PROJECT RESEARCH GRANT: ARTISTIC R&D

Titel:
**NanoForm**
giving through haptic, aesthetic laborations

Previous VR project
This practice-based research project in aesthetic reasoning builds on the experiences gained in our previous artistic R&D project: Cross-disciplinary studies of Complexity and Transformation (C&T) funded by the Swedish Research Council (Vetenskapsrådet, VR). The VR evaluation, Kontext-Kvalitet-Kontinuitet (6:2007), gave a positive appraisal of the C&T approach. The strength of the project was that it supported an in-depth dialogue and interaction over disciplines, offered methods that produced rich visualization material and communicated the results in exhibitions and texts that were well formulated and composed. Suggestions for improvement were to emphasize meta research structures and show how the aesthetic knowledge gained through the experiments could be applied within art and design processes. The proposed NanoForm project, is strongly influenced by the suggestions in the VR evaluation.


General plan
Our aim is to find ways to understand and experience nanostructures on an aesthetic level with emphasis on physical and virtual haptic experiences ending in a long term, solution-oriented project. The proposed project involves a multi-disciplinary group of professionals and researchers from the arts and art sciences, learning sciences, life sciences and natural sciences. We will drive the proposed project through two empirical phases: phase 1) *Aesthetic laboration* and phase 2) *Emerging solutions within formgiving processes*.

Questions addressed
- How can we compare haptic expressions of nano-properties with macro properties?
- How can virtual haptic experiences of nano-structures stimulate play and enhance understanding of the submicro/nano world?
- How can we merge the potentially new structures and behaviors that emerge from nano-technology with the holistic creative reasoning in formgiving processes?
- How can we catalyze formgiving activities through explorative aesthetic laborations performed in multidisciplinary teams?
- How can explorative laborations provide theoretical and practical support for development of courses in artistic Practice based research?
Survey of the field

The survey of the field is based on: (a) a general theoretical overview, (b) relevant contemporary research and (c) own experience.

(a) General theoretical overview: Aesthetics and haptics

There is a growing movement today in applied aesthetics that builds in part from Alexander Baumgarten’s definition of aesthetics as the science of sensuous cognition from 1735 (Shusterman 1992/2000, 263-7). The word ‘sensuous’ refers to the fusion of all our senses and ‘cognition’ meaning to know. This movement brings aesthetics into the sciences as well as into the experiences in the everyday world and lives of people. Aesthetics respected the intentions, sensitivities and experiences of individuals and communities as a vital driving force for changes in society (Akner-Koler 2007).

Within the field of aesthetics and sensory-based research there has been a strong development in haptics and intentional actions this past decade. The learning science are studying how physical engagement with materials and tools give a sense of control which build confidence and supports engagement (Ackermann 2007). Such findings about haptics underline the positive effects of feeling and hands-on experience which have always been of vital importance in sculpture, crafts and design.

The development of forced feedback technology has stimulated research in virtual haptic experience in areas as game design and invasive surgery. A recent report from the NVIS team in Lidköping has shown that virtual haptics feedback improves learning experience in task performance (Persson PB et.al., 2007). The Nanoform project emphasizes haptics because we are interested how nanostructures feel more than how they look. Researchers have also found that haptics are superior to vision when learning to detect properties such as texture, weight, elasticity, viscosity, temperature etc.. (Zangaladze, et al., 1999)

(b) Relevant current research

The current exhibition; “Design4Science”, from the UK at the Nobel museum in Stockholm engaged designers and scientists in a project to make the invisible world of molecular biology visible. The organizers Shirley Wheeler and Angela Long (2007) show a contemporary and historical view of this type of design and science collaboration. Most of the examples are about scientists working with artists, illustrators and designers to visualize complex ideas that are already established. This exhibition is an inspiration for us, however, our aims are different. The proposed NanoForm project aims to set up a cooperative discovery method that does not prioritize a natural science approach over sciences other and to emphasize haptics rather than visual senses.

