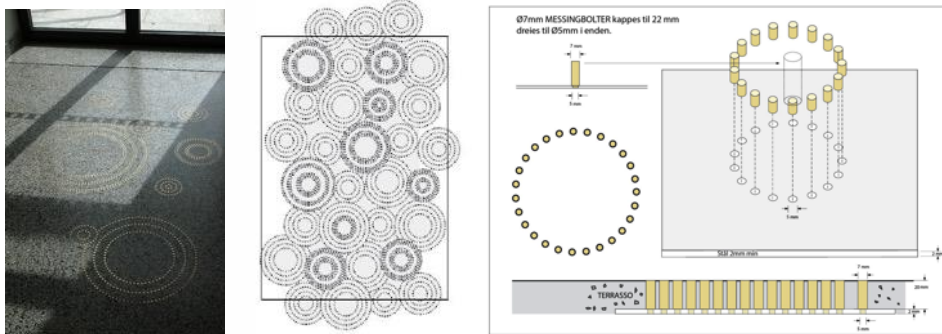
#### 4.5 Case 5: Material innovation in public art in a school

This case study showed how cultural preservation occurred through the conceptual design and visualisation of an art project, 'Sargasso' by Mikkel Wettre. The project was constructed in cement-based materials in a public school, including a floor made out of brass and steel materials in a terrazzo technique. The following text is based on the artist's own description of the project and shows how the artwork preserves diverse cultures:

The longitudinal direction of the schoolyard is facing southeast, and morning light falls into the schoolyard when the school day begins. This opened an opportunity to create an art project that uses sunlight and will have a dynamic expression as the sun moves. The upper part of the ocean swims in light during the day. This vertically illuminated area is called the euphotic zone (of gr. *good* and *light*). The exact extent of the area is determined by the clarity of the water but revolves, on average, a depth of 200 meters. What defines the area is algae's ability to photosynthesise, and the zone is characterised by a huge and varied wildlife. The project was named 'Sargasso' because the Sargasso is among the brightest of the oceans, bounded by the Atlantic and currents, which to some extent was the premise for life in our part of the world.

The artist was inspired by thoughts of light quality in urban space and how light, or rather the lack of light, helps to express social issues. In our consciousness, darkness and poverty are linked metaphorically, but in the city, this is manifested genuinely in that the poorest have traditionally been relegated to the narrow, shady streets and backyards. With focus being placed on developing a school that, in many ways, embody the conflict between old and new Oslo, the desire of the artist was to create an art project that openly suggests connections between biology and politics.

For the art project, the artist chose the conservatory and the floor in the school's entrance hall. He wanted to develop a transition zone between inside and outside. One part of the artwork for Hersleb School was an ornament embedded in the floor and consisting of brass bolts, steel plates and terrazzo coating. The ornament was drawn digitally and cut out by laser in 1.5 mm steel plate by Norwegian Stopping Industry in Skedsmo. About 12,000 brass bolts were manufactured in lathe with diameter adapted holes. The bolts were threaded through the steel plates and attached to them with a bonded collar. The steel plates, with their associated bolts, were transported to the school, where they were placed beyond a moulded concrete needle. Subsequently, all the plates/brass bolts were applied to the terrazzo surface and, after hardening, were grinded to the correct height.



**Figure 5. The aim was an art project that uses sunlight and has a dynamic expression as the sun moves.**

#### **4.6 Case 6: Material innovation in a public park for a hospital**

The final case study, based on a participatory design method, aimed to create art in the public space of a hospital (Berg, 2014). The project aimed to preserve a culture of healing. The process has relevance to emotional design and ethics because the patients were elderly people with severe illnesses, something that influenced the solution, which aimed to connect people and to create reflections. Concrete and porcelain tiles were used, and the solution was developed in a collaboration among landscape architect Mona Kramer Wendelborg, artist Arild Berg and stakeholders at the building site for Ullerud Health Centre. This text is from the presentation of the project:

‘The Window’ is intended as a metaphor for looking outward or inward, forward or backward in time. The form invites physical interaction by allowing children and adults to be inside the frame. The water and walking stones are intended to create a reflection of form and space and to inspire someone to explore balancing on the water. The wall creates a new room, which conceals and covers and creates room for new moves. The motifs are related to migratory birds and their long journeys. Snow crystals represent the winter season. They are in dialogue form-wise with other motifs on the porcelain tiles in the garden, such as seed capsules and planets on other sculptural elements.



