FORM & FORMLESSNESS
Questioning Aesthetic Abstractions through Art Projects, Cross-disciplinary Studies and Product Design Education

CHERYL AKNER-KOLER

RESEARCH COLLABORATION BETWEEN:
Department of Architecture
Chalmers University of Technology
Göteborg, Sweden 2007
Examination rights – Chalmers

Department of Industrial Design
Konstfack University College of Arts, Crafts and Design
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Department of Architecture Chalmers University of Technology Göteborg, Sweden 2007 Examination rights – Chalmers

Department of Industrial Design Konstfack University College of Arts, Crafts and Design Stockholm, Sweden 2007 www.konstfack.se cheryl.akner.koler@konstfack.se

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This research is based on empirical, embodied studies aimed to generate and regenerate aesthetic reasoning through three approaches:
• an educational approach concerned with developing an aesthetic discipline, supporting a formgiving process aimed to create tangible artifacts.
• an art-based approach supporting an open exploration of distortion and formlessness
• a multi-disciplinary exploratory approach concerned with aesthetic experiences shared in laboratories demonstrating complexity and transformation.

The overall aim of the thesis is to explore different types of aesthetic abstractions that elaborate aesthetic reasoning about form and formlessness. The thesis develops methods and models for aesthetic investigation that support, challenge and go beyond the normative concepts of beauty, with high relevance for teaching 3-D formgiving aesthetics and research by design methodologies. A central method applied throughout the entire research project is a cooperative inquiry method engaging students and experienced professionals as co-researchers in embodied/interactive physical form studies and laboratories.

The content of the thesis is presented in three parts relating to the approaches above:
• Part 1 defines an aesthetic nomenclature organized within a taxonomy of form in space. This aesthetic taxonomy is outlined in five levels based on essential aesthetic abstractions, emphasizing structure and inner movement in relation to the intention for the development of a gestalt. It originates from the educational program of Alexander Kostellow and Rowena Reed and has been further developed through an iterative educational process using a Concept-translation-form method, resulting in the Evolution of Form (EoF)-model. This EoF-model reciprocally weaves together geometric structures and organic principles into a sequence of seven-stages. To question the normative principles of beauty inherent in the EoF-model, a bipolar +/- spectrum was introduced at each stage to expand the model, aiming for a more inclusive approach to aesthetics.

• Part 2 both challenges and expands the aesthetic reasoning in part 1 through i) solo sculptural exhibitions exploring properties of distortion and transparency in a constructivist art community ii) collaborative projects with physicists concerning infinity and studies of continuous complex curvatures and iii) explorative studies of material breakdown and non-visual studies with ID Masters students at Konstfack.

• Part 3 problematizes the taxonomy of form by applying methods and results from a cross-disciplinary study of complexity and transformation involving artists, physicists, designers and architects. The three year study explored temporal events of changing phenomena and formlessness that did not comply with any traditional aesthetic norms. Based on experience from 12 laborations, three models were developed: The Transformation-model and Framing the dialogue-model were developed to physically interact with as well as to document and discuss change and transformation through bipolar reasoning. The Aesthetic phase transition-model was developed to capture the particular properties expressed in a transformation and unify stable objects with changing events.

In conclusion, the thesis claims the value of an inclusive aesthetic mode of abstract reasoning in the scientific and design communities. A provisional 3 modes of abstraction-model is presented placing numeric, linguistic and aesthetic modes of abstraction as interdependent within a spectrum from separation to contextualization.

Key words: Aesthetics, architecture, formgiving, gestalt, complexity, embodiment, art, design education, taxonomy.
LIST OF PUBLICATIONS
This thesis is based on the work contained in the following papers:

PART 1
Developing an aesthetic taxonomy of form

Paper I
Akner-Koler, Cheryl. 2006.
Expanding the boundaries of form theory. Developing the model Evolution of Form.

PART 2
Expanding & challenging the Evolution of Form-model

Paper III
Akner-Koler, Cheryl. 2006.

WORK/PAPER IV
“Infinity” (exhibition and program) shown September 17-29 at Kulturhuset, in Stockholm, Sweden. (www.formandformlessness.com)

Paper V

Paper VI
Akner-Koler, Cheryl. 2006.

PART 3
Formlessness - beyond the aesthetic taxonomy of form

Paper VII
Akner-Koler, Cheryl. 2007 (revised version).
Unfolding the aesthetics of complexity Cross-disciplinary study of complexity and transformation: Evaluation for the Swedish Research Council (Vetenskapsrådet).

Paper VIII
Akner-Koler, Cheryl. 2006.

Paper IX
Akner-Koler, Cheryl, Billger, Monica and Catharina Dyrssen. 2005.
Cross-disciplinary study in complexity and transformation: Transforming aesthetics.
Paper presented at Proceedings Joining forces conference ERA, University of Art and Design, September 22-24, in Helsinki, Finland. (http://www.uta.fi/page.asp?path=1866;1919;4179;4698;11302)

WORK/PAPER X
Akner-Koler, Cheryl (project leader and producer), Norberg, Björn (co-producer) Kajfes, Arijana and Ebba Matz (exhibition concept.) 2005.
DISTRIBUTION OF WORK
(SPECIFICATION OF CONTRIBUTIONS BY EACH AUTHOR)

Work/ Paper IV: Exhibition and program
Planning and production of the exhibition: Akner-Koler, Lars Bergström, Narendra Yamdagni and P.O. Hulth.
Lectures given by: Bergström, Akner-Koler, Narendra Yamdagni, Anna Berglind, Hulth and Monica Sand.

Paper V
Akner-Koler planned the outline of the paper. Lars Bergström prepared the visual material, analysis and discussion for the Calabi-Yau. Akner-Koler prepared the visual material, analysis and discussion for the development of the compound curvature sculpture and point clouds. Akner-Koler and Lars Bergström both contributed to writing the paper.

Paper IX
Akner-Koler planned the workshop and laboration. Monica Billger and Catharina Dyrssen were active participants in the laboration and gave theoretical and practical support for the development of the complexity and transformation project. Akner-Koler planned the outline of the paper. Akner-Koler and Catharina Dyrssen contributed to writing.

Work/ Paper X (exhibition and program)

Additional publications by the author


TO MY HUSBAND GUNNAR
FOR HIS INFINITE SUPPORT
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1. INTRODUCTION

As the field of design becomes broader by involving knowledge gained from many other disciplines, the common ground that traditionally supported the profession is transforming. The historical identity of design as a profession that produces “tangible, physical artifacts” is no longer a central issue (Buchanan 2001). Instead, design can be defined as a pluralistic activity that affects the way we live in the everyday world, by creating services, knowledge, events, and artifacts. Two common activities that the broad design culture tends to agree on are planning and organizing things into holistic solutions and inquiring into the real nature of things (Nelson and Stolterman 2003, 39–46, 117–130). Designers, and particularly industrial designers, are experienced in dealing with the interaction between people, events, and things in a real-world context. The field of design has therefore developed ways of reasoning that can work with contextualized problems that carry a high level of complexity. In my research, I position the arts and aesthetic reasoning as crucial factors in the development of the design profession and its ability to deal with contextual and complex problems. It is therefore necessary to develop the field so that we continue to explore the unpredictable and spiraling nature (Jonas 2003) of the design process. I argue that we need the arts to keep the field of design open, because the arts question the normative boundaries within which the design profession tends to work. To achieve this, the embodied reactions and self-governing ways of the arts must be woven into the design fabric along with our practical skills, methods of investigation and abstraction, together with the development of design theory.

1.1 Area of research investigation

The area of investigation in the present thesis covers the role that aesthetic reactions and abstractions play in holistic thinking about creating artifacts in a changing process. I begin by studying the organizing capacity of form on the concrete and abstract levels, tailored within a formgiving culture. The design process uses form to test and explore questions, values and potential solutions. I will investigate the pluralistic nature of form in space and its usefulness in the development of our cognitive and emotional abilities for problem solving. The emphasis should be on our need to become engaged and active in physical and emotional events in the real complex world, which takes us far beyond the law-bound principles of geometry and traditional design aesthetics.

Approach

I developed this research project from two different approaches:

• from an educator’s approach in teaching form analysis, aimed to prepare industrial designers for the formgiving process of creating physical products/artifacts.
• from an artist’s approach, working with the theme formlessness in solo, collaborative and cross-disciplinary studies in complexity and transformation with physicists and other artists, designers and architects as well as explorative studies with current and former students.

Point of departure

My point of departure starts with my experience as a personal teacher’s assistant for and student of Rowena Reed-Kostellow for two years in the late 1970s. During these years I became immersed in the coherent and structured approach toward understanding visual abstractions of form and space that she and her husband, Alexander Kostellow, developed at the Pratt Institute in New York City, USA. (To avoid confusion, in the present thesis, Rowena Reed-Kostellow will be referred to as “Reed” and Alexander Kostellow as “Kostellow”). Through their close collaborative working relationship, Reed and Kostellow created a
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A comprehensive educational program for foundation-year courses in the structure of visual relationships, as well as courses for industrial designers (Greet 2002). These courses successively introduced different levels of visual complexity through concrete experiences in a variety of different two-dimensional (2D) and three-dimensional (3D) media. Their program offered a system of terms, concepts, principles, and procedures that supported perceptual and conceptual involvement of the active designer and artist under the different phases of their education (Greet 2002) (see also chapter 2, “Theoretical background and framework”).

1.2 Form and formgiving

My main interest is in supporting the skillful aesthetic involvement of designers during the formgiving stages within the industrial design process. I have adopted, anglicized and updated the term formgiving from the Swedish word formgivning, meaning the conceptual and perceptual process of developing the product gestalt into a physical form, as an integrated aesthetic process within the industrial design process. The industrial design program at Konstfack was founded in 1980 as the first formal industrial design (ID) education in Sweden. Konstfack’s department of ID developed from an arts and crafts tradition that supported formgiving.

My research efforts have spanned over a period of twenty years, with several phases of development. I began with a three-year grant in 1990–1993 from the Swedish Department of Education (in Swedish: Universitetskå and Högskoleämbetet, UHÄ) that supported the development of industrial design education. The grant was formulated by professor Lars Lallerstedt, who founded the Department of Industrial Design at Konstfack. Prior to this grant, I had been responsible for the development of our foundation program in 3-D form from the middle of the 80s, that prepared our students for the coming formgiving challenges they would meet during traditional product development. As the program developed, I produced teaching material that outlined the principles and methods applied in each course. This material was published in 1994 as a textbook under the title Three-dimensional visual analysis (Akner-Koler 1994, see Paper II).

Initially I introduced the geometric-organic (geo-organic) foundation of Reed and Kostellow (Greet 2002). This was based on law-bound geometric volumes that merged with organic principles in a comprehensive approach. One would assume that aesthetic methods and concepts concerned with developing a foundation for 3-D formgiving were fairly well defined, since industrial designers, traditionally, have seen their main role as shaping products (Buchanan 1995). However, this is not the case. There is, in fact, very little documentation about the active formgiving process. Some reasons for this are that:

1. Documenting 3-D work is inherently problematic
2. The field of design has only recently been offered the opportunity to do research
3. The resources in design research concerned with aesthetics tend to go towards consumer-based aesthetic preferences rather than opening up the formgiving process from a designers position.

This lack of documentation and theoretical development about forming the artifact raises many questions about the identity of the design discipline itself.

In time, I developed a method that involved the students in expanding Reed’s/Kostellow’s foundation studies of form and space compositions. Many of the form studies in our teaching program at Konstfack referred to similar concepts that could be presented through more comprehensive visualization models, which worked for various form and space studies. These collective efforts...
led to the development of a taxonomy of form. Thanks to the educational grant and funding from Artistic Development (in Swedish: Konstnärlig Utveckling, Ku) at Konstfack, I was able to reformulate and reorganize my teaching material into a comprehensive textbook, which is part of this thesis. I was then given more time and resources to integrate the foundation program with product-oriented courses at the Department of Industrial Design at Konstfack. These courses merged form and gestalt development with semiotics, where I collaborated for more than ten years with Rune Monö (1997) and Bosse Lindström in model making in the second-year program. Later I invited Anna Thies (in semiotics, when Rune Monö retired) and Teo Enlund (in color and gestalt) to join the teaching team. I have also supported and at times co-supervised the examination projects in the final year of the bachelor’s program (see figure 1).

As the field of design joins the research community, we enter with a very fuzzy identity. The traditional and methodological knowledge about the development of artifacts, embedded in the practice of design, is unarticulated. The multidisciplinary and spiraling design culture of today does not seem to create supportive conditions for the profession to do practice-based research about making physical artifacts. To deal with this spiraling nature of design, I place form in the context of formgiving at the hub, giving it a significant role in the first part of my thesis. This emphasizes the roots of industrial design as a profession that makes things in the real world (Dunin-Woyseth and Bruskel and Amundsen 1995).

The form is simply that part of the ensemble over which we have control. It is only through the form that we can create order in the ensemble. (Alexander 1964, 27)

Christopher Alexander explains the need to use form for its controlling capacity (Alexander 1964). He works with form with the intent to deliver solutions. The tight schedules and economic framework of industrial design often focus the design process on solving particular problems, with very little time to develop coherent knowledge to enrich the field of design. To establish the field, we need to step back and create and document knowledge about form, to understand the explorative capacity of form beyond the needs of industry and the market place, and to question normative forces. My approach to developing exploratory knowledge has been through my role as an artist. I have spent half of my time in education and half on my own solo art or art-based collaborative project. The arts offer a free zone for unconditional exploration, which is explained in the coming section on formlessness.

1.3 Formlessness and art

Constructivism and productivism
A constructivist artist community centered around the gallery Konstruktiv Tendens in Stockholm became an important context for my own artistic development. The artists, gallerist, and collectors at the gallery taught me...
about the Russian constructivist and productivist movements and Central European constructivism with its center at the Bauhaus. I also experienced an enormous variation of expression that pushed the limits of geometry and spatial dimensions. My own art work was supported through the gallery, where I staged several solo exhibitions and took part in many group shows (see Paper III).

I found that the constructivist movement united my work with form in an industrial design culture with my initial sculptural interest of exploring geometric distortion (figure 2). The Russian constructivist and productivist art movement in the beginning of the twentieth century was one of the first art movements that directly collaborated with scientists (Lodder 1987 [1983]). It was also the major art movement that openly worked with industry to create products for society. The artistic roots of industrial design can be found in this movement, as can the methodological approach to aesthetic reasoning presented in this thesis.

Initially my own artistic interests were concerned with concepts of distortion. I limited my elements to hard-edged, planar structures that indirectly defined open constructions enclosing space pockets and creating voids as shown in figure 2. As a counterbalance to the dominant interest in form from the industrial design culture, I chose to emphasize spatial relationships in my art. Gradually I began to question the controlling role that concrete form elements take on and searched for media that prioritized spatial experiences. Rowena Reed had developed teaching methods with straight and curved planes aimed to expand, activate, and enclose space (Greet 2002). To push these methods further, I began to work with translucency and degrees of material density aimed to dissolve the hard edge transitions between concrete form and void.

I joined the St. Erik “Art reservation”, headed by artist Kjartan Slettemark, who supported explorative processes. At that time my interest was in transforming material through combustion that created smoke, ashes (figure 3), and other unstable materials. This change in my art brought up temporal issues and put emphasis on changing events rather than on the stages and sequential reasoning I had developed in my form taxonomy (Paper II).

Slettemark and I produced an exhibition in the Future’s Museum in Borlänge called “transformation” (in Swedish: Förvandling och Omvandling). I refer to my work in this areas with temporal issues and the dissolving of materials into space as included in the search for formlessness.

**Collaboration between art/design and physics**

My art projects in formlessness were open-ended and explorative. I studied Goethe’s perceptual work on trüben (a German word meaning “cloud”), which involved the embodiment of space and primary colors that arise in fog (Sällström 1979, 109–15). Through my interest in Goethe, I collaborated with physicist Pehr Sällström, who had updated and translated Goethe’s color theory to Swedish. From my studies of smoke and fog, I became involved in a collaborative project on the theme Empty Space with three physicists at Stockholm University: Professor Lars Bergström, Doctor Narendra Yamdagni and Professor P.O. Hulth. This two-year project resulted
in an exhibition and seminar series on cloud chambers, smoke filled prisms, and air-glass, coal and vacuum in the old Orangeri at Bergianska Gardens in Stockholm, supported by a grant from Stockholm Culture Capital 1998 (see figure 4). A short film was produced about this project and broadcast by Swedish Television (see thesis website).

The empty space group was later invited to be part of an art and science festival at Kulturhuset in Stockholm 2002, where we presented an exhibition and program on the theme Infinity. In this project, I worked closely with Lars Bergström and explored complex curvatures in multidimensional space. Both these collaborative experiences focused on developing and producing exhibitions that involved the public in our projects. Again, emphasis was on showing the results of our work rather than presenting our methods about how and why we arrived at these results.

Parallel to my art projects, I also was able to engage industrial design master’s students to take part in exploring formlessness, beginning with a project on ecology (Degerman 1997). We studied how organic materials could be transformed through dehydration and other processes such as heat, electricity, hydration and implosion (see figure 5). We also explored non-visual aesthetic studies of color and substance, which emphasized tactility, haptics, taste, temperature, and interactivity with emphasis on process (see film Non-visual color, on thesis website).

In collaboration with a design firm called No Picnic, I put together a two-day exploratory workshop that exposed the designers (my former students) to the explorative aesthetics of “formlessness” and “material transformation” (see figure 6). The enthusiastic response the No Picnic group gave this workshop strengthened my convictions regarding the importance of explorative aesthetics.

Needing to document and critically discuss what these exploratory aesthetic studies offered, I realized that the student courses and firm workshops could not provide a long-term forum for further development. Some of my former students sometimes found ways to apply these formless experiences in design; however, there was no feedback loop to help me develop knowledge from their products. I later used my experiences from the non-visual color laboration and the material transformation laboration to develop a plan for collaboration with physicists, artists, architects, and designers, called a Cross-disciplinary study in Complexity and Transformation described below.

**Cross-disciplinary studies in complexity and transformation**

Through funding from the Swedish Research Council, I became project leader of a three-year project to conduct exploratory studies on the theme of Complexity and Transformation (C&T) (see Paper VII). This C&T project gave me the opportunity to explore the ideas I had been working on about formlessness and temporal changes in collaboration with other researchers, professionals,
and teachers. My own drive to start such an explorative project was to counterbalance the structured geometric reasoning with form and materials in an industrial design context. I turned my back on the methods of abstraction that relied on simple geometric, stable materials or a structured spatial 3-D matrix. The C&T project was demanding, since it did not refer to a common discipline, only to a common yet ambiguous theme. The four workshops and 12 laborations introduced concrete examples of phenomena that demonstrated complexity and transformation. We managed to grasp the different interpretations of the theme through playful interaction with phenomena on an aesthetic level, where we could share our different views. The final report of this project is presented as Paper VII in the present thesis. Through this project we created an archive of documentary video films from all four workshops, giving an inside view of the dialogue and concrete laborations we performed. There were also two exhibitions/seminars of our activities; one in the context of SAPS at Art.Platform (URL) and the second at Konstfack.

1.4 Research profile

The design profession is going through fundamental changes that are creating an increasing gap between design and the arts/crafts. I see these human-centered activities of art and crafts being pushed aside rather than integrated with high technology and market strategies. My intention with the present thesis is to create a greater understanding for formgiving that embraces embodied methods of art and crafts within and beyond the industrial design field.

Through the research culture at Chalmers School of Architecture in Göteborg, in collaboration with Konstfack, I found support to conduct practice-based research that opens up aesthetic reasoning in both a mono-disciplinary context of industrial design and in cross-disciplinary projects. Chalmers underlines the importance of developing cross-links between experience, conceptualization, laboration, and problematization.
1.5. Aims

This thesis aims:
1. To generate aesthetic strategies that support skillful formgiving methods of conceptualizing and shaping artifacts in a design culture
2. To create a taxonomy that reciprocally interlaces geometric law-bound reasoning with organic growth principles
3. To develop constructive and critical methods and models that challenge normative trends in design
4. To conduct exploratory, cross-disciplinary studies in complexity and transformation that support the renewal of aesthetic reasoning in both the art/design and scientific communities
5. To generate methods that lift aesthetics into a dynamic mode of reasoning that supports change, transformation and formlessness
6. To support the interaction between the explorative, embodied approach of the arts and the didactic and concrete needs of design education

1.6 How to read the thesis

This thesis on art and design research mixes academic writing with presentation methods and exhibition/works from art and design traditions.

Structure of the research and disposition of thesis

The written material in the present thesis applies three writing styles. Most of the written articles use an academic writing style called the IMRAD structure (Introduction, Methods, Results, and Discussion). This writing style entails separating the background information, the methods used to conduct the study, and the results of the study with an overall discussion at the end. I found that this structure of academic writing helped to open up my work so I could present and discuss it with other researchers. It also set boundaries for the questions I set out to answer so I could easily focus on the different areas within the research project. The remaining written papers use the academic structure of reports as well as an essay form.

Also included in the papers are “works,” such as physical exhibits of artifacts and media productions with accompanying catalog texts, which will be presented on a thesis website. The combined presentation of both papers and works thus reflects ways for both the scientific community and the art and design community to share knowledge and experience. All ten “papers” in the present thesis refer to practice-based experiences centered around aesthetic issues concerning physical form and phenomena.

The Papers have been organized in three parts:

- **Part 1**: Developing an aesthetic taxonomy of form
- **Part 2**: Expanding and challenging the *Evolution of Form*-model
- **Part 3**: Formlessness—beyond the aesthetic taxonomy of form

The comprehensive summary (“coat”) of the present thesis is comprised of seven chapters ending with the individual ten papers:

**Chapter 1. Introduction**: Explains the area of investigation, my point of departure, form and formgiving, formlessness, and art, ending with the aims addressed in the thesis.

**Chapter 2. Theoretical framework**: Presents the theoretical background of the field, limited to the scope of the research. This is done by positioning the research in the field of aesthetics and outlining the main theoretical and practical sources that are relevant for shaping the way I have approached the concepts of form and formlessness.
Chapter 3. Results – summary and discussion:
This chapter is organized around the same three parts as described above. Each part summarizes the results, then provides a general discussion, including strengths and weaknesses.

Chapter 4. Methods and procedures—summary and discussion: This chapter is also organized around the same three parts as described above. Each part summarizes the methods, strategies, and procedures, then presents a general discussion, including strengths and weaknesses.

Chapter 5. Contributions, conclusions and future plans: A summary of the particular methods and models that the present thesis has developed and concluding thoughts about what these methods and models can offer in developing the field of applied aesthetics. This chapter ends with some suggestions for future plans.

Chapter 6. References.

Chapter 7. Summary of Papers.

Regarding referencing
Due to the multi-disciplinary nature of the field of aesthetics and the large amount of internal cross-referencing in the literature from many disciplines and different epochs, I have found it hard to keep track of how I refer to my sources. To make this clear to the reader (and to myself), I have used a system of referencing that looks like this: (Jones 2002, 23 [1927]). The authors’ last name, a first date that indicates the quoted source and the page number if necessary, then in square brackets the date of the original source. It is my hope that this system will help clarify to the reader: a) that many of the ideas I present come from a different epoch; and b) that the information has been republished, because the sources are still of interest for an audience.
2. THEORETICAL FRAMEWORK

This chapter gives the theoretical background to my work and terminological definitions, presented in four main sections:

- Aesthetics
- Form
- Formgiving
- Formlessness

2.1 Aesthetics

This section presents theoretical support for defining aesthetics within an applied, embodied context that recognizes the importance of immediacy through basic-level experience. It presents the need to develop skills and methods that support a way of reasoning through tangible form, developing aesthetic abstractions, experiencing playfulness, relying on sketching procedures, etc.

