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Recycle

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# Recycle About Sustainability in Glass Craft & Design

Ph.D. Dissertation by Maria Sparre-Petersen

The Royal Danish Academy of Fine Arts Schools of Architecture, Design and Conservation

> School of Design Institute of Product Design

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### ABSTRACT

Recently, increasing awareness of the impact of human behavior on the natural environment has brought international attention to the importance of sustainable development entailing a boost in the research into the subject. Within artistic fields including the fields of glass craft and design, a demand for aesthetic autonomy and innovation is still paramount. I have completed this project to contribute to sustainable development in consideration of this demand for aesthetic autonomy and innovation within glass craft and design. Hence, the central issues in the research are if and how introduction of sustainable principles in creative processes may influence expansion of aesthetic spaces of opportunity, and how glass craft and design may contribute to sustainable development.

To connect scientific and artistic research with glass craft and design practice and education, I have engaged in a practicebased research method in combination with elements of education-based research and action research. The dissertation presents a discussion of theories, methods and practices around glass craft and design and sustainability in relation to a series of activities including personal experiments, teaching, interventions in public spaces and collaborative experiments together with students, colleagues and users. I have conducted the project over a four-year period, as a combined faculty qualification and Ph.D. program, a format specific to The School of Design at the Royal Danish Academy of Fine Arts. In order to ensure relevance within this format, a premise for the project has been to develop as holistic a foundation as possible for creative experimentation using the facilities and resources available at this institution.

The outcomes of the project include practical, artistic and scientific knowledge and insight. The contributions are manifest in a range of epistemic artifacts, i.e. outcomes of my own experiments with recycled glass as well as a series of creative of collaborative activities. outcomes Through the creation of these works, my collaborators and I have developed tacit as well as explicit knowledge and insight about sustainability in glass craft and design. Along with these epistemic artefacts, I have proposed a theoretical model for addressing issues of aesthetic content, a theoretical framework for understanding the unique qualities of scientific-artistic practice-based research, along with a technique for experimenting with pressed glass and a strategy for making molds for casting glass (fig. 0.1).



Fig 0.1 Tool made from recycled metal waste

### DANSK RESUME

De seneste års øgede bevidsthed omkring menneskets indflydelse på miljøet har medført internationalt fokus på bæredygtig udvikling og styrket forskningen inden for feltet. Imidlertid er der inden for de kunstneriske fagområder et krav om æstetisk autonomi såvel som nyskabelse som også omfatter fagområdet glas- kunsthåndværk og design. Dette ph.d. projekt er gennemført for at bidrage til bæredygtig udvikling, inden for fagfeltet glas- kunsthåndværk og design, under hensyntagen til dette krav om æstetisk autonomi og nyskabelse. De centrale problemstillinger, der undersøges igennem projektet, handler således om, hvordan introduktion af bæredygtige principper i kreative processer kan medvirke til udvidelse af æstetiske mulighedsrum, og glaskunsthåndværk hvorledes and glasdesign kan bidrage til bæredygtig udvikling.

I projektet er anvendt en praksis-baseret metode i kombination med elementer af uddannelsesbaseret research og aktions research, for at skabe sammenhæng mellem videnskabelig- og kunstnerisk forskning og uddannelse praksis og inden for glaskunsthåndværk and glasdesign. Afhandlingen består af en diskussion af teorier, metoder og praksisser omkring bæredygtighed og glaskunsthåndværk and glasdesign i relation til en række aktiviteter herunder personlige eksperimenter, undervisning, interventioner i det offentlige rum, eksperimenter i samarbejde med studerende, kolleger og brugere. Projektet er udført som en lærer-ph.d. ved Det Kongelige Danske Kunstakademis Designskole. For at have relevans i denne kontekst, har det været en præmis for projektet at udvikle et så holistisk fundament som muligt for kreative eksperimenter med anvendelse af de på institutionen eksisterende ressourcer og faciliteter.

Projektet har dannet ramme om produktion af videnskabelig, praktisk og kunstnerisk viden og indsigt. Projektet har bidraget med epistemiske artefakter, dvs. resultater af mine personlige eksperimenter med genbrugt soda glas og med en serie kreative resultater af samarbejdsaktiviteter. Igennem fremstilingen af disse er der udviklet tavs såvel som eksplicit viden og indsigt omkring bæredygtighed i glaskunsthåndværk and glasdesign. Desuden er der foreslået en teoretisk model for forståelse af æstetiske problematikker og en teoretisk ramme for forståelse af de unikke kunstneriske aspekter af videnskabelig-kunstnerisk praksis-baseret forskning. Endelig er der udviklet en teknik til at eksperimentere med presning af genbrugsglas og en strategi til udvikling af støbeformer af skrot metal (fig. 0.2).



Fig. 0.2 Værktøj lavet af genbrugt metal.

## **1**. INTRODUCTION

In recent years, the social, economic and environmental conditions of the globalized world have raised the general awareness of the need for sustainable development and in this connection of the importance of the methods and processes by which products are made.

At the same time a number of the companies that used to produce glass design have outsourced the production and laid off the designers, focusing on the branding and retail end of the businesses. The Nordic tradition of designers working closely together with master glassblowers in the industry have been replaced by designs that are not necessarily based on a close familiarity with the material, which influences the aesthetic results.

Micro and small craft enterprises catering to the market for "authentic" handcrafted work and/or working with art or in multiple genres are defining new and different directions of aesthetic development. Mazanti (2006) discusses a fragment of this development that is working across genres with works that she defines as "Superobjects". These works draw references to material culture while at the same time being critical commentaries to the references.

Common to the different directions is the demand of aesthetic innovation in response to the increasing competition in the global market. Hence, there is a demand for sustainable development that does not jeopardize aesthetic innovation.

This project has been initiated to contribute to the advancement of such a sustainable development in glass craft and design, through the proposition of sustainability as a possible driving factor for expansion of aesthetic spaces of opportunity.

### 1.1. Environmental impact of glass

Glass is a natural material. It can be found in nature in the form of sea sponges that are multicellular, animal, oceanic organisms (fig. 1.1), fulgurites created by lightening striking in the desert (fig. 1.2), obsidian which is volcanic rock (fig. 1.3) and tektites originating from meteorite impact (fig. 1.4).



Fig. 1.1 Sea sponges.



Fig. 1.2 Fulgurite.



Fig. 1.3 Obsidian.



Fig. 1.4 Tektite.

Glass is inert, and the material in itself does not have a negative impact on the environment, whereas mining and transportation of raw materials and production of new glass products contributes to  $CO_2$  emissions. Therefore, a reduction of production of new glass is desirable (Environmental Protection Agency, 1999), and can be realized through recycling of already manufactured glass.

In addition to the CO<sub>2</sub> emissions connected to glass manufacturing, there are also issues concerning the work environment in the production facilities. The handling of batch and melting of virgin materials causes emission of dust and toxic fumes that reduces life expectancy significantly for the workers and affects the communities surrounding the production facilities unless strict safety procedures are being followed. Today, industrial production of handmade glass mainly occurs in countries with low wages and poor working conditions, where safety precautions are insufficient or nonexisting.

#### Recycling

According to Glass Packaging Institute (Glass Packaging Institute [GPI], 2016) statistics show that:

- Glass is 100 % and infinitely recyclable without loss of material qualities
- One ton of carbon dioxide is reduced for every six tons of recycled container glass used in the manufacturing process
- For each ton of shards that is recycled more than one ton of virgin materials are replaced

- By recycling the glass, deposition of glass and production of clinker from burning waste is reduced and
- By adding cullet to the batch, furnace life time expectancy is extended

Glass life cycles include mining and transportation of raw materials, production and transportation of products, use of products and handling waste streams. Glass decomposes into clay over an extremely long time.

Recycling of container glass is possible by re-use, by cold alteration of the material or by hot alteration of the material. Often recycling is categorized into "up-cycling" which means enhancing the value and properties of the material while maintaining it in a form that can be continuously recycled, as opposed to "down-cycling" where the value and properties of the material are degraded and in the worst case is prevented from further recycling.

Recycling by re-use is the most efficient way of adding to the lifespan of the glass, while there is a limit to the number of times a glass item can be re-used. Most glass bottles and jars can be re-used around twenty times. Remelting of the glass is then necessary and therefore constitutes an area of interest, with regard to sustainable development, as according to the statistics mentioned above. Successful re-melting of glass requires effective separation of waste fractions. Even the smallest source of pollution will cause stress in the whole melt, leaving it obsolete. Sources of pollution can be metals, stone or ceramics. Additionally different glass types can be sources of pollution to each other.

In Denmark, some of the world's most glass-recycling efficient systems are securing up to 88% recycling of the container the market glass on (Miljøministeriet, Miljøstyrelsen, 2011). Generation and sharing of knowledge and innovation on the subject combined with the increasing international political emphasis on sustainable development could result in successful export of some of the principles from the most efficient systems to countries with less efficient systems.

# **1.2. Aesthetic and technical qualities for different types of glass**

While an array of different types of glass are on the market today, the most common types of glass used for tableware and utility items are crystal glass, borosilicate glass and soda lime glass. Different glass types have different coefficients of expansion and hence are incompatible. Therefore, separate recycling of different types of glass is necessary. The ingredients in the recipes for raw glass determine the qualities in the final product. Glass contains three major components: a former, a flux and a stabilizer.

Historically lead crystal has been very popular in the market of consumers, and still is mainly due to aesthetical qualities like sound, transparency and index of refraction. The technical properties such as ability to retain heat and low melting temperature, makes it popular amongst crafts people because it lends itself to the mouth blowing technique. Crystal glass is mainly used for high-end tableware and decorative glass products such as vases, centerpieces, chandeliers, wine glasses, carafes and for works of art. Full crystal glass contains minimum 30% lead as the flux (Bray, 2001). While it is still debated how dangerous it is to use crystal glass, the question being how much of the lead that is transferred when drinking from a crystal glass, there is no doubt that it is toxic to produce and therefore lead is generally banned as a component in glass manufacturing.

As an alternative "modern crystal", glass types have been developed that hold qualities similar to the crystal glasses. In Scandinavia a barium crystal is commonly used in both studio glass and factory settings. There is still very little knowledge about the health and environmental impact of these products and they are complicated to recycle because the different types of "modern crystal" are incompatible.

Borosilicate is widely used for scientific glass and heat resistant products such as thermos and coffeepots due to its ability to withstand high and low temperatures as well as quick changes in temperatures during use. Both barium crystal and borosilicate glass is expensive to produce and cannot be recycled in the public recycling system. In fact, these types of glass will contaminate and destroy the container glass which is made from a soda-lime recipe. Soda lime glass is mainly used for packaging, low-end tableware and window glass. Soda-lime glass withstands heat better than barium crystal and is technically viable for production of craft and design items. It has lower refractory optical qualities and it is less "white" than crystal. Hence, it also has different aesthetical possibilities. It is available in large quantities locally in most populated parts of the world and has a lower content of hazardous ingredients than crystal glass. Different types of soda lime glass are compatible at temperatures above 1100°C allowing for melting them together. Soda lime glass does not retain heat very long making it hard to blow manually, but quite appropriate for casting, pressing, centrifuging and machine blowing. It melts at a higher temperature than crystal glass but lower than borosilicate glass.

The largest fraction of glass production in Europe today is glass containers for food and beverages (Glass Alliance Europe, 2015). Efficient systems for collecting container glass for recycling exist in most developed countries but unfortunately the collected glass often ends up in landfills due to the market that offers raw materials at a lower price than the cost of preparing collected glass for recycling (Ng, 2015).

Borosilicate and crystal glass constitute minor fractions of the market. Nevertheless, companies and institutions that use and produce these materials have to observe increasingly tighter environmental and CSR regulations following in the wake of more thoroughly documented environmental impacts.

### 1.3. Aims and research questions

Because of the factors mentioned above it seems reasonable to suggest using recycled soda lime glass as an alternative to crystal and "modern crystals". glass The development of aesthetic expressions in glass is highly influenced by the possibilities given by the material, its properties and the that complement techniques these properties. Glass design and craft, whether carried out by someone familiar with the material and its properties or someone who is depending on collaborating with skilled handcraft workers, is highly influenced by the processes by which it is being created. If, and when one variable in the creative process (in this case the material) is changed, the manufacturer has to adapt to the new adjust other variables situation and accordingly. I propose this approach of using recycled container glass as a trigger for innovation assuming that when the properties of the glass are changed, the results of the creative process will also come out different, which will lead to new aesthetic opportunities.

Even though glass craft and design hold only a small fraction of the market that predominantly consists of containers such as bottles and jelly jars and flat glass for architectural and automobile industries, there is reason to believe that generation and implementation of new knowledge about sustainability in the field of glass craft and design is desirable. By gaining knowledge of sustainability, the field may develop in a more satisfying sustainable direction and new generations of glass designers and craft people will be empowered to practice in a more sustainable manner. This may even translate to other fields. According to Friedman (2004) design influences trends in the patterns of consumption. If he is right it seems plausible to suggest that changing from making glass design and craft products the traditional way, to making them in a more sustainable way, may influence the development in the consumer market by acting as a catalyst of adaptation to more sustainable values. I will discuss this further in chapter 3.

The global market dynamics are not the only factors that influence the development of sustainable processes and products in the field of glass craft and design. Political factors play a major role in terms of regulations, e.g. how, where, how much and at what cost glass can be produced and deposited, which influence whether it is financially viable to recycle rather than to make from virgin materials. Social factors influence peoples' aesthetic preferences and inclinations to separate their waste. Economic factors determine how competitive recycled materials are compared to raw materials and hence the competitiveness of sustainable consumer products. Aesthetic factors including issues of materiality, texture. color. scale. transparency etc. also influence the competitiveness of the products as well as

the designers' preferences. The future sustainable development of the world is relying on everyone to contribute.

The project has two overall aims:

- To generate scientific, artistic and practical knowledge and insight, about how issues of sustainability may contribute to expansion of aesthetic spaces of opportunity. This will contribute to the establishment of a research foundation for the glass curriculum at the Royal Academy of Fine Arts, Schools of Architecture, Design and Conservation (KADK) for new generations of glass craft and design professionals to be able to make informed choices about their future practices. It can be further developed by glassmakers wishing to incorporate sustainability into their practice.
- To generate new knowledge about how glass design and craft can contribute to sustainable development through up-cycling of waste materials. Finding new aesthetic applications of waste glass may reduce CO<sub>2</sub> emissions as well as the amounts of waste ending up in landfills.

Funding for this project was granted subject to the condition that the results would support the education at KADK. Hence, a premise for the research has been to develop methods and techniques supporting and utilizing the resources and facilities at this institution. A map of possibilities and obstacles has been generated through implementation of soda lime glass in creative processes specifically in the experimental as well as the pretotyping (3D sketching that precedes prototyping in the design process (Savoia, 2011)) and prototyping phases. Thus the issues of sustainability have been embraced, contributing to further development of the sustainable initiatives that exist in glass design and craft already.

Education within glass design and craft in Western Europe including Denmark, where I am currently based, has been experiencing a decline in activities during the past decade with several glass programs at major universities closing down or being merged into more general areas of design or art studies. This development follows a series of manufacturing local glass companies production outsourcing their while maintaining their brands, and hiring in the service of designers rather than keeping a permanent staff of designers.

Meanwhile, glass is used globally for both decorative and functional purposes. Glass is an appropriate material for tableware since it is not hazardous to the human body, unlike plastics and metals. This calls for a continuous exploration of the aesthetic possibilities of the material and for ways of using the material in a socially, environmentally and economically sound manner for craft and design purposes.

Industrial and semi industrial glass production facilities, unfortunately very

seldom deal with issues of corporate social responsibility or sustainability, which leaves it up to the educational institutions to provide information about these matters to the coming generations of designers and craftspeople. I suggest we address and emphasize these matters theoretically, methodologically and practically at all levels of creative glass education in order to ensure that the new generations possess the knowledge and skills to address and act on the issues in their future professional lives. If education in glass craft and design is going to make a serious contribution to sustainable development of production of glass utility wares in the future, I assume that recycling of glass is a viable strategy for glass designers and crafts professionals, based on the statistics presented in section 1.1.

On that note, I raise the following questions:

In what way, if any, can principles of sustainability inform creative processes and contribute to generation of aesthetic innovation within glass craft and design?

And

How can the field of glass craft and design contribute to sustainable development?

My contribution to development of information, knowledge and artistic insight is to suggest strategies for establishment of lasting sustainable changes for glass craft and design and to demonstrate how these strategies may be implemented in practice as well as theory and thereby support a general sustainable development in incremental steps.

### 1.4. State of the art

Since the Brundtland report (1987) was released emphasis sustainable on development has been established internationally and extensive research into the matters from a great range of fields has begun. However, within the field of glass craft and design the academic contributions are sporadic. The physical and aesthetic qualities of fusing recycled container glass has been researched by Oseng, Done and Bender (2009). Applications for recycled TV screens have been explored by Siikamäki (2006). The Rakow Research Library offers a number of references to research on the thermo-chemical aspects of glass. The scientific search engines e.g. JSTOR, Directory of Open Access Journals, ProQuest Dissertations and Theses Global, E-brary provide vast materials on design and sustainability and limited materials about craft and sustainability.

Within design, I have chosen to focus on sources concerned with sustainability in practice, such as Mau, Walker, Braungart and MacDonough, as well as sources with a philosophical scope such as Parson and Fry.

Within crafts and sustainability the results of the searches include researchers concerned with the "resilience" aspect of the practices of craft, which is about creation of products that last, as well as about the virtues of the practices involved in crafts such as sociocultural and environmental engagement (Ferraro, White, Cox, Bebbington, & Wilson, 2011). Some researchers are concerned with psychological aspects of craft practices and the development of mental sustainability of individuals. I appreciate these various approaches to sustainability in craft although my specific concern for connecting practical, aesthetic, philosophical and theoretical aspects of the practice and processes of making glass has led me to focus on material with a more generic approach to the subject matter such as the work of Risatti, Mazanti, Sennet and Veiteberg.

The theoretical search combined with my personal experiences and communication with peers within the glass making community for about two decades, has given me reason to believe that the field is requesting and demanding an expansion of the discussion of sustainability in relation to the creative practices of making as well as development of sustainable methods, materials and processes. In addition to this, the many private initiatives investigating and developing sustainable materials, methods, techniques, equipment, energy sources etc. within the glass making community deserves to be shared and followed up in the academic realm.

In the late 1960'es the Studio Glass movement sparked a transition in the glassmaking tradition. The pioneers of the movement learned from glassblowers from the industry and started blowing glass on a small scale, mainly focusing on the artistic applications of the material. and experimenting with form. The results of these first endeavors into glass making were limited due to scarceness of supplies and most equipment was homemade. Often the only available material was recycled bottles and jelly jars, which of course was sustainable, but this was for want of a better alternative.

Some continued to use recycled container glass for their own individual reasons, of course including those interested and involved in sustainability. Some have thrived and been able to provide decent jobs and education for local communities, which indicate that glass craft and design in fact do have an impact. It may be on a local scale, but it can inspire and provide great information about how to go about changing existing non-sustainable practices.

The recent global increased awareness of sustainability has also initiated a renewed interest amongst glass designers and craft professionals in utilizing recycled glass. Many more or less skilled glass designers and craftspeople are producing recycled products mainly by cold-working existing containers using cutting, grinding, engraving, sandblasting and polishing techniques etc. The cold-working techniques require very limited skills but consequently also offer a relatively limited range of expression. possibilities for aesthetic Recycling glass by re-melting require a

higher skill level and more advanced equipment but offer more options for creative utilization of the material and thereby aesthetic directions to explore; directions that will ideally make it more attractive for small as well as large enterprises to utilize recycled glass and thereby contribute to generation of value for the global society.