The research team NVIS in virtual nanotechnology Dept. of Biomedicine and Surgery at Linköping University, Sweden. Their work aims to determine if virtual haptic feedback experience on a nano level improves learning outcomes. The results of a recent study in biomolecular education (Person et al 2007) showed a decrease in time requirement and an improvement of learning a docking process. (see collaboration)

Under the leadership of Architect Toskinko Mori (2002), professor at the Harvard graduate school of Design, a three year project called ”Immaterial/Ultramaterial” was set up to push the boundaries of materials. The project brought together a research group that involved collaboration with scientists/specialists in many fields of engineering, technology and architecture together with students of architecture. They performed first-
hand experimentation with material fabrication processes that included references to nanostructures. The goal of the project was to develop innovative materials and their possible use in architecture. There are many similarities between this project and the NanoForm project, however, the actors and methods are different. Briefly, our differences are separating a haptic explorative phase from the development of solutions.

The Swedish Royal Academy of Fine Arts recently started up an experimental exhibition in 2006 called “MejanLabs” (www.mejanlabs.se/index2_en.asp) curated by Björn Norberg (C&T and NanoForm participant). This interactive exhibition space shows work/projects by international new media artists that collaborate with natural/social scientists and engineers. MejanLabs has shown a number of artists who approached nanotechnique such as Natalie Jeremijenko och Andy Gracie. Their work points out philosophical and ethical issues concerning nature and electro/chemical processes.

(c) Our own experience and pre-studies.

Aesthetic laboration
The first phase of the NanoForm project builds on the research findings from our previous project Cross-disciplinary studies of Complexity and Transformation (Akner-Koler 2007). A major finding was the method aesthetic laboration, describing exploratory procedures in multi-disciplinary lab-sessions inviting participants to interact in experiments set up by a leader. An aesthetic laboration is conducted in a playful, hands-on way involving probing, perturbing and interacting with materials and tools. It should strive to bring together participants that come from different disciplines, cultures and generations as well as have a balance of gender. The method is rooted in a cooperative inquiry method that engages participants as co-researchers (Reason 2003) and serves as an alternative way of performing explorative experimentation that complement the classic methods of performing scientific lab-sessions.

Development of Masters courses
Two participants in the C&T project, Catharina Dyrssen and Monica Billger from the Dept. of Architecture at Chalmers University, have integrated aesthetic laborations as a means of generating knowledge and experience within a research based methods course. Their course “Research by Design” is now a required Masters course for all architect students at Chalmers (Dyrssen & Billger 2006). Through further collaboration with Dyrssen and Billger we started a new version of this course at Konstfack called Laboration, Provocation and Articulation (LabProArt) exploring the theme “Membrane” using different fluids (www.konstfack.se). This 5 week Masters elective course, given by Akner-Koler and Gustaf Mårtensson (physicist and C&T participant) during Feb-April 2008 with support from artist/entrepreneur Michael Scherdin (2007). The course was very successful and has influenced the development of the NanoForm project.

Formgiving
The concept “formgiving” is described in Akner-Koler’s (2007) thesis as an aesthetic, holistic activity involving conceptual and perceptual processes for developing the gestalt of a physical form. Formgiving is a human-centered process engaging the aesthetic sensitivities, intentions and values of artists and designers in a problem-solving context. Formgiving strives to bring out meaningfulness in the composition of materials and form. This particular engaged approach will be used in Phased 2 in the NanoForm project.

A new Masters program called Formgiving intelligence has been developed at the Dept. of Industrial Design at Konstfack 2007 (www.konstfack.se). The program constructively
explores and problematizes the industrial design process with a focus on formgiving activities, aesthetics and the role the arts play in product development. The program is co-founded by the chair/professor of the Dept. of ID, Teo Enlund (who will be a leader in the first formgiving workshops) together with professor Akner-Koler. The development of the vision for the formgiving intelligence program has inspired the second phase of the CaralyzeForm project. Integrating activities in research projects in the masters program are in line with Konstfack’s new Research and Educational strategy (FOUS 2009-2012).

Artificial life and ethical issues
Two C&T laborations, dendritic growth (Arijana Kajfes and Pablo Miranda) and the cellular automata (Narendra Yamdagni and Lars Bergström) involve inorganic crystal structures and mathematical programs, respectively, both expressing life-like growth patterns. Seeing life emerge from inorganic material and computer programs brought up ethical and existential issues about authorship and the boundaries between organic and inorganic systems (Norberg et al 2006). The way these two laborations related to each other and the ethical issues of ALife greatly enhanced the C&T project and have influenced the plan for the proposed NanoForm project.