Definition

The concept of aesthetics can be traced back to two main movements (Dahlin 2002, 15): 1) Analytical aesthetics, which aims to separate theory from practice as well as to institutionalize aesthetics as belonging only to the fine arts, 2) Pragmatist aesthetics, which regards aesthetics as perceptual experience involved in the everyday world and aims to unify theory and practice. There is, of course, a gray zone between these two schools of thought; however, this research is primarily based on a pragmatist aesthetic approach (Shusterman 2000 [1992]) (see figure 7).

I refer to John Dewey’s work, which outlines the main conditions of what is now considered pragmatist aesthetics. He considers aesthetic experience as such that is immediately felt and has a unifying holistic quality (Dewey 1980, 38–44 [1934]). Dewey is interested in aesthetics from the individual’s everyday experience. He also recognizes the organizational energy that an artist or designer works with during the active process of creating artifacts and events (Dewey 1980, chap. 9 [1934]). Dewey’s view of aesthetics involves a process of events that brings together intellectual and practical experiences through emotions. He states that our emotional, aesthetic reactions are what keep us involved in the immediate situation and embrace the feeling of the gestalt (Dewey 1980, 42 [1934]). I need to make a distinction between analytical and pragmatist aesthetics because the intention of this thesis is to begin to establish a viable academic platform that can support practice-based aesthetic reasoning. A pragmatist aesthetic approach offers such a platform.

Science of sensuous cognition

The German philosopher Alexander Baumgarten’s 1735 definition of aesthetics as the science of sensuous cognition (Shusterman 2000, 263–7 [1992]) is frequently referred to in the field of pragmatist aesthetics. He defined the word sensuous as meaning the “fusion of our senses,” and the word cognition as to “know.” The concept of fusion emphasizes the real-world experience and embodiment of knowledge, which is one of the themes of this research.
According to Richard Shusterman, Baumgarten recognized the importance of aesthetic reasoning to “promote greater knowledge” (Shusterman 2000, 264 [1992]) during scientific studies. Baumgarten understood the value of developing sensory skills that improved an individual’s ability to discern relationships between features, and to develop improvisation and imaginative capacity. Baumgarten suggested that aesthetic reasoning could offer ways to go beyond the established norms of order that scientists often rely on. He also proposed that aesthetic experience prepares individuals to deal with relative values as a useful way of reasoning when one deals with new territories that challenge conventions (Shusterman 2000, 263–7 [1992]).

The presented Fusion of our senses-model in figure 8 (see Paper VIII) further illustrates two concepts regarding fusion:

i) The spiraling form emphasizes Baumgarten’s idea of fusing the senses within an embodied real-world context; ii) The scale at the bottom of the figure refers to the sense of equilibrium that continually aims for a dynamic balance of aesthetic values.

The Fusion of our senses-model starts with the concept move at the top, then rotates clockwise through grasp, touch, etc. to underline embodied reasoning, emphasizing Kinaesthetic/haptic activities and placing see last. It is through movement and interaction we can fuse our senses together (Dewey 1980, 118–25 [1934]). Dewey claims that “vision is a spectator,” offering only a passive view of our world. This spectator view has dominated philosophy, aesthetics, and education for centuries (Levin 1999). Today, there is greater awareness of how our conceptual language has been controlled by visual metaphors that reflect a shallow experience (Smith 1999). In line with this reasoning, I have come to question the way vision has previously dominated my theoretical aesthetic approach.

Embodiment

The mind is inherently embodied, reason is shaped by the body, and since most thought is unconscious, the mind cannot know simply by self-reflection. Empirical study is necessary.

(Lakoff and Johnson 1999, 5)

Embodiment is a growing field of study that recognizes the role the body and perception play in developing the way we conceptualize the world. Strong evidence from scientific research is challenging the idea that the mind is separated from the body (Norman 2002 [1988]). Instead, scientists such as neurologist Antonio Damasio (2005 [1994]) state that our ways of reasoning arise from the commonalities between our mind and body immersed in the environment we live in. Through perception and motor activity, we build up a pool of experience that forms our cognitive unconscious (see figure 9). This pool of unconsciousness greatly affects how we act and think. As we shift our understanding of how reason is shaped through embodied experiences, society is changing the way it looks at the fields of art, design, and crafts. These fields have a long history of gaining knowledge through embodied processes and therefore have a wealth of experience to share with the academic world.

Aesthetic reaction

The idea of immediacy in aesthetic experience is a concept
that John Dewey (1980, 119 [1934]) argued for and that has been important to the development of this thesis. What Dewey aimed to support was the full force of an experience at the very moment one becomes aesthetically involved. He sees this immediacy as a key experience that builds on emotional involvement and recognizes the holistic features of the gestalt.

It cannot be asserted too strongly that what is not immediate is not aesthetic. (Dewey 1980, 119 [1934])

I build on Dewey’s idea of immediacy and use the concept of aesthetic reaction, because I am interested in supporting the action that may arise from the immediate aesthetic experience. In design, we work with a myriad of possibilities as we bring materials and techniques together to create a solution. Most developmental processes face many conflicting concepts or interests to be dealt with. What we need, to keep the process moving forward, is to dare to organized shape despite the turbulence in the process. Embodied aesthetic reactions can inspire the creation of such shape. Rowena Reed studied with Hans Hoffmann in Germany and applied his action painting methods in her teaching of 3-D visual structures. She saw a strong connection between reaction and reasoning through abstractions and creating spontaneous compositions (personal communication). Instead of starting with a white canvas as Hoffmann did, Reed started with movements in physical space and the direct use of sketch materials. John Rajchman (2003) supports an aesthetic reaction that, however question action painting, yet still regards the sensation prior to reflective judgment as vital for new ideas to come.

In defense of the immediate sensuous character of aesthetic experience, art theorist Susanne Langer explained what she called the “direct import” of expressions through form that have no prior activity of interpretation (Langer 1953, 31). Langer points out the difference between language and aesthetics by arguing that the elements of language (words) refer to conventions, while the elements of aesthetics (form) use sensuous qualities that allow the form expression to immediately become a part of our ongoing experience at the moment. Her criticism, from the 1950s, of research in aesthetics is that there is a strong tendency to transfer the structure of language to the field of aesthetics without any deeper understanding of the nature of art and design.

I believe Langer’s main contribution to the field of aesthetics lies in defining aesthetics as a discipline in itself and not as another type of language (Langer 1953, 31). This insight should expand research in applied aesthetics to counterbalance the limitations of semiotics and semantics (both rooted in linguistics), which aim to categorize form through social conventions (see below in this Chapter, Aesthetic abstractions: essential and substantial).

Basic-level experience

Dewey stated that in order to understand the nature of aesthetic experience, “one must begin with it in the raw” (Dewey 1980, 4 [1934]). He was referring to phenomena such as the sparks from a glowing fire, a bulldozer digging pits in the earth, or the spiraling cutting edge of a corkscrew. Dewey’s idea of raw aesthetic experience has strong parallels to what Lakoff and Johnson refer to as the basic-level experience, supported by findings in fields such as neurobiology and cognitive/perceptual science.
(Lakoff and Johnson 1999, 27–9). It is a level on which we interact with our environment through what they define as survival abilities, dealing with what we sense as real to us. This level is not governed by conventions or cultural interpretations, but rather aims to optimally perceive the world by relying on sensorimotor activities to interact with objects. Lakoff and Johnson define basic-level events as non-metaphorical concepts, such as move, drag, push, pull, lift, and fall. Moreover, they claim that basic-level events involve actions and emotions and are the “source of our most stable knowledge.”

This shift in our understanding of how reasoning is shaped through embodied experience is changing the way we look at the fields of art, design, and crafts. These disciplines have a long history of gaining knowledge through embodied aesthetic processes and therefore have a wealth of experience to share with the academic world.

Crafting skills
Skillful engagement is about creating a physical dialogue with materials and space. How one stands (posture) and moves in relation to the physical model strengthens or weakens perceptual awareness. Classic sculptural and crafting working methods train this engagement by keeping the body in motion with the intent of bringing energy to the work. An awareness of the way one holds and uses tools (haptic, Kinaesthetic) directly affects the way the materials of a physical model take shape. Philosopher Richard Shusterman’s research in somaesthetics (soma is the Greek word for body) defines a new area in aesthetic research that deals with how the well-being and skill of the artisan’s body affect his or her conceptualization and problem solving abilities (Shusterman 2000, 268 [1992]).

Movements of the body as it is engaged in work develop muscle memory (Sallnäs 2004), which can help guide the use of tools as well as allowing the body to independently make conscious aesthetic decisions on shaping the overall gestalt without language fixed associations (Langer 1953, 31).

Anthropologist Tim Ingold (2005) has researched qualities of discrete movement with the aim of understanding “movement as skill building.” He recognizes that engaging creative processes occur when the organization of a studio space or workshop supports a natural sequence of skillful movements. These movements are driven by the need to explore and solve complex problems.

Ingold’s conclusions seem simple to craftsmen and sculptors, yet his research shows how sophisticated the skillful shaping process is in practice (Ingold 2005).

Beauty and ugliness
The above definition of aesthetics, based on the work of Alexander Baumgarten and John Dewey, does not actively deal with the concept of beauty. Dewey (1980, 129–31 [1934]) even considered it to be an obstructive term, which he found difficult to handle in a theoretical way. I also find the concept of “beauty” difficult, because it implies aesthetic norms and therefore limits aesthetics to a very narrow area of human experience.

However, for the development of the present thesis I need to briefly present concepts of beauty that I have experienced through Rowena Reed’s teaching and traditional Swedish formgiving culture, as well as in relation to “ugliness.”

Rowena Reed clearly advocated beauty in her life and work. On the inside cover of Gail Greet’s (2002) book on Reed’s life and work is the quote: “If you can’t make it
more beautiful, what’s the point?” What this statement implies, I believe, is that Reed felt she had developed a
canon of principles that determined what was beautiful.
Her early education as a sculptor taught her to judge
balance, visual organization, and inner movement, all
expressing growth and life. She learned the complexity
of the human body through a classic sculptural discipline,
which aimed to bridge emotion and perception through
the articulation of form. Reed then took this tacit and
procedural knowledge further by merging it with an asym-
metrical aesthetic approach to the abstract geometric
structural knowledge she learned from Alexander Kostel-
low (Personal communication). Both the human figure and
geometry are considered sources that offer insight into
beauty. Reed’s sense of beauty and personal interest
aimed to push these principles of beauty by creating
tension and contrast within the inner structure of the
composition and how it activated and expanded space.
Her sensitivity to void, which she developed through
the Russian sculptor Alexander Archipenko, and her
awareness of architectural space were other aesthetic
sources that shaped her sense of beauty. Reed was not,
however, interested in integrating functional reasoning
with her aesthetics (personal communication), which is
very problematic in an industrial design profession.

The author and educator Ellen Key (1996 [1913]) was
one of Sweden’s most influential scholars in the field
of aesthetics at the beginning of the industrial revolu-
tion. She argued that beauty was expressed through a
“harmonious wholeness in relation to purposefulness”
and that the sense of beauty lies in the “true pleasure
of lagom (a Swedish word meaning “just enough”) and
moderation.” Key’s sense of beauty can be exemplified
in the functional and ergonomic shape of the traditional
wooden butter knife that every Swede creates as a school
project in their childhood (see figure 10).

Swedish architect Sven Hesselgren's (1954, 54–8) PhD
thesis in expressive modes of architecture, is an extensive
research project in aesthetics with a critical analysis of
earlier aesthetic principles of beauty. He questioned the
aesthetic assumptions concerning the golden mean,
claiming that they were based on “superstition and
numenology,” since there were no experimental studies
supporting them. His rigorous aesthetic experimental
studies with subjects, gave results that problematized
the idea that “pure” geometric forms were aesthetically
superior to deviating forms (Hesselgren 1954, 61). He
was particularly interested in what he referred to as
pregnant forms (Hesselgren 1954, 49–78), which were
developed by a gradual transformation of one geometric
form into another. This type of form was not “pure” yet
was considered by many as aesthetically pleasing.

Art historians Gregor and Nils Paulsson (1956, 25) felt
that the main goal of a formgiver was to create “beautiful
everyday things”. Their definition of beauty was that a
product has a “pure gestalt” and they claimed that only
experienced formgivers with taste and an open sensitiv-
ity can create. This normative and purist attitude of the
beauty concept, controlled through the inherent talents
of individual formgivers, confines aesthetics to a select
group. This elitist attitude was a way for industry to control
its aesthetic profile, but it renders aesthetics nearly use-
less in explorative processes that go beyond taste and
individual conventions. For this reason, the contemporary
arts have turned away from aesthetics. Leading design
firms in Sweden, aiming to develop innovative products,
also see the limits of classic design aesthetics and are
searching for alternative paths (personal communication
with No picnic and Ergonomidesign).

A book celebrating the 150-year anniversary of Svensk
Form (the Swedish Society of Crafts and Design) in 1995
still made strong reference to Gregor Paulsson (Wickman
1995) with few critical voices or opposing scholarly views.
Linda Rempell’s PhD thesis (2003), *Designatlas*, offers
a critical view on Swedish design, which among other things
has helped open up the design community to adopt a
more self-critical attitude.

Today, design culture in Sweden is in a state of flux and
the aesthetic dogma of Swedish functionalism is being
questioned as well as part of the taxonomy presented in
part 1 of this thesis that supports this geometric founda-
tion with a focus on solid “pure” form.

The scope of this thesis does not offer the opportunity to
pursue this subject in any depth. However, I will conclude
this passage concerned with beauty and ugliness with
some important insight into aesthetics from two influential
Swedish scholars, Tom Sandqvist and Gunnar Berefelt.
Sandqvist (1998) has summarized how the terms aesthetic,
beauty, sublime, and ugly have changed throughout history.
His study from an art theoretical vantage point questions
our current understanding of aesthetics, locked within
the closed arena of beauty and the sublime. According
to Sandqvist, historically the term sublime was meant to
represent the opposite of beauty, touching on the formless,
unlimited, frightening, beyond the limits of cognition, ugly,
and free from conventions. Today the sublime is defined
as almost a synonym to beauty, such as elated, revered,
spiritual, uplifted, inspiring, awesome, etc. (Sandqvist
1998). The aesthetics of beauty, which reject what is ugly
and formless, cannot generate new aesthetic reasoning,
because it excludes the untamed and complex world that
provides new material for developing aesthetics. Gunnar
Berefelt’s (1973) research also questioned the norms of
beauty. He considered an aesthetic experience to lie on
2. THEORETICAL FRAMEWORK

**Fields** | **Examples of systems of aesthetic abstraction**
---|---
Music | Symbol-based notation  
| Letter notation
Color | Perception-based color system, e.g. Johann Wolfgang Goethe (Goethe 1979 [1810])  
| Natural color system (NCS), e.g. Sven Hesselgren and Anders Hård (URL)
Form | Geometric-based system, e.g. Iakov Chernikhov (Cooke 1989)  
| Nature-based system, e.g. Denman Ross (Ross 1901)
Space | Space syntax, e.g. Bill Hillier and Julienne Hanson (URL)  
| Curved spatial system, e.g. Mikhail Matiushin (Tillberg 2003)
Dance | Geometric combination, e.g. Rudolph Laban (URL)  
| Figurative notation, e.g. Joan and Rudolf Benesh (URL)

*Fig. 11* Five examples of different systems of aesthetic abstraction inspired by Pehr Sällström (1991).

A spectrum from indifferent to overwhelming, where the “norms” of beauty lie close to the pole of indifference, while chaos and the ugly are at the overwhelming pole.

**Aesthetic abstractions**

The arts, and particularly aesthetics, have modes of reasoning that can deal with complexity in the real world (Nørretranders 2003). The mode I emphasize in the present thesis is aesthetic abstractions (see chapter 6, Conclusions, for a model that puts aesthetic abstractions in context with linguistic and numeric abstractions). An abstraction can be defined in two opposing ways: 1) a general concept formed by extracting common features from specific examples and 2) a concept or idea not associated with any specific features (www.visualthesaurus.com). In the present thesis I use the concept aesthetic abstraction as a mode of extracting, that is connected with specific features and context. Aesthetic abstractions build on embodied experience in the physical world. They are used to simplify or grasp an experience that attempts to be managed in some way. In a formgiving context, aesthetic abstractions are used to either explore and/or organize a project. The present research project is biased towards abstractions in sculpture and architecture, which are defined through structural features and relationships of form in space. Rowena Reed’s and Alexander Kostellow’s work in visual abstraction is my main source of reference here (Greet 2002). I changed their term visual to aesthetic abstractions to emphasize a more embodied experience, integrating haptic, kinaesthetic and visual/spatial sensitivities.

In the present thesis two possibilities of developing aesthetic abstractions are presented:

1. **Essential aesthetic abstractions**: Immediately felt structural and proportional expression of elements and forces in a composition that gain their role and identity through their relation to a coherent gestalt. This definition builds in part on Max Wertheimer’s work in gestalt theory (King and Wertheimer 2005, 42) as well as on Kostellow’s and Reed’s visual abstractions and idea of synergy (Greet 2002). Essential aesthetic abstractions are focused on an inner sense of form in space and are expressed through the interdependency between direct and indirect perception of movements, forces and proportions (see chapter 4, Methods Part 1 & 2, for further explanation). They are primarily about uncovering compositional structure for the sake of making constructive and sensuous decisions and do not necessarily lead to aesthetic judgment concerned with beauty.

2. **Substantial aesthetic abstractions**: Immediately felt gestalt experience, yet requires active immersed engagement to pick up on the expressed properties and qualities. Substantial aesthetic abstractions involve haptic and explorative experiences. They are more context-dependant and embodied than essential abstractions and are therefore much more complex to identify. John Rajchman (2003, 64) formulates arguments (that are shared by Gilles Deleuze) supporting this kind of aesthetic “exposure” that originates in experimentation. Substantial abstractions are loose enough to be able to adapt to the transforming event which means refraining from judgments like beauty or ugly.
Here are some examples of essential aesthetic abstractions taught by Reed and Kostellow that are presented in this thesis (Greet 2002):

- Elements: volume, plane, line, point, enclosed space
- Axis
- Axial movement
- Direct, position, tip
- Proportion: extension, massive, superficial
- Geometric volume
- Accent, directional force
- Tensile relationships between directional forces
- Oppositional relations
- Spatial organization: static, dynamic, organic etc.

The above terms for defining essential aesthetic abstractions can also be found in the work of such figures as Rudolf Arnheim (1974 [1954]), Gyorgy Kepes (1944), László Moholy-Nagy (1969), Kandinsky (1979 [1926]), and many more artists and teachers.

The various aesthetic disciplines in the art and design community have developed different types of aesthetic abstractions (see figure 11).

Many artists, authors, and scientists have written about aesthetic abstractions. A few central figures are mentioned below:

Rudolf Arnheim explained aesthetic (visual) abstraction as the art of drawing essential features from an entity. He saw abstractions in relation to the organizing principles of the gestalt (Arnheim 1969, 173), as did Reed and Kostellow (Greet 2002, 136–40). This implies that in order to discern abstractions, one must take into account an awareness of particular and overall qualities of the intent of the composition. Arnheim claims that abstractions are the very “basis of perception and the beginning of cognition” (Arnheim 1969,161).

In his book Beyond Sculpture, Jack Burnham (1978 3–6 [1968]) explained that the development of visual abstractions gave a means for technology to sidetrack aesthetics and our sensuous relationship to the world. He explained that by creating abstract notations of form, one can manipulate and control, rather than take part in, a sensual experience. Burnham showed that despite this detached way of abstracting form that technology aimed for, sculptors eventually developed a way to use abstract reasoning that stimulates our senses. This thesis supports aesthetic abstractions as sensuously derived experiences, rather than detached and uninvolved activities.

**Anti-aesthetic movement**

Since the seventies there has been very little development in understanding the practical application of aesthetics with regard to form and sculptural procedures. By the 1980s, a postmodern, anti-aesthetic movement began, advocated by the October group with Hal Foster (2002 [1983]), Rosalind Krauss, and others. Their theoretical work has had a strong influence over the art and architectural communities, creating an academic vacuum around aesthetic reasoning. In Sweden, Linda Rampell’s (2003) PhD thesis, Desinatlas, marks one of the first academic research projects in Sweden that strongly challenged the modern movement and its inclusive attitude of defining “pure form,” abstractions aiming to define a universal aesthetic. Her arguments were that modernist “purist” aesthetics are removed from the everyday world and therefore treat the product in isolation, separated from its context. In many ways, user-based design roots in Sweden never demonstrated the extreme purist version of modernism that was seen in the United States and many other countries. Besides, Sweden’s first formal industrial design department was founded at Konstfack, as late as 1980, so the academic forum to develop and discuss the pros and cons of industrial design aesthetics and processes has been very limited. It is no longer as relevant to state a postmodern argument today, because this movement is declining internationally (Rajchman 2003).

During the past few years, art theorist John Rajchman (2003) has attacked the postmodern French theorists, blaming them for breeding a deep melancholy in the art and architectural communities through their critical view. Rajchman refers to an international recovery period in which artists are becoming indifferent to the impossible demands of the post-modern critics. He and others with him see a movement towards a reinvention and/or renewal of aesthetics through the rediscovery of modernist strategies.
2.2 Form

This section offers a definition of form and its organizational capacity through geometric structures and organic principles in an aesthetic realm. A number of artists and researchers are presented below who have contributed to the development of our knowledge of form, mainly in an educational context.

Definition
The concept of form has to do both with the realization of concrete objects and the organization of ideas. It can be used as both a noun and a verb:

- **Noun**: This is a form.
  - Referring to the physical/spatial dimensions that form occupies and activates.

- **Verb**: To form an object/To form a concept:
  - The skillful procedures and craftsmanship necessary to make things.
  - The cognitive processes that develop concepts and images driving the formgiving process or any conceptual process that works through aesthetic methods.

This two-fold way of aesthetic reasoning through form (noun & verb) emphasizes the coinciding physical and conceptual aspects of form.

John Dewey (1980, 134–5 [1934]) refers to form as "relationship" and a means of organizing substance into unified wholes. He explains form as a sensorimotor experience with materials that stimulate aesthetic responses (Dewey 1980, 124–5 [1934]). He finds it impossible to discuss form without referring to the role it plays in an event in life. No matter how minimal the expression of form is, it is always about the "organization of energies" that create a life rhythm (Dewey 1980, 162, [1934]). Dewey attributes this rhythm within form as the energy source that engages our emotions, connecting form with aesthetic experiences.

Dewey’s defense of form as a catalyst for relationships through the organization of energy is similar to the way Reed and Kostellow treated it in their educational program (Greet 2002). They taught the importance of sensing the inner movements and forces through and beyond the positive and negative forms. This inner sense of form is the key to understanding how to build a holistic composition. Concrete examples of such compositional studies can be found in Reed and Kostellow’s visual “problems,” presented in the book *Elements of Design* (Greet 2002).

**Geometric form**

Most schools of arts, design and/or crafts deal with the complex nature of form by offering basic design courses that study geometric structures (Steinø 2006). These courses aim to give students an embodied and analytical experience of both the organizing capacity and the concrete properties of geometric form.