The successful examples of the use of recycled glass for hot-alteration I have been able to locate have encouraged my attempt to make new contributions. These initiatives include Studio Xaquixe in Mexico where the glass is recycled container glass and their kilns are using waste deep frying oil from local food venues. Green VI's Glass Studio that is currently relocating from Tortola to Virgin Gorda. Viggo Haaning in West Jutland is retiring from a long career of only using recycled container glass for his production, Leif Hauge runs Hauges Hantverksglas in Glasriket, where hot alteration of bottles and jars is the production method, and he and his wife has started up two similar workshops in Namibia. Visby Glass in Gotland is re-melting recycled container glass, using renewable energy for their kilns and reusing excess heat in the upstairs conference rooms. At Kitengala Hot Glass outside of Nairobi container glass is re-melted using recycled fuel, and New Mexico Experimental Glass Workshop is a nonprofit arts organization experimenting with recycled glass. Many of these collect their own container glass; others take advantage of existing public recycling systems.

The web portal "BioGlass" for sharing information on sustainable glass making has been founded by Julie Conway, a contemporary glassmaker and sustainability expert. She has also worked together with The Glass Art Society to establish the Green Panel Discussion forum at the organizations yearly conference.

Another initiative that should be mentioned is The Glass Heap Challenge organized by Matt Durran. This is a recurring workshop involving glass artists from all over the world in recycling activities. I had the opportunity to participate in 2015 in Boda, Sweden.

As a representative of an academic institution. I have the opportunity to share information about these kinds of initiatives with students and colleagues, as well as of developing new knowledge and insight that contributes to the already existing. Fortunately, members of the glass community are also very often very open and interested in sharing knowledge, which makes development easier and more fun.

### 1.5. Limitations and boundaries

The technical aspects of the research are limited to a framework that is realistic to carry out at The Royal Academy of Fine Arts Schools of Architecture, Design and Conservation (KADK) with the facilities available at present. The results are meant to inform a learning environment, with the financial and structural limitations it entails. The participants have agreed that all results of the project will be published and shared within the academic environment according to custom.

In this project, container glass is the material in focus. Other kinds of waste glass, especially window glass but also the modern crystals would be relevant to explore in a future project.

In this project, I have been concerned with glass craft and design. This distinction is to clarify a limitation of the scope of the research. In reality, the distinctions between glass art, craft and design are often blurred. Glass makers work in many genres and title themselves in various ways: glass maker, glass artist, glass "form-giver", glassblower, Studio Glass artist, flame worker etc. whether they do installation art. performance, utility wares, large or limited editions or a combination of several genres.

Traditionally glass has been labelled as a craft medium (Risatti, 2007, p. 16), and in recent years, this tradition has been subject to a debate about the hierarchies of the art, craft and design worlds. The overall discussion of art vs. design vs. craft shall not be addressed in this text. In chapter two, an explanation of how I use the terms craft and design in this text will be offered, for the sake of clarification. My use of the terms is not by any means meant as a definition of the terms.

### 1.6. Summary

The aims of the project are:

- to explore whether and/or how sustainable principles can inform aesthetic innovation in glass craft and design
- to improve the impact of glass craft and design on general sustainable development

In order to fulfill these aims I will

- create and /or prescribe strategies for implementation of sustainable practices in the field of glass craft and design
- contribute to an academic practice and discourse of sustainability in relation to glass craft and design

# **2.** KEY TERMINOLOGY

The focus of the project is sustainability and glass design and craft. Rather than failing an attempt to give an exhaustive definition of what these concepts mean or entail, I will describe how they are used and what they refer to in this particular project.

### 2.1. Sustainability

"Sustainable development is development that fulfills existing needs, without bringing future generations' possibilities for fulfilling their needs in jeopardy" (United Nations [UN], Report of the World Commission on Environment and Development: Our Common Future, 1987).

Although sustainability both as a concern for the natural environment and as social conscientious behavior has been a topic of discussion for centuries. the above mentioned definition of the concept is the most commonly used, in the recent academic discourse. In this project, the term sustainability is used much in accordance with this definition. The Brundtland report definition maintains a general perspective and pinpoints the necessity of the idea of sustainability, and although the definition has been subjected to criticism for sustaining the current unsustainable economical paradigm (Fry, 2009), I find that it describes the core intentions of sustainability sufficiently for the purposes needed in my research..

### 2.2. Glass craft and design

In this project, I am using the terms glass design and craft equivalent to glass craft and design. Currently the words design and craft are being used to describe an array of practices which calls for an explanation of what the terms refer to when used in this text.

The Danish design tradition is strongly linked to the arts and crafts movement as well as the Bauhaus school of thought. In this tradition experimentation with form, materials and techniques holds strong emphasis along with a human centered approach to design, and the distinction between design and craft is blurred. It is of less importance to me to distinguish between craft and design practices within glass making, than it is to emphasize and investigate the impact of the practices on sustainable development and the influence of sustainability on glass design and craft. The distinctions made here serve to clarify that I do acknowledge there are differences and to state, for the purpose of discussing the relation between sustainability and aesthetic innovation of glass, that I find it necessary to include both in order to relate it to the curriculum at the Royal Danish Academy of Fine Arts, School of Architecture, Design and Conservation (KADK), where this project is being carried out.

### Design

Hornby et. al. (1943) defined design as follows: "Drawing or outline from which sth. may be made". Since then the subject

has developed in correspondence with changes in society. Today the term the "expanded concept of design" is a topic of vibrant debate within the creative fields, and practitioners as well as researchers are continuously developing and expanding the theoretical discourse around this subject. Designers as well as theorists are discussing how designers contribute to society, if there are too many of them and whether design can or should "save the world", or perhaps just change a part of it. Designer and author Bruce Mau defines design as "the human capacity to plan and produce desired outcomes" (2004). The 1948 definition reflects a relatively limited perception of design which is typical of the particular sociocultural context of the time, where Mau's definition reflects the contemporary "expanded concept of design" that is far more inclusive than the first.

I will leave the question of definition of the concept of design to others who feel inclined to take on that task. Since the practice oriented questions of how to develop sustainable processes and methods is the focus of my project, the term "glass design", when used in this text, simply refers to glass artifacts, that have been conceived by a designer and produced in a fully or semiindustrialized context. The term design is being used to refer to a creative practice that includes scientific and artistic research and development as well as a practice of conceiving and/or realizing design artifacts, and the term designer is being used about a practitioner working with this type of design.

### Craft

The term craft has traditionally been used to describe artifacts made by a skilled person, and the use of the term has expanded in recent years much like the use of the term design. Mazanti (2006) is operating with a non-static definition of the term *kunsthåndværk*, which might be translated by the word craft, although nuances are lost in this translation. The understanding of the term craft seems to also vary in different cultures and to undergo constant changes within the different cultural contexts.

Nevertheless, I shall attempt to clarify my understanding of the term. I use the term, in this project, about a practice involving conception, development and production of artifacts in a process characterized by personal, hands-on involvement and engagement with materials and techniques. Hence, glass craft can be the result of a collaborative as well as an individual effort or process and the outcome can take the form of a functional, conceptual or narrative object, a performance or an installation and possibly more.

### 2.3. Epistemic artifact

According to Hansen (2009) an epistemic artifact is characterized by having the sole purpose to be a tool to develop theory in interplay with a verbal reflection and discussion in the context of practice-based design research. In my interpretation of the term epistemic artifact I expand on Hansen's definition to include the meanings of the term epistemic object as described by researchers from two other scientific research traditions. The term epistemic object was first used in the history and philosophy of science by Rheinberger (1997) to describe objects that embody what one does not yet know, and in constructivist sociology by Knorr-Cetina (1997) to describe objects that are generators of new conceptions and solutions and can be regarded as a central source of innovation and reorientation in societal practices. I consider both of these meanings to apply to the results of my personal experimentation done in this project.

Thus, the term epistemic artifact is used in this text about an object that is part of a process of experimental research. The epistemic artifact may embody the information of the process that it resulted from or it may point to new areas of interest for further exploration. The epistemic artifact is to be understood as an object that materializes aesthetic and conceptual as well as technical and material information and insight, which then can be shared and disseminated visually and physically much along the line of how knowledge can be shared through the use of words. The insights gained through the process of producing the epistemic artifacts can be part of a development of new materials, techniques or methods, it can be the initial steps towards development of a pretotype or prototype or it may feed directly into works of craft or design (Hansen, 2009). In the practice based research documented in this text the epistemic artifacts support the written materials and the written materials support the epistemic artifacts in the attempt to connect theory, art and practice.

### 2.4. Aesthetic innovation

The term aesthetic innovation in this text is used about generation of novel aesthetic ideas and visions much in accordance with the expression "expansion of aesthetic spaces or opportunity". An elaborated discussion of the subject matter of aesthetics is following in section 3.4.

## 3. THEORETICAL FOUNDATION

Academic publications discussing the relation between sustainability and glass craft and design are rare. Therefore, theoretical materials from the fields of research that are directly involved in the subject matter of interest in this project have been reviewed in order to establish a theoretical foundation for the realm that defines the intersection between them. The fields of craft and design, ethics and aesthetics have provided the main sources for this chapter. The literature about each of these topics is quite comprehensive and therefore only a limited selection of titles has been referenced, that are reckoned to have relevance for the project. If somehow any material of relevance has escaped my attention or received less attention than deserved, this is by no means intentional. The aim of the chapter is to shed light on how this research fills a gap in the literature about sustainability in relation to glass craft and design.

The chapter is divided into a section on craft, one on design, one on ethics with two subsections on sustainability in design and the cultural implications of sustainability in design, a section on aesthetics, and one on how craft and design relate to the discourse of sustainability.

### 3.1. Contemporary research in craft

The recent discourse within the field of craft predominantly concerns the rather general issues of status and identity of the practices, possibly due to several scholars representing a reflective theoretical view on craft, rather than an immersed view. Specific issues such as sustainability are covered sporadically as mentioned in section 1.4.

Sennett (2008) explores the importance of the development crafts to of the philosophical aspects of the footprint of mankind. Associating craftsmanship with a pragmatist philosophical school of thought, he accounts for a close interconnectedness between the hand and the mind characteristic of craft practices, emphasizing what he considers to be the most dignified way of living which is through "taking pride in ones work rather than in one self" (p. 296). Exercising craftsmanship, in his interpretation, is a manifestation of such an ethical choice. While appreciating his points about the experiences and knowledge that can be acquired through a craft practice, I find it questionable whether taking pride in one's work is specific to the crafts, and whether it is a value that should be held forth as the epiphany of craft practice. Claiming that it is particularly ethical to be proud of one's work rather than of oneself is also questionable in a postmodern paradigm where mindfulness, healing and celebration of the self is gaining more and more widespread recognition and support as opposed to puritan attitudes of self-denial.

Mazanti (2006) is proposing a theory of craft in its own right. She is arguing that particularly the recent conceptual craft wave is different from art in that it relates to material culture by embracing elements of it and creating critical commentary through this embracement. She explains how craft takes a semi-autonomous position similar to that of the avant-garde and particularly "in line with later avant-garde movements as Dada, Duchamp, pop and conceptual art" (p. 212), thus representing a unique position in an art/life dichotomy.

Risatti (2007), like Mazanti and Sennett, is also proposing a theory of craft. He attempts to show "the importance of craft in the development and expression of human values" (p. xiv). He believes craft has a value in and of itself that is functionally and aesthetically distinct, and that will disappear unless craft is defined properly especially in relation to art and design. He bases his account on comparative analysis of the relation between craft objects and tools as well as between craft objects and art objects to show that although relations exist between these types of objects a distinct definition of craft is relevant and necessary. Craft objects, according to Risatti, are defined by three main purposes: containing, covering and supporting, that make them into selfcontained objects independent of the user's handling of them. This differs from tools' main purposes of shaping through the directing of kinetic energy supplied by an outside source (p. 46). This part of his analysis seems to exclude certain craft practices. E.g. instrument making is a practice that is traditionally categorized as a craft. In Risatti's analysis, instruments would not fit into the category of craft but rather into the category of tools because of the need for an outside energy source to activate them. Instrument makers, as far as I know from being married to one for 10 years, do not think of themselves as tool makers, and their products do not fit the category of tools any more than bowls and furniture do although they have a tooling effect in music making. Jewelry would also have trouble fitting any of the three defining categories of containing, covering or supporting and would therefore also not qualify as a craft. His well-meant intention to classify what defines craft thus ends up as an exercise in excluding particular practices rather than promoting the overall idea of arguing for values brought forth in and by craft practices.

In his discussion of the differences between art and craft Risatti draws attention to what he defines as the "social function" of art as opposed to the "physical function" of craft that enables craft to be understood regardless of time and space, whereas art is only understood in the particular semiotic context that it is created within. He claims that works of art experienced out of context "descend to the level of artifact - artificial objects of solely historical or anthropological interest" (p. 85). Veiteberg on the other hand argues that, it is no longer a "requirement that craft be functional in the sense of useful" (2005, p. 41), which supports Mazanti's concept of Super-Object that reference the and comment on material culture but do not necessarily serve a particular practical function as its main purpose.

The problem of trying to define crafts, be it as containing, covering or supporting or other functions such as acting as tools or as signifiers of a conceptual content, is related to the problem of trying to define art. In the words of Veiteberg "Even though the process is not as far advanced in all countries, the tendency is still clear: it is becoming more and more difficult to employ fixed, internal criteria for what makes craft, and even though some of crafts institutions, be they museums, acquisition committees or groups of craft makers, still attempt to advocate an unambiguous understanding, it is becoming ever clearer that there is more than one truth about what is valid and historically relevant craft" (2005, p. 41). The autonomous character that Veiteberg ascribes craft practice allows for it to develop independently of any attempt at defining the limits of it, be it theoretical, institutional or individual, and it is likely that craft practices and products will continue to develop regardless of theorists attempts at defining it.

The current development of the field includes incorporation of new technology, conceptual content, formal crossovers to other art forms, user participation, interventions, installations inter- and cross disciplinary activities. New craft forms emerge in this development and the practitioners experiment with and combine whatever materials, technology, media, platforms, social forms and natural forms are available and generate new aesthetic expressions employing the findings of their experiments.

### **Concluding remarks**

The theoretical currents in craft cover concerns about establishment of the field as a research topic in its own right, attempts at defining the specific characteristics that distinguishes craft practices from other artistic or handicraft practices as well as mappings of the trails of the field. Various attempts to define craft seem to run the risk of inventing limitations that are not reflected in the realities of the practitioners of craft instead of clarifying the meanings of the concept. These attempts thus fail to supply the foundation for discussion of issues of content; discussions that could provide insight and shed light on the values that craft offers, what it is capable of doing to and for human existence and how it may contribute to development, preferably sustainable. The different positions in the theoretical discourse mirror a dilemma in sustainable development between expanding aesthetic spaces of opportunity while developing sustainable practices that could potentially seem like a limitation of the creative freedom much like the theoretical attempts at defining craft can come across as a reductionist attitude toward the conceptual contents of the subject matter.

The works of Veiteberg and Mazanti suggest that the field of craft is already going through a conceptual expansion including and incorporating disruptive ideas as part of its dna. In order for the field to be able to embrace sustainability in its practices it is productive to consider how sustainable practices may embrace the autonomous character of the field, since crafts professionals of the future are likely to continue to create new aesthetic visions and ideas that will challenge the attempts to make sense in a traditional sustainable manner.

# 3.2. Contemporary research in design

Research into glass design is scarce, likely due to the relatively small extent of this branch of design. Probably, most contemporary industrial glass design is designed by non-glass makers since the glass makers tend to lean more towards artistic practices rather than engaging in design, and designers generally do not limit themselves to a specific medium.

Design research much like craft research is a relatively new field but as opposed to craft it is growing fast (Engholm, 2011). A selection of the extensive material on the specific subject of design and sustainability will be reviewed in sub-section 3.3.1.

In design research the problem of definition is a recurring theme as it is in craft research. Since the field is expanding rapidly, the attempted definitions tend to become too narrow over time like in craft research. Nevertheless, definitions of what design is has been attempted by various theorists as well as practitioners. I have already mentioned Hornby et. al.'s and Mau's in the introduction. A more recent attempt from Parsons: "Design is the intentional solution of a problem, by the creation of plans for a sort of thing, where the plans would not be immediately seen, by a reasonable person, as an inadequate solution" (2016, p. 11) and Heskett's play with the words: "Design is when designers design a design to produce a design" (2001) may illustrate the difficulty of pinpointing an adequate definition.

In scientific research, it is important to clarify the subject matter for the research since the production of knowledge is closely linked to understanding and it is important for understanding that the subject matter to be understood is clear, which is also why I have formulated explanations of the key terminology in the previous chapter. In artistic research, it is different as artistic practice does not necessarily require or produce knowledge or understanding. Thus, describing the extend of the subject matter in relation to specific contexts may be more conductive to new understanding than attempting to tame this rather dynamic concept with a general definition.

The ever-growing amount of knowledge and information that is disseminated through practice as well as through theoretical sources blurs the boundaries between previously well-defined subject matters and hybrids become the norm rather than the exception. The complexity of the information stream makes everything, including design, more difficult to grasp but also offer new potent perspectives and possibilities for change. Establishment of a philosophy of design seems relevant in this perspective, especially in an academic discourse in order to set the stage for discussions of design's role in the society and in the production of information and knowledge. Such a stage seems important to be able to address and handle complex issues, including the issue of sustainability that the world faces today; issues that are global and therefore will not be solved by anyone in particular but only through joint efforts.

The viewpoints brought forth in a philosophical debate all contribute to the strengthening of the discourse and clarification of the complexities of the subject matters that will further the possibility for individual designers to find a personal path to follow. Engholm's proposal for a mapping of the positions in design research by introduction of the position model is an example of a way to begin to unfold the complexity of the matters. Such a model is helpful for the understanding of the research landscape and the immediate issues at stake and the shareholders of the different positions, and it can be further developed over time to include new currents (Engholm, 2011). This strategy seems viable for including sustainability in the research landscape and will be applied in this research.

It also seems safe to claim that it is mutually beneficial for artistic and theoretical discourse to connect to practice. Artistic practice, although mainly concerned with changing the world or proposing new worlds, is also reflective and science, mainly although concerned with understanding the world, under the right conditions is capable of generating change as mentioned by Parsons (2016, p. 22). Each offer distinct qualities to the development of the field as well as to development of the discourse, and thus also to the development sustainable of practices be thev artistic philosophical, scientific. or Furthermore, the scientific and artistic platforms for discussions, experimentation and proposals, can support knowledge production and artistic development within the specific realm of glass design and craft.

### Concluding remarks

design Research in can provide methodological and theoretical insight that can be transferred to research of glass design and craft which is relevant for the development of the field in general and thus for the development of future sustainable practices. In order for the research to contribute to sustainable development in the specific context of glass design and craft it is important to acknowledge the artistic as well as the scientific aspects of the field on equal terms.

### 3.3. Ethics

Sustainability dwells in the realm of ethics. Ethics theory is traditionally divided into meta ethics, normative ethics and applied ethics (Parsons, 2016). The *meta* level deals with the question of how we should live our

lives. *Normative* ethics covers the establishment of moral values within a particular paradigm, and *applied* ethics has to do with how choices are made in accordance with or in opposition to the current ethical paradigm.

The meta ethical question of whether human existence is valuable is not discussed in this text. For now, it is assumed that it is. The focus is on the normative and applied ethics; on the consequences of the human actions that constitute results of ethical choices specifically the consequences that influence a sustainable lifestyle. The question being what the issue of sustainability actually means when it comes to glass craft and design, and how the members of these professions (myself included) relate to the issue.

Our actions and the decisions we make shape our future. Most of us hardly ever think about e.g. brushing our teeth or walking down the street as ethical choices, although every action has a consequence. With our streamlined linear product development processes and waste management infrastructure we have installed systems that produce and send our garbage out of sight and thus out of mind. Design for obsolescence is the cornerstone of the materialistic consumption era with linear cradle-to-grave production management and environmental our footprints as the inevitable results of it.

Recently, the hazards of the overconsumption have become difficult to

ignore. The signs of it have surfaced through easy access to and sharing of information. The facts about e.g. the plastics in the oceans and other side effects of the modern lifestyle are now common knowledge. The current debate is no longer concerned with questions of whether change is necessary. The UN has been meeting every year since 1997, to try to come to agreements about how to bring down global warming (United Nations [UN], Framework Convention on Climate Change, 2015). Now the questions are whether it is possible and how. To gain a better understanding of the problem of sustainability and why the "how's" are so important yet hard to answer, a brief look at the development of the term "sustainability" may be called for.