Project description

The proposed NanoForm project supports a collective discovery process to occur over disciplines. The discoveries do not have to be totally unique or “leading edge”; our aim is to gain insight into a phenomenon /condition that is connected to nanostructures and inspires playful activities and meaningful discussions between the participants. The creative experiences during phase 1, aesthetic laboration, will set the stage for phase 2 that supports the emergence of solutions through a formgiving process. In other words, by emphasizing playful learning as we explore activities /phenomena in the real and virtual world, a good ground will be cultivated for innovative collaborative solutions.

Phase 1 - Aesthetic laboration
Aesthetic laborations (Akner-Koler 2007) emphasize haptic aesthetic experiences that stimulate direct experience of volume, proportion, weight, movement, vibration, roughness, smoothness, temperature, flexibility etc. relating to nanolevel phenomena.

Four aesthetic laborations will be completed under phase 1: two major NanoExploration workshops with two paired aesthetic laborations that bring up similar experiences / parallel concepts. By pairing the laborations we hope to simulate a comparative study that will strengthen our understanding of our project on a meta level. The workshop includes two days of laborations with all the NanoForm participants followed by two days of documentation and theoretical seminars with the laboration leaders. The last two days will discuss relevant and figuring out interesting ways of -Making Public- the findings from the laborations. These seminars will be lead by an invited scholar experienced in perceptual research (Ackermann 200 ), auto-ethnography methods (Mikael Scherdins 2007 & 2008) and practice base research methods.

Practical Procedures
At the onset of each aesthetic laboration, the leader(s) will present their background, basic concepts and terms that help understand their way of reasoning and explain their intentions. The materials and tools are laid out with some general instructions to get the laboration started. The participants are divided into 3-4 multi-disciplinary groups, which are regrouped for each laboration to ensure that all participants work together. The time
span should be generous, allowing the groups to playfully experiment and follow any path of exploration, as long as it involves sensuous experiences that test the limits of the phenomena in question. The leaders are actively involved in the performance and discussions in their own laborations, however, careful not to take on the role of a teacher. The laborations are documented with video cameras and some of the editing methods (Akner-Koler 2007).

Through collaborate with the research group NVIS in virtual nanotechnology at Linköping University we will have access to nanolevel virtual haptic feedback technology. We also plan to invest in 4 haptic lab stations with nanoscale control and manipulation using piezo translators and laser sensors. These stations will be available through out the project. To ensure the development of knowledge that bridges the laborations all the laboration leader are asked to make the findings of the laborations public. This can be done through, writing articles/essays, making an exhibitions, staging a performance, developing lectures, creating course material etc.

Phase 2 - Emerging solutions within formgiving processes

Phase 2 is about catalyzing an formgiving processes aimed to create solutions that are based on sensuous experiences and knowledge from phase 1. During the second phase we will move back and forth between nanolevel properties, everyday aesthetic experiences and holistic formgiving processes.

Practical Procedures
The procedures used here rely partly on creative methods from the industrial design culture supporting product development. Methods such as; senario visualization, forstorming, mapping, embodied studies, semiotic studies etc. Gestalt development from the arts will also support how solutions take form. Emerging solutions within formgiving processes attempt to merge both the art-based aesthetic experiences and a mechanistic understanding of nanostructures from the laborations with holistic strategies of formgiving processes. Three to four Formgiving workshops will bring together the participants to catalyze the formgiving process. A formgiving team of 3-4 participants will develop individual and collective ideas from this workshop during the time period between the workshops.

Leaders, Participants and Collaborators
The participants from the prior Complexity and Transformaiton project are marked (C&T)

Leaders
Cheryl Akner-Koler – Professor at the Dept. of Industrial Design at Konstfack. Her PhD research is in theoretical and applied aesthetics involving design education, art projects and cross-disciplinary studies. She was the main project leader for the C&T project and will act as the main project leader in the proposed NanoForm project.