Art historian Willy Rotzler (1977, 11) claimed that throughout history, mankind has always used geometry to create an alternative vision that reflects a “primary expression of the shaping will.” There is a long tradition in the arts and architecture of studying geometric structures to step outside of this conditions and explore future alternatives. Art historian Alfred Barr, who was instrumental in establishing the Museum of Modern Art (MOMA) in New York City, categorized modern art into two main movements: geometric abstract art and non-geometric abstract art (Encyclopedia Britannica). The emphasis on geometry and abstraction as a means of understanding the main influences in modern art underlines how important geometric abstractions were to the modern art movement.

Art historian Herbert Read (1992, 14 [1964]) has explained that the geometric movement in constructivism and modernism rejected “the human traditions as such together with their organic criteria, in order to create values of a different kind, the absolute value of “pure form.”” The source of inspiration for creating these absolute values came from the scientific world. According to Herbert Read, the modernist artist’s search for pure abstract form invented “the three-dimensional work,” which was constructed instead of sculpted, and which was understood through sight, not touch (Read 1992, 15 [1964]).

**Review of geometric form-references**

Below is a brief review of constructivist and modernist artists and architects, as well as perceptual psychologists, who have contributed to developing aesthetic knowledge about composition through the use of geometric structures:

- Russian painter Wassily Kandinsky conducted an aesthetic investigation of 2-D compositional elements. His first book—*Concerning the Spiritual in Art*, published in 1910—discussed the development of an “inner knowledge” of form through abstraction (Kandinsky 1977 [1914]). Kandinsky aimed to dematerialize objects by mapping out the forces in form, and he used geometric shapes to perform his studies (see “Formlessness” section below for Kandinsky’s further thoughts on dematerialization). This book has a very dogmatic tone and mixed his theosophical beliefs with his aesthetic and psychological studies, which makes it difficult to follow...
his line of reasoning. However, his second book, *Point and Line to Plane*, has a more open, exploratory writing style that presents principles and relationships that transferred terminology from music to aesthetic elements in a straightforward and illustrative way (Kandinsky 1979 [1926]). Kandinsky’s three structural categories start with point and then move to line and finally to plane. This arrangement reflects a painter’s approach to investigating composition. However, as a sculptor/form giver, I question his arrangement of categories and suggest a reversed order that starts with volume (which Kandinsky did not analyze) and progresses plane → line → point (see Papers I–II).

- Russian architect Iakov Chernikhov translated basic geometric constructions from mechanical engineering into an aesthetic program for basic design in the late 1920s. He explained the different kinds of unions between form in a strict geometric language of aesthetic abstractions that artists could relate to (Cooke 1989). His program explored organizational principles and demonstrated how simple elements can be combined in a multitude of different ways. Many of Chernikhov’s geometric constructions are similar to the form and space experiments that Reed and Kostellow taught at the Pratt Institute (Greet 2002). However, Reed and Kostellow placed more emphasis on proportional contrasts between elements and an asymmetrical organization that connected the inner structure of the geometric form with a similar spatial matrix.

- Russian constructivist Kazimir Malevich taught geometric composition in relation to architecture, urban planning, and painting at VKhUTEMAS in Moscow (Higher State art technical school that trained artist for the benefit of national economy (Willett 1978). His concern regarding 3-D composition was about how to cluster rectangular blocks that expressed innovative ways for planning cities. Some of these combinations were vertical stacks resembling skyscrapers, whereas others were spread out and incorporated negative space (Martin 1980). Malevich also used the minimal expression of geometric shapes in his spiritual studies of supermatism. The essential qualities of geometry had parallels with Russian icon painting, which most Russian artists were trained in (Lodder 1987, [1983]). Malevich’s spiritual search through minimal geometric composition was therefore not as radical as it may seem.

- The artists and architects teaching at the Bauhaus were all more or less involved in exploring basic form problems through geometry (Wick 2000 [1982]). The institution’s founding dean, Walter Gropius, explained geometry as a common denominator that would offer a foundation for all of the arts (Gropius 1974 [1943]). This search for a new aesthetic way of reasoning attempted to merge art and architecture closer to science and technology, without losing a dynamic rhythm that engaged individual sensitivity.

- Swedish architect Sven Hesselgren’s (1954) thesis on expression of architecture is an extensive research project in aesthetics and semiotics. He explored the perception of form through empirical and theoretical studies of the visual, audio, tactile, and haptic senses. His research included proportional studies of form and space, methods of transformation with continual and discontinual form, open and closed form, comparative proportions, and tone of textural surfaces, as well as color, ornament, and pattern. His systematic studies provide a strong foundation for applied aesthetics. The strength of his studies is that he shows there is no common agreement concerning forms that are inherently “beautiful,” and he has proven that pure geometric forms do not awake a universal feeling of beauty. Hesselgren thus defines applied aesthetics as a discipline that can deal with ambiguity, properties of pregnant form, degrees of articulation in relation to the development of gestalt, etc. (Hesselgren 1954, 60–6, 100). His method was to set up controlled studies of, for example, one form sequentially transforming into another (e.g. a square to a circle) and ask subjects to specify where roundness and squareness are equally expressed. I question some of Hesselgren’s value judgment studies, especially some of his assumptions regarding 2-D outlined forms and photographs of products and architecture in reference to perception of 3-D physical forms.

- Since the 1970s, perceptual psychologist James Gibson has argued against this mixing of 2-D and 3-D perceptual findings (Gibson 1979, 83), which has confused research in 3-D form perception for centuries. In some schools of perceptual psychology, there is an assumption that the sharp contour of a 3-D form or a 2-D illustration of a form projected on the retina is the first feature that is detected, followed by the perception of depth. Based on empirical experiments that studied foreshortening of form as it moves back in space, Gibson claimed that we perceive form through a “direct pick-up of solidity,” telling us an object “is in fact voluminous” (Gibson 1979, 83). Gibson offers a way to understand form that is based on volume perception instead of silhouette and contours, matching the sculptural approach Rowena Reed relied on (Greet 2002, 106).
Francis D.K. Ching (1979) also developed a system for ordering form and space within an architectural context. His aim was to present a "morphological study of the essential elements" through drawing skills. He covered a wide range of visual principles that showed how different elements may be organized into unified architectural structures. He recognizes Rudolf Arnheim's visual perception, gestalt theory, and the building traditions of Vitruvius.

Ilhan Koman worked through a practice-based method that started with a 2-D geometric form that developed into hyperforms through twisting, folding, and curving the surfaces (Koman 1994). Koman used the tensile structure in the material to strengthen the form, which added curvatures, giving a very organic quality to his work.

Wong Wucius (1993) developed a visual grammar of 3-D and 2-D form. His approach to 3-D form was through a complex method of folding, which resulted in constructed planar volumes made up of repetitive patterns.

Many other important artists and architects have contributed to developing knowledge about geometric structures and how they interact in space. To mention a few:
- Donald Judd: repetition of positive and negative volumes (Zelevansky 2004)
- George Rickey: kinaesthetic sculptures of lines at oblique angles (Rickey 1995 [1967])

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**Geometric and organic form**

There are strong traditions in art and design of merging geometric structural analysis with organic principles of growth and tension. Two main paths of organic reasoning are presented here:

1) **Human figure studies** based on classic artistic training through drawing and sculpting with roots in the work of Michelangelo and Rodin. These teaching methods prioritized touch and have survived over thousands of years (Read 1992, 11–7 [1964]).

2) **Nature studies** of living organisms and phenomena based on learning how forms are generated and degenerated in nature. The Sidney Opera House, designed by Jørn Utzon, applies this type of organic thinking (Thompson 1961, Weston 2001).

**Review of geometric-organic form references**

Below is a brief review of some artists and scientists who have contributed to unifying geometric and organic aesthetic reasoning:

- Sculptor Rowena Reed and painter/psychologist Alexander Kostellow merged geometric abstractions with organic principles of growth and tension, mainly based on human figure studies (Greet 2002). In the present thesis, Reed and Kostellow’s vision of merging geometry with organic principles will be referred to as geo/organic vision. They developed their theoretical framework and their geo-organic vision through teaching and curriculum development. Each course explored a number of principles that were embodied in 3-D models and successively built on the experience of the prior course. Their geo-organic vision of form was, in my opinion, their major contribution to applied aesthetics. The present thesis is strongly influenced by this vision.

  The 3-D principles, developed from assumed principles of beauty and growth, were inspired by classic sculptural traditions that Reed acquired through her many years of training in sculpture (Greet 2002, 104–7). She did not refer directly to the body, but rather abstracted the convexities and concavities from figure studies and allowed for a more plastic composition.

  Reed’s way of working with form opposed the superficial focus on the outline of form, which is common in design. She applied organic principles built on the experience of form from the inside out and all-roundness. Her argument for this inner and under-the-surface approach was that if you design the outline first, then the volume will be subordinate to the outline, which may force the volumes into spatial positions that are contorted and insensitive to the 3-D qualities of the all-round form. She taught the logic of her reasoning by starting with general rough volumes and organizing them in space with attention to the inner axis and the proportions of the volumes. The shapes of the major surfaces are secondary and express the inner movement, which controls the outer contours (Greet 2002).

  Reed’s main influence came from Russian sculptor Alexander Archipenko (personal communication Reed 1978), who was known for his work with both geometric abstraction of the figure and studies of convexities and concavities (Karshan 1989). Archipenko was one of the first sculptors who worked with void, treating it as if it were positive form (Archipenko URL). Similar ideas about inner movement through volumes can be found in the work of sculptor Henry Moore (Read 1992 [1964]), sculptor Anish Kapoor (McEvilley 1990), and architect Jørn Utzon (Weston 2001).
Reed and Kostellow deconstructed visual abstraction from geometry into forms, movements, and relationships in order to integrate them with organic principles of growth, movement, tension, gesture, asymmetrical composition, etc. Reed then developed this spatial reasoning further and the last two to three decades of her life were devoted to expanding and activating space. She even classified space into three categories; static, dynamic, and organic (Greet 2002). It was this open approach to geometry, figure studies, and void-space that gave a unique coherency to Reed and Kostellow’s educational program, distinguishing it from the different approaches developed at such institutions as the Bauhaus School, Germany (Wick 2000 [1982]) and the VKhUTEMAS in Moscow, Russia (Lodder 1987 [1983]).

• Oskar Schlemmer developed what he called *anthropocentric constructivism* in 1915, which was a synthesis of geometric form and the human figure (Wick 2000, 259 [1982]). He applied geometric abstraction to the body by translating the ribcage to a square, the neck to a cylinder, the head to a circle, etc. Schlemmer emphasized the importance of studying the human body, because the abstractions, laws, and rhythm one learns through the body are much different than those learned through pure, abstract, geometric composition (Wick 2000, 260 [1982]). Schlemmer’s choreographic work for dance was built on forces expressed through dynamic rhythm. He brought attention to the movement of the human body in relation to the 3-D cubic room (Hopsch 2002).

• Vladimir Tatlin and Mikhail Matiushin (Lodder 1987, Chapter 7 [1983]) became interested in studies of nature and living organisms to inspire and enrich their methods of working with law-bound geometric pattern. These growth principles gave life to their compositions and tempered the mechanical, systematic, geometric approach that engineers used to control form. Tatlin and Matiushin began to question the way art was becoming mechanized and advocated for a more artistic way of reasoning and a return to organic principles that could inspire technology. They attempted to start a movement called *organic constructivism* in 1923 (Lodder 1987, 212 [1983]), which developed first from curvilinear geometric structures. Later the movement took on tensile structures of materials, all-round spatial perception, referred to as zorved.

Tatlin and Matiushin were also involved in studies of the efficiency and energy-conserving qualities of the anatomy of animals, what today might be called a “bionic” approach. They were interested in expanding perception through all of our senses. Matiushin did extensive work in vision to include tactility and hearing (Tillberg 2003, 148–60) as well as “vision without eyes”, which dealt with visualizing a work of art before it was painted. However, their organic constructivism movement never gained any attention and was eventually ignored. Matiushin developed visualization models and manuals outlining his work in aesthetic reasoning of color, form and space (Tillberg 2003). Tatlin and Matiushin were central figures in the foundation of constructivism, which prioritized geometry and...
questioned mechanistic thinking in the constructivism/productivism movement that worked with industry (Lodder 1987, 223 [1983]).

- Naum Gabo played an important role in establishing the Russian Constructivist movement and was instrumental in introducing a geometric-organic approach. Gabo’s geo-organic interpretation was based on tensile structures and spherical curvatures (Nash & Merket 1985). Although Gabo, Tatlin and Matiushin were all involved in expanding constructivism beyond the limits of geometry, the theoretical and educational implications of their organic reasoning did not gain popularity within the movement.

- Robert G. Scott (1951) has presented a comprehensive approach to basic design principles. He started by defining form through contrast, rhythm, and figure organization, which refers to principles of gestalt psychology. His work uses both geometric form and plastic organization.

- Stephen Luecking’s (2002) work has roots in sculptural traditions combined with the logistics of engineering. He merged 3-D form with meaningful compositions and utilitarian functions in relation to simple elements of form as well as to complex classical sculptural work.

- In Mine Öskar’s (2004) PhD thesis in basic design education, based on the work of Denman Ross and Arthur Dow, she argues that training in the rearrangement of geometric elements improves designers’ ability to both recognize emerging compositions and develop desired strategies that optimize limitations. Through reasoning with simple forms, one can create a composition that has the potential to be recomposed in different ways, creating an array of compositions that express different qualities.

- Perceptual researchers Irvine Biederman and David Marr show that we intuitively understand the physical world through geometric abstractions. The structure of geometric volumes is easily understood, because the straight symmetrical axis in the volume and different shapes (e.g. cylinder, cone, sphere, rectangular volume, etc.) are easily discernable even in rough models. Irvine Biederman’s (1987) research on geons (figure 12) and David Marr’s (1982, 305–20) 3-D models explain our inherent ability to recognize geometric 3-D volumes (figure 13). Geometry helps to limit the possibilities of how to interpret the situation. Geometric volumes are built up around axes that define a simplified structural framework of the volume. An axis is an imaginary line within a form that elemental parts may be referred to. Still life studies and human figure studies apply such axial analysis (Hoppsch 2002).

Defining the inner axial movement and structure of a form or enclosed space is a classic method from painting and sculpture for dealing with complex compositions. David Marr has done extensive research concerning shape recognition through the awareness of axes. These axes, “determined by salient geometrical characteristics of the shape,” define what he called an “object-centered coordinate system” (Marr 1982, 298–320). According to Marr, actively perceiving and conceptualizing the coordinating role of axial structures is the most efficient, stable, and sensitive way of understanding shape (Marr 1982, 301). Marr’s reasoning about axes is very similar to they way Reed/Kostellow built up their visual structure (Greet 2002).

- Neurobiologist Semir Zeki (1999) also conducted empirical research that attempted to explain the drive behind aesthetic abstraction and the use of geometric structures in compositional development. Zeki’s research involved studying how the brain responds to different stimuli, such as the orientation of elements and their movements and contrasts. He also studied the work of artists such as Paul Cézanne, Piet Mondrian, Kazimir Malevich, and Ben Nicholson to learn about the way artists sacrifice information in order to express essential qualities that rely on geometric structures. Zeki’s own interpretation was that the artist’s use of geometry implies that the brain responds optimally to geometric form, because large groups of brain cells respond selectively to simple organized form (Zeki 1999, 112–3)

Form defined through 3-D computer modeling
3-D computer modeling technology has been extremely useful for developing software that builds up complex forms by transforming geometric volumes or changing topological points. The toolbars in modeling programs are organized into a variety of geometric primitives, such as sphere, cube, torus, and cylinder. These primitives can then be modeled through transformations, intersections, deformations, etc., in an X, Y, Z matrix (O’Rourke 1993/2003). The software programmers tutor the user in a sophisticated understanding of form, structure, space, texture, light, and so on. Before 3-D computer modeling technology was available, our first-year ID students at Konstfack had little active knowledge of geometric form. Today, designers are much more knowledgeable about geometric form, constructions, nanostructures, and more.
However, there is still a lack of aesthetic awareness and discussions concerning virtual and physical form and material development.

I recognize how potent this virtual world is for changing both our understanding of form and the formgiving/industrial process. Computer technology is one of the strongest drivers of research development in the field of form. However, I question the one-sidedness of a design process that relies too heavily on pure retinal input and ignores the other senses.

3-D printers
This thesis does not go into the way computers have affected form, mainly because my own experience is very limited, since Konstfack has a human-centered, model-making profile with little support from computers. We are waiting for 3-D printer technology to support the formgiving process by easily and economically making virtual models physical. Jan Capjon’s (2005) recent PhD thesis in industrial design presents empirical projects that skillfully alternate between the virtual and real worlds through rapid prototyping technology/3-D printing. Capjon’s research is very promising because his empirical studies underline the importance of bringing a number of virtual forms into the physical world to be tested and manually transformed at many phases within the formgiving process. In his laboratories at the Oslo School of Architecture, he uses technology in a very human-centered way. Eva-Lotta Sallnäs’ (2004) recent PhD thesis in human-computer interaction also presents evidence calling for a more embodied experience in innovative design processes that are developed in design teams working together around the world. Her findings state that the design process does not develop well if the team members do not have haptic and face-to-face experiences throughout the product development.

2.3 Formgiving
Although the papers presented in this thesis have only slightly touched on the design and formgiving process, my understanding of form and abstractions is directly related to these processes. I therefore introduce the concept formgiving and some theoretical background to the activity of creating concrete artifacts.

Definition
The concept of formgiving is briefly explained in the introduction of the present thesis. It is derived from the Swedish and German words formgivning and formgeben, meaning to give form as well as color, texture, sound, etc. to concepts, needs, and desires of contemporary society. It has roots in the collaboration between arts/crafts and technology that is involved in serial production. Historically, the Swedish word formgivning referred to a gestalt process assumed to rely on unique artistic talent alone and which could therefore only be carried out by chosen talented individuals in a solitary activity (Paulsson and Paulsson 1956, 98).

This idea of formgiving as an inborn personal talent reflects the attitude in the first part of the twentieth century when the identity of an artist and artisan was a person who skillfully expressed themselves through a medium. Today, designers work in collective situations with many other disciplines that aim to mix the skills and sensitivities of individuals to express the intent of the project. The expression of the unique individual character or profile of an artist or formgiver can be very submerged in one project, and yet be a central focus in another. In this thesis, I argue that there is always an element of individual expression in the formgiving process, because it actively engages value judgments and aesthetic sensitivities that are essential for the development of holistic imagery. These sensitivities have to do with an individual’s ability to discern contrasts, tensions, proportions, coherency, balance, etc. The important issue today is that we are much more capable of coordinating and engaging the individual sensitivities of designers and artists, as well as other professionals, in collective problem-solving processes.

From the beginning of the industrial revolution until the 1970s, the central task of the formgiver/industrial designer in Sweden was to integrate user needs with function and technological requirements in an aesthetically unified artifact (Paulsson and Paulsson 1956). Designers were therefore able to concentrate on the formgiving process.

In Sweden, formgivning was considered synonymous for the concept of design up until the 1970s. By the 1980s the word formgivning was replaced with the international term industrial design and the identity of a designer was no longer linked to the arts and aesthetics. Today, design is a multidisciplinary process involving much more than the realization of tangible products and the shaping of artifacts. The formgiving process can therefore be considered an activity that works within a design process. However, the design process today does not necessarily have to include a physical product and can be systematically carried out without relying on aesthetic or visual inductive reasoning (Goldsmith 2001). When a formgiving process is applied, there are no clear boundaries between the formgiving level and the design/planning level, because aesthetic reasoning in formgiving activities can be used to solve conceptual problems that do not have direct links to the shaping of a physical object.

Psychologist Edith Ackermann (2006) argues for inductive
reasoning and the use of physical forms to enhance our way of “making ideas tangible.” She suggests that tangible forms offer the chance to **negotiate** meaning, as well as to discover meaning through our embodied experience.

**Gestalt**

Gestalt is a central concept for understanding applied aesthetics and the formgiving process. Gestalt originally stems from German and refers to the forming capacity of our senses to recognize holistic structures through the interdependency of the role the parts play in the composition. The word gestalt can be found in many English dictionaries, but is not commonly used.

To further explain this concept, I summarized the early work of Christian von Ehrenfel and Max Wertheimer, who renewed the concept and brought it into an aesthetic realm. Von Ehrenfel’s experience in music led him to describe *gestalt qualities* in 1890 (Behrens 1998). In this paper, he proposed to redefine the German word *gestalt* by explaining that the elements gain their character through their role in the “compelling power of the composition that holds our attention over time.” In the same paper, Ehrenfel brought up the commonalities between 1) Objects that activate space and 2) Audio melodies that are expressed over time (Behrens 1998). He saw these two experiences of space and time as inseparable and explained their unifying character through gestalt. Max Wertheimer, a student of Ehrenfel, collaborated with him on the further development of the gestalt concept based on conducting studies in visual perception. These studies involved what he called *hidden forces*, which are inferred through indirect perception. In 1912, Wertheimer published *Experimental Studies on Seeing of Motion* (King & Wertheimer 2005, 75). This work involved identifying *apparent motion* between two blinking lights that were placed apart from each other. His studies showed that test subjects perceived the light as moving from one position in space to the other and then oscillating back again, despite the fact that the light sources were stationary. The scientific community considered these findings, which did not correspond with the physical facts, as *illusions* or *misperceptions*. Wertheimer, however, insisted that perception can be based on more than the measurable physical stimulus and how it is represented on the retina. He wrote about hidden forces and *invisible activities* (Wertheimer 1997 [1924]) that are part of our perceptual experience, and included Kinaesthetic forces that create a deeper structural organization going beyond the physical features. Wertheimer attributes this deeper structure to the intentions of the composer or participant. Experiencing a gestalt therefore includes the physical properties of an event and the emotional state and cognitive *intention* of the individual. Wertheimer collaborated with Kurt Kaffka and Wolfgang Köhler, forming a group referred to as gestalt psychologists. Their visual research on part, motion, and intrarelationships between elements across space (King & Wertheimer 2005, 155) was performed by arranging dots, straight and curved lines, lights, and a variety of geometric 2-D figures. These compositional studies resulted in a definition of the “laws of organization in perception of forms” (Wertheimer 1997 [1924]). Each law is correlated to a specific perceptual study such as *similarity*, *proximity*, *closure*, and *continuity*, as shown in figure 14.

The empirical research of the gestalt psychologists brought attention to the interrelationship between tangible and intangible properties, as well as to how the intentions of the composer drive the development of a gestalt.
Many of the visual laws from gestalt psychologists primarily apply to 2-D flat pattern recognition. The fixed view of a 2-D image makes it easy to recognize the overall figure and see how the hidden forces move between points. The reference to geometric, graphic surfaces and smooth, continual lines also reduces complexity and strengthens legibility. The relevance of these 2-D laws to the aesthetic experience of 3-D artifacts is an issue I take up in the present thesis. It is important to deal with the multiple dimensions that physical artifacts offer. This includes many different viewpoints as well as an embodied experience, all of which greatly affect how the gestalt is developed and perceived. Physical all-round 3-D perception involves a much more embodied experience than 2-D pattern recognition. Nevertheless, the conceptual idea of gestalt is a very useful concept in aesthetic reasoning. What I find important in the work of the gestalt psychologists is that their initial discoveries were made through the arts; first in music and later applied to the visual perception of graphic shapes. Wertheimer’s passion for music and his aesthetic sensitivities for discerning tone and compositional features led him to write his first article on music and his aesthetic sensitivities for discerning tone and compositional features led him to write his first article about the interconnected organizing structure of gestalt (King & Wertheimer 2005, 80–1).