The idea of living in harmony with nature is not new. Precolonial American Indians, the inhabitants of the islands in the South Pacific, Inuit, Buddhists, Hippies, Vikings and many others have been worshipping nature. As quoted by Welker (2013) Luther Standing Bear states "Only to the white man was nature a 'wilderness' and only to him was it 'infested' with 'wild' animals and 'savage' people. To us it was tame. Earth was bountiful and we were surrounded with the blessings of the Great Mystery." The wild/cultivated dichotomy lies at the root of western culture that has long promoted controlling nature, consequently now facing massive depletion of resources and contamination of the natural environment. Amazing technical achievements and a historically unprecedented high standard of living for a large part of the human population, have nurtured the belief that this was a positive direction, or at least blurred the fact that it was an unsustainable direction.

According to Brown & Katz (2009, p. 195) "environmentalism entered the cultural mainstream with the publication of Rachel Carson's Silent Spring in 1962". In the late 60's life cycle assessment was introduced as a tool for holistic mapping of the environmental impact of products, from production to discarding (European Environmental Agency [EEA], 1997). In the seventies, the term circular economy emerged. The concept of circular economy entails recycling of resources, and establishment of product development processes that do not generate waste. In a circular economy the linear product development processes, also known as the "Cradle to Grave" model, that have been the foundation of the current capitalist consumer paradigm are replaced by circular systems in which access to services replaces private ownership and waste is considered raw materials. In 2012 the report Towards the Circular Economy was published by The Ellen McArthur Foundation and development towards a circular economy has since been formulated as an EU strategy (European Commission [EC], 2015).

Simultaneously the concept of corporate social responsibility (CSR) that deals with the ethical aspects of running businesses, has gained momentum (Caroll, 1999). Today CSR and sustainability are on the national and international agendas for development in the globalized economy. It has had an exponential growth in interest from the private sector possibly due to recent research showing that implementation of CSR and sustainability strategies in large businesses enables them to meet the increasing demands for sustainable products and services by the consumers and is very likely to have a positive effect on their bottom line (Robins, 2015). Glass design and crafts businesses are confronted with issues of CSR when outsourcing production just as every other type of business. Ethical issues have to be addressed with entire supply chains, to avoid participation in activities that compromise ethical standards.

People/planet/profit (PPP) also known as the "triple bottom line" and "the three basic pillars" is a conceptual term that originated in business studies but soon spread to other providing framework fields а of understanding for implementation of sustainable parameters that allow for analysis of how the individual factors influence each other. The term covers the idea that in order for any system to be sustainable the three factors are equally important: the "people" factor concerns proper working conditions for the labor force, the "profit" factor concerns financial accountability, and the "planet" factor concerns the sustainment of the natural environment. The understanding of the three pillars is prevalent in the current sustainability discourse that also influences design and craft studies.

The multifaceted character of the issue calls for a joint effort in order to implement the changes. Designers and craftspeople as well as researchers in design and craft are not exempt. On the contrary, many researchers believe design and craft play an important role in the development, and there are several viewpoints about how this role may be played out. Some of the main currents in the different positions will be examined in the following.

#### 3.3.1. Sustainability in craft and design

Within design and craft practice the issue of sustainability has been а topic of investigation historically dating back to the arts and crafts movement of the late 19th century. Morris (2000) and other members of the movement worried about the impact of industry on the natural environment as well as on the working environments already in the end of the 19<sup>th</sup> century. Lately the issue seems to have died out in the realm of crafts studies in favor of the discussion of whether the field should enjoy the privilege of having a theoretical discourse of its own. Within the design field, the topic has gained attention in recent years. Notably, Victor Papanek should receive credit for his contribution: "Design for the Real World: Human Ecology and Social Change" (1984) being one of the earliest published accounts on the subject.

A major breakthrough in sustainable thinking within design came with Braungart and McDonough's book "Cradle to Cradle" (C2C). The idea promoted here was to make sustainability compatible with the prevailing growth paradigm. In the C2C model continuously increased production would not compromise sustainable development since the production would be using waste as a resource and therefore be in harmony with nature. Just like the cherry tree that overproduces flowers every spring and still maintains balance with nature (2002). This approach has been criticized by Fry who claims that it "can again so easily fold into 'sustaining the unsustainable' and support a continual growth capitalist economy" (2009, p. 190). Whether or not the C2C idea is realistic, it has contributed to a shift in the mainstream attitude towards the idea of sustainability, from being considered "odd" to being considered "respectable", as well as to a shift in the theoretical goals that previously aimed for reduction of negative impact and now is more directed towards enhancement of positive impact.

Fry argues that we need to remake; not only our ideas and objects but "our being-in-theworld toward-sustainment" (p. 206). His point is that design has agency. ..."[w]hatever is designed and brought into being goes on designing" (p. 190) and in order to redirect the agency of the present unsustainable world we need to remake it in order to make it go on designing what he frames as a "sustain - able" world. Fry's account is predominantly theoretical although it includes examples of projects using the redirective power of design, not only by designers but also by e.g. homeless people. He calls on his readers to take action
by use of the redirective power of design, because "for humanity to continue to have a future as a species, the impossible has to be attained" (p. 248). He claims to have provided the knowledge about what needs to be done, leaving the challenge of realizing his ideas to practitioners of design and to lay people.

Proposals of how the changes may be realized on a more hands-on level are delivered by Mau and the Institute without Boundaries (2004). They prescribe visions and strategies for the use of new technology, biomimicry, renewable energy etc. and include experts' accounts for how it may be done. Brown and Katz (2009) describe how the company IDEO is tackling the great issues the world is facing, employing design thinking in development of interdisciplinary design projects. Like Braungart and McDonough, Brown is backing his accounts with real life projects. Doing that means running the risk of failing, at the price of gaining practical knowledge which takes the challenge one step further. Fry may be right in his critique of Braungart and McDonough, but they as well as Mau and Brown & Katz should be given credit for implementing their ideas in real life projects, an ambition that is shared in this project, and one of several reasons for choosing the practice based methodology for the project, as described in chapter 4.

Walker (2006) states "sustainability represents not so much an environmental crisis but a crisis of meaning" and "it follows that when the ethical and environmental aspects of sustainability are given prominence in the theoretical foundations of design ... this should be welcomed as an exciting and important challenge to the design profession to develop a new aesthetic sensibility for sustainable design. It provides a meaningful impetus for jolting design out of its current and often trivial self-absorption and lays the basis for transformation" (p. 198). He considers current design selfabsorbed and often trivial while sustainable sensitivity is considered a basis for transformation. Like Fry, he may be right in his critique of the current design paradigm and in his call for development. However, in order to engage practitioners in transformational process inspiration is needed rather than condemnation of their current habitual practices. Walker also claims "there is no correct way and no right solution" (p. 77), and states "a barrier to the progress of sustainable product design is that conventional industrial design practice tends to constrain the intellectual understanding of what a product is or could be within extremely narrow limits, that is, those set by assumptions, intentions the and requirements of the predominant existing condition. With such a narrow intellectual new and radically different basis. conceptions of objects are often eliminated even before the design process begins. Sustainability demands a wider view of material culture and its possibilities, and a much broader intellectual base" (p. 189). Thus, he calls for expansion of the views on design yet he also calls for a sustainable typology that can pinpoint the unsustainable in existing products which reflects a

condemning attitude. This ambiguity between the wish to expand consciousness and generate more diversity while being creative in a conscientious manner makes sustainable development very difficult to handle in practice.

While hopefully contributing to the development of a broader intellectual base as Walker requests, the incentive in this project is to be inclusive rather than exclusive, due to a belief that theory has to be connected to practice in order to invoke a shift of paradigm, so that the products representing a "narrow intellectual understanding of design" also become sustainable.

Harper (2015) has developed a strategy for implementation of sustainability in a design process, much in accordance with Walkers idea of adopting a sustainable sensitivity. Although prefabricated strategies are counterproductive to creativity if blindly followed, her account offers valuable insights especially about endowing products with aesthetically sustainable value that she believes will help generate an alternative to the linear consumption paradigm (p. 246).

The insights provided by the various accounts, both the strictly theoretical, the ones prescribing methodologies and the practice based, have formed a framework for understanding the scale and scope of the issues of sustainability the world is facing today, and craft and design's role in creating the problems as well as solving them. In this project, I attempt to adopt and transmogrify these insights in order to find out how to deal with the issues in the specific context of glass craft and design and how to contribute to the advancement of insight in a wider context. Some of the challenges of actually developing a sustainable sensitivity and engaging in a real time process with real time people and real time materials in the field of glass design and craft will be unfolded in chapter 5.

# **3.3.2.** Cultural implications of sustainability in craft and design

SITRA, the Finnish Innovation Fund, is pointing to three mega trends as the world's major issues right now: The sustainability crisis, the technological development and the global interdependency with growing tensions (2016). The OECD and the Danish Agency for Science, Technology and Innovation (2016) also point to the issues connected to the environment, globalization and technology and claim that these "... issues all require new technological breakthroughs for which the disruptive potential of research will need to be mobilized" (p. 73). They are "...calling for new ways of doing research" (p. 73), mentioning breaking down research silos, building new research methods. incorporating citizen science etc. and emphasizing the role of new technology with regard to finding solutions to the great challenges.

Friedman (2004) claims that designers are trendsetters and therefore have the power to influence the mainstream behavior through

the trickle-down effect. The trickle-down effect, generally attributed to Georg Simmel, a German sociologist, suggests that the fashion preferences of the rich over time will be copied by the less rich and eventually become the preference of the poor. By designing sustainable products for the rich, the mainstream trends would then become sustainable over time. Trickle-down theory also suggests that once the poor have adapted to the new trend, the rich will want to differentiate themselves by adopting new preferences (Simmel, 1904). As explained by Attfield the trickle-down theory has been questioned by curators of an exhibition named Street Style at the Victoria and Albert Museum in London, which was attempting to reveal that the so called "street style" has a "bubble-up" effect on the couture created for the rich (Attfield, 2000, p. 92). Whether a trend is started from the "upper" levels of the social hierarchy or the "lower" levels, it seems that glass designers and crafts people according to both theories could potentially influence the trends of a society, either as part of the "street style" segment that influences the trends through bubble-up effect, or as caterers to the rich trendsetting segment through trickle-down effect.

Trends and fads of a given historical period are subject to change, and the sustainable impact that is called for in our historical development, as argued in the previous chapter, is what Fry calls "a shift of paradigm" (2009, p. 215) rather than a new trend. The trend can contribute to development in the short run but cannot be relied on to supply the necessary lasting changes in the practitioners' as well as the consumers' behavior.

Fry suggests that we need to redirect the agency of the present unsustainable world. Redirection being "... a profoundly political proposition" ... "and while revolution is refused, the radicality of what is actually proposed, if it is to gain any substantial foothold, requires mobilizing powerful arguments, delivering practical results and overcoming considerable resistance." (p. 47). He goes on to argue, that "...no matter who or where we are, it is possible for us to redirectively advance sustainment by design" (p. 223). The Brundtland report in Fry's view "was an argument for a mild reform of the existing paradigm of 'economic development'". In opposition to this definition, he proposes his own definition of "sustain-ability...a means to secure and maintain a qualitative condition of being over time" (p. 43). Thus, he supports the idea that bottom up action has leverage as opposed to the incentives generated from within the system that he claims will sustain the unsustainable world. Walker, as we have seen in the previous section, is less exclusive when attributing the redirectional action to the theoretical foundations of design as well as the design profession. Fry's point of view, if followed exclusively, risk missing opportunities of incremental cultural change by disregarding initiatives that occur from within the existing paradigm as invalid contributions.

Initiatives that promote incremental change towards sustainability from within the existing paradigm including political and systemic incentives implemented through legislation and regulations are currently on both the UN and the EU agendas and even if the consequences of their work has so far been limited it is still raising awareness. NGO's (non-governmental organizations) and NFPs (not for profits) like e.g. Greenpeace also contribute to generation of awareness by fighting to "save" the environment through activism development sustainable Businesses increasingly sustainability into their Designing and crafting for the 99% as well as sustainable design have become a subject renowned educational at worldwide e.g. Parsons New School (2016) and Design School Kolding (2016). Crowdfunding projects for sustainability, makers' movements, networking activities, local empowerment projects, slow living initiatives, co-creation initiatives, cross- and interdisciplinary collaborations, individuals attempting to live sustainable lifestyles etc. are contributions. Glass design and craft education can make a contribution as well which I will get back to in section 5.2. A variety of tools are already available that

promote development toward circular economy. Certifications such as Fair Trade, C2C, ØKO, ISO 14001 etc., although they often exclude SME's (small/medium enterprises), also help businesses promote sustainable benefits of their products, and consumers navigate in the sometimes confusing flow of products. Philanthropy is used by countries, businesses, organizations

and individuals with varying degrees of success. Nudging for sustainable causes is becoming more and more popular as an alternative to scare campaigns. Microloans can be used to allocate finances for startup of sustainable initiatives. Home sourcing can eradicate problems connected to an outsourced production. Research, debate, experimentation, creative thinking, critical thinking, collaborating, discussing and rallying can be evoked to call attention to unsustainable practices and to develop sustainable alternatives. With regard to running sustainable businesses there are numerous methods and strategies available in book form as well as on line, that can help stay afloat of the current do's and don'ts, e.g. greenwashing, staying under the radar, life cycle approaches etc. e.g. Ottman (2011).

# **Concluding remarks**

and/or

projects.

incorporate

portfolios.

institutions

The various positions in the theoretical currents suggest strategies for implementing sustainable theories, methods and principles into practice and finding the balance between people, planet and profit. I presume, glass craft and design can contribute to sustainable development by joining forces with other fields, lay people, academia, politics, business etc. to form a global movement towards sustainability. "Crosspollination" of insight through as many sources and channels as possible, connecting theory and practice and establishing a sustainable foundation of the theoretical and practical activities rather than adding them on late in the creative processes, or as fleeing fads or trends may initiate the paradigmatic turn that Fry (2009) calls for.

To begin the "cross-pollination", I have adopted an approach that is inclusive rather than exclusive, borrowing some of the above-mentioned tools and strategies from the different positions. This approach has been adapted in the project through hands-on experimental activities and the benefits and obstacles that have occurred will be discussed in chapter 5.

# 3.4. Aesthetics

A central issue in both craft and design is the understanding of aesthetics and the values connected to aesthetic perception, experience and creation such as beauty, expression, form, texture, etc. For artistic professionals, the creation of aesthetic statements whether it be visual, audio, performance or any other media, takes its departure in an artistic position. The artistic position is expressed through aesthetic choices and decisions. It can take the form of a chair or a song and it can be individual or collaborative; it can be developed through planned efforts or by chance. To become an artistic position someone must recognize it as such. Everybody makes. But not everybody considers what they make an artistic position. Everything that exists can be the object of aesthetic perception. But not everything that exists is an artistic position expressed through aesthetic choices and decisions. For an artistic position to exist, human intention has to be either defining or creating it. The aesthetic incentives that are put to work when proposing an artistic position are not necessarily the same as the aesthetic values that may be perceived by the audience when beholding the statements resulting from the artistic position. It is not the same as the aesthetic notions that are processed in philosophical aesthetics either. Adorno writes as follows: "Hegel and Kant were the last who, to put it bluntly, were able aesthetics without to write major understanding anything about art. That was possible so long as art itself was oriented to encompassing norms that were not questioned in individual works and were liquified only in the work's immanent problematic. True, there has probably scarcely ever been a work that was important in any regard that did not, by virtue of its own form, mediate these norms and thus virtually transform them. Yet these norms were not simply liquidated; something of them towered over and above the individual works. The great philosophical aesthetics stood in concordance with art to the extent that they conceptualized what was evidently universal in it; this was in accordance with a stage in which philosophy and other forms of spirit, such as art, had not yet been torn apart. Because the same spirit ruled in philosophy and art, philosophy was able to treat art in a substantial fashion without surrendering itself to the works" ([1970] 2004, p. 424). He claims there is something evidently universal in art that was conceptualized by philosophers of aesthetics. But, at the same time he recognizes that artistic works of any importance cannot be oriented to encompassing norms, and that it was only possible for the great aesthetic philosophers to conceptualize the "evidently universal" in

art during a time when philosophy and art were not yet torn apart and set norms were still towering over and above art.

A preoccupation with this problem of defining whether or not universality may exist for aesthetic judgment seem to prevail in philosophical aesthetics. This concern seems to be shared in the discourse of artistic practice historically and is still very influential, although in direct opposition to another agenda of artistic practice which is to uphold autonomy and indifference towards ideas of hierarchies. It is ironic that the creative arts historically have been structurally divided and understood in the structural terms of fine arts as opposed to applied arts. As Risatti states some types of function are apparently assigned superiority in the western material cultural construct (2007).

The information and values carried by the products of artistic practices is not to be neglected. According to action network theory "goods and services have a social life" (Callon, 2004, p. 3). Products influence the way we live our lives and the way we interact with each other. Thus, the ideas of the creative professionals that manage to survive in the marketplace will affect the way in which society develops. In the artistic practices the results of the process is important on several levels. The practitioner needs to exist in the world and therefore has to market the products, the results may spark ideas for new work and when they enter into the user cycle they influence the society and hence the creator as well. The results then

become part of the core aim of the artistic practice which is to create new realities. Thus, if artistic practice, including glass craft and design, is going to contribute something to sustainable development that will not be contributed by any other fields, I suspect it will be through its products as conceptual carriers of the autonomous nature of the field and through its actions and its abilities to envision and communicate new aesthetic sensibility, spirit, territory and reality. Therefore, it is important to me as a researcher and an artistic practitioner of glass design and craft to investigate what and how artistic practice can contribute to a sustainable development without jeopardizing the aesthetic autonomy of contemporary and future artisans.

To provide a better understanding of what I mean by aesthetic autonomy and how I recon aesthetics are employed in artistic practices it may be productive to examine the word, concept and realm of aesthetics. The word aesthetic is commonly used in terms of whether something is more or less adorable or beautiful. This use of the term is correct grammatically and linguistically but it can confuse the meaning of what constitutes a philosophy of aesthetics. To clarify what I think a contemporary philosophy of aesthetics could contribute to the discussion of sustainability in relation to artistic practice, I find it relevant to distinguish between perceived aesthetics and envisioned aesthetics. The perceived aesthetics concern an audience's aesthetic experience, whereas envisioned aesthetics are employed in artistic positions and the results of these.

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Envisioned aesthetics seem to have gained less attention than perceived aesthetics. This text will attempt to make up for that and handle the questions of both perceived and envisioned aesthetics, from a theoretical and methodological as well as a practical point of view.

The discussion of perceived aesthetics and particularly of taste, which includes the question of whether it is relevant to distinguish between good and bad taste, has been central in the field of philosophical aesthetics as well as in the arts. Certainly, the question of why we find some things beautiful and others repellant, and whether "taste" is universal or individual, is and has been an interesting topic. Attempts to make general rules about perception of beauty or ugliness run the risk of falling into a trap of revealing personal prejudices and preferences rather than clarify the roles of aesthetic notions. This is also true for sustainable theory. Harper (2015), Walker (2006), Skriver (2008) amongst others seem to be concerned with the development of a sort of "correct sustainable aesthetics" for artistic works. Such a concept rings alarmingly totalitarian in my ears.

It is interesting though that e.g. in the realm of food certain flavors are easy to like and others are more challenging. Black liquorice is very popular in Denmark but not so common in other countries. It is what can be categorized as an "acquired taste". Danes grew up with it; therefore, they have acquired the ability to appreciate this particular taste, whereas others have no frame of reference for it and often find it unpleasant. Here it is easy to comprehend why it is hard for some to like it, and it is obvious that it would not make any sense to place judgment about whether liquorice either does or does not taste good. It is not as easy to comprehend why some works of art are easy to like and others are more challenging, even if we can understand why certain works of art were initially rejected by the art world and later became included. It is even more difficult to comprehend why some works of art are perceived as sublime, although often it is obvious to many that particular works of art are indeed sublime e.g. Mozart's symphonies or Picasso's paintings.