**Figure 6. ‘The Window’ was intended as a metaphor for looking into time (3D model).**

## **5 Discussion and conclusion: Sustainable working methodologies**

Perspectives from Arne Næss’ theory of ‘Deep Ecology’ (Næss et al., 1989) can enhance issues of sustainability in the case studies. Deep Ecology and Ecosophy T (Næss et al., 1989) are holistic and comprehensive theories. The later-developed Ecosophy T has 18 points, compared with the 8 basic Deep Ecology principles. The 18 points can be used as an analytical tool for discourse due to being descriptive, whereas initial theory can inform the case study analysis (Yin, 2009). The 18 points are pollution, resources/dividing resources, population stabilization, classlessness, self-governing, decentralization, local societies, district development, self-preservation, division of labour, complexity, diversity, preservation of diverse cultures, symbioses (mutual benefits), egalitarianism, fight against humans’ self-domestication, field thinking/interplay in nature/gestalt thinking and Docta Ignorantia. This is a wide field, and some issues of sustainability for plaster, clay and cement-based composites as tangible working materials in co-design processes that can be connected to the 18 points were identified through concept mapping (Maxwell, 2005). These were technology, design education, conceptual design, design learning, emotional design, innovation, ontologies,



participatory design, visualisation, creativity, social responsibility and ethics. These concepts, which emerged between Ecosophy and issues identified in the case studies, are relevant for sustainable collaborative practices between industry, academia and education.

These concepts are all connected, and in this study a specific, sustainable focus was on expanding the knowledge and understanding of how to preserve diverse cultures in various innovations of tangible working materials in technology, art and design. In the cement industry, a sustainable aspect was to develop lasting materials in a harsh climate and to use local materials to reduce pollution. The student example showed how aesthetic expressions were transferred to another material. The 3D print examples showed a mixture of technology and aesthetic experiments. The art project at the school showed how visualisation and social responsibility became a part of the technological solution. In the final project, concrete sculptures were used in an ethical way to connect visitors and family to elderly patients with severe illnesses. In artistic research, the art philosopher Varto claimed that a researcher should be aware of ideology and ontology, both in practice and in research (Varto, 2009). These examples show various types of sustainable ideologies concerning both pollution and social awareness.

Through his ideas on complexity, Næss claimed that mature and stable ecosystems are characterised by great inventiveness and the multiple uses of resources, and that every society has alternative ways to satisfy its needs; if one factor reduces the possibilities, there are alternatives within the local community. The processes of creative experiments with concrete materials show various ways of working with innovation that can be discussed through the idea of self-preservation. This is about using 'soft' and 'close' technology, techniques that are less likely to reduce environmental qualities and diminish local resources. It emphasises that materials and tools can be found locally and also creates meaningful work. In these case studies, it was important to use local resources, preserve the natural environment and create meaningful solutions. The idea of diversity is also of relevance, because it discusses, amongst other concepts ways of expression and use of geographical.

The conclusion was that innovative practices can indeed be connected to research traditions in technology, art and design, and that there is a higher potential for sustainability with a complementary research approach. According to Næss, the concept of Deep Ecology is interesting from a design perspective, because it emphasises the importance of relational thinking, holistic thinking and system thinking. These are all factors of importance within a holistic design paradigm (Næss, 1993; Varto, 2009). In Deep Ecology, everything is connected with everything else through a mutual, dependent relationship in a long-term perspective. It is a symbiosis in which all parties extract mutual benefits from each other through companionship and every action affects all life around us. These experiences demonstrate important and tangible contributions to relational and sustainable thinking in design education where technology, art and design connect with complementary practices for sustainable innovation.