Application of gestalt laws of perception

Rudolf Arnheim is a central figure in American art education who applied the gestalt laws of perception to how we visually perceive art. Arnheim studied with the gestalt psychologists in Berlin and did his PhD thesis in perceptual psychology. His book, Art and Visual Perception (Arnheim 1974 [1954]), is one of the most influential books in art education today. His work is focused on visual abstractions and gives detailed explanations of how to analyze compositions through perception of inner axial structures and the interrelationship between direct and indirect perception. Arnheim (1969, 153-87) argues that we have an inborn capacity to comprehend and perceive abstractions. He explains that visual abstractions take place in perception and are not divorced from context or invented by the mind alone. Visual abstractions are always discerned in direct relationship to the holistic gestalt (Arnheim 1969, 161). Arnheim also reversed this statement, claiming that a holistic gestalt presupposes abstractions. An individual’s ability to perceive abstractions is therefore directly correlated with how a holistic image develops (see section Aesthetic abstractions above).

Gyorgy Kepes (1944) compiled visual principles in a comprehensive book about painting composition entitled Language of Vision. Kepes acknowledges the work of gestalt psychologists, who inspired him in his development of illustrations and explanations of the aesthetic laws of visual organization. Kepes was instrumental in what he called the “visual re-education” of artists by teaching systems of abstractions that he claimed would “mobilize the creative imagination for positive social action.” Kepes (1965) edited a series of books on Values and Vision as well founding MIT’s Advanced Center for Visual Studies, which brought artists and scientists together in collaborative projects.

The whole idea of gestalt was to understand and support the creative process of performance and compositional work. Arnheim and Kepes show a particular way to understand the relationship between form and gestalt through application.

Gestalt/haptic and Kinaesthetic

Although gestalt implies a holistic experience that engages our human capacities from intellect through emotions to all our senses (King and Wertheimer 2005, 41–4), today we associate it with the visual principles of form from Wertheimer’s research with dots and indirect perception (King & Wertheimer 2005, 155). The present thesis emphasizes form in relation to the active, embodied process of creating a holistic gestalt that begins with an inner sense of form (see section 2.2, “Form”), which is more than a visual experience. Formgiving is performed through an engaged and interactive contact with form and material. The results of the formgiving process also include color, sound, taste, and smell; however, my experience from teaching industrial designers is limited to experiencing form through sight and the use of our body movements (kinaesthetic sense) with particular emphasis on how our hands test and shape materials.

Perceptual psychologist David Katz (1989 [1925]) was also an advocate of the gestalt movement. His research in tactile, Kinaesthetic, and haptic senses concerned how our bodies respond to direct stimuli imposed on us from the outer world, as well as how we use our bodies to explore and intentionally feel our way through the complex world (Katz 1989, 83 [1925]). Katz emphasized our need for movement of our bodies and putting our hands on and around a form or material (figure 15) in order to create an impression of its properties, proportions, pronouncedness, density, weight, etc.

Katz (1989, 79–84 [1925]) explained that the intentional movement of our limbs, purposeful touch, carries a creative force, which I feel is important for the development of our understanding of the formgiving process. Through Katz’s work, we can find theoretical and empirical support for the need to experience direct contact with form and substance through our hands and bodies.

Active formgiving process
There is very little research and documentation of the active formgiving process showing the skillful aesthetic reasoning applied in shaping artifacts. This is a dilemma for the field of design, because the concrete product mediates decisions of the design process; yet we know so little about what is going on within the formgiving process. One obvious reason for this lack of research in understanding form and the formgiving process is partly related to the problem of documentation. To be able to transfer the first-hand haptic, Kinaesthetic and visual/spatial experiences that are linked to the dialogue within the formgiving process requires documentation from an insider’s vantage point that can record knowledge in action (Molander 1996, Chapter 10). The scope of the present research does not include detailed documentation of the formgiving process.

Anders Warell’s (2001) PhD thesis aims to bridge active applied aesthetics with technology through a model referred to as form syntactics modeling. His research defined form elements and form entities of a product, aiming to draw attention to the wholeness of the form. He looked for ways to deal with alternative visual form solutions, mainly through 2-D sketching methods. Warell’s process is only applicable in the late or final phase of the formgiving process, after the main gestalt process has been developed.

In a recent PhD thesis on branding, market researcher Toni-Matti Karjalainen (2004, 30) addresses a lack of knowledge of the formgiving process:

In the same breath, three-dimensional product characteristics are those that largely dictate the interaction between the company’s product and the customer. In this sense, it is surprising how little research exists on the relationship between three-dimensional product design and brand.

(Karjalainen 2004, 30)

Karjalainen’s research focused on how visible form language and design cues communicate brand identity. The interviews he conducted are very useful for the present thesis, because they include comments about the design process that explain the need for a balance between the degree of novelty and the consistency of product profile (Karjalainen 2004, 176–8, 204). I am interested in how this balance is achieved and the unpredictable and contrasting nature of creating a combined vision of a gestalt.

Jan Capjon’s (2005) research on the formgiving process involves combining rapid prototyping technology and manual skills for shaping products. Capjon (2005, 166–88, Chapter 10) has further developed David Kolb’s “experiential learning model” into the presented “Plant of Emerging Materiality” model (PoEM), which gives technology and the embodied aesthetic process equal roles in defining the physicalities of the product. Capjon deals with form through an aesthetic awareness and play in collaboration.
with Erik Lerdahl (2001). He argues that the interpretive aspects defined in research in semiotics, do not deal with the form parameters in the early making process (2005, 202–3). Capjon states that there is an unnecessary tension today between the semiotic aim to interpret and the aesthetic aim to sensuously perceive form. He is against such dualism and offers the PoEM model to unite the verbal and perceptual experiences. I see Capjon’s research as pioneering, because it offers a method of bringing human aesthetic perception of users and designers together with high technology that explores 3-D physicalities of form.

**Play**

Fredrik Schiller’s (1995, 82 [1795]) letters on Aesthetics from 1795 advocated that play catalyzes aesthetic experiences and expressions. He regarded spontaneous play as a means of emancipating our senses and bringing one in touch with a richer awareness of the perceptual world. Play, he claimed, is a necessary activity to expand our consciousness and bring life to the development of the gestalt.

The design process is often dependent on the playful activities of designers, and we consider play as a counterbalance to the systematic and rational demands during the design process. Through the unconditional and explorative process of play, people get involved and interact spontaneously, relying more on their senses than on their rational mindsets. Barbara Marie Stafford (1994) regards exploratory play as a means of educating, because it helps develop the ability to synthesize, which is of vital importance to the design process.

Using aesthetic reasoning that involves play is part of our design educational traditions as well as of the practice of design. Erik Lerdahl’s (2001, 21–9) PhD thesis defines play as a means of developing creative collaboration in design teams. Play has also been used as a catalyst for discovery in a newly developed master’s course, “Research by Design,” at Chalmers School of Architecture, Sweden (Dyrsen and Billger 2005). This course gives a holistic experience to the students that takes them through 1) a playful discovery process; 2) the development of methods and procedures; 3) the articulation of hypotheses; 4) the development of visualization models; 5) academic writing skills in formulating an abstract for a conference; 6) the design of a scientific poster; and 7) preparation for a short conference presentation. By directly involving students in a playful and provocative discovery process, they efficiently learn the formalities of the research process. (Dyrsen and Billger 2005).

**From aesthetics to communication**

The Swedish industrial designer Rune Monö (1997), with whom I have collaborated for more than a decade, presented what he considered a holistic view on the product design process through a theoretical model shown in figure 16. This model consists of a triangle with the three sides labeled communicative, ergonomic, and technical. Two rings representing ecology and economy encircle the triangle.

I argue that if Monö’s model aims to be holistic, he needs to include aesthetic reasoning that goes beyond the conventions of semiotics. In his theoretical work in the aesthetics of design from a semiotic approach, he strived to “read” products through their visual signs and codes (Monö 1997, 117). Monö’s overriding aim was to support an understanding of products that was as unambiguous as possible. His quest for meaningful visual communication ignored the aesthetic relationships that hold the holistic gestalt together. Monö also presented a
dismantled mechanical device (a regulator) (Monö 1997, 32–3) as an example of a gestalt supporting an atomistic, mechanistic and reductionistic scientific approach, which is entirely opposite to the holistic gestalt that Wertheimer advocates. As a matter of fact, Wertheimer and von Ehrenfels specifically stated that a holistic gestalt can be transposed into a different set of elements, which are independent of the isolated qualities of the separate elements (Kring and Wertheimer 2005, 42–3). Gestalt is thus about emerging properties that are unpredictable in relation to the parts. I need to make it clear that gestalt and aesthetics are not meant to be treated through a reductionistic, mechanical approach. Through my years of teaching with Rune Monö, I know he was open to a more aesthetic and inclusive approach to support the formgiving process of our ID students; however, his applied theoretical work in his book “Design for Product Understanding” (Monö 1997) does not reveal his aesthetic reasoning or the interdependency between semiotics and aesthetics.

Finnish industrial designer and design theorist Susan Vihma (1995, 151–68) has studied the relationship between aesthetics and semiotics; however, the scope of her doctoral research restricted her to the representational qualities of products, which made it difficult to defend many aspects of aesthetic experience. Vihma clearly states that the intentions and aesthetic preferences of designers play a significant role in product development. Her creative way of mapping out the steam iron demonstrates her awareness of the role art and aesthetics have had on industrial product development (Vihma 1995, 101–22).

A recent article about the history of aesthetics in design in France explained the gradual shift from aesthetic exploration to communication and information (Le Boeuf 2006) as outlined in figure 17.

Replacing aesthetic reasoning with communicative reasoning has had a profound effect on the design profession. In the foreword to Klaus Krippendorff’s (2006) book, “The Semantic Turn”, Bruce Archer summarizes Krippendorff’s contribution in the following axiom:

_Humans do not respond to the physical properties of things to their form, structure and function but to their individual and cultural meanings._

Bruce Archer (Krippendorff 2006, foreword)

Krippendorff (2006, 283) endorses this axiom in his book and explains that semantics takes a distinctly different route, turning away from aesthetics and towards a sociolinguistic view. He argues that we cannot experience attributes that we have not verbalized. This statement goes against research in embodiment (Damasio 2005 [1994]), which says that most of our reasoning is not on a conscious level and that sense perception, emotions, and feeling play a central role in how we reason. What worries me about Krippendorff’s need to place language and cultural meanings first is that he puts design in the intellectual/social world and gives less emphasis to the aesthetic/sensory world.

What is vital about aesthetic reactions and reasoning is their capacity to explore and organize phenomena and situations that have not gained the attention of society at large. Antonio Damasio’s (2005 [1994]) research states that sensuous experience is extremely important for decision making, because we can rely on our sensitivities to emphasize certain alternatives over others. Without these somatic mechanisms we would be overwhelmed by our pluralistic and complex society. One way to understand what this embodied aesthetic experience involves is to work with processes that are strange and formless and thereby not easily understood in terms of social meaning.

### 2.4 Formlessness

In keeping with Reed and Kostellow’s support of the arts and my own search to understand form through negative-form void and material breakdown, I embarked on explorative studies of formlessness (see figure 18).

**Paradox**

The following passage embarks on a paradoxical task, which defies the very nature of formlessness. My plan is to place the theme of formlessness within the walls of academia, attempting to define the concept from different vantage points that I have found relevant. Since this is an empirical, rather than theoretical, thesis, I have not attempted to cover the theme formlessness in depth. My mapping of formlessness has developed in an ad hoc way, because my drive to explore it was intuitive, not theoretical. The longer I worked with form and formgiving in the industrial design educational community, the more claustrophobic I felt. Working with formlessness brought me back to an immediate, improvisational and embodied working method that I was loosing in the design world. Moving theory and methods of formlessness through an academic process has intensified the discovery process, because I was able to share laborations with other researchers. Yet, the academic writing phase has forced me to retreat from the immediate experience and return to reflection and disembodied, theoretical working methods, which are contrary to formlessness. Nevertheless, I defend this academic process, because it has been the only way to put these conflicting experiences on the same table.

This section on formlessness aims to give theoretical support that can reorient aesthetic reasoning in order
to deal with change and uncertainties. It involves an inclusive, open attitude that embraces emerging and transforming phenomena. Some sources of inspiration for the conceptual development of this section is found in the field of complexity (Gell-Man 2003), since it is concerned with studies of chaos and order in relation to disorder. I also refer to theoretical and practice-based work in the arts concerning the theme formlessness (in French, “informe”) (Bois and Krauss 1997) and John Rajchman’s work in relation to Gilles Deleuze concerning transforming aesthetics and the “science of the sensible” based on unconditional experimentation. A last source comes from the contributions from perceptual psychology that study blur, blobs, and gradation.

The question this section addresses is: how do we develop aesthetic reasoning that can follow the emergence of new structures as well as the breakdown of old structures? What abstract principles (if any) can we formulate that can offer a means of orientation as materials change and transform? Or, perhaps even more importantly, what concepts of reality do we need to help us deal with formlessness? Can a form-based taxonomy expand to include events and changing phenomena? Or is there, as suggested by George Bataille, a way to make a “taxonomy of disorder” (Bois and Krauss 1997, 18)?

**Context, change, and event**

A physicist looks upon the world as energy, matter, and forces operating in space—an isolated, stable object in space does not exist in the physicist’s view of the universe (Greene 2000, 79). The contemporary world of art has shifted its attention from isolated art objects to the contextual conditions that generate and underline a work of art or an installation (Bourriaud 2001). In effect, like physics, art has cultivated an approach in which genesis is more important than a concrete expression in space. This shift to context, change, and event has challenged the limits of object-based aesthetics. My goal in this section is to find theoretical and practice-based sources that expose the strengths and weaknesses of investigating formlessness.

Art historians Yve-Alain Bois and Rosalind Krauss (1997, 18) charted and reconceptualized the field of formless as an alternative way to approach the unknown and avant-garde. A central figure in this field is George Bataille, who explored the formless to find freedom from conventions.
of representation. He refused to define the word formless (informe) (Bois and Krauss 1997) and declared that formless is understood through the immediate experience. The formless takes on different shapes and conjures up unexpected happenings that can not be repeated. Due to this constant transformation, the formless has no sharp contours or stable structures, making it difficult to literally grasp and control. Bataille started the informe movement with the aim of sabotaging the academic world and its need to categorize and organize. Bataille saw formlessness as a means of provoking an embodied, erotic response through the “impurity” of substance and the amorphous nature of material (Bois and Krauss 1997). Although my exploration of formlessness through my work in art and complexity does not reach the depth of Bataille’s experience, I have approached it to problematize the field of aesthetics and go beyond social conventions and essential aesthetic abstractions. The concepts formless and formlessness are very pluralistic, which can be shown in the map of synonyms in figure 18, inspired by Thinkmap Visual Thesaurus (URL). The synonyms are clustered without any hierarchy.

The material in this section is presented through five different areas that link to various laborations, courses, works of art, and literature references that have inspired the development of the thesis.

**Five areas of formlessness:**

- **Void**
  - Empty space,
  - Blur
- **Transformation**
  - Distortion
  - Irregularities
  - Asymmetry
- **Amorphous phenomena**
  - Blob
  - Decomposition and breakdown
- **Haptic and kineasthetic**
  - Movement and intention
- **Emerging properties**
  - Conflicting forces
  - Context dependency

**Void**

Kazimir Malevich and Alexander Archipenko were both challenged by the mathematical concept of zero and explored ways to transfer this concept into their art. Malevich used geometric shapes to express his interpretation, and his famous Black Square was part of the “Zero, ten” exhibition in 1915 (Kovtun 1989, 157). Alexander Archipenko’s interest in the concept zero was inspired by
his father, who was a mathematician. His aim was to give void (zero) a predominant role in his sculptural composition (see figure 19).

Reed and Kostellow emulated Archipenko’s way of materializing void through the direct and indirect properties of form into their educational program.

Sculptor Anish Kapoor’s work is also devoted to exploring what he calls void fields, offering a hidden space for the unconscious (McEvilley 1990). Kapoor’s work with form is very much about negating form by expressing forces through and beyond material.

Empty space
Wolfgang Goethe studied the polarity between empty space and matter. His method for conducting his studies was to observe “truben” or fog/cloudiness, which fills space (see figure 20). He saw the particles of clouds as a “primary phenomenon” (in Swedish: “ur-fenomen”) in nature, because they make up the first step towards the embodiment of space/room (Sällström 1993, 106–11). He considered clouds as a medium for the further development of color theory in relation to light and darkness. Goethe emphasized human perception, which connected him with art more than science (at that time). His observations showed that yellow is the first color that is expressed in clouds in relation to light, and bluish/violet in relation to darkness (see figure 21).

Blur
Visual psychologist David Marr (1982, 56) stated that perception is all about the detection of intensity changes. His research involved studying blurred images to emphasize contrast and to fuzz the physical boundaries and edges (figure 22). Marr believed that the “heart of perception” is to grasp the structure of things in the real world and that blurring their images is a means of understanding this structure. This method of blurring is also common in the arts. See also blob below.

Transformation
Transformation involves the act of changing from one form or state to another. Material transformation can occur as a gradual modification, so that the original form can be observed more or less throughout the process or as a radical change, where the material is transformed at the root. These changes can come from internal or external processes or forces. One example of radical change is defined by philosopher Manuel de Landa (2000, 60) as a transformation process that changes between scale entities. He uses an example of a loose collection of pebbles that transform through sedimentation into large-scale rock. DeLanda refers in turn to Deleuze and Guattari, who call this scale-to-scale transformation “double articulation.”
**Distortion**

To distort means to alter the original shape of form by introducing forces that expand, contract, twist, turn, and so on, changing the structure of the form. Despite distortion, the identity of the original form is still expressed. To distort implies a process that refers back to the recognizable shape in order to grasp the features of the distorted form (see figure 23). Malevitch used distortion of rectangles and squares, as well as diagonal placement of elements to develop a sense of floating and fading away, which were the aesthetic aims of dynamic supremaism (Moszynska 1990, 60–2).

In computer technology, distortion usually refers to the increase or decrease of space between designated points (Ware 2004, 340). Distortion relies heavily on indirect perception, because the distorting forces move within and beyond the form.

**Irregularities**

Irregularities are what give life to a system. When unexpected features take the place of expected features, this is what makes something stand out and gain identity; see figure 24. Learning to prioritize regularities and ignore irregularities may inhibit one’s appreciation of complex relationships and events. Physicist Murray Gell-Mann (2003) has observed such problems with the way scientists tend to work. His years of experience in research into complexity have brought him to the conclusion that if we focus too much energy on learning to see order, we tend to see order where it is not. Gell-Mann explains that since the universe is a dynamic, changing system, there is a need for alternative methodologies that support studies in irregularities.

In the arts, we explore the irregularities and deviating characters of individuals, society, and world events. We applaud the artists who expose our dysfunctional behavior and deviations. As philosopher Fredrika Spindler (2004, 19) states (in reference to Deleuze), to really work at the “extreme point,” where the known meets the unknown, we need to force ourselves to deal with unconventional and strange conditions. Spindler goes further by explaining that meeting the strange means confronting a conceptual violence that is fueled by overwhelming our senses with input that is too complex. The force we gain out of the violent shock can help articulate an immediate understanding of the situation.

Spindler and Gell-Mann both see the same problem. Gell-Mann warns of the complacency that science exhibits when confronting the strange, while Spindler warns of the risk one takes in the immediate interaction with the strange. The focus of my investigation with regard to irregularities and the strange is to confront them and develop aesthetic methods that use the overwhelming feeling and clash that new experiences cause.
Asymmetry
Poincaré associated truth in mathematics with beauty, order, harmony, and symmetry. His view reflects a long tradition of western thinking starting with Plato (Lorand 2003–4). It is a view that aims to define a higher, ideal order that does not exist in the mundane world. It seems art and design are more interested in learning from asymmetric movement and composition, prioritizing contrast and tension between elements expressing more dynamics.

Ruth Lorand (2003–4) challenges the classic idea that order and symmetry are the same. Her argument is that order relies on a combination of symmetry and asymmetry, because breaking symmetry creates distinction, which increases the level of complexity and creates a more vitalized order. Lorand’s theoretical work in aesthetics has a very practice-based reasoning that uses examples from domestic life to prove her point. Her arguments about the interdependency between symmetry and asymmetry have helped to problematize the way I treat the concepts of symmetry, asymmetry, and dissymmetry in the present thesis. Further support for the interdependency of symmetry and asymmetry is given by Vera and Francois Molnár (2005) in their definition of controlled disorder and hidden symmetry—which lies behind the structures of many asymmetrical compositions.

Amorphous phenomena
Amorphous phenomena are made of unstable materials that can change shape over time and are therefore difficult to recognize, categorize, and classify. Art theorist Tom Sandqvist (1998, 51) explains that substances that do not have clear boundaries (i.e. are sticky, leaky, slimy, liquid, etc.) are considered repulsive, because the separation between the amorphous material and our bodies is vague. This vagueness seems to threaten our identity, according to Sandqvist. Bataille was also interested in how formlessness can be absorbed into other substances and break down barriers (Bois and Krauss 1997). There are, however, amorphous solids that do not change over time, yet have vague and uneven contours, such as wax, clay, etc. These formless volumes are easier to grasp, both physically and conceptually.

Blob
A simple clump of clay, as shown in figure 25, expresses a spontaneous 3-D raw shape that captures a sense of the volume, proportion, and axial movement that lies beneath the surface qualities and the contours or form. Learning to work through this unpolished phase supports a deeper perceptual experience that involves volume. The research of visual psychologist James Gibson (1986, 83 [1979]) supports our inherent ability to sense volume. He states that we experience “a direct pick-up of solidity”
that is continuous through the volume and does not rely on silhouette. Visual psychologist David Marr (1982, 52) has also studied how we perceive these voluminous clumps, which he termed “blobs”. His research confirms that we perceive rough position, length, width, and orientation in spatial context, rather than contours. Marr also emphasized our ability to prioritize spatial localities, while the edges and contours are controlled by these spatial structures. Both Marr and Gibson question the research results on shape recognition through contours and outlines presented by researchers such as da Fontura Costa and Cesar (2001). Rowena Reed also stated that the perception of mass dominates over the perception of contours, edge, and silhouette (Greet 2002, 106).

Decomposition and breakdown
Decomposition refers to the breakdown of organic material through various stages or phases. Through these stages, materials may change, for example, by releasing gas and odor at one stage and changing from firm material to liquid at another. Eventually the material that is left dries out and is either preserved or dissipated. Bataille compared the ideal form of matter in opposition to dead matter (Bois and Krauss 1997, 29)

He considered formlessness as demonstrated through phenomena such as death/decomposition or trauma/sores, offering a state of unity between form and content. He explained that when an insect is squashed, it is no longer an image or object that can be abstracted and analyzed. The squashed insect does not represent anything; it becomes real and immediate in the momentary state. The processes that break down materials create a great deal of disorder, which frees the material from the role it plays in society. Bataille suggested the need for a science of what is entirely disordered, which he called “scatology”. Scatology refers to “feces” or “waste” products, which have no articulated place in society. Bataille was looking for a “taxonomy of disorder of base material” so that we might learn to understand the degradation of material and energy.