Böhme (2010), as cited by Harper, claims that there is some universality to what is conceived of as beautiful. This universality is what practitioners of the creative industries are employing and relying on when creating aesthetic expressions. Harper adopts Böhmes assumption, as a basis for her own development of a strategy that applies a particular set of criteria for development of a sustainable aesthetic.

Likewise, the initiators of some of the most influential schools of thought within the design and craft traditions, such as Loos ([1908] 1997), have upheld strong beliefs in designating specific criteria for "good design", although recent discourse debates if anyone in particular holds the authority to determine the criteria by which "good design" is assessed. The idea of "good design", particularly in the modernist sense, 2016

has been criticized by practitioners as well as theorists, e.g. Ahl & Olsson (2002) argue that the modernist aesthetic attitude promote a gentrified ethnocentric predominantly white male taste, which no longer is uncritically accepted to uphold superiority over other sensibilities. In practice, it is very important for artistic professionals, to be able to identify and promote the particular values embedded in aesthetic outputs. Claiming the authority to generalize about "good" design and craft, can be a necessary strategy for the sake of securing a position in the market and obtaining a proper price for services or products.

As previously mentioned we find a similar tendency in philosophical aesthetics to seek a hierarchical organization of aesthetic notions and a focus on perceived aesthetics rather than on envisioned aesthetics. "Aesthetic judgement, according to Kant, is merely a critical, not a productive faculty" (Graham, 1997, p. 22). Kant claims that if someone says that "...[e]very one has his own taste. This would be equivalent to saying that there is no such thing as taste, i.e. no aesthetic judgment capable of making a rightful claim upon the assent of all men" (Zangwill, 2014). Zangwill goes on to interpret Kant's' position of equating aesthetic judgment to judgment of taste that is defined by universal validity combined with subjectivity to justify an understanding of aesthetic judgment that takes its point of departure in a western philosophical ontological organization into dichotomies of good and bad, beautiful and ugly etc. He places major focus on a beautiful-ugly

dichotomy for understanding the nature of aesthetic judgment leading to the conclusion that "we need a hierarchical rather than an egalitarian conception of aesthetic notions" (2014, p. section 3.3.). Zangwill's analysis of the issue of aesthetic judgment is insufficient for the understanding of the realm of aesthetics, in that it neglects to take into account the type of aesthetic judgment that artistic professionals are exercising when creating new aesthetic positions and results. In this perspective, aesthetic judgment is aiming at developing new aesthetic value rather than organizing existing aesthetic value into a hierarchical order.

What Zangwill rejects as a relativist attitude towards the notion of aesthetics, presuming what he calls "an egalitarian conception of aesthetic notions" may offer a more nuanced understanding of the realm of aesthetics that takes envisioned aesthetics into account. I suggest adapting the traditional categorization of ethics (see section 3.3) to the realm of aesthetics. Through an understanding of the realm of the aesthetic, that includes meta aesthetics, normative aesthetics and applied aesthetics I propose a non-hierarchical, inclusive and holistic attitude toward aesthetics that embraces perceived as well as envisioned aesthetics.

As summarized in table 3.1, the realm of *meta aesthetics* includes questions of perception and envisioning in the aesthetic aspects of our existence. What do we perceive and intend aesthetically, and why and how do we do it? The realm of

*normative aesthetics* includes questions of how we understand and prescribe aesthetic experience e.g. through fashion, trends etc. The realm of *applied aesthetics* includes less yellow, big, elegant, organic, ephemeral, loud, massive, silly etc., and each aesthetic quality is regarded equally important for the expression of a particular

	Ethics	Perceived aesthetics	Envisioned aesthetics
Meta	How should we live our lives?	What, why and how <i>do</i> we perceive aesthetically?	What, why and how <i>can</i> we envision aesthetically?
Normative	How do we prescribe and	How do we prescribe and	How do we prescribe and
	understand ethics through	understand aesthetics through	understand aesthetics through
	morals and laws?	fashion, trends and fads?	creative practice?
Applied	How do we live our lives in	How do we respond to aesthetic	How do we generate, respond
	accordance or opposition to	norms and aesthetic	to, express and/or communicate
	the norms?	experiences?	aesthetic ideas and visions?

Table 3.1. Classification of the realms of ethics and aesthetics

questions of how we respond to fashion and trends and why and how we create new aesthetic statements.

The division of the perceived and the envisioned aesthetics may further the understanding of the personal individual artistic positions that are important foundations in artistic practice. The division into meta, normative, and applied aesthetics may further the understanding of the relation between ethics and aesthetics in artistic practices.

In the proposed conception of the aesthetic realm divided into the two areas of "perceived" and "envisioned" as well as into the meta, normative and applied categories hierarchies are employed for the sake of understanding whether something is more or value. By organizing aesthetic information structurally, an understanding of how aesthetics influence our cognition is emerging which philosophically becomes particularly interesting around the edges of aesthetic spans; i.e. whether something can be more or less black, dead or infinite.

This way we can begin to understand the aesthetic realm as a toolbox of different aesthetic expressions and impressions of which some may be appropriate for the sake of communicating a specific idea within a given aesthetic paradigm, and others would be inappropriate or unclear. The separation of the study of the aesthetic realm from the discussion of taste introduces a focus on how different aesthetic paradigms influence and sometimes shape our values and ontological conceptions, much along the same principles as ethical paradigms.

When we shift the focus away from the establishment of a universal set of criteria for assessment of the values of aesthetic expression, that seem a recurring theme in artistic practices as well as in artistic and philosophical discourse, and replace it by a search for understanding of how aesthetic diversity may enrich our lives, we can begin to discuss the content of aesthetic practice instead of discussing whether any particular aesthetic expression is representative of good taste or proper sustainable ethics according to the aesthetic norms of a particular historic period.

This nonhierarchical approach to а classification of aesthetics will be applied in the discussion of and reflections upon the experimental activities carried out in this project. The classification of the realms of the meta aesthetic, normative aesthetics and applied aesthetics will be used as a tool for understanding of the ideas about the perceived vs the envisioned aesthetics. Issues of taste can be disturbing, when the aesthetic processing information embedded in the results of an experimental activity. The classification table offers a framework for assessment of the experiments that enable aesthetic analysis on several levels. The ideas about the perceived vs the envisioned aesthetics are used to assess correspondence or lack of correspondence between purposes and outcomes of the experiments on the applied level. When analysis is done relative to the normative and meta levels, deeper aesthetic insights can be obtained.

# Expansion of aesthetic spaces of opportunity

Thus, having established a foundation for understanding the ideas of perceived and envisioned aesthetics in the three realms of the philosophy of aesthetics, we can begin to decipher the meanings of aesthetic judgment as a productive faculty.

Envisioned aesthetics is the foundation of artistic thought and practice; professional artistic practitioners employ aesthetic visions, they subject these visions to judgment in their aesthetic creative processes and express them by means of aesthetic statements. Whether or not the aesthetic visions are perceived according to how they were envisioned varies and can be discussed, but this is not the issue here. An aesthetic agency for an envisioned aesthetic statement is derived through the practice of research and reflection both upon subjective and objective information infused with one or several artistic practitioners' aesthetic position(s). Other professional practitioners may be creative, but do not necessarily have specialized aesthetic competences to develop aesthetic positions. Theorists and researchers of artistic practices have specialized knowledge about conceiving, perceiving, interpreting and critiquing aesthetics from a theoretical point of view. Artistic practitioners master the aesthetic knowledge, insight, methodology and skills

required for intentional professional creative innovative practice, which enable them of developing aesthetic positions into real time aesthetic results. These competences enable artistic practitioners of contributing to expansion of aesthetic spaces of opportunity.

Expansion of aesthetic spaces of opportunity is the artistic equivalent of generation of new knowledge in scientific practice. New aesthetic positions developed within the expanded aesthetic space of opportunity may influence the normative aesthetic realm of how we understand and perceive aesthetics through fashion and trends. It may even push the boundaries of the realm of meta aesthetics, i.e. what we consider beautiful or ugly, similar to how knowledge production in scientific research can push the boundaries of the meta scientific questions of how we perceive of who and what we are and what the world is. Artistic practitioners activate their envisioned aesthetics and apply their aesthetic competences to develop new aesthetic positions that may provoke shifts in our perception of what is ugly and what is beautiful.

Aesthetic agency derives from the practice of researching the realm of aesthetics and reflection both upon subjective and objective aspects of aesthetic values. In this endeavor, it is important to beware of the danger of trying to argue scientifically for an aesthetic choice, decision or judgment and vice versa, which is not to say that aesthetics cannot be the subject of scientific study and scrutiny. Likewise, trying to justify scientific propositions through aesthetic positions is questionable.

In the pursuit of ethical goals through glass craft and design it is equally important to bear in mind that the meta ethical questions of how we should live our lives do not necessarily always match the meta aesthetical questions of how we perceive something as beautiful or ugly. The focus on ethical value as described in the previous chapter may prevail over the aesthetic position in an artistic project and vice versa, while the understanding, sustaining and developing of aesthetic diversity through expansion of aesthetic spaces of opportunity is central to creative practice and may occasionally conflict with our ethical goals.

# **Concluding remarks**

Reducing the understanding of aesthetics to a question of taste within the realm of perceived aesthetics is inadequate to answer the questions and deal with the dilemmas that arise when attempting to incorporate sustainability into the practices of glass design and craft professionals. Theoretically conceived hierarchical normative structures about aesthetic judgement prescribing rules for what is sublime and what is mundane, are upheld by some theorists as well as artists. Such structures, if allowed to dictate sustainable development in artistic practices in the worst case scenario may lead to stereotypical "sustainable" aesthetics that can be promoted as good taste but does not allow aesthetical diversity.

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Instead aesthetic research embracing both the critical and the productive faculties of aesthetics and enabling understanding of the complexity of the aesthetic realm is needed to support and empower artistic practitioners in their aesthetic research and enable them of developing a plethora of strategies leading to aesthetic diversity and to sustainable as well as non-sustainable aesthetic positions.

# 3.5. The relation between ethics, aesthetics and contemporary glass design and craft

Although pioneers of the studio glass movement started out using recycled container glass, this was out of a lack of a better alternative, rather than as an attempt at establishing sustainable practices. Consequentially, this material was soon to be discarded by the majority of the practitioners in favor of modern crystals that entered the market as the movement gained Lynggaard in his book momentum. "Glashåndbogen" (1975) links the choice between scrap and new glass to the skill level of the practitioner. He claims that the practitioner with higher technical skill levels will require new glass that offers more control whereas the beginner will be happy with scrap glass for financial reasons and of sheer happiness with the possibility to blow glass. Lynggaard was still melting soda lime at the time "making a small contribution to the recycling campaign" as he put it (p. 64), but later on changed to crystal.

As a contemporary glass designer or crafts professional it may be difficult to envision how one's own professional activities can have even the most remote influence on the mega-trends mentioned in section 3.3. It may seem more likely that the mega-trends have crept up on glass designers and crafts professionals and eliminated the possibility of making a decent living based on glass craft or design competences. Many fail managing to make a living in this field. Those who do build and run financially sustainable glass design and craft businesses tackle an array of obstacles whether they produce their own products, outsource production or work freelance for production companies. Challenges include competition from cheap glass products of relatively high functional and aesthetical quality, prices of energy, equipment, space and labor. Reporting on CSR and sustainability, finding resources for research and development towards sustainable practices, and acquisition of certificates like C2C, Fair Trade etc. simply may be impossible to the majority of glass designers and craft professionals. Despite the numerous obstacles, some are in fact doing a great job of running sustainable local initiatives as mentioned in section 1.4. Glass design and craft statistically account for an extremely small part of the market but the field is still contributing to overconsumption, generation of waste, pollution and depletion of resources and therefore the ethical questions of this particular trade also calls for critical examination

Nevertheless, it has received little if any attention in academic discourse. The focus in the research of artistic glass is on the rise of the studio glass movement in the last half of the past century that has attracted much deserved attention for its innovative and pioneering role in the development of glass as an artistic medium. The emphasis of the development of the movement has been on aesthetic, artistic and to some extent innovation. The technical issues of sustainability apparently have not been of interest in this development and discourse. The historical documentation of the development in the field of glass design and craft also has been evolving around the aesthetic, artistic and technical innovations. Numerous museum catalogues and books are available portraying a great plethora of wonderful works, "Modern glass 1890-2000" (Schou-Christensen, 2002), "New Glass in Europe" (Ricke, 1990) and "Glass Art" (Layton, 1996) just to mention a few.

Moreover, current research into the subject matter of glass from the point of view of the technological and natural sciences has maintained a focus on technological innovation. Macfarlane and Martin (2002) present a thorough account of the materials contributions to science as we know it today, describing how glass has played a major role in human identification and development of ontology for its own condition: "...optics became a central field of medieval science in the west, the counterpart of physics in the later centuries. The metaphysics of light, its symbolic importance both in Greek Neo-Platonic thought and in Christian thought, is a rich theme with enormous consequences. It is also immensely complex. Styles of thought were inherited, but given new impetus by the expanding world of light through the windows in churches and private houses. Thus light and knowledge, truth and beauty, became fused. It was glass that united them. So there was combination of the impetus to explore and a developing set of glass artifacts. This made that exploration possible and became part of what we call the experimental method" (p. 45). Glass in the form of lenses has made micro and macro cosmoses visible to the human eye; it has enabled us to adapt to and understand our physical environment by supplying containers and membranes. It has enabled us to travel in space as well as under water and in thin air. It has enabled us to document and perform processes, precise measurements, and the invention of fiber optics by Robert Maurer, Donald Keck and Peter Schultz glass has enabled communication infrastructure that forms the core of the computational sciences that has changed the lives of human beings radically in the past 20 years (Glass Innovation Center, 1999).

As we can see, the research traditions involving glass offer knowledge of great value to humanity including present and future scholars of glass design and craft. However, the technological development has not been in harmony with the social and the natural environment. There is a lack of information about questions of sustainability, which I will begin to address in this project. Meanwhile the studio glass movement gained momentum in the western world and technological glass inventions improved our communication, globalization changed the landscape of production and distribution and industrialized glass manufacturing moved from countries with relatively high standards for workers' rights and environmental regulations to countries with lower standards and lower average wages. The political and economic reasons for this development will not be discussed here, but it is obvious that development has had ethical this Scandinavia, consequences. In production companies phased out employing designers in permanent positions and began a new trend of hiring designers on a freelance basis. A trend of hiring famous design icons became a way of attracting attention to brands and recently bloggers have become the missionaries of brands that have gone viral in their attempt to stay afloat in the increasing competition for consumers' time and interest. Thus, the changes brought about new

most

conditions for glass designers in the western world. Some have outsourced production of their personal design lines, some are still working for the production companies on a freelance basis and others have turned towards the designer/maker strategy running their own studios and productions locally. Glass craft professionals who produce their own work have been less affected by the changes in the industry since their value proposition is not based on competitive prices and their target market is different from the target market for designproducts.

When confronted with the issue of sustainability many glass designers and craft professionals respond that they would really like to run more sustainable practices, but it is not possible right now, or the companies they work for are not compliant, or it is too aesthetically limiting or it is impossible to be 100% sustainable anyway. The development of the market as well as new legislation may eventually force glass designers and artists toward more sustainable practices though. Recently, an American manufacturer of colored glass was forced. by the Protection Environmental Agency, to observe strict safety measures around the use of arsenic, cadmium and other chemicals in their manufacturing of certain colors. This has also affected the company's customers who have built their businesses on products containing these particular colors, and are now suffering from increasing prices due to installation of the safety equipment. this indicate that Examples like all businesses are vulnerable when rules and regulations become tighter and that there is a need for knowledge about sustainable materials and processes in the field as a whole.

Other craft and design fields like textiles and fashion have experienced a boom in the research into sustainable development, possibly due to the size of these fields and to the fact that they are generally attracting more attention by the media. Glass has, probably unintentionally, been "staying under the radar" an expression used in sustainable theory which means to stay away from the attention of the media, and thus also failed to develop sufficient new knowledge about both environmental and aesthetical implications of the existing practices.

# **Concluding remarks**

In glass craft and design, the knowledge of issues of sustainability in glass craft and design lags behind general developments, which may render the field unaware of its environmental footprints and hence vulnerable to changes in legislation as well as in the market. Production of more knowledge is in demand in order to support future sustainable development of the field, and thereby secure the businesses of contemporary and future glass design and craft professionals.

Today, individual glass professionals are developing sustainable knowledge that is shared through social media, word of mouth and at conferences and workshops. This knowledge deserves to be documented systematically, which would be a research project in and of itself. In this project, I will concentrate on the issue of merging sustainability with aesthetics and research with practice in the experimental academic context that I am a part of.

# **4.** METHODS

This Ph.D. project is completed within an artistic academic context. The Ph.D. framework requires that I produce knowledge. As is the case with craft, design, ethics and aesthetics the concept of knowledge is subject to continuous analysis from as many viewpoints as one can possibly imagine. In this context it is relevant to draw attention to a few. Gardener (1993) has proposed a theory or a typology for multiple intelligences dividing the types of intelligences into a number of different categories, and over the years he has added new categories. The reason his work is important is because it parts with the traditional idea of acknowledging only the intelligence connected to the logical, positivist realms. In craft and design, many types of intelligence are activated at different stages in the processes. The knowledge produced through these practices also may be divided into several types or categories. Tacit knowledge as described by Polanyi (1966) is just one of them that have received quite a bit of attention in recent research

In addition to this issue of the different types of knowledge there is an issue concerning the artistic part of the project. Although production of knowledge through artistic practice may occur, the primary aim of artistic practice is not always production of knowledge. Artistic activity does not necessarily have a purpose at all, let alone the purpose of producing knowledge. Artistic activity may just as well be dedicated to production of non-sense or anything or nothing.

Artistic activity is autonomous above all. It cannot accept or adhere to any rules or purposes. In the following, I will therefore refer to artistic insight as the equal and equivalent purpose of the project. I have chosen a practice based research method to be able to handle this paradox from within the scholarly research format, while calling attention to the importance of maintaining an egalitarian attitude towards the parts of artistic research and education that is concerned with artistic insight as something that holds value similar to but different from scientific knowledge.

In the pursuit of new knowledge and artistic insight about sustainability and glass craft and design, qualitative as well as quantitative research methods are appropriate. Technical aspects of the subject regarding energy consumption and heat recuperation and the like I have left to be dealt with by someone with adequate technical competences, the technical aspects dealt with here, concern the creative process and the techniques involved in the forming of glass. The main question of expansion of aesthetic spaces of opportunity involves issues of subjectivity that are not quantifiable. As clarified in the previous chapter, theoretical knowledge is already available on aesthetics, sustainability, crafts and design as separate subject matters. Knowledge and artistic insight derived from individual practices is also available as mentioned in section 1.4. The knowledge that is missing and that this research is attempting to provide concerns matters of connecting theoretical knowledge with artistic insight and practice.

### Triangulation

The project has run over a four-year period during which theoretical, artistic as well as practical and technical research has been conducted. During this process, I have come to learn about theories and methodologies unknown to me before I started. My initial plan was to build an argumentation on the basis of theoretical research as well as practical research to link the two together, and to engage in a variety of activities in the attempt to avoid or in the least identify biases. Along the way I have discovered that what I have been doing can be described as triangulation, which is a strategy that involves exploration of at least three perspectives of a given issue, to generate a nuanced basis for the discussion. The Robert Wood Johnson Foundation (2008) states: "Rather than seeing triangulation as a method for validation or verification, qualitative researchers generally use this technique to ensure that an account is rich, robust, comprehensive and well-developed."

In this project, the triangulation includes activities in the following categories:

- theoretical research
- aesthetic, technical, material and contextual experiments

- experimental workshops with students
- application of findings into experimental practice
- application of findings into individual student or professional projects
- activities involving user participation
- interventions in public spaces
- participation in juried exhibitions
- participation in a workshop together with peers

Descriptions, analysis and reflections follow in chapter 5.