## References

- Aagaard Nielsen, K., Elling, B., Figueroa, M., & Jelsøe, E. (Eds.). (2010). *A New agenda for sustainability*. Farnham: Ashgate Pub. Company.
- Al-Manasir, N., Zhu, K. Z., Kjoniksen, A. L., Knudsen, K. D., & Nystrom, B. (2012). Effects of addition of anionic and cationic surfactants to poly(N-isopropylacrylamide)

- microgels with and without acrylic acid groups. *Colloid and Polymer Science*, 290(10), 931-940. doi:10.1007/s00396-012-2607-0
- Barnett, H. G. (1953). *Innovation: the basis of cultural change*. New York: McGraw-Hill.
- Berg, A. (2014). *Artistic research in public space: participation in material-based art* (Vol. 33/2014). Helsinki: Aalto University.
- Brevik, B. (2014). *LEGO & læring : en kvalitativ studie av elektrofaglæreres bruk av LEGO mindstorms som læringsverktøy i norsk videregående skole*. (nr. 195), Det utdanningsvitenskapelige fakultet, Universitetet i Oslo, Oslo.
- Chesbrough, H. (2003). *Open innovation: the new imperative for creating and profiting from technology*. Boston, Mass.: Harvard Business School Press.
- Curaj, A. (2012). *European higher education at the crossroads : between the Bologna process and national reforms*. Dordrecht: Springer.
- Gadamer, H.-G. (2004). *Truth and method* (2nd, rev. ed. translation revised by Joel Weinsheimer and Donald G. Marshall. ed.). London: Continuum.
- Hammersley, M. (2007). *Ethnography: principles in practice*. London: Routledge.
- Heimdal, E., & Rosenqvist, T. (2012). Three roles for textiles as tangible working materials in co-design processes. *Codesign-International Journal of Cocreation in Design and the Arts*, 8(2-3), 183-195. doi:10.1080/15710882.2012.672579
- Maxwell, J. A. (2005). *Qualitative research design : an interactive approach*. Thousand Oaks, Calif.: Sage Publications.
- Melles, G., de Vere, I., & Misic, V. (2011). Socially responsible design: thinking beyond the triple bottom line to socially responsive and sustainable product design. *Codesign-International Journal of Cocreation in Design and the Arts*, 7(3-4), 143-154. doi:10.1080/15710882.2011.630473
- Mjelde, L. (2006). *The magical properties of workshop learning* (Vol. Bd. 2). Bern: Peter Lang.
- Naess, A. (1973). The shallow and the deep, long-range ecology movement. A summary. *Inquiry*, 16(1-4), 95-100. doi:10.1080/00201747308601682
- Næss, A. (1993). *Deep ecology and politics* (Vol. 1993.7). Oslo: The Centre.
- Næss, A., Rothenberg, D., & Næss, A. (1989). *Ecology, community and lifestyle: outline of an ecosophy*. Cambridge: Cambridge University Press.
- Stoltenberg, E., & Firth, R. (2015). Sand casting on the beach - Introducing traditional making skills, materials and process through play and experimentation *Great expectations : design teaching, research & enterprise : proceedings of the 17th International Conference on Engineering and Product Design Education, Loughborough Design School, University of Loughborough, United Kingdom, 3rd-4th September 2015* (pp. 344-350): The Design Society.
- Varto, J. (2009). *Basics of Artistic Research. Ontological, epistemological and historical justifications* (E. Lehtinen & L. Mänki, Trans.). Helsinki: University of Art and Design Helsinki.
- Yin, R. K. (2009). *Case study research : design and methods*. Thousand Oaks, Calif.: Sage.
- Aagaard Nielsen, K. (2010). *A New agenda for sustainability*. Farnham: Ashgate Pub. Company.