Physicist Brian Greene (2004, 174) provided an elaborate explanation of an egg falling off the edge of a countertop and splattering on the floor. His message is that we need to experience the unfolding of disorder in order to understand processes of expansion of the universe. In a sense, Greene is also saying we need to complement today’s science with a science of disorder. James Crutchfield (2003, 35) also points to a need to understand the mechanisms underlying what he calls a deterministic chaos.

Haptic and kinaesthetic
David Katz’s (1989 [1925]) research in haptics, which included kinaesthetic and tactile experiences, emphasized the need to explore complex phenomena rather than isolated specific sensations that focus on individual sensory modalities, such as vibration or temperature. His research also supported the immediate felt experience and the role of “active intentionality”, which is an important part of
2. THEORETICAL FRAMEWORK

Theorizing the active hand

Katz advocated that the active hand has a greater sensitivity, because sensation from muscle movement (Kinaesthetic) enters into the experience. He referred to the intentional movement of our hands as extremely important in forming our understanding of a tactile phenomenon, and he connected a creative force to the active hand (Katz 1989, 75, 79–84 [1925]). Figure 27a–27b shows how dominant the hands are for sensuous cognition through movement.

Emergent properties

Physicist Paul Davies (1995, 21–3 [1987]) considers the universe as a continually changing and creative system. He states that in nature, there are physical processes that show a kind of spontaneous creativity, giving rise to unique “emerging” formations. He argues that our universe started in a featureless state and continually increases in complexity so that new forms and structures are constantly coming into being.

Emergent properties arise out of contextual conditions that support the development of a distinctly new system. The emergent properties have no similarities to the properties from which they arose, so they cannot be reduced to elements (Davis 1995, 114–5 [1987]).

Movement and intention

David Katz studied movement in two ways: 1) the resting passive hand that is stimulated by the movement of material under the fingertips, and 2) the active hand that intentionally explores material by moving fingertips over it. Katz advocated that the active hand has a greater sensitivity, because sensation from muscle movement (Kinaesthetic) enters into the experience. He referred to the intentional movement of our hands as extremely important in forming our understanding of a tactile phenomenon, and he connected a creative force to the active hand (Katz 1989, 75, 79–84 [1925]). Figure 27a–27b shows how dominant the hands are for sensuous cognition through movement.

Fig. 26a-c represent the three modes of touch as outlined by Katz: surface, immersion, and volume. Photo 26b shows a non-visual color study from a laboratory involving haptic experiences. The fingers explored a warm tomato which was meant to give a sensation of red. This experience would be considered an immersed touch based on Katz’ definition. I find Katz’ explorative attitude towards perceptual research vital for expanding our understanding of aesthetics, and especially in the further development of the visual foundation my work is based on.

In the visual world, it can be hard to understand what Dewey meant by an “immediate impression,” because we are so focused on the semiotic representation of objects. However, the concept becomes much easier to understand in the haptic world, where we deal with such immediate impressions as cold, sticky, and soft. It may be that haptic sensitivities are more reliable in exploratory studies than our visual sensitivities, because we can more readily experience the direct phenomena.

Research in computer–human interaction has put more and more emphasis on haptic experiences, because it is evident from the work of researchers such as Gupta that haptic feedback improves performance (Sallnäs 2004).

Fig. 27 Homunculus showing the dominance of the hands for both sensory and motor activities

a. Brain representation of the Homunculus (URL), showing the dominance of the hands in both the somatosensory and motor strips of the human brain cortex.

b. Model of the Homunculus. Printed with permission from The Natural History Museum.
aimed to explain the development of “reward mechanisms” for adapting to problems in the environment. The crystals “learned” to construct and reconstruct branching structures due to local changes in surrounding conditions. Useful structures were rewarded by the allocation of more energy, thus attracting more material to areas “fighting” to maintain intended growth. Feedback systems developed that affected the entire system in unpredictable ways. One of Pask’s conclusions was that conflicts stimulate growth processes.

From a formless substance, a very defined system can arise. Figure 28 shows crystal structures emerging from a transparent copper sulfate fluid solution (see Paper VIII).

**Context dependency**
Formlessness implies the ability to adapt and change in response to the environment. A formless system is therefore considered context-dependent, because its shape depends on external conditions such as temperature and movement. Figure 29 shows how smoke patterns change from linear to non-linear behavior due to surrounding conditions.

Vassily Kandinsky stated that “every form is as sensitive as a puff of smoke; the slightest breath will alter it completely” (Kandinsky 1977, 32 [1914]).
This chapter is divided into 3 parts. Each part presents a summary of results in relation to aims followed by a discussion of strengths and weaknesses.

Part 1: Developing an aesthetic taxonomy of form (Papers I–II)

Part 2: Expanding and challenging the Evolution of Form-model (Papers III–VI)

Part 3: Formlessness—Beyond the aesthetic taxonomy of form (Papers VII–X)

Each part begins with a brief outline of how the results relate to the aims, followed by a summary of results, which are then discussed in terms of strengths and weaknesses.

Part 1: Developing an aesthetic taxonomy of form

I refer here to my experiences from:

- Work and studies with Rowena Reed in New York City
- Developing an educational program for form theory and practice for industrial designer at Konstfack
- The Swedish cultural context

Results in relation to aims

The results presented below attempt to address aims 1–3 and aim 6 defined in the Introduction:

Aim 1: To generate aesthetic strategies that support skillful formgiving methods of conceptualizing and shaping artifacts in a design culture.
- The present thesis offers an aesthetic taxonomy of form, which supports the organizational needs of formgivers in developing a gestaltgestalt (Paper II).

Aim 2: To create a model that integrates geometrical law-bound, aesthetic reasoning with organic growth principles.
- The present thesis offers the Evolution of Form (EoF) model as a way to support the reciprocal weaving-together of geometric and organic form principles (based on human figure studies) (Papers I–II).

Aim 3: To develop constructive and critical methods and models that challenge normative trends in design aesthetics.
- The present thesis uses a bipolar spectrum in the Evolution of Form-model, which provides possibilities to work outside the norms of beauty along the negative pole, yet still included in the same aesthetic taxonomy that supports these norms (Paper I).

Aim 6: To support the interaction between the explorative, embodied approach of the arts and the didactic and concrete need of design education.
- The present thesis offers didactic teaching material in the aesthetic taxonomy of form including the EoF model that relies on creative and skillful embodied procedures to bring conceptual and perceptual reasoning together (Paper II).
Summary of results – Part 1

Aesthetic taxonomy of form in five levels
The term taxonomy originally referred to classifying living phenomena into sets, relationships, and principles, but today it can apply to anything. The aesthetic taxonomy of form presented in this thesis was developed by defining 3-D essential aesthetic abstractions of form and space that compactify properties, movements, relationships, and organizations. The aesthetic abstractions are derived from geometric structures and organic principles of growth and tension, founded by Rowena Reed and Alexander Kostel- low at Pratt Institute (Greet 2002). The taxonomy grew within the context of a Swedish formgiving culture and an industrial design educational institution at Konstfack rooted in Arts, Crafts and Design.

Paper II is a textbook originally published in 1994 outlining four levels that organize the taxonomy and its nomenclature, conceptual models, illustrations and photographs of 3-D physical models. The four levels are: I. Elements and their properties, II. Movements and forces, III. Relationships and IV. Organization. This research develops arguments and theoretical support that expand the taxonomy to also include an additional fifth level, Intention involving the formgiver’s individual sensitivities applied during the gestalt process (see figure 30). However, the scope of this research does not include a detailed revision of the entire taxonomy, see Future plans.

During this research project many revisions of the taxonomy outlined in paper II have been considered, such as: i) problematizing the concept visual, ii) questioning the theoretical implications of adding a bipolar spectrum, especially regarding the negative pole, iii) improving the graphic layout, photographs and illustrations and iv) adding examples of products that apply this taxonomy.

The Evolution of Form-model in figure 31 and the expanded Evolution of Form-model in figure 33, show examples of revised models.
Evolution of Form (EoF) model

The EoF model, as shown in paper II and figure 31, has a 7-stage horizontal axis that reciprocally interlaces geometrical law-bound reasoning with organic principles from simple to complex. Each stage has a vertical axis with a bipolar spectrum.

**Horizontal axis**

The 7 stages start with join at the left end and progress through increasing complexity ending in the organic stage at the right. The 7 stages are:

1. **Join**—cutting away a part of one geometric volume to exactly fit with another geometric volume
2. **Intersection**—the common mass within the joint of two geometric volumes, defined by the geometric properties of the surfaces of the joined forms
3. **Divide**—cutting through geometric forms, creating two or more parts
4. **Adapt**—fitting a compliant geometric form up against or around another form that is stable
5. **Merge**—blending two or more geometric forms into a combined figure
6. **Distort**—exposing a geometric form to forces that affect its inner structure and elemental parts
7. **Organic**—beginning with formlessness (clay) and creating complex movements and tensions in the form expressed through convexities and concavities having no geometric reference.

**Bipolar spectrum**

The bipolar spectrum moves vertically across the horizontal axis at each stage in the EoF-model (see figure 31). The spectrum introduces a positive and a negative pole that expand the practical and theoretical dimensions of this evolutionary model. This spectrum both supports and challenges the classic aesthetic aims of achieving beauty and expansion. It gives equal weight to activities that build up and break down the geometric structure.

The top half of the model represents the positive pole of the spectrum, which supports congruence with the original geometric structure. The terms **accordance**, **assimilate**, **converge**, and **conform** indicate support for the geometric structure or identity of the original forms. The bottom half of the model represents the negative pole, which supports incongruence with the original geometric structure. The terms **discordance**, **dissimilate**, **diverge**, and **deform** are meant to disturb, take away and work against the geometric structure or identity of the original forms.
3. RESULTS

The ten steps are:
1. Lecture on concept
2. Translation/interpretation
3. Experimental 3-D modeling
4. Individual support
5. Gathering the work
6. Perception and reflection
7. Exploring aesthetic reasoning
8. Bipolar spectrum
9. Summary
10. Feedback

This method developed over many years within an industrial design educational program that aimed to generate new concepts and conditions for organizing and shaping form. The method was based on working back and forth between conceptual development and physical experimentation with 3-D form. A major goal was to develop concepts and forms, eventually resulting in the EoF-model (figure 31). A cooperative inquiry method was applied, using students as co-researchers.

The 10-step method is considered both a method and a result in the present thesis and is presented in detail in Paper I-II.

Discussion of results - Part 1

Strengths

Five strengths concerning the aesthetic taxonomy of form are discussed below:

1. Five levels and coherent nomenclature supporting the creation of the gestalt
2. Blending geometric/organic structures and principles
3. Bipolar spectrum problematizing “beauty”
4. 3-D sketching and crafting skills
5. Designers as problems solvers

A first strength of the present taxonomy, including its revisions, is that it offers a coherent way to understand form in space. The concepts, principles, and graphic models are organized into five levels (figure 30) that correspond to different levels of complexity and to gestalt reasoning. These five levels reinforce the interrelationship between the way the elements and their movements/forces make up and/or reflect a meaningful organization. The concentric order of the five levels as shown in figure 30 therefore supports ways of analyzing aesthetic abstractions of a 3-D composition as it emerges. It also indicates the increasing contextualization and complexity one is faced with when moving from description of properties to artistic intention.

The way to use and understand an applied aesthetic taxonomy is not like anatomy or a map. An aesthetic taxonomy is calibrated through the sensitivities of the individuals involved in the formgiving process. It is about aesthetic abstractions that must be discerned in relation to the whole to help clarify options and choices.

Through research in perceptual science, starting with Max Wertheimer (King and Wertheimer 2005, 4), there has been a strong commitment to developing knowledge about how we perceive both measurable physicalities and non-measurable experiences.

The non-measurable experiences are about:
- Indirect perception referring to how properties, movements, and forces relate through mass and over space, derived from the physical and contextual situation.
- The intentions, sensitivities, and experiences of the involved individual in the interaction with the gestalt

The nomenclature of this aesthetic taxonomy (Paper I) is based on aesthetic abstractions that are derived from geometric structures and organic principles. The concepts are defined, and the visual images and physical models are specifically developed in parallel with the development of the concepts. There is therefore a direct correlation between concepts and aesthetic abstractions with physical features and perceived expressions.

A second strength found in the EoF-model (figure 31) applies to the sequential and reciprocal reasoning that blends geometric structures and organic principles in the same model. It is common in basic design courses to present one way to understand and analyze the construction of geometric forms and another way to understand and sculpt organic forms and figures (Read 1992 [1964]). The 3 stage geometric-organic (geo-organic) “vision” conceived by Rowena Reed strived to weave together the geometric and organic ways of working and reasoning (Greet 2002, 106–16). The proposed EoF-model, derived from Reed’s vision, offers the first comprehensive visualized diagram over her geo-organic reasoning and present 7 stages (including the 3 stages from Reed) that explicitly shows the stage for stage link between geometric and organic qualities and principles.

A third strength is the bipolar spectrum, which includes a negative pole that supports concepts of breakdown, discordance, etc. It is the negative pole that expands the EoF-model and challenges the normative principles
concerned with “beauty” from which Reed’s early geo-organic vision developed. Reed was strongly committed to supporting “beauty” in product design (Greet 2002). Her sensitivities, procedural knowledge and critiques were tempered by her attempts to develop beautiful solutions, which also underlines how the principles developed and were interpreted by students. By adding the bipolar spectrum at the different stages of the EoF-model, I was able to step out of Reed’s “principles of beauty” through the negative pole. Thus, through this bipolar reasoning, I could both a) problematize the EoF-model by making it much more inclusive, and b) impose a regeneration of the definition of concepts at the positive pole by their relationship to the negative pole.

A fourth strength is that the 10-step method relies heavily on the 3-D crafting skills of the students/participants. The discrete and skilful movements (Ingold 2000) that students employ to create clay models over the years is a key procedure for the development of this research. Interesting, sensitive, and creative solutions stimulated intellectual involvement and moved the research forward. Gabriella Goldsmith’s (2001) research explains the importance of the sketching process when dealing with complex problem solving, and is equally important in this research for the development of a taxonomy of form.

A fifth strength is that this research was developed within the educational framework of industrial design, because designers are problem-solvers with an interest in understanding how people perceive their products. Their willingness to materialize possible solutions for a problem has kept this theory and vision in touch with the concrete world. Without this willingness to “just do it,” the taxonomy of form and the Evolution of Form-model would not have developed. In Henrik Gedenryd’s (1998, 9) PhD thesis in cognitive science on How designers work, he points out the vital importance of “practical skills and authentic activity” in the development of the design profession. He even states that recent cognitive research sees “cognition as fundamentally practical by nature.” This statement is also supported and further developed by Edith Ackermann’s research, which concludes that cognition is greatly enhanced by fusing concrete experience with abstract analysis (Ackermann 1996).

Weaknesses
These 5 points were raised concerning the weaknesses of the aesthetic taxonomy of form:
1. Geometry and aesthetic abstractions play a normative role.
2. No application.
4. Lack of historical roots in aesthetic judgment.
5. Innovative vs. didactic solutions.

A first weakness is voiced by the Swedish postmodernist critic Linda Rampell (2003, 373–6) in her recent PhD thesis Designatlas. Rampell considers geometric references for developing aesthetic abstractions as a means of separating designers from becoming contextually grounded. She bases her criticism on a number of established postmodern critics such as Evgenii Kovtun, who explains that the use of geometry entails a reductionism that excludes and “washes away” contact with the real world. To an extent, I agree with postmodern critics about geometry offering ways to step back from the immediate context, however, I do not agree with the critic of losing contact with the real world. If the design process was always embedded in context and refrained from using abstractions, it would not have been able to produce solutions and products for society. Being able to apply geometrically derived aesthetic abstractions allows the individual to step back and aesthetically summarize the complex context without loosing contact with the physical world. Rotzley (1977) states that throughout history we have used geometry to develop something different from the present. He says that geometry and abstractions are directly linked to human perception and our drive to create. Rudolf Arnheim (1979) and Christopher Alexander (1964) also defend the organizing capacity of geometric form and abstractions as central to the creative process.

In a user-based culture like Sweden, the industrial design process is often contextualized in relation to i) the human body through ergonomics, and ii) the complexity of the particular problem in focus from a human perspective. Industrial design is one of the most contextualized professions in our society (Thackara 2005) daring to take on problems in the real world. I argue that aesthetic abstractions supporting visual imagery and physical model making have helped create the development of this problem-solving profession. However, we need to better explain our methods to gain support for further in-depth documentation of these contextualized procedures, to show the role aesthetic abstractions and geometry play in the process of planning and formgiving.

Given the “ill defined/wicked problems” (Rittel 1972) that industrial designers take on, the nature of geometric
composition offers ways to gain holistic control over the process (Alexander 1964, 27). The design process usually involves developing solutions for conflicting concepts and desires in a competitive market. Geometry can catalyze ways to organize the “infinite variabilities” (Deleuze and Guattari 2003, 201 [1994]) that design activities bring forth. As long as we use geometry as a way to explore possibilities, geometry can act as a way to bring conflicting forces into balance. What often happens in the design culture is that superficial aesthetic experience of geometry hinders the explorative process and “geometric clichés” (Deleuze and Guattari 2003, 204 [1994]) are applied. Using geometry in the design process begins with using its organizing capacity on a structural and proportional level. Geometric reasoning in the design process does not dictate however, a geometric solution.

I urge the aesthetic disciplines to regenerate knowledge about geometry by challenging geometric principles in relation to different modes of aesthetic reasoning. As mentioned above, Rowena Reed (Greet 2002) created a geo-organic vision that brought the principles of growth, tension, and expansion to geometry and the law-bound order of geometry to organic composition. The 7-stage Evolution of Form-model (Papers I & II) further developed Reed’s geometric-organic vision and set up an opposing bipolar dimension that runs perpendicular to each of the original stages. This model confronts the cliché use of geometry as well as the normative concept of beauty by introducing possibilities of exploring geometric breakdown, deformity, discordance, etc., through a bipolar spectrum.

A second weakness points out that the taxonomy presented here does not directly show how it is applied in art, design, or architectural work. The criticism is that the taxonomy is too abstract and loses relevance through the lack of application. To my knowledge, the majority of books published in this area of applied aesthetics and foundation design courses present and discuss the work of established artists, architects, and designers who apply aesthetic concepts and principles (Stephan Luecking 2002; Jonathan Block & Jerry Leisure 1987; Francis D.K. Chung 1979; Moholy Nagy 1969; Robert Gillam Scott 1951).

My argument is that I deliberately excluded applications of the aesthetic taxonomy because they would influence and restrict the way an aesthetic abstract principle is expressed. I am following the traditions of Reed and Kostellow (Greet 2002), which are rooted in a scientific attitude and a commitment to developing original and innovative products. By working with essential aesthetic abstractions within the context of a real problem, one can develop solutions that do not necessarily have strong prior references to other work. Materials, techniques, functional problems, ergonomics, etc., contextualize the aesthetic abstractions; thus, analogies are not necessary. The proposed taxonomy was developed in a context supporting the education of industrial designers in learning to deal with an active formgiving process in product development. Students see the work of other students in the advanced classes and eventually develop their own applications of the taxonomy. Through conversations with former students, I found that there are strong educational benefits to working with the aesthetic through abstract models rather than applied directly in products. The benefit is that the students can recall the experience of the taxonomy and the EoF-stages, making it easier to discern form in the formgiving process.

The present thesis does not present how our curriculum integrates the proposed aesthetic taxonomy of form with semiotics, user needs, marketing, technology, function and sustainability that reflect the Swedish formgiving culture. However, it is important to validate this taxonomy through application. It was my intention to explain more of the formgiving process and how aesthetics work within the process, but the scope of the present thesis could not include this material. A few applications of students’ work are found in the introduction and included on the thesis website.

A third weakness is that 80 percent of the nomenclature presented in paper II is rooted in modernistic terminology. This aesthetic nomenclature was influenced by science (particularly physics) and some examples are force, space, axis, movement, mass, position, and expansion (Wick 2000). By putting emphasis on the essential abstract structures of form in space, the non-structural properties, such as color, texture, smell, sound, and ornamentation, are assumed to have little effect on the structural organization. This assumption is something I have questioned over the years, and I suggest a more inclusive approach that brings together all other aesthetic disciplines to create an overall aesthetic field of knowledge. Part 3 in this chapter opens up aesthetics beyond essential abstractions.

In 1983, philosopher Jürgen Habermas explained that “the spirit of aesthetic modernity has recently begun to age” and that modernism was “dominant but dead.” I agree with Habermas, because I see very little energy within the design field to develop knowledge about aesthetics that push the limits of modernism. Since there has not been any other coherent aesthetic movement in modernism, it is still the language used by active designers who create artifacts. My hope lies in John Rajchman’s (2003) recent prediction about a renewed interest in modernist aesthetics fueled by a loss of interest in the anti-aesthetic and highly critical postmodern movement. In this renewal period, we
can aim to bring all the aesthetic disciplines together to compare, interweave, and oppose each other.

A fourth weakness has to do with Klaus Krippendorff’s (2006, 159) critique about the aesthetics of modernism being unable to deal with the “cultural roots of aesthetic judgment”. I agree with Krippendorff, since dealing with cultural roots is one of the most difficult issues in the design process. Our aesthetic discipline within the design process is underdeveloped and does not have the methods or principles for dealing with deep cultural roots. Cultural differences are slowly being swept away as more and more nations become industrialized and product designers ride on this wave. Krippendorff sidetracks aesthetics and points to a “semantic turn,” which, he argues, will support cultural expression. I argue that the active formgiving/design process concerned with cultural issues needs aesthetic reasoning. Semantics (without aesthetics), as Krippendorff suggests, has no formative methods for developing products and services that explore contemporary ways of expressing culture. Besides, if we are to deal with cultural historical roots, then historically aesthetics, art, and culture are inseparable.

Part 2: Expanding and challenging the Evolution of Form-model

I refer here to my experiences from:
• My art within a constructivist community of artists
• Art/physics collaboration projects
• Exploratory laborations with industrial design students

Results in relation to aims

The results presented below attempt to address aims 3, 5, & 6 defined in the Introduction:

Aim 3: To develop constructive and critical methods and models that challenge normative trends in design aesthetics.
• The present thesis shows how art is a method for aesthetic development. An art–physics project developed collaborative methods, procedures and techniques to explore aesthetic issues concerning complex curvatures and transparencies (e.g., point-cloud volume) in the physical and virtual world that challenge the aesthetic taxonomy of solid forms in the EoF-model in part 1 (Papers III–V)
• The present thesis has developed procedures to study material breakdown, which also challenges the usual ways of transforming solid form as defined in the EoF model in part 1 (Paper VI)
Aim 5: To generate methods that lift aesthetics into a dynamic mode of reasoning that supports change, transformation, and formlessness.

- The present thesis introduces procedures that show how the particular physical context around an “organic cube” affects material change over time. The material transformed into a somewhat formless mass (Paper VI).

Aim 6: To support the interaction between the explorative, embodied approach of the arts and the didactic and concrete need of design education.

- The present thesis presents a new model that expands the EoF-model from Part 1 (Paper VI).

Summary of results – Part 2

Art as a method for aesthetic development

Another question concerning the whole idea of creating or expanding any sort of aesthetic taxonomy and nomenclature is whether the arts are interested in supporting such a movement. Since the mid-1980s, mainstream postmodern art has “repudiated” modernism and the field of aesthetics to celebrate the social context and a changing culture (Foster 2002 [1983]). As I see it, what happened in the vacuum of this anti-aesthetic movement is that the design world was left on its own to develop applied aesthetics in isolated communities.