The main method applied in the project qualifies as practice based research. Elements of action research apply to the activities that include users, peers and students. These methods have been chosen due to their relevance with regard to incorporation of several knowledge parameters i.e. tacit knowledge, practical and theoretical knowledge as well as artistic insight, in the pursuit of new knowledge and insight about the relations between sustainability and glass craft and design.

# 4.1. Practice based research

In the Northern European tradition, the field of design builds upon a long and rich craft history that has experienced a shift in focus since the industrial revolution in the 19<sup>th</sup> century. In recent years, the design field has been undergoing a process of defining its own theoretical foundation (Galle, 2010). Likewise the field of craft has begun to establish a theoretical foundation in its own right "to show the importance of craft in the development and expression of human values" (Risatti, 2007, p. xiv preface). The development in the creative academic world has resulted in a turn towards investigating design and craft from a scientific point of view in addition to the traditional professional practical and artistic points of view, and has led to the emergence of the term practice based research, a type of research that involves methods from both the practice involved in the act of designing and the theoretical and philosophical understanding of what design practice is and means. This methodology allows for a reflection upon the design and craft processes and theories as well as upon the aesthetic value of the results derived from these processes.

Practice based research as defined by Candy (2006)"is an original investigation undertaken in order to gain new knowledge partly by means of practice and the outcomes of that practice. In a doctoral thesis, claims of originality and contribution to knowledge may be demonstrated through creative outcomes in the form of designs, music, digital media, performances and exhibitions. Whilst the significance and context of the claims are described in words, a full understanding can only be obtained with direct reference to outcomes" (p. 1). Candy is primarily concerned with the production of knowledge, which is the criterion of assessment for scientific research.

Secondarily she is concerned with the knowledge derived from the practice as well as the outcomes of the practice, and also emphasizes that "the full understanding" can only be obtained with direct reference to outcomes. In this definition production of artistic merits is subordinated the purpose of knowledge production which fulfills the requirements of the current educational criteria of assessment.

This strategy of claiming validity of the production of artistic insight within practice based research through an attempt to "fit it" into the framework of scientific research seem to have been adopted in artistic education in several academic institutions internationally. The problem with this strategy is that it potentially confuses the distinct values of artistic insight with the distinct values of scientific knowledge. In this confusion, artistic insight may end up not being acknowledged in its own right. Stiles and Selz point out that "...Western epistemology inscribes deep divisions between reason (as expressed in language) and emotion (as conveyed by art)". The divisions serve to dedicate exclusive claims to logic and philosophical systems of knowledge to the realm of science. (1996, p. 8). Claims to logic and philosophical systems of knowledge apparently hold more value than claims to artistic insight in the Western epistemology, which may influence the self-understanding in the fields of the creative arts that seem to accept evaluation of artistic insight mainly through criteria of assessment based in a scientific tradition.

An example of this is practiced at the institution hosting this project, where artistic research is included within the formal framework of scientific research. Hence the institution defines its dna as a merge of practice, art and science, while mainly stressing the *knowledge* produced by the three different realms, not the non-sensical aspects of artistic insight (KADK, 2016).

Reasons for the inclination to overlook the non-sensical may be found in the difficulty of defining the character of artistic practice. Mazanti (2006) calls attention to the tendency towards erasing the definitions in the discourse of the fields of the arts, crafts and design. She defends the position that the specific qualities and contributions of craft are overlooked when the differences between the areas are neglected. If her concern is transferred to the areas of the arts and sciences, it is possible that nuances of the contributions of the arts are neglected in the attempt to erase the differences between art and science.

Adopting a point of view from philosophy of the arts Graham (1997) discusses the attempts made in the field of the history of the arts to define artistic practice. His point is that "philosophical definitions of "art" invariably involve unwarranted generalization" (p. 225). He argues that there are similarities between art and science such as the involvement of imagination and directing of the minds of the audience, but concludes that there are also fundamental differences in that "art does not expound theories or consist in summaries or facts" (p. 74). He still maintains the idea that "art like science is an important source of understanding", though. While artistic practice may make important contributions to knowledge production, and thus to understanding, as Graham holds, the point that "contribution to understanding" is not necessarily the main concern of neither practice nor artistic research can easily be missed.

These different viewpoints call attention to a dilemma of embracing the artistic realm within an academic framework that is claiming its relevance by contributing to knowledge and understanding. This dilemma is enhanced by the fact that scientific research has a long tradition and a well-established system for assessment of the results within academia whereas the same is not the case for artistic research.

In my understanding of the term practicebased research both the artistic and the scientific realms are included, and I think of them as distinct realms as sketched in table 4.1.



Table. 4.1 Two distinct realms

These realms may influence each other and can be activated at different times towards different aims. The one realm has a purpose; It produces knowledge. The other realm does not necessarily serve a purpose and it may produce anything and/or everything, something and/or nonsense.

With regard to the practice based research method, I find it relevant to note that I also distinguish between three separate methods contributing to this method: scientific research, artistic research, and professional practice and that I consider the aims of the three methods fundamentally different from each other. I consider scientific research to be aimed at producing new scientific knowledge, artistic research aimed at producing new artistic insight including knowledge and non-sensical insight and practice aimed at producing value in the form of e.g. design or craft products that can be marketed as commercial value. Scientific research may produce knowledge that can be activated in practice just as practice can involve actions that may produce knowledge that can feed into scientific research activities e.g. in the form of material tests or testing of equipment. The knowledge derived from practice can also be artistic e.g. production of epistemic artifacts that could not have been produced without the practical and technical crafting skills and tacit knowledge that are inherent qualities of practice, and produces aesthetic outcomes. Ideally, the differences in scientific research, artistic research and practice are activated in mutual fertilization where practical application of results of the two different kinds of research serve to emphasize the relevance of the research to practice and practice infuses the research with empirical material that qualifies the research beyond theoretical and artistic speculation as illustrated in table 4.2



Table. 4.2 Practice based research method

I assume the three methods can contribute to both knowledge production and artistic insight just as both artistic and scientific research can be employed as research for practice.

The practice based research method involved in this project includes both artistic research, scientific research and to some degree professional practice. Through the research I have produced scientific knowledge e.g. about the aesthetic consequences of incorporating sustainable principles in the production of artistic artifacts that will contribute to artistic insight. I have also produced artistic insight e.g. into the aesthetic opportunities derived from the incorporation of sustainable principles in the creative processes and nonsensical outputs e.g. failed experiments, technical errors and voids. I have also produced practical value. Although the explorations have mainly addressed phases of idea generation of the creative processes and the outcomes therefore are to be understood as epistemic artifacts; some of them have been subjected to exposure in the market and thus can be understood as objects of craft or design as defined in section 2.2.

The research has involved individual as well as collaborative material specific, aesthetic, technical and conceptual experimentation along with non-systematic and nonreproducible actions and events carried out in order to produce new artistic insight, new scientific knowledge and new professional practice. Research of existing sustainable initiatives in the market is an example of a type of research, that have been employed in this project, to provide information that is relevant to both artistic, scientific and practical aspects of the project. The accumulation of data about the initiatives, both qualitative and quantitative, provide solid information that can be subjected to reflection and support the aims of both artistic research, scientific research and professional practice. Aesthetic experiments with recycled glass are examples of research that qualifies as artistic research. The results of this type of experiments are described as epistemic artifacts. They embody artistic insight. I do not consider experiments of this kind to qualify as scientific in and of themselves. but when subjected to systematic, rigorous analysis and reflection they may serve as empirical material for scientific scrutiny. In professional practice such experiments would be analyzed and the experiment that was showing most promising in terms of a specific aesthetic value would be developed into a finalized artistic proposal e.g. in the form of an object that could be sold or exhibited. Thus, the different research methods are employed at different times toward different aims, in pursuit of the overall aims of the project as stated in section 1.3.

### **Education based research**

Research as a base for education has its roots in academic practice ranging from the social sciences to natural sciences, whereas design and craft education has traditionally been based in a master – apprentice approach. The recent inclusion of research into the design and craft curricula and consequently into the practice of design and craft complement the design and craft education on a critical, analytical and methodological level. Along this development, design and craft research curricula have undertaken a transformation towards inclusion of methods of design and craft education into the research through the active engagement of the students in the research activities. This will be referred to as education based research, and I consider it an addition to the practice based research framework adapted in the project, that contributes to the quantity and quality of the experiments as well as to the critical analytical content.

In the project period I have enjoyed the opportunity to involve students from the Royal Danish Academy of Fine Art's,

School of Design in the experimental activities and thus applied the approach of education based research. The research and the work of the students have fed into each other in a mutually beneficial dialogue. The students have gained experience in experimental activity for production of knowledge and artistic insight, as well as for production of design and craft solutions, and the project has benefitted from the diversity of aesthetic expression accumulated in the range of experiments performed by the students. In education based research the students and the researcher ultimately work together towards common goals, experimenting, writing and producing collaboratively from the beginning to the end of the project. This level of education based research has not been possible in this project, but is an ambition for future research activities.

# Action research

Circular economy seems to have political emphasis right now (European Commission [EC], 2015), and according to the European Parliament News 67 % of the Europeans want the EU to do more for the environment (2016). Researchers like Fry (2009), Mau (2004), Brown (2009) and Walker (2006) proclaim that sustainable development is depending on radical changes and prescribe different solutions to how the changes may be implemented. To effectively promote and provoke changes towards sustainable development it seems insufficient to do research and disseminate results within circles of likeminded. Therefore, while mainly resting in a practice based method elements are included in the project that could qualify as action research. As defined by Reason and Bradbury "action research is a participatory process concerned with developing practical knowing in the pursuit of worthwhile human purposes. It seeks to bring together action and reflection, theory and practice, in participation with others, in the pursuit of practical solutions to issues of pressing concern to people, and more generally the flourish of individual persons and their communities" (2008, p. 4). This method offers a framework for integration of an audience into the research activities, which again provides an opportunity to explore differences in aesthetic outcomes by engaging lay people as opposed to professionals in the creative process.

Moreover, craft and design has recently experienced increased interest in incorporation of performance, installation, site specificity, user centeredness, user inclusiveness, sustainability, collaborative efforts etc. into the artistic creative work. This tendency reveals a mindset of unwillingness to accept any sort of limitations. The action research approach seems well fitted to embrace these tendencies, and along this idea, parts of the experimentation for this research has engaged museum visitors, fellow teachers, researchers and students.

# **Concluding remarks**

In summary, the most important characteristics of practice based research are its inclusion of the three different but equally important methods, artistic research, scientific research and professional practice. The distinction between the three different methods enables understanding of what each method contributes. While scientific research produces new scientific knowledge, artistic activity generates new artistic insight and creative ideas and/or visions that may make sense or non-sense. Artistic and scientific research feeds into practice that produces design and craft products and that may additionally, contribute to both scientific knowledge and artistic insight.

## 4.2. The role of experimentation

In the following, questions of how and why to experiment will be discussed. MacFarlane and Martin (2002) propose that experimental methodology has influenced all species including humans since the dawn of life on earth. They argue that the experimental method of forming and testing hypotheses is crucial to scientific thought. Franklin & Perovic suggest experimental practice may extend forming and testing of hypothesis and even may provoke paradigm shifts. Adopting the perspective of the natural sciences, they suggest an epistemology of experiment, a set of strategies that can be used to argue for the correctness of an experimental result. Their claim being that if experiments are to play important roles and if we are to believe in them, the results of the experiments ought to be correct (2015). Their focus on the correctness of the results of the experiments is in opposition to ideas about experimentation in artistic research. Experimental activity in the artistic fields is concerned with openness to new possibilities, being alert to new directions and always being willing to propose new questions, tolerance for risk-taking and acceptance of failure. In artistic research, the experiments are not necessarily conducted to find correct results but rather to reveal or create new possibilities (Brown & Katz, 2009). There seems to be discrepancy between how experimental activity is understood depending on field specific points of view.

Within artistic practice based research experimental activities also have been argued to hold a significant role while the epistemology of the experiments has not yet been extensively critically examined. As mentioned by Pajunen et. al. (2013, p. 2), "the new turn towards the epistemology of been driven experiments has by 'naturalistic', bottom up, grassroots or shop floor-level accounts of what really goes on in the laboratory. But while there [is] a plethora of arguments based on physics, there are fewer arguments based on other academic disciplines".

An alternative point of view to that of the natural sciences as requested by Pajunen et. al. is contributed by Bertolotti. Coming from a multidisciplinary perspective of applied philosophy Bertolotti distinguishes between generative and demonstrative experiments. Generative experiments include all scientific experiments. They may be aimed at verifying a theory or generating a new one or they may be "entirely explorative", conducted "simply out of curiosity to see

what will happen" as also suggested by Hacking (1983, p. 154). Demonstrative experiments are carried out to explain or present a theory to an uneducated target group. Bertolotti establishes the two categories as poles in a continuum rather than as opposites. His agenda is to emphasize the importance of sociality on science (Bertolotti, 2015). Very much in accordance with Bertolottis' ideas Graham stresses the importance of creativity to science as he puts it: "Hypothesis in science and history have to be checked against the facts, but scientists also "float" ideas, engage in guesswork, and follow up lines of thought according to their sense of the problem" (1997, p. 63).

The different approaches to experimentation and to the epistemology of experimentation mentioned above are relevant to this practice based research although none of them have been followed exclusively. It seems safe to claim that experimental activity is indispensable not only to science but equally to artistic research and to generation of scientific knowledge and artistic insight by expansion of aesthetic spaces of opportunity.

It is important for the sake of clarification to distinguish between different roles of experiments i.e. technical, aesthetical, structural, material, conceptual etc. The specific roles of the individual experiments carried out in this project are described in further detail in chapter 5. For now, I will explain two major overall objectives in the experimental activities. The first is concerned with establishment of an experimental framework. E.g. the pressing technique, which has traditionally been used for production of tableware, has previously been difficult to experiment with, due to the relatively high price of pressing molds. Pressing molds are traditionally made from metal or graphite, both being expensive options. An experiment with high temperature castable concrete was made to test if this relatively inexpensive material could replace metal and graphite and thus facilitate cheap and quick experimentation with the pressing technique.

The second objective is concerned with expansion of aesthetic spaces of opportunity. E.g. introduction of deliberately generated obstacles in the artistic process may prove to be conducive to expansion of aesthetic opportunity. spaces of Deliberately generating obstacles to force oneself in new artistic directions of exploration is quite common for artistic practitioners, and may be classified as a primary generator as suggested by Darke: "It has been suggested in this paper that designers do not start with a full and explicit list of factors to be performance considered. with limits predetermined where possible. Rather they have to find a way of reducing the variety of potential solutions to the as yet imperfectlyunderstood problem, to a small class of solutions that is cognitively manageable. To do this, they fix on a particular objective or small group of objectives, usually strongly valued and self-imposed, for reasons that rest on their subjective judgment rather than being reached by a process of logic. These

major aims, called here primary generators, then give rise to a proposed solution or conjecture, which makes it possible to clarify the detailed requirements as the conjecture is tested to see how far they can be met" (1979, p. 43). In the pursuit of generating aesthetic innovation, such a primary generator could be a deliberately generated obstacle in the form of introduction of recycled soda-lime glass.

The character of experimentation has alternated between "entirely explorative" experimentation, aesthetic experiments carried out to test techniques, materials or applications. experiments directed at questioning preconceptions and skepticism towards the idea of recycling as a sustainable alternative to making from fresh raw materials and experiments involving implementation of the results of the technical and aesthetical experiments.

The approach to the experimentation has followed Bertolotti's idea of the generative experiment while adding a dimension of reflectivity to the definition of this category; the reflective dimension expanding on or synthesizing the results of the generative dimension. Some experiments have been carried out with a specific question, theme or aesthetic exploration in mind, and some have been more spontaneous. Some experiments have had a clear structure with a welldefined preconceived logical purpose, procedure and outcome, others have made sense in hindsight, and yet others have started out making sense and ended up not making sense.

Experimentation with recycled soda lime glass in the glass workshop has constituted the core of the explorations. Information developed in my personal experimentation have fed into teaching situations where students have been elaborating on the experiments while changing details to find better solutions to specific challenges.

The active engagement of students, professionals and laypeople in experimental activities in the glass workshop has expanded the scope of the results of the research following a methodology very much in accordance with the action theory mentioned in the previous section.

# **Concluding remarks**

An epistemology of experiment for artistic practice based research is yet to be developed that embraces the parts of artistic research that do not make sense. Meanwhile, ideas about experimentation from other fields, although lacking reflection upon the non-sensical aspects of artistic experiments, can provide a conceptual background for contextualizing ideas about the sensible aspects of explorative artistic experimentation.

The overall role of the experimental activities in this particular research, in accordance with the research questions, has been to explore if and how introduction of principles of sustainability may contribute to aesthetic innovation by expanding the aesthetic space of opportunity and to identify if and how glass design and craft may contribute to sustainable development.

# **5.** SENSE AND NON-SENSE OF SUSTAINABILITY IN GLASS CRAFT & DESIGN

Having reviewed the theoretical and methodological aspects of the issues of sustainability in relation to glass craft and design conceptual prerequisites have been established for a discussion of the consequences implementation of of sustainable principles in practice. These prerequisites include a framework for understanding the different aspects of the aims of the practice-based research in terms of scientific knowledge, artistic insight including knowledge and non-sensical output, and practical value including knowledge and commercial value (see section 4.1). The prerequisites also include a framework for understanding the different aspects of aesthetic matters including the meta aesthetics, normative aesthetics and applied aesthetics as well as the distinction between the perceived and the envisioned aesthetics. Additionally, education-based research, action research and an epistemology of experimentation have been introduced as a triangulation framework for a nuanced account of the qualitative empirical material.

In this chapter, the issues of concern, initially posed in section 1.3, have been unfolded to account for practical, aesthetic and philosophical implications of a transition toward sustainable development in glass craft and design. The research questions along with the nuances that appeared through the discussions in the previous chapters will be addressed through descriptions and discussions of a series of activities. Issues such as how aesthetics and ethics complement and/or oppose each other, what the role of craft and design is and can be in relation to sustainable development, practical questions of how to implement sustainability in professional practices, and of what the practical and aesthetic consequences of substituting crystal for soda lime glass is and could be will be dealt with through and in relation to experimental processes as accounted for in chapter 4.2 and through a series of efforts to share and disseminate ideas about sustainability as well as the results of the experiments.

# Structure of the chapter

The chapter is divided into six sections. Five sections account for activities performed during the research including:

- personal experiments
- workshops with students
- experiments with students and professionals' individual projects
- interventions
- communication and distribution of results

These five sections are divided into subsections with descriptions and analyses of the specific purposes of the activities, the procedures, materials and/or resources used in the activities and the outcomes of the activities. Each of the five sections are concluded with a summary of the outcomes of the activities in the section. The descriptions and analyses in the subsections include assessment of

- how the sustainable principles have informed the activities
- if and how the activities have contributed to expansion of aesthetic spaces of opportunity
- if and how the activities have contributed to sustainable development

The last section is dedicated an overall discussion of the results of all research activities with regard to the research questions as mentioned in section 1.3 as well as to the three basic aspects of practice-based research as described in section 4.1.

#### **Delimitation of empirical explorations**

In order to optimize holistic life cycle approaches information is needed about how to handle the various phases of production, distribution and recycling of glass products. All stages of the life of a product are to be considered from the conception of an idea to the distribution and decomposition of artifacts and reshaping of the materials into new concepts as described by McDonough and Braungart (2002). In recognition of the fact that several aspects of glass manufacturing are problematic seen from a point of view of environmental sustainability it must be noted that in this project I have been able to deal with only a limited selection of these issues on a practical level. Conceptually, I have mainly been concerned with the nature and diversity of the aesthetic realm, its relation to the ethical issues and the connection to the practice. Thus, I have limited the area of investigation to encompass how introduction of sustainable principles in the creative processes for generation of aesthetic form in glass may influence aesthetic innovation, and how the field can contribute to sustainable development through such an incorporation of sustainable principles specifically in the phase of idea generation in a creative process.