- Gustav Mårtenson – technology Dr. in Mechanics researching turbulence in mechanical and natural systems from the Royal College of Technology KTH in Stockholm. He was a scientist in residence at Konstfack (2005) and recently co-taught a masters course; Laboraiton, Provocationa and Articulation. (C&T)

- Arijana Kaifes – artist with many years of experience in Interactive Institute: Smart Studion. She is interested in interdisciplinary projects and is a leading artist in developing creative and innovative concepts that apply new technology. (C&T)

- Narendra Yamdagni – Dr. in elementary particle physics at Stockholm University at Albanova center. He has taken part in several experiments at CERN and FNAL (USA) and has recently conducted haptic feedback experiments on nanoparticles. (C&T)
- **Björn Norberg** – curator at Mejan Labs at The Royal College of the Arts in Stockholm which supports art projects on the interface between art, technology and science. His interests are in ethics and social issues concerning new media. *(C&T)*
- **Teo Enlund** – Professor and chair of the Department of Industrial Design Konstfack. He has 10 years experience as a professional designer and founder of the Masters program: Formgiving Intellegence at Konstfack. *(C&T)*

Participants:
- **Lars Bergström** – professor of theoretical physics, specialising in astro-particle physics, at Stockholm University and is involved in several international research collaborative project between researchers in the USA, Italy, France, Japan. *(C&T)*
- **Monica Billger** – technology Dr. in color research employed at the Department of Architecture at Chalmers. She specialising in visualisation and modulation and is also head of Research at the Dept. of Architecture at Chalmers. *(C&T)*
- **Catharina Dyrsen** – technology Dr. with a thesis work in an interdisciplinary study between architecture, music and anthropology. She is the vise the Department of Architecture at Chalmers and has been instrumental in established a creative approach to practice based research. *(C&T)*
- **Christian Bohm** – Professor of physical systems technology at Stockholm University (Fysikum). His doctoral thesis was in nuclear physics and he has been working for a number of years on medical nuclear physics. *(C&T)*
- **Ebba Matz** – artist with a Masters from The Royal College of the Fine Arts Stockholm working with art installations that include multidisciplinary collaboration.
- **Fredrik Berefelt** – a mathematician and astrophysicist working for the Defence Research Institute FOA. His researches involves differential geometry methods for nonlinear systems that include a approach for aesthetic reasoning for gaining knowledge about complex systems with many levels of freedom. *(C&T)*
- **Elisabet Yanagisawa Avén** – associate professor at the Dept. of Textiles at Konstfack doing research in aesthetic sensiblitites in relation to philosophy. *(C&T)*
- **Pablo Miranda** – an architect working with computer-generated complex patterns and artificial life theory. He is currently working for research team at a London based architectural firm *(C&T).*

New collaborating partners
- Edith Ackermann has a PhD in developmental psychology. She teaching at School of Architecture, Massachusetts Institute of Technology (MIT) in Boston, USA. Ackermann collaborated with the INVIVIA design team to produce an exhibition called “Nano within reach” in Seoul, Korea. They used space design and nanotechnology to give experience of scale, nanotextures & transforming mechanisms.
- Lena Tibell is associate professor from the research team NVIS in virtual nanotechnology Dept. of Biomedicine and Surgery at Linköping University. Their pedagogic ambitions and knowledge of haptic nanostructures will be valuable for the development of the NanoForm project.
- Per Hedförs, Dr. in landscape architecture at Swedish University of Agricultural Sciences in Ultuna/Uppsala with special interesting in sound design. His research includes how water flows in landscape creating site soundscapes
- Mikael Scherdin is an artist working as associate professor at the Department of Business Studies, Entrepreneurship, Uppsala University. He will collaborate with us in making our process public referring to his PhD thesis in auto-ethnographic processes.
**Timetable**