However, in art and architecture today, there are signs of a renewed interest in aesthetics. John Rajchman (2003) explains that postmodernism is no longer attracting interest and that there is a growing interest today in becoming more “sensible,” as he puts it, and to begin to develop the field of aesthetics. Since the proposed form taxonomy has roots in the arts, it seems imperative to keep a relationship with the arts as the field of aesthetics undergoes change. The arts were vital for the development of the visual structure, principles, and terminology that Kostellow and Reed founded, as well as the aesthetic taxonomy and EoF-model presented in the present thesis. The arts have also been instrumental in finding ways of going beyond the taxonomy to generate and regenerate knowledge of contextualized form.

In paper III, I give a brief summary of my work as an artist in a constructivist community centered on the “Konstruktiv Tendens” gallery (URL) in Stockholm. I refer to a number of exhibits and projects that I developed over a period of ten years. My work involved distortion of geometric triangular forms composed with enclosed space and eventually exploring transparency and material breakdown inspired by Goethe’s color theory. Goethe’s scientific approach supported a productive critical attitude (Sällström 1993), which bases the development of knowledge on individual interests, experiences, and sensitivities. Both constructivism and Goethe were two important sources of inspiration in part 2, because they were both centered on the value of aesthetic experiences.
The scope of this thesis does not include an extensive presentation of my work in the arts. However, without the possibilities of free exploration supported by the art community at large, I would probably not have found ways to develop, expand, and go beyond the taxonomy of form and the EoF model.

**Expanding the Evolution of Form-model**

The expansion of the EoF (conceptual) model was accomplished through the following two methods leading to 3-D (physical) models: i) Complex curvatures and ii) Material breakdown, described below.

**Complex curvatures—“point-cloud volume”**

Papers IV–V offer methods, procedures and results from an art/physics collaborative project on the theme infinity between astro-particle physicist Lars Bergström and me.

Our approach to the theme was to explore complex curvatures that moved between dimensions in a cyclical process. Bergström applied the multi-dimensions of the Calabi-Yau model from string theory and I developed a hypertwist of convex and concave surfaces based on the “Möbius strip” (URL), creating a “point-cloud volume” (see figure 32a). The study extended the horizontal axis of the EoF-model, pushing the limits of the 7th stage—“organic” into an 8th stage (see figure 33 and Paper VI). The method for developing the models was in a dialogue, where we shared ideas and materials in preparation for the coming exhibition. We were both interested in explorative methods that transformed the original models into an alternative expression, hoping to uncover new properties. The exploration of our respective models met in a study of transparency as a way to transpose and overlap dimensions as well as blend points with the surrounding space. During an art-science festival in 2002, the project was presented in an exhibition combined with a lecture series at Kulturhuset in Stockholm.

**Material breakdown**

This study involved ecological issues related to material transformation and breakdown in courses offered to both bachelor and masters students in industrial design, briefly presented in paper VI. The course was inspired by an ecology theme at Konstfack in 1995. At the time I developed the course, I did not see any relationship between it and the EoF-model presented in Papers I & II. The course aimed to study how organic materials (potatoes, ginger, pear, apple, etc.) cut into cubes change through different processes such as heat, pressure, dehydration, etc. (see figure 32b). The aim was to observe the transformation process and record changes. This very intuitively planned course gave many important results, see below.

**Discussion of results - Part 2**

Before I explain the way the EoF model expands, it is important to discuss why this model should expand, or if indeed an aesthetic taxonomy should exist at all.

In the introduction, I refer to John Dewey as a source of inspiration; yet Dewey was very much against the idea of creating categories and terms, because they reduced the total holistic experience and “tie[d] the material down to rigid immobility” (Shusterman 2000, 16 [1992]). If the present thesis refers to Dewey’s ideas of art as experience, then perhaps creating terms and categories may create an incompatible factor.

My interpretation of Dewey’s critical view of categorization and terminology comes from his worry over the “discursive way” art theorists and philosophers develop theory and terminology. Dewey would perhaps have agreed on categorizations that involved the particular perceptual experience of things. As Richard Shusterman (2000, 58 [1992]) points out, however, the main criticism of Dewey’s aesthetic thesis is that it is hopelessly impractical. It offers no applied methods that unfold the procedures of working with pragmatist aesthetics from a creative position. The scope of the present thesis was not to tailor an aesthetic taxonomy to suit Dewey’s intentions, but rather to see parallels between what Dewey aimed for and what supports a formgiving process.

I argue that the creation of an aesthetic taxonomy and nomenclature deriving from the practice of art and design creates a different kind of structure than an aesthetic one defined from an art theorist’s or philosophical vantage point. An aesthetic taxonomy should be structured experientially, and nomenclature should be directly understood and also invite a continuing renewal process. An aesthetic taxonomy aims to support the development of knowledge that will enrich the process and result in more sensuous products. Alexander Kostellow, the founder of the visual approach on which the present thesis builds, emphasized the importance of visual concepts that are defined through the language of today. Kostellow strived to convert moods to terms and develop abstract conceptions driven by inner compulsions (Greet 2002, 26). If this sensuous link between concept and experience is supported in the abstractions and nomenclature of a taxonomy, then Dewey’s (1980 [1934]) holistic approach could gain an applied profile. Again, it is important to remind the reader that the present thesis only presents an aesthetic taxonomy of form.
3. RESULTS

Strengths

Five strengths concerning the expansion of the EoF-model are discussed below:

1. Expansion of the EoF-model along the horizontal axis
2. Visual links between the virtual (high-tech) and physical (low-tech) models
3. Expansion of the EoF-model along the vertical axis
4. Process-based aesthetics
5. Unifying form with color, texture, material, and shape in a holistic process

A first strength is the revision of the EoF model along the horizontal axis, where the concavo-convex volume (at stage 7) was translated into a transparent point-cloud volume, creating a possible stage 8. This point cloud at transparent stage 8, in the revised model in figure 33, marks a move away from the law-bound structure of geometry and from stable solid objects in space. Point clouds introduce amorphic characteristics with a vague spatial position pushing the limits of the concrete expression of form. These cloud images bring up concepts of density, overlap, and all-roundness. The unexpected results of this scanning experiment were that the majority of the 2-D images that were produced were not easily recognized as originating from the same sculpture. Although I know this sculpture (as a solid form) from all angles, I was not able to easily locate the particular view from which each scanned image was taken. This shows that although we are able to grasp a coherent, holistic, and complex 3-D volume by fusing all the different views of the form together, it is much more difficult to grasp the superimposed, transparent "point-cloud image" that shows the back and front through the same picture plane.

A second strength is about finding visual links between i) the virtual Calabi-Yau multidimensional model based on string theory (see Paper V), and ii) the physical sculpture entitled "complex curvatures" and its virtual counterpart, the scanned point-cloud volume. An important issue in the art–physics collaboration was the combination of low technology—sculptural craftsmanship with clay and metal casting—and high-technology—3-D digital scanning and computer-generated hypermodels (Hanson 1994).

This combination of hand craftsmanship and high technology is a central issue in merging embodied reasoning with the challenges of the visual expression of the digital world. The industrial design process is becoming increasingly dependent on digital information and new media. An important question is: Are we able to support aesthetic reactions and reasoning through these primarily visual/virtual media? Malcolm McCullough's (1996, 48–9) practical and theoretical work in digital craftsmanship highlights this question. He praises the hands and haptic experience, while at the same time predicting the decline of physical objects as we offer more and more virtual solutions to problems. McCullough presents the situation of the “de-materialized artifact” and the changes in professions and technology that will bring new forms of visual knowledge in the virtual and real worlds. These point-cloud images are a product of virtual technology that literally dematerialized the solid physical sculpture by merging physical "points" with spatial distance. At the same time, this virtual technology “re-materialized” the complex curvatures of the sculpture into an unpredictable sequence of images. How to follow the development of a physical form that is transformed into new imagery is one of the areas of development that form theory will need to include. How these new visual images relate to our embodied and haptic experiences is yet another question.

A third strength is the expansion of the EoF-model at the 6th stage—“distort”—along the vertical axis of the bipolar spectrum. The dehydrated organic shapes express a distortion of the original cubes through cracked and dried surfaces as well as color and texture distortion. The EoF-model was expanded along the negative pole towards “deform” (see figure 33 and Paper VI). Discussions with students regarding the different organic cubes uncovered the following issues:

- The changes of the organic cubes were context-dependent, sensitive to climate, position, and the unique transforming effects these conditions had on the various organic materials.
- A gradual, temporal process controlled the transformation.
- The transformation of organic materials was partially determined by the geometric structure of a cube. The sharp edges and corners of the cubes were retained throughout the entire dehydration process, and the concavities and surface deformation were framed by the six separate surfaces of the cube.
- The study introduces complex forms that cannot be separated from the properties of the material.

This particular material breakdown study mixes amorphous substances with geometric form and introduces aesthetic reasoning that contrasts with traditional sculptural and industrial design aesthetics. It challenges the tensional surfaces and highly polished shapes established through traditions such as car design. By setting up explorative studies of non-traditional and organic materials that change
over time, we can problematize aesthetics by asking questions such as: 1) How do highly polished products defy aging or wear and tear? 2) How can organic spontaneous processes be introduced into product development?

A fourth strength lies in exploring process-based aesthetics as an alternative or complement to object-based aesthetics, through material transformation. The ecological issues concerned with dehydration (such as the dried pear cube shown in figure 33) aimed to present alternative concepts such as life cycle, decomposition, and context dependency into an aesthetic realm.

A fifth strength lies in unifying form with color, texture, material, and shape through a holistic transformation process. The dehydration study demonstrated how context dependency and time are factors for transformation. The study also supported an awareness of the difference between the materials traditionally used in industrial design, which are chosen because they do not easily change, and organic materials that are in a constant process of transformation.

Weaknesses
Two weaknesses concerning the expansion of the EoF-model are discussed below:

1. Expansion of the EoF-model creates “unbalance”
2. Spontaneous and contextualized process driven by a spontaneous contextualized process that changes form, color, texture, and smell, controlled by the properties of the materials. This process introduces a very different kind of procedure for changing the properties of form than the traditional sculptural craftsmanship applied in the other stages of the EoF model. Thus, a formgiver can only influence the transformation by shaping the surfaces cut on the material and placing the organic cube within a context. To combine the active formgiving process that this aesthetic taxonomy and the EoF model build on with an autopoiesis process is perhaps too great a shift. A completely new model might be needed—which again points out the merit of expanding the model. I argue that this is not a normative action, but a mode of exploring its possibilities and limits to inspire the further development of aesthetic reasoning.

A first weakness in the expansion of the EoF-model is that the model loses its symmetrical legibility and becomes “unbalanced” as it expands. In general, all models represent an oversimplification of the problem and are not easy to transform when a deeper understanding of a structure or principle is developed. Often, a totally new model is needed to accommodate the changes. One may argue, though, that expanding the model not only provides an ordered structure, but also allows contextualization and adaptation, thereby generating a way to use it for explorative purposes.

A second weakness involves material transformation driven by a spontaneous contextualized process that changes form, color, texture, and smell, controlled by the properties of the materials. This process introduces a very different kind of procedure for changing the properties of form than the traditional sculptural craftsmanship applied in the other stages of the EoF model. Thus, a formgiver can only influence the transformation by shaping the surfaces cut on the material and placing the organic cube within a context. To combine the active formgiving process that this aesthetic taxonomy and the EoF model build on with an autopoiesis process is perhaps too great a shift. A completely new model might be needed—which again points out the merit of expanding the model. I argue that this is not a normative action, but a mode of exploring its possibilities and limits to inspire the further development of aesthetic reasoning.
Part 3: Formlessness – Beyond the aesthetic taxonomy of form

I refer here to experiences from:

- My art beyond constructivism
- The Complexity and Transformation (C&T) project supported by the Swedish Research Council (see also chapter 4, Methods)

Results in relation to aims
The results presented below attempt to address aims 3–5 defined in the introduction.

Aim 3: To develop constructive and critical methods and models that challenge normative trends in design aesthetics.
- The present thesis has developed methods to conduct the cross-disciplinary Complexity and Transformation project. A major method was laboratories involving applied explorative procedures of formlessness and contrasting the normative structures of geometry (Paper VII)

Aim 4: To conduct exploratory, cross-disciplinary studies in complexity and transformation that support the renewal of aesthetic reasoning in both the art/design and scientific communities.
- The present thesis applies a cooperative inquiry method involving individuals from different disciplines as co-researchers in the explorative procedures (Papers VII–X).

Aim 5: To generate methods that lift aesthetics into a dynamic mode of reasoning that supports change, transformation, and formlessness.
- The spatial staging method supports aesthetic reasoning by presenting concepts and percepts in a spatial context (Paper VII & X).

Summary of Results – Part 3

Background
To orient the discussion I present a provisional figure 34, Embedding Form in Formlessness that offers conceptual orientation in how formlessness is dealt with in the present thesis as well as how parts 1, 2 and 3 are related.

The illustration in figure 34 shows a “form” as a conical funnel that contains the properties, principles, and tacit knowledge of aesthetics supporting a normative order of beauty. The positive pole of the bipolar spectrum in the EoF-model lies within the form cone, including the geometric, joined stage at the tip of the cone and the organic stage at the opening. The negative pole of the
bipolar spectrum can lie within or outside the cone. The form cone is then embedded in a sphere of formlessness within the real world. Formlessness contains the unpredictable, chaotic, ugly, and complex real world. The arrows that move between the open base of the cone and the outside formless world support a continual flow of new charged material and matter that can circulate within the cone. This flow gives rise to turbulence and conflicts with the established structures within the form cone, as well as offers potential material for developing new aesthetic abstractions. By working with contrasting concepts/features in the same event, we can learn to recognize transformation as a common happening, rather than as a paradox or dilemma.

The Transformation-model
The central theme in part 3, formlessness, emphasizes the importance of actively working with complex phenomena that demonstrate unpredictable and transforming behavior. Complex phenomena can be analyzed in terms of opposing concepts or features, and bipolar reasoning has been integrated in all models in the present thesis.

The Transformation-model in paper VIII and figure 35 defines two opposing, bipolar concepts within one coherent phenomenon. The first concept (above frame 2 in figure 35) was found by viewing and listening to the recorded conversation between the participants about particular features during a certain laboration. The second concept (above frame 5 in figure 35) was developed by a search for contrasting features or concepts in an inductive or deductive approach showing transformation. These two contrasting sets of features and concepts support an understanding of the complex and pluralistic nature of a changing phenomenon. By working with contrasting concepts/features in the same event, we can learn to recognize transformation as a common happening, rather than as a paradox or dilemma.
explained the dynamic interrelationship of opposing forces. From an art/design experience of developing a gestalt, it is crucial to work with oppositions. It was easy to transfer this need for opposition to conceptual reasoning, particularly in developing innovative ideas.

**Aesthetic Phase Transition-model**

The Aesthetic Phase Transition-model was developed to map out sequential changes as material undergoes transformation (Paper IX). Both abrupt and gradual material changes were easy to recognize on a visual level and therefore gave concrete, shared experiences for the cross-disciplinary participants. The purpose of the C&T collaborations was to lift aesthetic reasoning into a dynamic and inclusive way of working that got the participants involved. The Aesthetic Phase Transition-model focused on the process of transformation by examining phenomena on the periphery of or beyond the current, established aesthetic boundaries. The chronological event framed in figure 37 shows the material transformation of an eggplant wedge as it was exposed to heat from a gas torch.

**Spatial staging-method**

Spatial staging brought together diverse activities and viewpoints within the cross-disciplinary project, primarily for the sake of the participants/co-researchers in the project, and secondarily for an interested audience. Paper VII describes the aesthetic strategy of spatial staging as an alternative to traditional art and design “exhibitions” for the evaluation of the C&T project. Spatial staging offers a holistic way of sharing first-hand experiences of key laborations from the workshops, interwoven with the lectures and discussions (figure 38).

Work/Paper X presents a film showing the exhibition space and the ongoing activities. The film material is a documentation of the exhibition. However, it was the first-hand interaction with the participants in the space and the exploration of the laborations that offered insight into the value of spatial staging.

**Discussion of results – Part 3**

This discussion was developed in response to the weaknesses presented above in parts 1 and 2 concerning the aesthetic taxonomy of form and its geometric foundation. “Formlessness” is an antonym to “form,” implying an opposing approach to aesthetic reasoning, problematizing the concept of “form.” However, it is not part of an anti-aesthetic postmodern approach aiming to sacrifice the modernists’ aesthetic knowledge of form (Foster 2002 [1983]). Instead, the results and concepts presented here question the normative tendencies and the concern for beauty generated by the taxonomy. The discussion here strives to open up the field of aesthetics beyond the boundaries of predictable form and applied principles towards a process-based aesthetic reasoning, which has the potential to reorient the field of aesthetics.

Since the proposed aesthetic taxonomy of form developed within a design paradigm (as outlined in part 1), I began to recognize the risk of creating an exclusive system that ignored the chaotic and complex nature of form and formlessness in the real world. A taxonomy might confine form within a very narrow field of aesthetic concepts and principles for designers, which could easily become dogmatic, as was the fate of the aesthetic studies at the Bauhaus (Fitzgerald 2002).

Part 3 was developed through empirical investigations
conducted during the Cross-Disciplinary Studies in Complexity and Transformation project. The methods used in this study are described in chapter 4 of the present thesis, and in Papers VII–IX. The aim of the C&T study was to support the renewal of aesthetic reasoning in both the art/design and the scientific communities.

Formlessness and the field of complexity

Two main sources of inspiration for the conceptual development of part 3 are:

- Theoretical and practice-based work in the arts on the theme “formless” (in French, informe) (Bois & Krauss 1997)
- The multidisciplinary field of complexity, which is concerned with studies of chaos and emerging and transforming phenomena

The questions I discuss here in part 3 concern the following: How can we develop aesthetic reasoning that follows the emergence of new structures as well as the breakdown of old ones? What abstract principles (if any) can be formulated that offer a means for orientation as materials change and transform? Or, perhaps even more importantly, what concepts of reality could be helpful in finding ways to deal with formlessness? Finally, a short discussion is presented around George Bataille’s suggestion of a “taxonomic disorder” (Bois and Krauss 1997, 18).

Aesthetic reasoning that embraces formlessness and ugliness has offered me a way to step out of the restricted aesthetic paradigm of design. As mentioned in chapter 2, George Bataille declared that the formless is understood through an immediate experience (Bois and Krauss 1997). An awareness of the immediate is also an important issue in Dewey’s (1980, 119 [1934]) aesthetic approach. Since formlessness has no simple organized contours or stable structures, one cannot easily classify it in the same way as we classify stable structures such as chair, apple, nail, etc. Formlessness therefore provokes an aesthetic reaction that engages our biases and individual sensitivities. Understanding formlessness requires risk-taking, because it challenges the aesthetic threshold of what we can tolerate or appreciate. By accepting formlessness in an aesthetic approach, we go beyond beauty, geometry, and the well-known curvature of the body (which is the foundation of the taxonomy of form in part 1 & 2).

The constructivists and modernists radically questioned aesthetic norms, which were established within an elite culture. Their approach for a renewal of aesthetics was to turn to science for concepts and models. Throughout the first two decades of the constructivist and modern movements, their aesthetic reasoning was considered provocative, challenging the norms of beauty (Krauss 1981, 53 [1977]). Today, the aesthetic contributions of these movements have become the dominant aesthetic norms (Habermas 1998 [1983]).

Even though designers need to work with norms in order to easily communicate semiotic attributes, it is also vital for the design profession to develop unconventional approaches that break and go beyond the norms. I argue...
that the return to the arts and the active acceptance of formlessness—which includes the ugly—is an important step towards aesthetic renewal. The Transformation- and Framing the Dialogue-models, presented here, provide support for this step toward renewal.

It is becoming apparent in the design community that survival in the marketplace today cannot rely simply on following norms. New expressions must be uncovered through interaction with the real, complex world. I argue that to develop aesthetics, we need to connect the normalizing and exclusive aims of form/beauty with the chaotic openness of formlessness/ugliness.

**Strengths**
The strength of the C&T project was the opportunity to explore a common theme from different, contrasting disciplines: art/design and physics. Four strengths concerning formlessness are discussed below:

1. Process-based aesthetic reasoning
2. Bipolar reasoning
3. Conflict and reward
4. Spatial summary

**A first strength** is found in the three models: The Transformation-model, the Framing the Dialogue-model and the Aesthetic Phase Transition-model, which all attempt to bring aesthetics into a process-based reasoning that changes over time and grasps the unpredictable qualities of formlessness. According to Pehr Sällström (1999, 15–6), our senses have evolved to deal with long-term changes. He states that we easily learn to select relevant relationships and properties in continuous processes. Only since the industrial revolution have we been surrounded with artifacts about which we have little or no comprehension of the particular process that produced them. Formgiving and explorative studies of complexity are about taking part of transformation processes—including generative and degenerative processes—that show predictable and unpredictable changes.

**A second strength** is the bipolar reasoning in the Transformation- and Framing the Dialogue-models, which promotes an awareness of differences through contrasting concepts and features. Bipolarity is different than a dichotomy, because it is not necessarily about creating poles that mutually exclude the qualities at the opposite pole. Bipolar reasoning involves more of a sense of mutual dependency; each pole needs the other to embrace complex reasoning. Edith Ackermann’s (1991) research supports the need for “differences,” because they provide a framework for studying new ideas. She connects our ability to deal with differences with our ability to develop rich and diverse individuality, which can challenge formalized thinking. Christopher Alexander (1964) refers to studying the “misfit” as a method for learning about what the problem is and is not. Deleuze also explains the need to meet the radically unknown and foreign, if we are to learn something new. According to Fredrika Spindler, Deleuze considers the meeting of the unknown as initiating a kind of “conceptual violence,” because the unknown usually opposes the known, which shakes our view of the world (Spindler 2004).

To summarize, if our goal is to renew our aesthetic reasoning, we need to be prepared to confront the unknown and question the foundation and biases that make up our present aesthetic knowledge. It is therefore important to develop models that expose us to this confrontation, if we truly wish to generate and regenerate aesthetic knowledge.

**A fourth strength** lies in summarizing a controversial project, like the C&T project, by spatially organizing the methods and results. The Spatial staging method uses the exhibition hall as a 3-D model to navigate through the project. By placing laborations together simultaneously in the same space, one could walk between them and begin to draw parallels that would not be possible in the traditional way of summarizing a report. What spatial staging offers is an experiential opening that may stimulate the participants’ involvement. Its strength lies in the demonstration of real phenomena, which stimulate immediate aesthetic reactions and invite individual interpretation.
Spatial staging differs from a traditional exhibition, because the focus is on continuing the development of knowledge for the active participants in the project by reliving and reexamining moments and concepts within the project. Spatial staging supports a way of summarizing our diverse interpretations of the theme and gaining better insight into our differences and similarities through a spatial medium. Just as a written report offers a means of gaining a better understanding of a project, a “spatial report” may offer a means of seeing connections between ideas and artifacts, thereby enhancing understanding.