Direct interaction with materials, tools, technologies techniques and provide experienced knowledge that is significant for material specific designers and craft practitioners. Therefore, the sustainable principles that have been investigated in the first three sections include use of recycled materials, development of tools for experimenting in the recycled materials and development of tools from recycled materials. These principles are far from exhaustive of sustainable principles that could be investigated if given the time and resources. They are merely a beginning.

The interventions and the different efforts of dissemination and communication are opportunities that have come up during the period. I have used these project opportunities as platforms for conversations about what glass craft and design may contribute to sustainable development. Like the experimental activities reported in the first three sections these opportunities have used investigate been to wavs of contributing to sustainable development through my own glass design and craft

research and teaching practices and they are by no means exhaustive of the possible strategies for contributing, but merely constitute examples of such strategies.

In sections 5.1 - 5.3, priority has been given to experimental investigation of aesthetic range through a variety of techniques in order to convey that aesthetic innovation is possible rather than to generate actual innovative solutions. The investigated techniques have primarily been analogue. Digital tools have been included in some experiments in consideration of the likelihood that an increasing number of designers and craft professionals will use digital tools for conception of their creative ideas, and to adapt to the technological advancement at the KADK that encourages combination of analogue and digital technology. Hence, the digital and analogue tools and technologies have also been available limited to those at the SuperFormLab and other workshops at KADK with few exceptions such as 3D prints that have been provided by our long term collaboration partner Damvig Develop. The activities reported in the sections 5.2 -5.5 in addition to the above mentioned purposes, have been included to reflect a variety of viewpoints in accordance with the triangulation framework, while the selection of activities has been based on the relevance with regard to the research questions.

# Practical foundation for the experimental activities reported in sections 5.1 – 5.4.

Initially some practical prerequisites for experimentation had to be addressed.

Obstacles can trigger innovation but if they take on too overwhelming proportions, i.e. if materials or processes are too expensive, slow or inefficient, they tend to be counterproductive. Thus, a framework for a relatively free experimental process relies on access to and development of cheap, quick and efficient materials, tools, techniques and technologies.

# Tools, techniques and technologies

Tools, techniques and technologies have to be adjusted when changing the material in order to accommodate the substitute material's specific qualities. Development of tools, techniques and technologies is also known to contribute to innovation, therefore experimentation with different types of trash for creating tools, and mold materials has also been part of the experimental activities in this research.

# Materials

Finding a reliable source of recycled glass is important in order to secure a sustainable practice. Recycled container glass is probably the easiest glass fraction to come by. Industrial plants producing container glass have not been outsourced and the recycling of the container glass is commonly handled locally although not necessarily efficiently. Thus, it is relatively cheap and easily available in large quantities.

In Denmark, municipalities are responsible for collection of waste container glass. The containers are transported to cleaning facilities where they are sorted into re-usable and recyclable fractions. The process by industrial and involves manual checking of the bottles when they come out of the machine that removes the labels. This process does not require re-melting of the glass, and therefore re-use is by far the most sustainable solution for the environment. The re-usable fraction is sold to breweries and jam factories etc. after being cleaned and sorted (fig. 5.1 - 5.4).

Fig. 5.1 Recycled bottles enter the cleaning facility.

which the container glass is cleaned is semi



Fig. 5.2 Labels that do not come off in the lye bath are removed manually.



Fig. 5.3 Clean bottles are removed from the conveyor belt.



Fig. 5.4 Cleaned and wrapped bottles ready to go to the wine or liquor companies.

The recyclable fraction is sold to the company Reiling that runs a special facility for crushing the glass and sorting out the non-recyclable materials. Their facility also divides the glass into size and color fractions that is sold to the glass manufacturing company (see fig. 5.5 - 5.8). According to their sales representative they cannot get enough recycled glass to meet the demands of their customers!



Fig. 5.5 Recycled container glass.



Fig. 5.6 Green fraction.



Fig. 5.7 Detail of small size green fraction.



Fig. 5.8 Detail of medium size clear fraction.

Recycled float glass is also an option, although cleaning and preparing of recycled float glass can be extremely time consuming. The glass is often tempered, coated, laminated and/or framed into double or triple layer panes with vacuum in between the layers, which complicate the cleaning process.

Many of the studio glass workshops that are currently using container glass collect it in their local communities and do the cleaning and crushing of the glass by hand. Then the glass is free but it is time consuming and hard work.

Soda lime glass requires higher melting temperatures than modern crystals, while melting recycled glass requires lower temperatures than virgin materials which make the recycled soda lime more energy efficient than the non-recyclable alternative. Vellini & Savioni provide a lifecycle analysis for container glass compared to plastic (2009), while I have not been able to find a comparative analysis of modern crystal and soda lime. Recyclability is an value important core in terms of sustainability, but it is worth mentioning that the daily cost of energy consumption for a glass studio may vary depending on the particular glass used. The studios I have been in contact with in the Copenhagen area use pre-melted modern crystal cullet, which means they can melt at very low temperatures, and probably would increase their energy consumption by switching to recycled container glass. This would have a negative effect on the economical

sustainability of their business. Studios that melt batch which require higher melting temperatures might be able to lower their energy consumption. The change of material thus entails implications that influence professional practices on a day to day level, with financial consequences that will be different in each individual instance.

The materials for the experimental activities in this project have come from several sources. Some have been found in the trash bins at the KADK workshops and around the campus. A ton of recycled pharmaceutical tubing was donated by the German company TGI. Two tons of recycled container glass was donated by the company Reiling that runs the only facility for preparing trash glass for re-melting in Denmark. All the glass was soda lime, although not of the same recipe. The melting pot in the furnace at the SuperFormLab was replaced in between melting different types of glass, a precaution that is recommendable when working in different glasses. Donations of scrap float glass for student projects have come from Glarmester Snoer & Sønner A/S and Cerama A/S has kindly sponsored several materials for the project and hosted a masterclass with the students of the first workshop. 3D plastic prints have been donated by Damvig Develop and silicone molds have been donated by 10Tons.

# 5.1. Personal experiments

In this section, I will describe, analyze and reflect upon a series of personal experiments

informed by the sustainable principle of using recycled waste materials instead of new materials, carried out at the SuperFormLab (SFL) during the project period either singlehanded or with the help of students or colleagues.

#### Structure of the section

This section is divided into seven subsections defined by techniques that have been explored through the use of recycled soda lime glass followed by a subsection for evaluation of the conceptual and aesthetical results of the experiments. The techniques that have been explored include pressing in concrete molds, pressing in sand molds, blowing, hotforming, casting and fusing. These techniques are commonly used in glass craft and design and have been chosen to generate aesthetic variety rather than exploring any aesthetic positions in depth, and to establish relevance for a variety of creative applications of recycled soda lime glass. They each have required adjustments in the process of changing from modern crystal to soda lime that in several cases have led to further explorations of a range of details. The techniques represent а framework for the creative processes informed by the sustainable principle of using recycled materials instead of new materials.

Each subsection presents a description and an analysis of the particular technique, the creative processes that have been explored within the given technique, the aesthetics explored through the processes and an evaluation of the aesthetic results with regards to contribution to expansion of aesthetic spaces of opportunity and to sustainable development. The last subsection is dedicated an overall evaluation of all the outcomes and their implications with regard to the research questions while simultaneously addressing issues raised in the introduction, theoretical review and method chapters.

# General aesthetic and conceptual purposes and delimitations of my personal experiments

A common reason for glass makers not to use recycled glass is that it is thought to influence the aesthetics of the outcomes, and while some glass makers are intentionally attempting to exaggerate such "aesthetics of sustainability", using it as a marketing parameter or claiming it as part of their personal aesthetic position, others are dreading it.

Hence, the creative processes in my personal experiments have been informed by the sustainable principle of recycling materials, while the experiments have explored aesthetic range and examined the effects of the introduction of this sustainable principle on aesthetic innovation understood in terms of expansion of aesthetic spaces of opportunity rather than in terms of development of one aesthetic position.

The aesthetic range that have been explored include geometrical shapes (subsections 5.1.6 and 5.1.7), organic shapes (subsections 5.1.2 and 5.1.5), simple shapes (subsections 5.1.4 and 5.1.7) and more complex shapes

(subsections 5.1.1 and 5.1.3), clear glass (subsections 5.1.1, 5.1.2, 5.1.3, 5.1.4 and 5.1.5) and translucent glass (subsections 5.1.4, 5.1.6 and 5.1.7), textured glass (subsections 5.1.2, 5.1.6 and 5.1.7) and smooth glass (subsections 5.1.1, 5.1.2, 5.1.3, 5.1.4, 5.1.5 and 5.1.7), coloration (subsections 5.1.4 and 5.1.5) and decoration (subsection 5.1.7).

# General technical consequences of substituting modern crystal with recycled soda lime glass

The overall purpose of working in recycled soda lime glass is that it can be recycled in the regular glass waste system which closes the loop in the lifecycle of the products and makes them enter a "circular economy" (Pearce & Turner, 1990). The use of recycled soda lime glass thus represents a principle of sustainability that runs through all the empirical explorations.

The implementation of this principle in the creative processes has structural and technical consequences. A specific quality of soda lime glass in general (container glass, tubing etc.), that influences all the explored techniques, is that it does not retain the heat as long as the crystal glass (Hodkin & Cousen, 1925, s. 43). Different crystal glasses also retain heat differently. When lead crystal glass was replaced with barium crystal and other formulas in the Scandinavian glass industry due to environmental regulations glass makers had to adjust their working style to the new materials that retained the heat shorter than lead crystal. The life expectancy of the glass

makers increased significantly from the change though.

A quality specific to container glass is that it devitrifies quickly, which influences the fusing and casting techniques in particular. Hence, the shift from modern crystal to recycled soda lime effects the working conditions of the glass, which constitutes an obstacle that influences the creative process and thereby the aesthetic outcomes. As mentioned in the introduction to the chapter a general purpose of the experiments therefore has been to adjust and develop old and new techniques, materials, tools and technologies for working in recycled soda lime glass. In this endeavor, emphasis have been placed on development of cheap and quick methods for experimentation to accommodate tight budgets and deadlines common in artistic education as well as in practice.

#### **Delimitation of the personal experiments**

The artistic glass community has a rich tradition of combining techniques, inventing new techniques and developing old techniques, which means that the transition from one material to another can be very complex and not necessarily possible at all. In certain instances, the transition may eliminate certain possibilities shrinking the aesthetic space of opportunity. The purpose of the experiments therefore, is not to provide correct solutions or prove that recycled glass is as good or better than new glass. It is merely to exemplify that recycled soda lime glass is a material with a rich and diverse aesthetic potential that may provide a decent alternative that is more environmentally sustainable than modern crystal glass or new soda lime glass, although it may not replace the opportunities offered by these types of glass.

#### 5.1.1. Pressing glass in concrete molds

Some of the earliest pieces of glass found in archeological excavations are pressed bowls and goblets. During the late 1900th century, pressing became very popular as an industrial process for mass production of imitations of cut crystal ware. Later the technique has been used for functional glass products such as measuring cups, drinking glasses, bowls, storage containers etc. "Kubus" by Wagenfeld (Fiedler & Feierabend, 1999) is a renowned example of a modernist product in the pressing technique (fig. 5.1.1.1).



Fig. 5.1.1.1 "Kubus" by Wagenfeld.

The technique has received little attention in the last few decades possibly because it is associated with cheap products and

imitations, and currently the pressing technique is mainly used for industrial production of design products. Recently, Hursty (2016) has taken up the challenge of developing the technique to accommodate contemporary artistic practices, suggesting the use of rapid manufacturing to overcome the issue of expensive and time-consuming mold-making. His research includes important information on previous attempts by Stuart Garfoot, Anthony Pollock and Margareth Troli, at finding appropriate mold materials for pressing glass.

## Purpose

This series of experiments was aimed at exploring aesthetic issues of rustic/classic, sharpness of detail, difference in inside and outside shape of a vessel, wall thickness and symmetry/asymmetry.

# Procedures

# Developing mold materials for experimentation with the pressing technique

The pressing technique is convenient for experimentation with soda lime glass since this technique does not require a long span of heat retention. The forms for pressing glass are traditionally made from steel, and the cheapest steal molds that can be purchased locally in Denmark within a decent timeframe cost 5-10.000 DKR. Graphite is another appropriate form material for this technique that can be manipulated with hand working tools as well as electrical tools, but it is also expensive. The price of the forms is an issue, as mentioned earlier. It must be fairly low to allow for a diverse experimental process and therefore a search for a cheaper alternative was initiated.

Experiments with materials such as ceramics and plaster, together with my teacher and colleague Charlie Meaker, over the course of several years had not been successful. The first obstacle for the introduction of sustainable principles in the idea generation phase thus being the need for a cheap mold making material for experimentation.

This led me to consult Bendt Sørensen the leader of the ceramic workshop SuperFormLab at the KADK, who generously offered to assist in finding an appropriate material for experimentation with pressing of soda lime glass. He directed me to high fired concrete produced by Refcon. Alocast H60 is traditionally used for production of kiln shelves, gloryhole doors, bricks etc. The mixture is poured directly in the pan mixer where it is dry mixed for 3 minutes, then water is added and it is mixed again for 8 minutes. Then the concrete is poured into a mold. The concrete has to dry in a humid atmosphere for 24 hours before it can be bisque fired. The maximum service temperature is 1650°C.

The concrete is not reusable but can be recycled. In Denmark more than 95 % of waste concrete and plaster, mainly from demolition, is being recycled into road construction (The Danish Environmental Protection Agency, 2015, p. 21). Although this must be considered down-cycling since it devaluates the quality of the material it still reduces the mining of gravel that is replaced

by the recycled concrete, and reduces landfill depositing. Separation into waste fractions and handling the waste can be an obstacle that may deter small workshops from doing it, instead dumping the waste in the back yard or into the general household waste stream that goes to the incineration plant where it ends up as slag.

The lifecycle analysis' for concrete and steel are dependent on so many factors that it is impossible to get a clear answer to which is more sustainable, and graphite is presumably similar to steel. It would be interesting to find out if the use of high fired concrete as mold material for industrial production of glass design might offer a financially and environmentally competitive alternative to the metal molds that are used today.

The first high temperature castable concrete mold was cast using a glass lens from a car headlight as the positive for the external shape, and an IKEA bowl as the positive for the stamp. Before pressing the glass, the mold was prepared with graphite powder (fig. 5.1.1.2 & 5.1.1.3).





Fig. 5.1.1.2 & 5.1.1.3 Preparing high temperature castable concrete mold with graphite.

Previous experiments with plaster and clay molds for pressing and centrifuging has caused problems with bubbles and/or breakage of the molds. In this experiment the mold did not break and there were no problems with bubbles.

The mold was cheap and easy to make and it was used 10-12 times before cracking. The material for the piece was equally inexpensive. The outcome had a rather rough surface and the details were blurry (fig. 5.1.1.4).

![](_page_71_Picture_8.jpeg)

Fig. 5.1.1.4 Pressed soda lime glass form.

The experiment verified that high temperature castable can be used to create molds for pressing glass.
The outcome as well as the process called for further experimentation. Graphite powder dissolved in water was used as a slip agent for the first mold. This material is expensive and problematic health wise because it dries out and turns into dust that flies around in the air when the hot glass is poured in the mold, therefore alternative slip agents were tested. Materials for creating the positive had to be explored as well as how to obtain a smoother surface on the concrete molds. The life of the molds could be extended to allow for more pieces to be produced in order to get at good prototype. Finally issues around how steep sides, how sharp corners, how large differences in wall thickness etc. had to be addressed in order to evaluate the efficiency and applicability of the technique.

Thus, the purposes of the next series of experiments included:

- using separator as slip agent on the concrete press molds to avoid breathing graphite powder fumes
- pressing in unfired concrete without slip agent to save time and possibly get a smoother surface on the glass
- getting a smoother surface on the press molds
- exploration of mold materials for positives
- reinforcement to extend lifetime of the molds
- margins for levels of detail

# Experiment with separator as slip agent on the concrete press molds

Vahidi, a student in the first workshop tested separator as an alternative slip agent. The separator is made from kaolin, flint and aluminum hydroxide dissolved in water and is regularly used to prepare kiln shelves for fusing projects or ceramic projects (fig. 5.1.1.5).



Fig. 5.1.1.5 Concrete press-mold with separator and pressed artifact by Tarlan Vahidi.

This slip agent resulted in a quite smooth surfaces with a bit of a translucency to the glass.

The molds were also tested without surface treatment which made the concrete stick a little bit to the glass in the nooks and crannies of the details (fig. 5.1.1.6).



Fig. 5.1.1.6 Concrete from the pressing mold stuck to the glass.

# Pressing in unfired concrete without slip agent

The students in the second workshop were asked to collaborate around a number of experiments including a test of pressing into unfired molds. Two mold sizes were fabricated and tested. One mold was approximately 12 cm diameter and 6 cm deep and the other approximately 18 cm diameter and 9 cm deep (fig. 5.1.1.7 & 5.1.1.8).



Fig. 5.1.1.7 Small bowl pressed in unfired concrete. The smaller unfired mold held up to the pressing.



Fig. 5.1.1.8 Large bowl pressed into unfired concrete mold.

The large amount of glass used for the larger mold resulted in the glass sticking to the concrete stamp pulling chips off the surface (fig. 5.1.1.9).



Fig. 5.1.1.9 Large unfired concrete press stamp after pressing.

The external mold held up to the heat although it got a small crack where the wall was thin (fig. 5.1.1.10).



Fig. 5.1.1.10 Large unfired press mold after pressing.

Using a high frequency vibration poker rather than shaking the mold by hand eliminated bubbles on the surface of the concrete molds and made it significantly smoother (fig. 5.1.1.11).



Fig. 5.1.1.11 Concrete mold on the vibration poker.

# *Exploration of mold materials for casting concrete molds*

The materials tested for production of positive molds included glass, polyethylene sheets, Gelflex, silicone, 3D printed plastic and plaster. Glass and polyethylene sheet produced an extremely glossy and smooth surface to the concrete.

## Polyethylene

Clay was used to hold the polyethylene in place inside the mold for the casting and vibration processes (fig. 5.1.1.12).



Fig. 5.1.1.12 Concrete press stamp before biscuit firing.

After biscuit firing the surface was still smooth but no longer glossy (fig. 5.1.1.13).



Fig. 5.1.1.13 Concrete press stamp after biscuit firing.

The polyethylene sheets were vacuum formed in a machine using heat to make them malleable (fig. 5.1.1.14).



Fig. 5.1.1.14 PE sheet is heated up in the vacuum forming machine.

A strong vacuum was applied to stretch the warm polyethylene over the desired shape (fig. 5.1.1.15 & 5.1.1.16).



Fig. 5.1.1.15 The heater is removed and the vacuum applied.



Fig. 5.1.1.16 The sheet has taken the shape of two half spheres.

This procedure only works in order to form over a convex shape. High definition of details is obtained by slicing the mold vertically which allows for air to escape during the forming of the PE sheet. The form must have slip in order to be removed from the polyethylene sheet after the vacuum forming (fig. 5.1.1.17).



Fig. 5.1.1.17 Positive is removed from PE mold.

Steep sides will result in "wings" (fig. 5.1.1.18).



Fig. 5.1.1.18 Objects with steep sides result in "wings".

The vacuum forming technique has benefits and disadvantages seen from an environmentally sustainable perspective. The benefits are that the polyethylene sheets are cheap, quick and easy to handle and the surface of the unfired concrete becomes extremely smooth and glossy. Some disadvantages are that they cannot be recycled, they give off greenhouse gasses when burned in incinerators, creating a positive adds a step to the process which is time consuming, and getting access to a vacuum forming machine may be hard and or expensive.

## Gelflex

Painted hard cardboard was tested as a mold material for a positive. Hard cardboard can be cut extremely precisely with a laser cutter and is non-toxic.

Gelflex was used to cast a mold over the painted cardboard. The Gelflex was heated and poured into the same type of setup as used for casting plaster molds (fig. 5.1.1.19).



Fig. 5.1.1.19 Setup for casting Gelflex mold into cardboard negative.