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<thead>
<tr>
<th>Year</th>
<th>PHASE</th>
<th>Activity</th>
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<tbody>
<tr>
<td>2008</td>
<td>PHASE 1</td>
<td>Aesthetic Laborations</td>
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<tr>
<td>Nov</td>
<td>#</td>
<td>Project start - Build the network between universities, Institutions &amp; professionals</td>
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<td>Develop 3 year timeplan: Phase 1) 4 laborations &amp; Phase 2) Formgiving workshops</td>
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<td></td>
<td>Start up NanoForm website, order materials for lab stations</td>
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<td>2009</td>
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<td>Start planning May and Sept. NanoExploration with laborations</td>
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<td></td>
<td>#</td>
<td>Develope Publication approach: exhibition, text, performance, lecture &amp; seminar</td>
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<td></td>
<td>#</td>
<td>Built up 4 Nanohaptic lab stations</td>
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<tr>
<td>May</td>
<td>NanoExplorations</td>
<td>with 2 Aesthetic laborations + define publication approach</td>
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<tr>
<td>June</td>
<td>Making public</td>
<td>– experience and finding from laborations</td>
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<tr>
<td>Sept</td>
<td>#</td>
<td>NanoExploration with 2 Aesthetic laborations + define publication approach</td>
</tr>
<tr>
<td>Oct</td>
<td>Making public</td>
<td>– experience and finding from laborations</td>
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<tr>
<td>2010</td>
<td>PHASE 2</td>
<td>Emerging solutions within formgiving processes</td>
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<tr>
<td>Jan</td>
<td></td>
<td>Develop time plan - Integrate Phase 1 experience and findings with Phase 2</td>
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<td>Start planning for the March and May Formgiving workshops</td>
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<td>Develop force feedback procedures /nano &amp; macro level to support formgiving</td>
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<tr>
<td>Mar</td>
<td>#</td>
<td>Formgiving workshop + Establish a formgiving team that use force feedback</td>
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<td>Seminar</td>
<td>- support virtual haptic force feedback in formgiving</td>
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<tr>
<td>May</td>
<td>#</td>
<td>Formgiving workshop + presentation of work plan for formgiving process</td>
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<td></td>
<td>Seminar</td>
<td>- support virtual haptic seminar in formgiving</td>
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<tr>
<td>2011</td>
<td>Sept</td>
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<tr>
<td></td>
<td>Seminar</td>
<td>- support virtual haptic seminar in formgiving</td>
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<tr>
<td>Nov</td>
<td>MAKING PUBLIC</td>
<td>Final exhibition: presentation of project + NanoForm solution</td>
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Fig. 1 The timetable shows some of the key activities during the three year project. The symbol # make particular days that the entire NanoForm group meet.

**Expected Results**

We will: a) further develop Aesthetic laborations methods, b) integrate these laborations with emerging formgiving processes, c) develop multi-disciplinary methods for stimulating different phased of the formgiving process, d) deliver concrete prototype(s) e) develop different ways to make our findings public that mix traditional scientific publications methods with the visualization and exhibition traditions in the arts.

**Significance**

Consider the following quote by Francis Crick commenting his research on DNA:

"the whole process seemed so utterly mysterious that one hardly knew how to begin thinking about it. In research the front line is almost always in a fog”.

It seems obvious that the scientific community is ignoring a vital source for developing knowledge, which can be found in the field of applied aesthetics. When we reach our conceptual limits, where mathematical formulas and language no longer apply, then we can still explore and experiment on the front line by relying on our senses.

The NanoForm project carries potential significance for the scientific community because it integrates applied aesthetic within a multi-disciplinary group of reseachers and professionals. Aesthetic methodologies make it possible to support an individual sensetivites and curiositues (Shusterman 2000) as we make the transition from traditional mono-disciplinary methods to todays science of collective, trans-disciplinary methods (Nowotny 2001). This transition towards a collective science aims to open communication between the sciences and society during the production of knowledge. (Nowotny 2001). The field of applied aesthetics can offer alternative methods to make this happen.
References

- Billger, M. and Dyrssen, C. 2006. *Research by design (or design as research?)* In Proceedings of joining forces design conference, University of art and design, Helsinki,
- Formgiving Intelligence Find under Masters program (www.konstfack.se)
- FoUS 2009-2012 Konstack policy document on the Research and Educational Stratagies for the school. Find under policy documents (www.konstfack.se)
- Weber EH. *Tactile Senses* Erlbaum (UK).Taylor & Francis on behalf of the Experimental Psychology Society, East Sussex UK

Websites (accessed in March 31 2008)

- Konstfack www.konstfack.se
- Axlbooks: www.axlbooks.com
- CoPS Cosmology, particle astrophysics and string theory: http://cops.physto.se
- Cross-disciplinary studies of complexity and transformation (C&T project): www.complexityandtransformation.com
- MejanLabs: http://www.mejanlabs.se/index_anim.html