Weaknesses
Three weaknesses of embedding form in formlessness are discussed below:

1. Inclusive and boundless
2. Art as intrinsically open
3. The theme of Complexity and Transformation was not easy to define

A first weakness lies in the inclusive and boundless nature of formlessness. Dealing with formlessness requires a very different way of reasoning than the aesthetic reasoning through essential abstraction of form in space presented in part 1 and 2. The EoF-model has a foundation in geometry, which makes it much easier to focus on the differences and similarities of each stage within the model. Since there is no easy way to abstract qualities of formlessness, each phenomenon is treated more or less in a unique way. Formlessness is therefore boundless in two ways: i) It offers no simple system (like geometry) to compare to, in order to judge the level of complexity, and ii) an infinite number of possible situations are formless. There is no real overall model that provides a sense of aesthetic orientation in the infinite field of formlessness.

A second weakness could be rooted in what art theorist Morris Weitz (1996 [1956]) defines as the “intrinsically open” and “mutating” nature of the arts. The arts, as we know them today, are unwilling to offer well-formulated theories, methods, or models. This unwillingness to define a common ground makes it impossible to structure nomenclature or agree on procedures and working methods. The arts, according to Weitz, want to maintain a free attitude to methodology in order to develop a unique individual and contextualized approach. I argue in favor of this intrinsically open and free relationship at the cost of strong methods at different phases within the creative process, because I believe designers need to engage their unique sensitivities in the formgiving process on which mutating methodological development relies. This sense of openness is what makes it possible to see unpredictable relationships, which is still very much a part of an innovative design process.

A third weakness is that the cross-disciplinary approach did not evolve into a transdisciplinary project that could focus our collective energy on an innovative design project. This would have required resources to free the core group from other commitments. If the core group was able to spend time creatively planning a number of laborations that were contextualized in a landscape, culture, and territory, we would be able to test the methods and models developed in the C&T project integrated into a design process. Future plans for the C&T group would be to reapply for trans-disciplinary funding, focusing our efforts on a project that is more contextualized.
This chapter is divided into 3 parts. Each part presents a summary of methods followed by a discussion.

Part 1 Form—Developing an aesthetic taxonomy of form (Papers I–II)
Part 2 Expanding and challenging the Evolution of Form-model (Papers III–VI)
Part 3 Formlessness—Beyond the aesthetic taxonomy of form (Papers VII–X)

Concluding discussion of methods

Background to methods and procedures

Until recently, research resources have not been available for art and the art-oriented design/architectural field, leaving a weak collective understanding of methodology. Now that the academic community is developing a growing interest in the art-oriented methodological development of the practicing design/architectural world, we can begin to open up the process. However, in order to create a supportive research atmosphere, the academic community at large needs to re-examine its criteria of what a “method” is. In the early 1900s, perceptual gestalt scientist Max Wertheimer found scientific methodology too insensitive to the field he was studying.

We go from the world of everyday events to that of science and not unnaturally assume that in making this transition we shall gain a deeper and more precise understanding of essentials. The transition should mark an advance. And yet, though one may have learned a great deal, one is poorer than before. It is the same in psychology. Here too we find science intent upon a systematic collection of data, yet often excluding through that very activity precisely that which is most vivid and real in the living phenomena it studies. Somehow the thing that matters has eluded us.

(Wertheimer 1997 [1924])

Today, science is much more open to alternative methods that can deal with living phenomena, as well as direct and indirect human perception, thanks to the efforts of scientists like Max Wertheimer.

Search for alternative scientific methods

In 2001, the Swedish Parliament passed “Government Bill 2000/2001:3,” giving research status to the arts and encouraging the development of networks between art schools and other universities offering research experience, as well as the initiation of art/science projects. The main argument for passing this bill was that artistic development projects play an important role in exploring new areas of human endeavor representing alternative sources for developing knowledge. Another argument stated in the bill was that the government needed to stimulate alternative methodologies that deal with “creative subjective values” as opposed to traditional scientific activities. In the wake of this bill, the Swedish Research Council offered funding for artistic research and development and gave the arts a place on its research board.

What is a method?

When I began to pursue my formalized research education in collaboration with Chalmers, the first task I was given by my supervisor, Dr. Monica Billger, was to explain the methods, strategies, and procedures I had used to develop the educational material that served as the starting point of my research. At that time, I could not clearly explain how I integrated my teaching practice with research in form theory. My course plans did not go into detail about the procedures in the studio, focusing rather on the learning outcome for the student. All my previous art and educational projects prior to doing research focused on presenting the results through sculptures, 3-D models, exhibitions, graphic illustrations, and concise texts. It took a lot of effort for me to begin to outline my educational methods and to define the underlying theoretical basis guiding the
particular way I approached the aesthetic field of form and space. Although I build heavily on my experience with Rowena Reed, she never documented the methodology she and Alexander Kostellow developed through their teaching. So I had no literature to refer to that explained the methods and procedural traditions I had inherited and those I planned to develop.

Procedural knowledge
Donald Norman (1988, 57–8) explains that we use two different types of knowledge: “knowledge of,” which involves facts and rules that are easy to document, and “knowledge how,” which deals with procedural knowledge that is almost impossible to write down and is taught by demonstration and through practice. Most of the methods I have used to conduct the present research project concern procedural knowledge. Since art, design, and architecture rely heavily on such procedural knowledge, this may explain why it has been so difficult for these disciplines to define research methods. Victor Margolin (1984) refers to this lack of “self-definition” of methods from inside the active design field as one of the major problems in design research today.

Part 1: Form – Developing an aesthetic taxonomy of form

The five main methods and procedures developed and applied in part 1 are:
- Pedagogically framed research
- Cooperative inquiry
- Essential aesthetic abstractions
- 10-step Concept-Translation-Form-method
- Sculptural working procedures

Pedagogically framed research
Using pedagogically framed research methods, I engaged students in the development of aesthetic knowledge of form and space (Paper I). Traditionally, art and design schools have had little academic structure or funding for doing research, especially if the research was not “contract research” geared to areas that are sponsored and controlled by industry. One way of doing more “self-defined,” practice-based, explorative research is to combine it with teaching, a method referred to here as pedagogically framed research. Reed, Kostellow, and the artists/teachers at the Bauhaus and at the VKhUTEMAS in Moscow all developed their ideas through teaching, as well as through their art (Greet 2002, Lodder 1987[1983], Wick 2000 [1982]). My work continues and expands this pedagogically framed research tradition.

Cooperative inquiry
Peter Reason’s (2003) research in cooperative inquiry has strong parallels with how teaching and research have merged as a method during the development of the present thesis. The epistemological grounds of the “cooperative inquiry” method are to engage the participants (students) as “co-researchers” in a joint venture with the researcher to develop new knowledge (see Paper I). These co-researchers participate in the project by relying on their experiences and ability to react and reason about the way the project progresses. As defined by Reason, the four interwoven activities that support cooperative inquiry are face-to-face encounter, presentational knowledge, propositional knowing, and practical knowing. As the industrial design program at Konstfack is based on these four activities, it was easy to apply this method in my research.

Essential aesthetic abstractions
The development of the aesthetic taxonomy of form, presented in paper II and in chapter 3, builds on methods that emphasize essential aesthetic abstractions of form in space. Essential aesthetic abstractions are immediately felt and relate to the overall gestalt. The term “essential” is defined in the perceptual and neurological sciences as meaning the vital properties of a composition or body. It is about the inner essence of objects and how they occupy space (Zeki 1999, 10–2). Perceiving essential aesthetic abstractions has to do with direct and indirect perception and is similar to visual studies in experimental gestalt research (King and Werthiemer 2005, 343). It is about the capacity to sacrifice superficial qualities and properties in order to grasp three-dimensional, inner movements and structures (see chapter 2). Essential abstractions, as presented in the present thesis, are synonymous with Reed and Kostellow’s concept of 3-D “visual abstractions,” defined in their structure of visual relationships (Greet 2002, 32–42). I chose to use the term essential aesthetic abstraction in the present thesis instead of visual abstraction because my practice-based, embodied methods question the dominant role of our visual senses. Examples of essential aesthetic abstractions are inner axis, directional forces, tensions, spatial dimensions, expansion, and matrix. Wassily Kandinsky (1979 [1926], Rudolf Arnheim (1969, 48) and others also worked with essential abstractions.
10 step Concept-Translation-Form-method

Through close collaboration with industrial design students, a pedagogically framed 10-step Concept-Translation-Form-method (see figure 39) was developed within a practice-based, art-oriented, formgiving culture at the Department of Industrial design at Konstfack in Stockholm. The method is explained in detail in Paper I.

The 10 steps are:
1. Lecture on concepts
2. Translation
3. Experimental 3-D modeling
4. Individual support
5. Gathering the work
6. Perception and reflection
7. Exploring aesthetic reasoning
8. Bipolar spectrum
9. Summary
10. Feedback

This method alternates between developing concepts concerning aesthetic abstractions and developing 3-D physical models, aiming to merge analytical reasoning with embodied reasoning. Since I work in a practice-based culture, we rely on developing knowledge-through-action (Molander 1996). I therefore purposefully start by presenting concepts to underline the importance of developing a nomenclature and broaden the possibilities of how form can take shape. The steps in the method reflect a) sculptural procedures and techniques from my own education with Rowena Reed; b) the students’ need for translating aesthetic concepts into Swedish; c) the students’ interest in advancing 3-D aesthetic knowledge and procedures; and d) my own need to develop teaching material and further explore the field of applied aesthetics. This method is also presented as a result in chapter 3.

Translation

Living in Sweden imposed the need for me to translate the terminology I brought from my education with Rowena Reed and the new terms that were emerging through the development of the Evolution of Form-model. The students and I re-examined the visual vocabulary systematically, moving back and forth between English and Swedish. We discussed domestic and professional terms, concepts and words in an open dialogue, exposing the differences in our cultures, as well as our individual backgrounds. The translation process made me keenly aware of the semantic problems all terms impose (see paper I). The important issue I found was that the aesthetic definitions of form are vague and cannot be understood until embodied in a perceptual, physical form. The entire procedure developed to deal with cross-cultural terminology was intuitive. Today, I continue to apply this process of translation even though I speak fluent Swedish. Due to the abstract nature of the terminology I use, it is important to spend time examining a concept from different cultural and semantic vantage points and expressing its meaning through form.

Sculptural working procedures

In the 10-step model, we have worked with certain inherited sculptural principles, procedures and techniques (see figure 39).

Here I list only a few that stem from my practice-based studies with Rowena Reed and her former student, Dr. William Fogler:
- Sensing the immediate responses first, followed by aesthetic analysis.
- Making quick sketches to catch the immediacy of an impression (based on Hans Hoffman’s “action painting”).
- Perceiving the inner sense of form expressed beyond and beneath the surface.
• Experiencing form in relationship to void and space.
• Using a turntable as a method for grasping a gestalt. When an object is rotated on a turntable, the details are blurred and it is easier to grasp the totality of the experience (see figure 40). Learning to deal with the all-roundness of a 3-D model from an infinite number of angles is a tradition developed in the arts.

The hands-on procedures we applied in the 10-step model to develop the EoF model were supported by the set-up of tools, materials, and work spaces in the studios and workshops at Konstfack. The procedures were, as Donald Norman explains, articulated “in the world” (Norman 1988, 56–8), but they were not formulated in words at the start of the research project (see Paper I). My understanding of procedural methods progressively developed as the project advanced. This is in part due to the demand I had from my research education and from the academic writing process. I eventually found ways to communicate aspects of our procedures, though the majority of methods are still hidden within the process.

Discussion of methods – Part 1

The methods for developing the taxonomy of form and the EoF model are based on working with essential aesthetic abstractions (see above) that prioritize 3-D structural compositions as well as supporting the development of a 3-D gestalt process (see chapter 3, Results). It is important to examine how this essential gestalt approach prioritizes properties, relationships, movements, and the like, because these directly shape the way the taxonomy developed. It is equally important to examine what is excluded by this essential-gestalt approach in order to determine the limitations of the taxonomy. The more I develop the present taxonomy of form, the clearer it becomes to me how other means of aesthetic abstractions are excluded, such as texture, color, and sound (see Part 3 Formlessness for a more inclusive approach to aesthetics).

Uniting concepts with percepts through form

The 10-step method can be further discussed in more specific ways through perception psychologist Edith Ackermann’s (1996) work in “situated knowledge”, that involves formgiving activities. She has studied the way individuals “give form to their ideas, and how these forms, once built, inform back their ideas.” Her work both questions and supports Jean Piaget’s “stage the-
ory,” which claimed that separating abstract concepts from context represents a higher level of cognitive skills. Seymour Papert, Edith Ackermann and other scholars in the learning sciences have focused attention on the importance of the artifact in reasoning and have founded a “constructionist learning theory” (URL) based on learning-through-making. Constructionist research findings suggest that working back and forth between concrete experiences and abstractions enhances cognitive activities. My research, contextualized in the arts and crafts-oriented design traditions in Sweden, is also grounded in this type of physical–perceptual–conceptual method of reasoning. The difference between a constructionist perspective and the approach I present in the present thesis is that we emphasize the actual formgiving process, which is grounded in the intentions of the individual creating a gestalt (see Figure 41). What we can bring to the learning sciences is insight into learning through developing tangible gestalt. This important area for research development has gained recognition the past few years; however, there is very little research available, since the field is so young and few practical formgivers have managed to find funding and supervision that support research from inside the process.

Questioning object-based scientific methodology
According to Barbara Stafford (1994, 138–40), historically there has been a very negative attitude toward research in object-based methodological development. She traces this skepticism toward experimentalists and artisans to a fear from scholars of uncovering evidence that questions theoretical dogma. She goes on to say that stereotypes were fostered depicting people from the art and crafts traditions as “impulsive-ridden” (Stafford 1994, 284) and “hedonistic” in order to keep art and artisans on the outside of the academic walls. My own experience in trying to establish research in applied aesthetics and formgiving processes has been very difficult. The majority of researchers in the academic and science world considered this field either too chaotic or too trivial and ostensive. I argue the contrary and claim that it is through interaction with tangible forms that one can learn to a) recognize the organizing capacity of form and b) develop values and skills relating to the aesthetic processes that help artists and designers deal with a high level of complexity and find order in chaos.

Both original and didactic
I end this part of the discussion with some comments concerning advantages and disadvantages of pedagogically framed research methods in an art-based design school. To a large extent, my research has relied on creative energy, aesthetic reasoning, and the skills of industrial design (ID) students to develop the EoF-model. However, the students’ original and novel forms did not always serve the purpose of my research. For example, to illustrate a spectrum between two contrasting poles on the bipolar axis of the EoF-model, I needed a sequence of didactic 3-D models that were based on the same geometric forms and included at least one very predictable solution at the positive pole (see Paper I). ID-students at art-based schools are usually more interested in new and unfamiliar solutions, which reflect the traditions of the arts (Weitz 1996 [1956]). However, this need for originality, makes it difficult to develop didactic, physical forms. In the past few years, I have found ways to motivate students to create more logical, sequential
4. METHODS AND PROCEDURES

solutions, thus improving the EoF-model. Therefore, in comparison with the early version of the EoF-model in Paper I, the version presented in Paper II is easier to understand.

Part 2: Expanding and challenging the Evolution of Form-model

The three main methods and procedures developed and applied in part 2 are:
- Technology and natural processes
- Exhibition, lectures and writing as a methods for exchanging ideas between disciplines
- Witnessing transformation through similarities and differences

Technology and natural processes

The procedures and techniques described in papers V–VI, expanding on the EoF-model, were:
- Low-technology sand-casting aluminum of a convex and concave clay sculpture
- High-technology digital scanning, which produced a point-cloud volume
- Natural autopoiesis process of dehydration
- Drawing techniques that generate analogies

Exhibition, lectures, and writing as methods for exchanging ideas between disciplines

The Infinity project was developed around planning for an exhibition and a public lecture program (see Paper V and figures 42–43). This method of using spatial dimensions, physical artifacts, and oral/visual presentations for organizing ideas offers a very productive approach to support the exchange of ideas between different disciplines (Molander 1996, 220). The objects, events, instruments, and images materializing the content of the exhibition emphasized our different intentions within the theme early in the process. In the planning procedure, we were able to grasp our different approaches and find where our ideas overlapped. During the ongoing exhibition, we gave lectures and took part in sofa discussions about the exhibition in an aula linked to the exhibition space, helping us articulate and confront our differences and similarities. It became very apparent how we alternated between verbal expression and embodied experimentation (Dyressen 2006).

After the Infinity exhibition, Lars Bergström and I collaborated on writing a scientific article entitled *Complex curvatures in form theory and string theory* (Paper V). The writing process we undertook helped us visualize our different ways of thinking for each other and made it easier to push our ideas further (Björk and Räisänen 1996, 16). We developed a strong conceptual understanding of how transparency fused materials with space in an overlapping depth dimension. By formulating questions about the particular transparent impressions that both our models expressed (figure 44–45), we could discuss transparency in a very real way that altered our understanding of the models.

This method of exhibition, lecture, and writing was further developed later in the cross-disciplinary study of complexity and transformation (see papers VII - X).
Witnessing transformation through similarities and differences

The transforming process that occurred as the pear cube dehydrated (see paper VI) was a temporal event that was witnessed in real time over about three months. The students were asked to draw or paint the different stages of change in order to:
- improve their own observation of the changes
- become involved in the transformation process through active visualization

Each drawing or image showed the particular features the student had singled out from the change process. The sequence of drawing can be considered “visual analogies” (Goldschmidt 2001) that build on similarities and differences between the transforming stages of a physical object. The final stage of the dehydration process, as shown in figure 32b, shows an object (pear cube) that transformed over a long event into a stable object. The event that produced the object is as important as the object itself.

Discussion of methods – Part 2

Both the point-cloud volume (figure 45) and the dehydrated pear (figure 32b) and apple cubes were developed as explorative projects/studies that were not initially planned to expand the EoF-model. The transparent point-cloud volume is the result of digital scanning of a clay sculpture, which involved a different technique than the solid forms that make up the stages and spectrum in the EoF-model. The idea of transparency introduces a radically different aesthetic experience opening up the EoF-model (see figure 33 in chapter 3). The aesthetic abstractions presented in the taxonomy of form apply to solid forms and may not easily adapt to issues of transparency. If we include the point-cloud volume and the organic cubes in the expanded EoF-model, a renewal of the entire aesthetic taxonomy of form is needed in order to deal with transparency and the changing qualities of such characteristics as color, texture, deformations, and translucency. However, such a renewal is not included in the scope of the present thesis.

Drawing/painting as a way to develop analogies

The sequence of drawings that captured the dehydration process of an organic cube (see Paper VI) stimulated students to single out the particular features that they recognized as important. According to Gabriela Goldschmidt (2001), the act of drawing generates analogies that improve cognitive skills by stimulating “mental imagery.” Her conclusions are similar to those of Ackermann (1995) and the constructionists. Learning to create mental imagery is very
in instrumental in the design problem-solving process. The more we study transformation processes, such as those involved in the material breakdown study (Paper VI), the greater chance we have of developing the mental imagery that helps us understand life-cycle processes that include material breakdown. These images can act as a counterbalance to the aesthetic traditions of industrial design, rooted as they are in car design, whose aim is highly polished fixed surfaces that withstand degenerative forces.

Exhibitions and the writing process

Presenting the results of our Infinity project in an exhibition space and developing parallel lectures on the exhibited work gave us the opportunity to bring out our own personal and collective experiences. The experience we shared through building the exhibition helped us structure the article we wrote about our collaboration (Paper V). Referring to the models and concepts presented in the exhibition gave us a common problem to explore. The combined experience of creating an exhibition and collaborating on writing a scientific article made this collective project very valuable. This approach of combining experience from exhibitions with academic writing processes is a well-developed research method at the university of Art and Design in Helsinki, Finland (UdA) under the leadership of Susan Vihma (URL).

Dehydrated pear cube

Part 2 represents a long transitional process that mainly developed through questions in my art, culminating in the material breakdown study embodied in the pear cube (Paper VI). This study marks an important shift in my way of approaching aesthetics, making me realize the limitations of essential, aesthetic abstractions and inspiring me to initiate an explorative process for finding other means of abstracting (see the first workshop in the C&T study, which developed this material breakdown study further as presented in Papers VII - IX).

Part 3: Formlessness – Beyond the aesthetic taxonomy of form

The three procedures and strategies developed and applied in part 3 are:
- Laborations as multidisciplinary and art-based explorative methods
- Cooperative inquiry
- Non-geometric and substantial aesthetic abstractions

Papers VII-X in part 3 describe and visualize methods of the Cross-disciplinary study of complexity and transformation (C&T) project. This project was funded by the Swedish Research Council for three years, 2003–2005 and was summarized in both an exhibition and a final report of the entire project. The C&T study involved a group of artists, designers, architects, and researchers from different branches of physics. It was planned around hands-on laborations (see below) that demonstrated transforming and complex phenomena. The C&T study offered four workshops with twelve lab sessions representing ten individual interpretations of the theme complexity and transformation.

Laborations as multidisciplinary and art-based explorative methods

The word laboration is used as an alternative word to “lab session” in the C&T papers VII–X. It is a Swedish word meaning experimental work in a laboratory, though here the meaning is changed somewhat, as well as contextualized. I would like to introduce the term laboration as an international word used in an art-based context meaning:

Laboration: Interactive, embodied experiment performed in a collective, where the participants are free to explore many different approaches within and beyond the broad interpretation of the intentions of the laboration as such. Laborations invite aesthetic reactions and reasoning, as well as creating a forum for dialogue and playful impulses. They were developed for multidisciplinary collaboration, but is suitable for any group constellation.
How the laborations were planned

Through a number of meetings with the workshop leaders, project leader, and one or two members from the core group, we discussed a theme and procedures for the laborations. The workshop leaders were asked to create a laboration as follows:

- Exemplify complexity and transformation
- Introduce an unexplored area/question in relation to your work/research field
- Stimulate perception
- Support open experimentation
- Inspire playful interaction

The workshop leaders introduced the laborations through an oral/visual performance (Stafford 1994, 1) explaining their own background and their intentions with each laboration (figure 46).

The laborations were not to be regulated through strict protocols. Rather, the workshop leaders were asked to supply materials, provide a general setup and formulate somewhat “ambiguous” directives so the participants had to use their intuition and experience to develop the procedures of the laboration. Insight from game theory shows that individuals tend to become engaged in playing when they must make choices that determine certain pathways and give unique outcomes (Graver et al 2003).

Play and skill

The particular development of each laboration emerged through playfulness entwined with the skillful discipline of the participants. Friedrich Schiller (1995, 76–80 [1795]) advocated that the drive for an aesthetic experience and the drive to play are one and the same. He found that unconditional play overcomes egotistic behavior, which stimulates interest for others and urges a drive to create (see figure 47a-c). Bringing highly disciplined professionals together in a situation that supports play with relevance for a common project is an art-based method that is very valuable in multidisciplinary projects.

Haptic and intentional movement

All laborations in the C&T project supported various degrees of haptic/embodied experiences. By stimulating hands-on interactivity, the participants were easily engaged in exploring the complex phenomena presented in the laboration (see figure 48 a-e and papers VII–X).
Cooperative inquiry

Peter Reason’s (2003) research in cooperative inquiry describes methods that involve the participants as co-researchers in projects. In the C&T project, the participants helped to plan and carry out the laborations. This method was expanded to encourage explorative, immediate and playful interaction during the concrete laborations, supporting a relaxed dialogue of everyday reasoning, mixed with professional insight.