Gelflex can be reused a number of times, and is excellent for certain purposes especially when working with non-slip forms. A mask with special filters has to be used when melting the material, not to get sick from the fumes. This material was chosen to allow for making multiple concrete molds from the same positive. The painted surface reacted with the Gelflex and generated bubbles on the surface of the latter. Therefore, it could not be used for casting concrete that would have run into the holes caused by the bubbles and create bumps that would translate into holes in the glass later in the process (fig. 5.1.1.20).



Fig. 5.1.1.20 Mold with bubbles from a chemical reaction between paint and Gelflex.

## Silicone

An experiment was made with silicone for the same purposes and as an alternative to Gelflex. The process of casting the silicone involves mixing two toxic liquid components and pouring them into the mold that is then placed inside a suction chamber while setting. It is a toxic chemical procedure but the fumes are contained inside the suction chamber. Unless strict safety precautions are obtained this material cannot be recommended. A negative mold for casting concrete tiles and a positive mold for casting concrete press molds were produced in the material. The same painted cardboard positives as used for casting Gelflex was used for casting these molds (fig. 5.1.1.21).



Fig. 5.1.1.21 Setup for casting silicone mold.

Both molds came out perfectly smooth without bubbles or any other issues. They were very flexible which made it easy to remove them from the concrete (fig. 5.1.1.22).



Fig. 5.1.1.22 Silicone positive is easily removed from a concrete mold.

#### Plastic

3D printed plastic was used with three different lubrication agents. 3D printing machines are becoming cheaper and they offer more and more options for building both simple and complex geometries. Today many designers use the computer as their primary tool for exploring form and 3D printing is a relatively fast route from a computer rendering to a form that can be translated through analogue processes. To accommodate the combination of digital and analogue processes the printed plastic was tested.

The surfaces of the 3D prints were sanded before application of the lubricants to erase the riddles from the printing process. Before casting the concrete over the plastic positives the surfaces were treated using different materials as slip agent for the three different pieces. For the small plastic print a soap lubricant was used that is also used for plasterwork. Soap flakes and water is whipped into a creamy consistency, with an electrical drill. Then the soap is applied to the surface of the object in an extremely thin invisible layer using a brush (fig. 5.1.1.23).



Fig. 5.1.1.23 Plastic print with soap lubricant.

The middle sized print was first painted with shellac and then lubricated with the same soap (fig. 5.1.1.24).



Fig. 5.1.1.24 Plastic print with shellac and soap lubricant.

The large print was spray painted and then sprayed with WD40 (fig. 5.1.1.25).



Fig. 5.1.1.25 Plastic print with spray paint and WD40.

The surface treatment and lubricant for the two smallest prints were less toxic but a bit more time consuming. They were all difficult to get out of the molds. The air gun that works well for getting plaster molds apart because it is porous had no effect when used on the solid concrete, and the plastic prints had to be pried out using a screw driver (fig. 5.1.1.26 & 5.1.1.27).



Fig. 5.1.1.26 Small 3D print stuck in concrete.



Fig. 5.1.1.27 Large 3D print pried out of the concrete.

The surfaces were still smooth once the prints were successfully removed and could be used for pressing. The damage to the prints was within a margin that allowed for future reuse. Although 3D plastic prints are gaining popularity and the 3D printers, the software and the materials are getting cheaper high quality prints are still extremely expensive and the plastic is not recyclable.

As an alternative to these relatively toxic materials, plaster was tested. Several layers of shellac were applied followed by soap but the plaster stuck to the concrete and had to be chiseled out. (fig. 5.1.1.28).



Fig. 5.1.1.28 Plaster positive is removed with hammer and chisel.

A test was made to determine if biscuit firing would help the process of removing the plaster. The plaster shrank and could be removed very easily (fig. 5.1.1.30).



Fig. 5.1.1.30 Plaster shrinkage after biscuit firing.

The same procedure could be used for any material that can burn away at temperatures around 1250°C, preferably materials that do not produce toxic fumes when fired. I assume the high degree of shrinkage is caused by the high temperature.

#### Margins for levels of detail

To test margins of details that translate from mold to pressed object, a geometric shape was generated in the 3D modelling software program Rhino (fig. 5.1.1.31).



Fig. 5.1.1.31 Rhino 3D model.

The object was then routed in cheap foam (fig. 5.1.1.32).



Fig. 5.1.1.32 Router working from Rhino file.

Concrete was cast over the foam that was removed using the compressed air gun together with a screwdriver. The mold had to be thoroughly covered with graphite powder to keep the glass from sticking since the surface came out quite rough (fig. 5.1.1.33).



Fig. 5.1.1.33 Rough surface on concrete mold made from foam positive.

Denser types of foam would give a smoother surface, but they are also more expensive. For this shape a plunger made from scrap metal was used to form a cavity in the glass, to play with different shapes protruding into the glass from opposite ends (fig. 5.1.1.34).



Fig. 5.1.1.34 Setup for pressing with plunger.

The glass easily let go of the form, but the details were not sharply defined (fig. 5.1.1.35).



Fig. 5.1.1.35 Blurry details on pressed glass artifact.

The foam is cheap, but not environmentally friendly. The new technology offers great experimental opportunities but the milling of the foam is time consuming. Considering the pace of the development of the 3D area, solutions to these dilemmas may already exist or be on their way.

### Reinforcement of the molds

For reinforcement a layer of chicken wire was embedded in the molds. This did not have the intended effect. The molds still cracked. Other methods could be tested if and when given the time. Metal reinforcement of the concrete is problematic with regards to separation of waste. Fiberglass could be tested as an alternative, but might stick to the glass.

*Pressing glass in high fired concrete molds* The working temperature for the pressing process was 1180°C. A ball was used to gather molten glass and fill it into the press mold (fig. 5.1.1.36).



Fig. 5.1.1.36 Filling molten glass into concrete press mold.

The mold had not been preheated, which might affect the durability of the mold. The glass was pressed using an old ceramic tile press. The stamp was securely attached to the press and guards were set up on the bed to keep the loose bottom mold in place. The pressing had to be done with tenderness, since the force of the handle was strong enough to break the glass (fig. 5.1.1.37).



Fig. 5.1.1.37 Pressing glass into concrete mold.

When the glass had been pressed, the mold was flipped over and emptied on to a piece of wood by which the glass piece was carried into the annealing kiln (fig. 5.1.1.39 & 5.1.1.40).



Fig. 5.1.1.39 Removing glass from a concrete mold.



Fig. 5.1.1.40 Carrying a glass artifact into the annealer.

### Outcomes

The initial experiments, carried out in the pursuit of cheap, quick, efficient and nontoxic mold materials for making pressmolds, call attention to a common dilemma in the attempts to implement sustainable procedures in craft and design processes. What is gained through one aspect of the process may be compromised by another aspect of the process. Plaster is a cheap, quick and non-toxic material to use for production of positives to cast the press molds from. If the positive could be removed from the cold concrete mold, the timeconsuming and costly biscuit-firing of the mold could be avoided, as shown in the experiment with pressing in the raw concrete.

The aesthetic range of opportunity is limited with the pressing technique regardless of the type of glass used, but recently the technique has been explored relatively modestly, it holds potential for further development and innovation especially in combination with the possibilities offered by new technology. In this experiment, a traditional symmetrical bowl shape was used to explore how much the traces of the concrete could be controlled.

The aesthetic outcomes were quite rustic, although most of the rather sharp details translated from the positives to the glass artifacts (fig. 5.1.1.41 - 5.1.1.43).



Fig. 5.1.1.41 Pressed bowl.



Fig. 5.1.1.42 Pressed bowl.



Fig. 5.1.1.43 Pressed bowl.

The successful experiments using high fired concrete for the production of press molds provided a basic foundation for experimental activity in the pressing technique, facilitating expansion of aesthetic spaces of opportunity. The technique still being at a rudimentary level has left room for improvement.

To get a more refined look the edges of the bowls were cut and polished (fig. 5.1.1.44 - 5.1.1.46).



Fig. 5.1.1.44 Pressed bowl with polished edge.



Fig. 5.1.1.45 Pressed bowl with polished edge.



Fig. 5.1.1.46 Pressed bowl with polished edge.

In this version the aesthetic of the bowls became more traditional in their reference to the pressed glass of the past century. If the bowls were to go into production a metal mold could be fabricated that either copied the surface from the concrete or made a smooth surface depending on the designers' preference for the "rustic" or the "classic" look.

The rustic appearance of the pressed glass was explored further through a series of experiments with pressing into sand molds.

# **5.1.2.** Pressing or casting into a wet sand negative

Pressing or casting into a wet sand negative is another ancient method for shaping glass. The technique has been used in recent years by e.g. Sia Mai (2016) (fig. 5.1.2.1).



Fig. 5.1.2.1 Champaign flutes with sand cast feet by Sia Mai.

#### Purpose

In the pursuit of aesthetic range, the experiments with sandcasting expanded on the variety of options for pressing. While pressing into a concrete mold requires an involved process as revealed in the previous subsection, pressing into a sand mold offers opportunities for a much more immediate interaction with tools and materials.

The idea that aesthetic form often reveals signs of the procedure by which it is made is common in design and craft as explained in the introduction to this chapter. Some practitioners even make a deed of letting the form reflect the process by which it was made e.g. by leaving marks of the fingers on a thrown ceramic vessel. The strategy of letting the tools and the technique guide the process in order for the aesthetic outcomes to reflect the makers' direct interaction with the materials, tools and technology is a variety of the strategy of using deliberately generated obstacles that is common in glass craft and design practices. This strategy has been used in this series of experiments to generate organic shapes as part of the range of formal explorations.

## Procedure

The tools were concrete half spheres, made from the left over concrete from the casting of the press stamps for the previous experiments, a pressing tool made by my colleague Anders Raad and beach sand, which is a sustainable alternative to casting sand that contains oils that release toxic fumes when heated. The sand comes in different grid sizes that allow for more or less smooth surfaces on the glass.

Cavities were pressed in the sand using the concrete half spheres (fig. 5.1.2.2).



Fig. 5.1.2.2 Cavities in sand.

Enough slip was secured to keep the sand from spreading over the surface of the glass piece during the process of filling the mold. The glass had to be relatively hot. We worked at 1180°C, which was enough to make the glass run nicely off the gathering ball, but not enough for the trail to disappear without torching (fig. 5.1.2.3).



Fig. 5.1.2.3 Filling a sand mold.

The glass was pressed into the cavities using the pressing tool (fig. 5.1.2.4).



Fig. 5.1.2.4 Pressing the glass into a sand mold.

The viscosity of the recycled soda lime glass is lower than modern crystal and the working temperature therefore had to be higher. Due to the soda lime retaining the heat for only a short period of time it is necessary that the glass is torched while setting in the sand to avoid cracking edges (fig. 5.1.2.5).



Fig. 5.1.2.5 Chill cracks on the edge of a piece of glass.

Experiments were made to explore different colors and textures on the surface of the glass by applying different materials to the sand mold before pressing the glass (fig. 5.1.2.6 - 5.1.2.9).



Fig. 5.1.2.6 Sand mold with separator.



Fig. 5.1.2.7 Sand mold with graphite.



Fig. 5.1.2.8 Sand mold with Universal color.



Fig. 5.1.2.9 Sand mold with talc and molten glass.

Talc, sugar, separator, graphite and two types of glass colorants were tested and a pressing was produced without added color or texture for comparison (fig. 5.1.2.10 - 5.2.1.23).



Fig. 5.1.2.12 & 5.1.2.13 Glass pressed in sand with sugar.



Fig. 5.1.2.10 & 5.1.2.11 Glass pressed in sand with talc.



Fig. 5.1.2.14 & 5.1.2.15 Glass pressed in sand with separator.



Fig. 5.1.2.16 & 5.1.2.17 Glass pressed in sand.



Fig. 5.1.2.20 & 5.1.2.21 Glass pressed in sand with Cerafloat color.



Fig. 5.1.2.18 & 5.1.2.19 Glass pressed in sand with graphite.



Fig. 5.1.2.22 & 5.1.2.23 Glass pressed in sand with Universal color.

# Outcomes

The results were quite thick, heavy and rustic blue and green vessel shapes (fig. 5.1.2.24 - 5.1.2.33).



Fig. 5.1.2.24 Sand-pressed epistemic artifact.



Fig. 5.1.2.25 Sand-pressed epistemic artifact.



Fig. 5.1.2.26 Sand-pressed epistemic artifact.



Fig. 5.1.2.27 Sand-pressed epistemic artifact.



Fig. 5.1.2.28 Sand-pressed epistemic artifact.



Fig. 5.1.2.29 Sand-pressed epistemic artifact



Fig. 5.1.2.30 Sand-pressed epistemic artifact.



Fig. 5.1.2.31 Sand-pressed epistemic artifact.



Fig. 5.1.2.32 Sand-pressed epistemic artifact



Fig. 5.1.2.33 Sand-pressed epistemic artifact.

The switch to soda lime would require quite insignificant adjustments to the existing methods for sand pressing glass, which means that this method does not qualify as a deliberately generated obstacle. The color options will be affected due to the soda lime glass being greenish by default. The form options will be more or less the same. A bit more precaution has to be observed with regards to temperature control while the glass is setting up in the sand, and the working temperature of the glass will need to be higher than the working temperature for sand pressing in modern crystal. This increases energy consumption which brings about a dilemma between the agendas of reducing energy consumption versus recycling materials.

The technique in itself is good for experimentation from a sustainable point of view for a number of reasons; the materials are cheap, there is a minimum of waste and it is fast.

The contribution to furthering expansion of aesthetic spaces of opportunity from this series of experiments is on the level of formal and conceptual development. Although they are in fact recycled it is not explicit through the form that this is the case.

The sand-pressed epistemic artifacts have been reviewed by Magnus Jørgensen, Creative Director of Holmegaard, who recognized a potential in them for development of novel industrial design products. He commented specifically on their rustic and rudimentary appearance that he considered of unique formal aesthetic value, and additionally emphasized the added conceptual value of the material being sustainable.

# **5.1.3.** Ladling into a mold made from waste materials

Ladling into metal or graphite molds is widely used for production of various products like tiles, skipping stones, paperweights, jewelry, tabletops etc. (Etsy Inc., 2016) (fig. 5.1.3.1).



Fig. 5.1.3.1 Graphite molds by Etsy.

The technique offers possibilities for developing intricate relief by carving graphite or routing metal molds. Carving and routing of graphite and metal is quite involved, expensive and time consuming but the ladling is quick and easy.

# Purpose

For this series of experiments, there was no aesthetic aims. To accommodate experimenttation with the technique the idea was to find a sustainable alternative to the expensive and time-consuming existing options for the molds.

Therefore, another sustainable principle was introduced as a deliberately generated obstacle for these experiments, in addition to the material being recycled. Only metal scraps from the metal workshop at the KADK were allowed to be used for the development of a set of tools for producing cast objects. In these experiments, the aesthetic outcomes were meant to reflect the shape and flexibility of the tools by which they were created.

# Procedure

A number of metal scrap pieces was selected from the metal workshop waste bin and cut

to sizes that fit into a fixed format (fig. 5.1.3.2).



Fig. 5.1.3.2 Flexible mold made from scrap metal.

The pieces were then assembled on the marvering table (a thick slab of steel on legs used for glass making). A frame was set up around it using four steel L-irons (fig. 5.1.3.3).



Fig. 5.1.3.3 Setup for casting tiles.

Each time glass had been cast into the frame a new combination was installed in the frame. This way a wide variety of combinations could be obtained from the same selection of scrap pieces (fig. 5.1.3.4 & 5.1.3.5).



Fig 5.1.3.4 Flexible mold and glass tile.



Fig. 5.1.3.5 Flexible mold and glass tile.

Aluminum scraps turned out to melt when being exposed to the hot glass for too long (fig. 5.1.3.6).



Fig. 5.1.3.6 Glass tile with melted aluminum.

An experiment was made using a one mm. thick metal sheet (fig. 5.1.3.7).



Fig. 5.1.3.7 1 mm metal sheet and glass tile.

It stuck a little to the glass but was able to come off without breaking the glass (fig. 5.1.3.8).



Fig 5.1.3.8 1 mm. metal sheet and glass tile.

Higher melting temperature of the metal, more slip and thicker metal reduces the risk of the metal sticking to the glass. It was convenient to be able to remove the frames individually. Cooling the metal bits between casts also reduces risk of the metal sticking to the glass.

## Outcomes

The idea of letting materials, tools and techniques guide form-giving processes has been explored extensively in the Danish design tradition. This strategy allows the designer/craftsperson to bypass personal taste during the creative process, which is productive since sometimes creative professionals are judgmental of their own work before it has reached a level where relatively unbiased reflection is possible.

The obstacle of only being allowed to use waste for the tool became a framework that guided the experiment, and although it was limiting the artistic freedom, it did enable variation over a theme as the mold allowed for different sizes and shapes.

The epistemic artifacts produced during this experiment show just a fraction of the options offered by the alteration of the tool (fig. 5.1.3.9 - 5.1.3.19).









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Fig. 5.1.3.9 – 5.1.3.19 Tiles in different shapes.

The multiple versions that can be produced within the limited format allow for individualization of a semi serial production, which can be incorporated into design and craft as well as architectural applications. Additionally, other tools can be created by using waste metal creatively, hence enabling further innovation.

### 5.1.4. Blowing and colors

Blowing glass has been extensively explored historically and recently, with the emergence of the studio glass movement, also by designers and craft practitioners. I was introduced to this technique during my studies of design at the, then called, Danish Designschool in the 1990'es. During an exchange visit to the Edinburgh College of Art I had the opportunity to blow lead crystal. Having ever only tried blowing the modern crystal available at the Danish Designschool the difference was evident. The lead crystal retains the heat much longer than the modern crystal. Later I went to study at the Rhode Island School of Design, where I had the opportunity to blow Spruce Pine batch, which is a soda lime glass that retains the heat significantly shorter than the modern crystal.

The technique offers a vast variety of technical options that have been mastered by glass blowers historically and contemporarily e.g. by Møhl (2016) (fig. 5.1.4.1).



Fig. 5.1.4.1 Conch Bowl by Tobias Møhl.

### Purpose

The aesthetics explored in these experiments concern clean, simple, elegant, transparent, sharp, cool, symmetry and to contain. The color explorations are divided into coloration by adding color to the entire melt, and by adding color powder after gathering the glass on a blowpipe, the range of colors is not exhaustive but only exemplifies that these are possible routes to explore.

## Procedure

Glass that retains heat for a long time is advantageous for the blowing process. The reason I decided to experiment with this technique anyway was to find out how short the soda lime container glass is in comparison with modern crystal. The initial blowing tests were made together with the second workshop students (fig. 5.1.4.2 & 5.1.4.3).



Fig. 5.1.4.2 Bowl by Bjørn Kauffeldt.



Fig. 5.1.4.3 Tumbler by Maria Sparre-Petersen.

All the participants in the workshop, including myself, had a go at blowing the recycled container glass which proved to perform better than we had expected. It only required reheating a bit more frequently than the modern crystal we normally use.

The outcome of the initial blowing experiments encouraged further experiments in this technique. The glass used for the initial blown objects was a donation from the local supermarket in Nexø that the students had cleaned before melting. This glass was dark green.

The donation from TGI was light clear green and thus, offered the option of being tinted using metal oxides. The oxides for coloring the glass are toxic. Protective gear has to be worn when charging the furnace, and proper filters must be installed in the ventilation system, to absorb the chemical fumes. For the first color experiment cobalt, manganese and chrome oxide was added to a melt of the tubes from TGI (fig. 5.1.4.4).



Fig. 5.1.4.4 Color experiment.

The light green color of the recycled tubing glass was completely dominated by the cobalt. The cobalt also influenced the viscosity that was lowered a bit.

The recycled container glass from Reiling was also light green (fig. 5.1.4.5).



Fig. 5.1.4.5 Recycled container glass.

Manganese and iron was used to produce a greyish color (fig. 5.1.4.6).



Fig. 5.1.4.6 Recycled container glass with manganese and iron.

Cobalt was used to make light blue (fig. 5.1.4.7).