Non-geometric and substantial aesthetic abstractions

The development of the Aesthetic Phase Transition-model (see chapter 3 and Paper IX) was based on strategies challenging the use of geometric references and essential aesthetic abstractions, as defined in part 1. My interest in formlessness has led me to try and find explorative methods for developing substantial abstractions that treat material as substance in a physical context and engage more haptic experience. This includes eg. regular and irregular outer properties as well as color and texture on a surface in relation to the inner properties of density and viscosity (figure 48e). I am also concerned with the aesthetic experience connected with how material changes over time, which places aesthetic reasoning in a more temporal and context-sensitive mode that even includes the negative pole of aesthetic experiences such as “ugliness”. Gathering samples is one means of developing substantial abstractions.

Discussion of methods – Part 3

Stimulating explorative experimentation

The present thesis introduces the art-based multidisciplinary laboration method that enables participants to engage in embodied explorative experiences. The laborations are set up with the intent to stimulate an aesthetic exchange between participants in the ongoing experiments. I argue that the laboration method introduced in the present thesis is a valuable, and perhaps necessary, complement to rigorous monodisciplinary methods. Innovative researchers and teachers seldom have time to play together and allow their immediate reactions to guide an explorative project. Tapping into these more embodied reactions of skilled individuals from different disciplines is, I believe, an important art-based scientific method to stimulate discovery and change. Similar types of laborative procedures are also used in the Masters introductory research course, “Research by design,” at Chalmers (Billger and Dyrssen 2005).

Art historian Barbara Maria Stafford’s (1994, 190) book on “Artful science” supports this laboration method, implying the importance of play, aesthetics and sensuous experience in experimentation and knowledge development. However, she points out that the scientific community, residing within its academic walls, discourages this kind of aesthetic playfulness (Stafford 1994, 140). She argues that qualitative methods of playful exploration of phenomena do not easily translate into quantitative methods that offer measurable results.
No common methods or definition
A weakness of the open explorative methods used in the cross-disciplinary C&T study could frustrate those participants who were goal-oriented problem solvers. Since the theme complexity and transformation was a controversial theme in the scientific community and an ambiguous one in the art/design community, we had no common ground to stand on. Therefore, we did not offer a definition of the theme or suggest methods at the start of the project. Instead, the purpose of the project was to experience different interpretations of the C&T theme and broaden one’s own direct experience.

Cross-disciplinary studies are difficult in themselves, so perhaps a theme like complexity and transformation makes it even more difficult to understand each other. Halfway through the project, I felt overwhelmed and at times wished for a more focused theme. However, now that the project is completed, I feel that the complexity theme is exactly what the project was about, on both a meta and a concrete laboration level. The theme complexity enhanced an open dialogue because no one was an expert in the field. Sometimes the physicists offered insights into the mechanisms of heat shock or crystal growth that helped sharpen our focus and benefited the development of the laboration. At other times, the inspired formulation of how to disturb a system could motivate interaction with the phenomena. Since most of the participants felt uncertain about the definition of the theme, we needed the various individual interpretations embodied in the laborations to grasp what complexity and transformation could mean.

Beyond essential abstractions and regularities
Regarding the need to go beyond essential abstractions and explore new methods that can deal with complex phenomena and formlessness, I found inspiration in the theoretical work of Gilles Deleuze as described by architect Fredrik Nilsson (2004, 109–11) in his recent doctoral thesis. According to Nilsson, Deleuze strongly questions the idea of essential abstractions of modernism. Deleuze recognizes the need for “impure” abstractions that are embodied in the material world and come directly from empirical, pragmatic and experimental activities. Instead of striving for universal abstractions, he contextualizes them. The C&T project that was planned around laboratories of complex phenomena has many parallels with how Nilsson interprets Deleuze’s way of reasoning. In my view, the challenge is to show practically how substantial, meaning “unpure”, aesthetic abstractions may be used to enrich the formgiving process and in turn broaden our applied aesthetic knowledge.

George Bataille uses the concept “formless” to create complex methodology that looks for heterogeneity and aims at declassifying and emancipating objects from simple categories. Bataille was against the creation of categories and abstractions. However, he toyed with the idea of creating a “taxonomy of disorder” (Bois and Krauss 1997, 18). According to Yve-Alain Bois (1997, 53–62), formlessness means to appreciate matter for what it is and not for what it might “resemble” or “should be”.

In the book *Art and Complexity*, physicist Murry Gell-Man (2003) also argues for the need to prepare scientists to recognize and expect impure and “irregular structures.” Gell-Man reached this conclusion through his research in complex and adapting systems, as well as in how irregularities mark complex systems. Yet, according to Gell-Man, a natural science education seldom provides students with methods for studying irregularities. I argue that art-related research exploring impurities and irregularities through formlessness may improve our methods of understanding complex phenomena.

Concluding discussion of methods
The most valuable method I have used throughout my research, as described in the present thesis, is the cooperative inquiry method, which engaged students and experienced professionals as co-researches in explorative studies to develop aesthetic knowledge.

In the monodisciplinary, pedagogically framed studies with ID students, a common nomenclature was used and a workspace set up that placed physical and conceptual boundaries around the questions to be explored. In the multidisciplinary, open-ended studies of complexity and transformation with experienced professionals, however, we shared no common nomenclature and worked in a variety of situations.

Both of these approaches gave very different results that complemented each other. By going between a focused and a fuzzy approach, the inquiry of aesthetics may become vivid as form at one level and elude us through formlessness at another. Both vivid and elusive impressions are part of an aesthetic experience.

_Art is a quality of doing and of what is done._
John Dewey (1980, 214 [1934])

_...art as intrinsically open and mutating._
Morris Weitz (1996 [1956])
5. CONTRIBUTIONS, CONCLUSIONS AND FUTURE PLANS

5.1 Contributions

Part 1: Developing an aesthetic taxonomy of form

- Documented and further developed a four level taxonomy of form in space including a nomenclature, building on essential aesthetic abstractions (Paper I-II).
- Created and visualized the Evolution of Form (EoF)-model (Paper I-II).
  - Developed four of the seven stages along the horizontal axis of the EoF-model, i.e. intersection/ adapt/ merge/ distort.
  - Developed the bipolar spectrum along the vertical axis of the EoF-model including the following eight concepts: accordance/ discordance, assimilate/ dissimilate, converge/ diverge, conform/ deform.
- Developed a 10-step Concept-translation-form-method encouraging students to participate in the conceptual and practical development of the EoF-model (Paper I).
- Established the concepts formgiving and formgiver.

Part 2: Expanding & challenging the Evolution of form-model

- Expanded the Evolution of form-model (Paper VI)
  - Developed concepts of material breakdown, transparency and point-cloud volumes in the expanded version of the EoF-model.
- Developed exhibitions, lectures, artifacts and writing as methods for driving trans-disciplinary, collaborative projects (Paper IV, VII and X).

Part 3: Formlessness – beyond the aesthetic taxonomy of form

- Developed art-based, explorative Laboration-methods (Paper VII-IX, chapter 3 in coat)
- Developed Aesthetic phase transition-model (Paper IX)
- Developed Transformation-model (Paper VIII)
- Developed Framing the dialogue-model (Paper VIII)
- Developed Spatial staging-method (Paper VII and X)

Concluding contribution

- Presenting the provisional illustration: Three modes of abstraction – to support a discussion of what aesthetics can offer (figure 49 and section 5.2)
5. Contributions and Conclusions

5.2 Concluding remarks

The present thesis has developed alternative methods engaging students and experienced professionals from different disciplines in active formgiving procedures and explorative laborations, attempting to develop and renew applied aesthetic knowledge. Aesthetic abstractions, of both essential and substantial character, may offer theoretical and procedural knowledge about the structure of form as well as grasp a deeper contextual understanding of the theme complexity and transformation.

Modes of aesthetic abstraction

I would like to suggest a provisional mode of abstraction, designated aesthetic abstraction, which contextualizes reasoning by supporting the unique background, sensitivities and experience of individuals. It is about sensuous cognition relying on immediacy, playful interaction and engagement in order to "charge" the process with energy to create a gestalt. This aesthetic mode of reacting and reasoning needs to operate in authentic situations that offer a sense of coherency and motivate gestalt processes.

Aesthetic abstractions, driven through our embodied experiences, complement numeric mode = measurable units of abstraction, and linguistic mode = words of abstraction. All three modes of abstraction are interdependent on each other, and although the present thesis attempts to zoom in on aesthetic abstractions, they should all be integrated when applied. The art, design and architectural disciplines are known to actively use aesthetic reasoning within their professions (Karlsson 2002), thus clearly marking the difference between prioritizing numerical abstractions, in eg. engineering, and linguistic abstractions, in the humanities.

Figure 49 shows a provisional Three modes of abstraction-model, which was initially developed in response to a questionnaire from the Swedish Research Council for the evaluation of the Cross-disciplinary study of Complexity and Transformation. The questions focused on explaining the results of our project on a meta-level and the issue of who/whom might have practical use of art-based research. I argue for aesthetic abstractions as an embodied kind of "meta-level" and through collaboration with other disciplines I have found that aesthetic modes of reasoning are important for the development of knowledge in any field. I believe the field of applied aesthetics can benefit the research community by offering ways to open up a sensuous cognition that is inclusive and not restricted to the norms of beauty. The intentions, sensitivities and experiences of individuals need to be respected as a vital driving force for the research process since they often play a part in determining how research results may be interpreted.

Figure 49 shows three overlapping cones of different heights, with their shared base surrounding the upper half of a sphere. The tip of the largest cone is aligned with the concept separation and the base of the cone, surrounding the sphere, is aligned with the concept contextualization. The three modes of abstraction are defined as numeric, linguistic and aesthetic, and are placed in relation to the spectrum between separation and contextualization. Aesthetic abstractions are grounded in context at the base, while linguistic are in the middle and...
numeric abstractions are at the tip of the largest cone.

Finally, as I consider my experiences in developing the present thesis, I feel ambivalent about how I have prioritized linguistic abstractions to argue for the importance of aesthetics. I would have felt more comfortable by arguing more through different types of aesthetic abstractions in the creation of forms, photos, diagrams, illustrations etc. In the future it is my hope that the scientific community will include aesthetic abstractions as a mode of reasoning so that research in the field of aesthetics (and any field) could actually be structured through aesthetic arguments, using linguistic and/or numeric abstractions only to support the aesthetic reasoning. If science aims to deal more closely with contextualized knowledge development, we must give the field of applied aesthetics a chance to prove its validity.

5.3 Future plans
Here are a number of suggestions for future plans that aim to generate and regenerate aesthetic abstractions:

1. Elaborating within and beyond the aesthetic taxonomy of form
   a. Develop a masters course at the Dept. of Industrial Design at Konstfack
      This course should problematize the modernistic foundation of the original work presented in the book *Three Dimensional Visual Analysis* and involve a collaboration with students and experienced professionals by:
      - Re-examining the ways of reasoning that essential aesthetic abstractions are built on.
      - Re-conceptualizing the taxonomy of form in relation to the 6th stage, distort, and the 7th stage, organic, in the Evolution of form (EoF)-model. The approach to distort needs to be defined in depth. The approach to organic, based on human figure studies, could eg. be developed to include more specific aesthetic knowledge of aging during our life span. Emphasis could be placed on comparing generative and degenerative processes in both the distort- and organic stages.
      - Exploring possibilities of integrating haptic, kinesthetic and tactile qualities within or beyond the taxonomy of form, with the aim to develop a more embodied approach to applied aesthetics.
      - Pushing the limits of the negative pole in the bipolar spectrum of the EoF-model at all stages.
   b. Revise the aesthetic taxonomy of form
      Improving photographic material, format/graphic layout and the original text in the book *Three dimensional visual analysis*.

2. Investigating the formgiving process as a method to develop knowledge
I would like to organize a trans-disciplinary project that uses the industrial design process, including formgiving activities, developed at our ID department. The proposed project could aim to develop both aesthetic knowledge and offer tangible and intangible product solutions. The steps for the development of the project might be:
   - Formulate an applied design project attempting to solve a particular authentic problem within a defined context.
   - Interlace the formgiving process within the design process, with an academic ambition to develop and document aesthetic knowledge. This entails oscillating back and forth between problem solving and studying relevant aesthetic issues, unfolded within the design process.
   - Set up a number of laborations parallel with the design process that further explore, organize and document relevant aesthetic issues. Many of the methods and models presented in the present thesis could be applied.
   - Develop innovative design solutions aiming to both generate new aesthetic abstractions and regenerate established aesthetic procedures within and beyond the presented taxonomy of form.
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PART 1
DEVELOPING AN AESTHETIC TAXONOMY OF FORM

PAPER I
Akner-Koler, Cheryl. 2006.
Expanding the boundaries of form theory.
Developing the model Evolution of Form.

The two major aims of this empirical study was:
i) to investigate ways for creating a visualization model outlining 3-D form that reciprocally merges geometric and organic structures, ii) to find a way to expand aesthetic reasoning to include incongruency in reference to geometry.

An educationally framed research approach was developed applying a cooperative inquiry method engaging industrial design students at Konstfack (Stockholm Sweden) as co-researchers with feedback and feed-forward loops. A practice-based, 10-step Concept-Translation-Form-method was developed. The different steps developed from the following sources: a) sculptural working method from my own education with Rowena Reed, b) students’ need for translation of aesthetic concepts from English to Swedish, c) students’ participation in practical/analytical studies that advanced their 3-D aesthetic knowledge and d) creating teaching material based on a comprehensive analytical structure.

The main result was the development of the 7-stage Evolution of form-model including a bipolar spectrum at each stage. The visualization model presents an aesthetic nomenclature with a dozen specifically defined terms illustrated by physical forms. Furthermore, the practice-based, 10-step method is also presented as a result.

PAPER II
Three dimensional visual analysis.

The aim of this paper was to create an aesthetic taxonomy and nomenclature of principles, concepts and models presented through 3-D physical forms and/or 2-D illustrations. The methods to develop this system were: i) the 10-step method outlined in Paper I combined with informal discussions with students about translation of general aesthetic concepts, ii) my own sculptural/design experiences with Rowena Reed, iii) literature studies in the transdisciplinary field of art, design, architecture, learning sciences, engineering and physics and iv) my own artistic experience within a contemporary constructivist artists community in Stockholm.

The result was the development of a taxonomy of form in space organized around four major sections:

I. Elements and their properties
II. Movements and forces
III. Relationships (including the Evolution of form-model, mentioned in Paper I)
IV. Organization

The material in this text book has been partially revised during the present research project resulting in e.g. a new version of the Evolution of form-model presented in Paper VI and in an enclosed poster in the thesis.
PART 2
EXPANDING & CHALLENGING THE EVOLUTION OF FORM-MODEL

PAPER III

This article summarizes my early work with hard edge geometric compositions up to a recent project, Point cloud volumes. It briefly presents my different exhibitions at the Gallery from 1986-2006 and the turning point from distorted geometric reasoning to transparency and formlessness.

WORK/PAPER IV

This Work/Paper IV is primarily presented by photographic documentation of the exhibition, (see Paper V for an in-depth description of the collaboration that drove the project).

The final exhibition was designed to express our collaborative approach emphasizing our different viewpoints concerning the theme Infinity and complex curvatures. The final goal of this study was to present material from an exhibition on Infinity at the Art and Science Festival: Spelplan Stockholm in September 2002 (see Paper V).

PAPER V

The aims of this collaborative art/science study were to develop aesthetic criteria concerning complex curvatures moving between dimensions in conceptual and perceptual space.

The methods used were open explorative meetings for nine months to prepare the content of an exhibition and program for an art science festival at Kulturhuset in 2002. Physical Lars Bergström and artist Cheryl Akner-Koler developed a theme around complex curvatures, twisting and curving within an unending cyclical path with no separation between inside and out. Bergström’s background in theoretical physics and his interest in string theory inspired him to further develop his conceptual and perceptual awareness of the digital model of a Calabi-Yau manifold.

Akner-Koler sculpted a compound twisted sculpture that explored variations of density, width and a shift of accents, based on the construction of a Möbius strip. A practice-based aesthetic study of transparency was a central part of this project by using 3-D digital scanning technology and digital tools for 3-D transparency.

The results were: i) a final sculpture, Twisting curvature, produced in aluminum through a lost-wax method and then plotted through a 3-D digital scanner, which translated the aluminum sculpture into a translucent “point cloud” volume, 2) a transparent digital model of the Calabi-Yau was developed creating a manifold that blended into the surrounding space giving a better expression of the multi-spatial dimensions of the Calabi-Yau.

PAPER VI

The aim of this paper was to challenge and expand the foundation for aesthetic reasoning in the general field of industrial design, and specifically the Evolution of form-model described in Papers I & II. The project addressed two major questions: How can we gain new aesthetic awareness through art/science collaborative projects concerning the theme Infinity and cyclical processes? How can ecological issues inspire aesthetic reasoning?

Two empirical methods were applied: i) Complex curvatures/transparency: Sculpting procedures and 3-D digital techniques were used to explore complex curvatures in multi-dimensional space through collaboration between art and physics, ii) Ecology/Material breakdown: Pedagogically framed experiments where students were asked to cut organic material in geometric shapes (cubes) and allow the cubes to dehydrate.

The results offered new form examples that expanded the Evolution of form-model in two different ways:

1) Complex curvatures extended the horizontal axis after the organic stage towards transparency and amorphic properties
2) Ecology/Breakdown expanded the vertical, bipolar axis at the stage, Distort, towards the negative pole, Deform.
PART 3
FORMLESSNESS - BEYOND THE AESTHETIC TAXONOMY OF FORM

PAPER VII

Through the support of a three year grant from the Swedish Research Council, a diverse art/science network of researchers, free artists, practitioners and educators from the arts, physics, design and architecture was formed to study the theme Complexity and Transformation (C&T). This cross-disciplinary network of individuals represented a balance between gender as well as different cultures and ages. Some of the questions this study aimed to answer were:

1) How can aesthetic reasoning embrace a more temporal and context-sensitive awareness?
2) How can exploratory laboratories offer experiences to learn about complexity and transformation?
3) How can aesthetic strategies for gaining knowledge from the complex real world help the scientific community deal with unpredictable and contradictory behavior?
4) How can the systematic and reductionist approach developed in physics have a positive impact on research development in the art and design communities?
5) Does a cross-disciplinary culture offer insight into formulating new aesthetic reasoning?

The empirical methods for driving the project were to involve participants as co-researchers in the project. Four embodied workshops with 12 interactive laboratories were planned and performed playfully exploring complex and transforming phenomena. Video documentation from a participant’s vantage point created a C&T video film archive that exposed the meaningful dialogue and working processes conducted during the laboratories. Some results were: i) Spatial staging as an evaluation method and model to share the content of the project; ii) Three models were developed: Aesthetic phase-transition-model, Transformation-model and Framing the dialogue-model. These models are presented in Papers VIII and IX. The project was concluded by formulating a manifest attempting to unfold the aesthetics of complexity.

PAPER VIII

The aim of this study was to generate and regenerate aesthetic concepts in a cross-disciplinary study of complex and transforming phenomena over time.

The methods were to set up an explorative, interactive laboratories on dendritic crystal growth for the C&T participants. The laboration was video documented and the films were edited after the laboration. This particular laboration set up by an artist and architect, involved an electro-chemical process producing branching crystal structures called dendrites. This scientific experimental study from the 1950s, inspired by the work of Gordon Pask, was reintroduced because it offered a physical real time experience of generative processes. The intention of the laboration was to show how a self-organizing structure could emerge from a simple salt solution. The generative pattern is a fractal structure, which means that it grows by following similar rules at all levels of growth. The dendritic growth laboration was selected because it presents complex behavior over time in the following ways: i) exhibits growth and deterioration of patterns, ii) builds up and breaks down symmetry, iii) is context sensitive, iv) shows emerging properties. Through reviewing the films and listening to the dialogue between participants many concepts were articulated that related directly to the growth patterns of the dendritic crystals.

The study resulted in a further development of the Transformation-model and the Framing the dialogue-model to correlate bipolar concepts with perceptual within a temporal event; now referred to as contextualizing aesthetic abstractions within an event. One conclusion from these two models was that opposing behavior at some phase within an event shows that the event is complex. Finally, there is a discussion concerning symmetry, asymmetry and dis-symmetry.

PAPER IX

The aim of the study was to investigate changing processes over time and develop a way to study the aesthetic changes expressed within an event. The methods used here were similar to the Ecology/Materials breakdown study described in Paper VII. Four groups of C&T participants were created to experiment in the Material degeneration-laboration, which was set up with four stations to expose organic materials (e.g. eggplant, parsnip, potato etc.) to radiation, microwaves, gas and steam. The groups documented their activities on video films and edited the films at the end of the laboration based on aesthetic reactions and reasoning. The films were then reviewed and discussed. From these observations and discussions we developed the following results: 1) The concept process-based aesthetics, which is about exploring both time-related events and isolated embedded objects within the event; 2) The Aesthetic phase transition-model, which is about aesthetically recognizing a number of gradual and radical changes in an event. By comparing the patterns, structures, textures, colors etc., one could discern substantial abstractions. The Aesthetic phase transition model presented here introduces the interdependency between event and object.
This Work/Paper X is primarily presented by photographic documentation of the exhibition, (see Paper VII for an in-depth description of the collaboration that drove the project). The cross-disciplinary project on Complexity and Transformation was summarized in the form of an exhibition, exploratory laboratory experiments and a dialogue lecture series. The spatial staging of the project’s activities provided an alternative, holistic method for bringing together a diverse number of exploratory and experimental studies. The project was organized through Konstfack and Albanova at Stockholm University in collaboration with Chalmers University of Technology in Göteborg, Smart Studio at the Interactive Studio and the Royal Institute of Technology in Stockholm. The final spatial staging presented a selection of concrete laboratory exercises, film clips from video documentation during workshops as well as recorded interviews giving insight into individual interpretations from the project participants. In parallel, there was a seminar series with lectures and open discussions.
PART 1
Developing an aesthetic taxonomy of form

- **Paper I**
  Akner-Koler, Cheryl. 2006.
  Expanding the boundaries of form theory. Developing the model Evolution of Form.

- **Paper II**
  Three dimensional visual analysis.
  Printed by Swedish National Education Board, Stockholm, Sweden.

PART 2
Expanding & challenging the Evolution of form-model

- **Paper III**
  Akner-Koler, Cheryl. 2006.
  Twisting, blurring and dissolving the hard edges of constructivism.

- **Work/Paper IV**
  Akner-Koler, Cheryl, Bergström, Lars, Yamdagni, Narendra and P.O. Hult. 2002.
  “Infinity” (exhibition and program) shown September 17-29 at Kulturhuset, in Stockholm, Sweden. (www.formandformlessness.com)

- **Paper V**

- **Paper VI**
  Akner-Koler, Cheryl. 2006.

PART 3
Formlessness - opposing the aesthetic taxonomy of form

- **Paper VII**
  Akner-Koler, Cheryl. 2007 (revised version).
  Unfolding the aesthetics of complexity
  Cross-disciplinary study of complexity and transformation: Evaluation for the Swedish Research Council (Vetenskapsrådet).

- **Paper VIII**
  Akner-Koler, Cheryl. 2006.

- **Paper IX**
  Akner-Koler, Cheryl, Bilger, Monica and Catharina Dyrsen. 2005.

- **Work/Paper X**
  Akner-Koler, Cheryl (project leader and producer), Norberg, Björn (co-producer) Kajfes, Arijana and Ebba Matz (exhibition concept.) 2005.