Fig. 5.1.4.7 Recycled container glass with cobalt.

Tests were made with application of color powder, to allow for a greater range of color options for small scale productions and experimental facilities. Colors from the brand Kugler were used since I did not have access to soda lime color powders. If more glass designers and craft professionals converted to soda lime glass I am sure the suppliers would follow, but for now I had to make use of the existing options. Only one of the tests broke (fig. 5.1.4.8 - 5.1.4.13).













Fig. 5.1.4.8 - 13 Recycled container glass with powdered glass color.

This might be because of the stress caused by mixing two different types of glass. More likely, it is because they were dropped on a steel marver and not annealed. The same colors were used on bubbles that were annealed properly and of which none broke.

I decided to use the shape of a half sphere in different thicknesses as color samples as well as the solid nuggets. This allowed for a simultaneous test of aesthetic content. The half sphere being simple and easy to read is also a shape that allows for altering wall thickness and thereby offering information about the relation between thickness and saturation of color.

Bubbles were blown in different sizes, thicknesses and colors (fig.5.1.4.14 - 15).





Fig. 5.1.4.14 – 15 Blowing recycled soda lime glass bubble. Photo by Anne-Marie Bisgaard.

After annealing, the bubbles were cut in half and the edges were polished to achieve a "clean" aesthetic that would support the claim that a range of aesthetic outcomes can be obtained in this type of glass. Also, this shape illustrate that recycled container glass does not look very different from crystal glass when blown into a simple shape. The main differences are the refraction of the light and the sound when hitting the glass. In principle, I assume the waste glass can take any color, either by sorting it into very precise color fractions or by adding colorants to the melt.

Blown bubbles were produced with both green and greyish glass in the melting pot, as well as with powder overlay. One color powder resulted in an opaque and metallic surface (fig. 5.1.4.16).



Fig. 5.1.4.16 Opaque and "metallic" surface on blown object.

This indicates that the firing is reducing which makes the metal ions travel to the surface of the glass when it is reheated in the furnace. There is no gloryhole (reheating kiln) at the SuperFormLab, so I had to reheat in the electrical furnace that does not offer the possibility of adjusting the reheating environment.

In an ideal situation the workshop would include more equipment, and the equipment would be running on renewable energy sources. Building a sustainable glass workshop would be an interesting and relevant class for graduate level glass students and a welcome prerequisite for future research into sustainable glass craft and design.

### Outcomes

The blown bowls are simple, symmetrical, concentric, colored, with a sharp rim that frames the cavity and optically make it difficult to read if they are concave or convex. They are round on the bottom which makes them turn and rock when handled. The colors are secondary and tertiary. The sharp edges are fragile and chip easily which is unpractical. The aesthetic value of "fragile" is often connected to "expensive". Exhibition visitors, judgments include: classic, stylish, beautiful, optical illusion and simplistic (fig. 5.1.4.17 - 29).







Fig. 5.1.4.17 – 29 Blown epistemic artifacts.

Personally I am inclined to only use clear glass when working in modern crystal. Using soda lime forced me to let go of this preference and consider color options. For practitioners normally working in color it would probably be possible to arrive at these results without the deliberately generated obstacle, and the obstacle would be more in terms of being able to get an acceptable range of colors to choose between.

### 5.1.5. Hot-forming

The technique of hot-forming has been used to create both design and craft for as long as glass has been manmade. The very first glass flasks were formed around a sand core. Paper weights and figurines are examples of contemporary design and craft objects in this technique.

### Purpose

A series of hot-formed shapes were made to test how the soda lime glass was performing with this technique, to evaluate the quality of the glass when thick, and to explore aesthetic aspects of organic, softness, chubby and indents. The shapes were produced in a blue, a green and a dark greyish that resulted from the color experiments described above.

### Procedure

Hot-forming required frequent reheating but not nearly as frequent as expected. The glass came out quite homogenous. There were few seeds (tiny bubbles) and hardly any cords (stringy effect in the glass), the refraction of light quite high considering the color. The glass was stable to cutting, grinding and polishing after a regular annealing cycle.

The soft and organic forms hold expressions of feel good, calm and comfortable. The formal language holds stylistic references to modern art. This size indicates paperweight, gift object or hand cooler.

## Outcomes

The shapes describe an organic, transparent, monochrome aesthetic. Audiences have described associations to teeth, knots, clouds, paperweights, body parts, and boxing gloves (fig. 5.1.5.1 - 7).











Fig. 5.1.5.1 – 7 Hot-formed artifacts.

## 5.1.6. Casting

Casting is a technique that has traditionally been used for both design and craft. A wax model for the vase "Une Friese moineaux" by Rene Lalique is in the Corning Museum of Glass (2002) (fig. 5.1.6.1).



Fig. 5.1.6.1 Wax positive for glass vase by Lalique.

It takes years to master this technique, and each casting project can be extremely timeconsuming. Therefore, casters are reluctant to switch to a new type of glass once they have found a particular type that has proven successful. The casting method calls for different qualities than blowing and pressing. Low viscosity at low temperatures is preferable in order for the glass to fill details well. Optic qualities like clarity and high level of refraction are popular.

## Purpose

For the casting experiments formal issues of geometry, static and complexity were

chosen to complement the organic forms created in the hot-forming experiments and the simple forms of the blown experiments.

## Procedure

The first donation of recycled tube glass from the German factory TGI proved fine for casting, but the regular recycled container glass that was donated by the Danish recycling company Reiling, turned out to devitrify before melting into the mold (fig. 5.1.6.2).



Fig. 5.1.6.2 Devitrified soda lime glass casting.

The chemical composition of the glass determines this property that was used as an aesthetic element for fusing experiments later in the process.

Hot-gobbing - a technique where the molten glass is brought directly from the melting furnace into the casting kiln was used for further experimentation with casting (fig. 5.1.6.3).



Fig. 5.1.6.3 Hot-gobbing glass into a preheated mold.

Shapes for the casting experiments were made from expanded polystyrene (EPS) waste collected in the wood and metal workshops at the KADK. Fairly quick and simple shapes were made as an initial trial to find out how the details of the surface of the shapes would translate to the glass, and explore how the soda lime glass performed in this technique (fig. 5.1.6.4).



Fig. 5.1.6.4 Expanded polystyrene positive.

The plaster was reinforced with fiber glass sheet, which did not seem to prevent cracks in the plaster. Recycled plaster chunks were mixed in the plaster to save materials (fig. 5.1.6.5).



Fig. 5.1.6.5 Recycled plaster inserted into plaster mold.

Grinding the recycled plaster down to a powder make the mixing easier but the process of grinding it is very time-consuming. The molds were fired at 600°C to get the expanded polystyrene out (fig. 5.1.6.6).



Fig. 5.1.6.6 Plaster molds ready for burn out.

This method is not recommendable due to the emissions of CO (Doroudiani & Omidian, 2010), unless correct ventilation with proper filters and safety outfits are used. Even then, it should be considered if less environmentally hazardous materials can be used, although the EPS manufacturers claim that this material gives off less carbon monoxide in combustion than organic materials like wood and wool (EPS Packaging Group, 2016). They also call attention to the facts that expanded although polystyrene being а nondegradable material is recyclable, consist of 98 % air and that the manufacture of it is a low pollution process. Nevertheless, it is probably wise to be careful when burning any material, and to be careful when using trash as a resource!!

The details of the positive transferred with a high degree of precision (fig. 5.1.6.7).



Fig. 5.1.6.7 Details transferred from positive to plaster mold.

The EPS left debris in the molds that was removed using a vacuum cleaner with appropriate dust filters. Then they were taken up to 890°C, at which temperature the hot glass was filled into them by the hotgobbing technique. After being annealed the plaster was removed and the glass was cleaned with water soap and a toothbrush (fig. 5.1.6.8 & 5.1.6.9).





Fig. 5.1.6.8 & 5.1.6.9 Glass casting before and after removal of the plaster investment mold.

Again, the details of the mold transferred with a high degree of precision (fig. 5.1.6.10 & 5.1.6.11).





Fig. 5.1.6.10 & 5.1.6.11 Cast epistemic artifacts.

Experiments were made with surface treatments to enable more smooth surfaces.

A thick layer of soap made a scruffy surface (fig. 5.1.6.12).



Fig. 5.1.6.12 A layer of soap adds a new texture to the EPS.

A thick layer of plaster covered the underlying material (fig. 5.1.6.13).



Fig. 5.1.6.13 A thick layer of plaster cover the texture of the EPS.

A thin layer of plaster partially erased the underlying texture (fig. 5.1.6.14).



Fig. 5.1.6.14 A thin layer of plaster partially covers the texture of EPS.

A mix of flour and water made its own crackle texture on top of the underlying texture (fig. 5.1.6.15).



Fig. 5.1.6.15 A mix of flour and water adds a new texture to EPS.
Glue in different thicknesses softened the details of the structure of the underlying material (fig. 5.1.6.16).



Fig. 5.1.6.16 Glue in different thicknesses softens the details of the EPS.

Large pieces were made to test how scale would influence the outcomes. The formal theme of geometry was chosen for the technical explorations of these castings. A number of rectangular shapes were cut out of EPS and glued together with wood glue (fig. 5.1.6.17).



Fig. 5.1.6.17 Positives made from EPS and wood glue.

The surfaces were covered in a thin layer of plaster that would break off and leave the surface of the plaster smooth, when the molds were fired to get the EPS out (fig. 5.1.6.18).



Fig. 5.1.6.18 EPS with plaster coating.

Casting boxes were used to avoid leakage during the casting of the 70 liter molds. The casting mold were reinforced with fiber glass sheet (fig. 5.1.6.19).



Fig. 5.1.6.19 Casting a mold.

The mold was biscuit fired to get the EPS out (fig. 5.1.6.20).



Fig. 5.1.6.20 Placing the mold in the annealer.

For the first 2 large casting I used a silicaplaster mix which had worked for the smaller castings. But the weight of the glass poured into the large molds made them break and the glass ran out. Especially the largest one ran out fast, and the firing was immediately crash cooled to prevent damage on the kiln. Unsuccessful annealing cycles resulted in both pieces cracking. The pieces were cleaned up and left for a while, for later reflection and contemplation (fig. 5.1.6.21).



Fig. 5.1.6.21 Removing the plaster from a casting.

For the next mold silica was replaced with tennis court sand which is cheaper than silica and chicken wire reinforcement was used instead of fiberglass. The new mold held up (fig. 5.1.6.22).



Fig. 5.1.6.22 Mold filled with glass.

Although the annealing cycle was increased for each new casting the next three castings also cracked in the cooling process (fig. 5.1.6.23).



Fig. 5.1.6.23 Crack in glass.

#### Outcomes

The largest epistemic artifact resulting from a broken mold had elements of geometry and organic elements that were in contrast; and thin parts that contrasted the thick parts, altogether generating quite a dramatic composition. The formal language being dynamic and aggressive (fig. 5.1.6.24).



Fig. 5.1.6.24 Cast epistemic artifact.

The second large casting did not run out as much and therefore the geometrical parts became dominating only interrupted by occasional organic elements. The formal language of this epistemic artifact was static, grounded and heavy (fig. 5.1.6.25).



Fig. 5.1.6.25 Cast epistemic artifact.

The third epistemic artifact came out geometrical as intended with only minor "wings" from glass running out into small cracks in the plaster. It had a rough texture, as a result of beginning devitrification, that was contrasting the rigidity of the geometrical composition. The formal language being static and composed (fig. 5.1.6.26).



Fig. 5.1.6.26 Cast epistemic artifact.

#### 5.1.7. Fusing

In recent years fusing and slumping glass has become a mainstream activity like doing ceramics, due to the relatively cheap and easy access to hobby materials and equipment that has followed in the wake of the studio glass movement. Fusing basically means "melting together", and slumping is the process of forming the glass by heating it up until it moves enough to fall into a mold or a cavity. Glass fusing is done in a kiln where the glass is taken up to 820 - 1050°C depending on the type of glass and annealed in the same kiln. Slumping is done at lower temperatures depending on the type of the glass and the intended deformation of the glass. The technique is used for a variety of products and even if it is a simple and relatively easy technique it does hold plenty of potential for experimentation also in combination with other glass forming techniques.

The experiments done in this project has been exploring patterns following a line of works done during my graduate studies at the Danish Designschool (fig. 5.1.7.1 - 3).







Fig. 5.1.7.1 - 3 Fused recycled float glass by Maria Sparre-Petersen.

#### Purposes

The experiments were made with the glass that was left over from the other experiments, and with components made when the pot had to be emptied between melts. This way waste from my own production could be recycled. Aesthetic issues of pattern, repetition, composition and decoration were explored.

#### Procedures

The first group was made of the glass donated by TGI that came in tubes which were used in combination with the leftover melted glass scraps (fig. 5.1.7.4 - 7).









Fig. 5.1.7.4 - 7 Fusing test setup.

While the contrast between the clear tubes and the frit was well defined in the setup it did not show much in the fused results (fig. 5.1.7.8-11).







Fig. 5.1.7.8 -11 Fused tubing glass.

A test was done with Universal color, a lead free water-based color for ceramics and glass, available in 43 nuances for firing at  $920 - 1300^{\circ}$ C. The aim was to achieve a more defined division between the tubes and the cross.

The color was applied to the tubes that were filled with cross inside and outside much like the previous tests, and taken up to 950°C.

The outline of the tubes almost completely disappeared and the result was a block of green glass with smudgy inclusions of white. (fig. 5.1.7.12).



Fig. 5.1.7.12 Soda lime tubing glass with Universal color.

Another test was made using clear tubes filled up with blue scraps. This test also came out with a smudgy result (fig. 5.1.7.13).



Fig. 5.1.7.13 Soda lime glass with color inclusion.

Additional tests in this technique were made by dipping large and small scraps of glass in the water-based led free color and fusing them together with frits of different grain sizes and colors (fig. 5.1.7.14 - 17).







Fig. 5.1.7.14 – 17 Fused glass scraps with color inclusions.

And yet other tests were made by fusing scraps into slabs (fig. 5.1.7.18 - 21).





Fig. 5.1.7.18 - 21 Slabs made from left over glass scraps.

When empting the pot in between melts the glass was ladled into blocks originally

intended for casting experiments. Since the recycled container glass turned out to devitrify significantly, they could not be used for casting and instead a number of these blocks were used for fusing experiments. In order to minimize devitrification, the glass was crash-cooled which resulted in a translucent surface (fig. 5.1.7.22).



Fig. 5.1.7.22 Test of crash cooling soda lime glass to control devitrifying.

After a color melt the melting pot was cleaned with a clear melt. A test was performed by hot-gobbing the clear melt including the blue leftovers into a fusing setup held at 900°C (fig. 5.1.7.23).



Fig. 5.1.7.23 Reuse of the waste glass from cleaning the pot after a color melt.

#### Outcomes

The ideas of recycling scraps from studio production and using devitrification as an aesthetic component are not new. Nevertheless, the fusing experiments are displaying a range of aesthetic options of pattern, repetition, composition and decoration in support of the claim that the sustainable principle of recycling as a deliberately generated obstacle may facilitate development of novel aesthetic form.

## **5.1.8.** Evaluation of the outcomes of the personal experimentation

The strategy of introducing recycled waste materials as deliberately generated obstacles in the creative processes of my personal artistic practice has been described for each of the techniques in the previous subsections. This has produced knowledge and insight on several levels. In this subsection, I will evaluate the findings with regards to their contribution to expansion of aesthetic spaces of opportunity and to sustainable development.

The issue of contribution to expansion of aesthetic spaces of opportunity will be evaluated in relation to the dual aim of the research question. First, I will address *if* aesthetic innovation may derive from informing creative processes by sustainable principles. Then I will address *how* this has been unfolded in the experimental activities. The issue of contribution to sustainable development will be addressed in a similar fashion.

# Contribution to expansion of aesthetic spaces of opportunity

The evaluation of the aesthetics is referring to the distinction between envisioned and perceived aesthetics. The envisioned aesthetics for each group of epistemic artifacts has been presented in the previous subsections and will initially be briefly summarized. The perceived aesthetics will be analysed for each group of experiments and the analysis will frame a comparison of the range of the produced aesthetic outcomes as well as a discussion of the relation between the envisioned and the perceived aesthetics, to address the issue *if* sustainable principles may lead to aesthetic innovation.

*How* introduction of sustainable principles in creative processes may lead to innovation will be discussed in relation to the distinction between artistic research, scientific research and professional practice.

The envisioned aesthetics explored in the experiments include issues of shape, size, color, texture, transparence, opacity, refraction and decoration. Specific issues for the individual groups of experiments are as follows:

Pressing in concrete molds:

Rustic/classic, sharpness of detail, difference in inside and outside shape, wall thickness and symmetry/asymmetry.

Pressing into sand molds:

Spontaneous shapes, letting the materials and technique guide the aesthetics.

Flexible mold:

Strategy of deliberately generated obstacles, tools and techniques guide the aesthetics.

Blowing and colors:

Clean, simple, elegant, transparent, sharp, cool, symmetry and to contain.

Hot-forming: Organic, softness, chubby and indents.

Casting:

Geometry, static and complexity.

Fusing:

Pattern, repetition, composition and decoration.

The epistemic artifacts resulting from the deliberately generated obstacles in the creative processes of my personal experimental activities describe a range of aesthetics (fig. XX - XX). A selected group of epistemic artifacts from each of the explored techniques will be evaluated with regard to:

- Form
- Decoration
- Optical qualities
- Conceptual reference
- Cultural reference
- Reference to envisioned aesthetics

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Pressed epistemic artefacts (fig. 5.1.8.1a & 1b).

Form:

Round, shallow "shell shapes" with diagonal groves on the outside. Sharp and flat or soft and rounded edges. Clear, slightly textured surface. Sizes  $\emptyset$ : 11 - 17 cm.

Colors: Light green and light blue.

Optical qualities: Transparent with refraction and reflection.

Conceptual references:

They evoke references of function, classic, to contain, stability, decoration and romantic.

Material cultural reference:

Their formal language is associated with snack bowls and decorative bowls.

Reference to envisioned aesthetics:

Envisioned and perceived aesthetics coincided.



Sand-pressed epistemic artefacts (fig. 5.1.8.2).

## Form:

Shallow "shell shapes" with multiple soft indents. Bumpy outlines. Soft thick edges. Clear inside surface, textured outside surface. Sizes  $9 \times 17 - 25 \times 28$  cm.

## Colors: Light green and light blue.

Optical qualities:

Transparent inside with refraction and reflection, translucent on the outside.

Conceptual references:

Function, rustic, to contain, stability and play.

Material cultural reference:

Their formal language evokes associations to snack bowls and decorative bowls, serving dishes, clouds.

Reference to envisioned aesthetics: Aesthetics follow spontaneous action in the workshop.



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Epistemic artefacts cast in mold made from recycled metal (fig. 5.1.8.3).

Form:

Geometric, square solid shapes with relief surface on one side. Soft edges. Clear surface. Sizes  $7 \times 9 \text{ cm}$ .  $-11 \times 12 \text{ cm}$ .

Colors: Light green, light blue and greyish.

Optical qualities: Transparent with refraction and reflection.

Conceptual references:

They evoke references of function, surface, pattern, stability, decoration, compact, thickness, complexity, geometry, system.

Material cultural reference:

Their formal language is associated with tiles, bricks, paperweights and skylights.

Reference to envisioned aesthetics: Aesthetics dictated by strategy, tools and technique.



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Blown epistemic artefacts (fig. 5.1.8.4).

Form:

Simple, round half spheres. Shallow and tight with round bottoms. Their wall thicknesses are between 2 and 12 mm. The edges are sharp, polished and precise. Sizes 7-15 cm.

## Colors:

Clear light green, clear light greyish, semi opaque dusty grey, semi opaque rose, semi opaque gold.

Optical qualities:

The colored artifacts are semi-transparent and has low refraction of light. The clear and transparent.

Conceptual references:

Function, clean, cool, to move and to contain.

Material cultural reference:

Their formal language is associated with salt containers, snack bowls and yogurt bowls.

Reference to envisioned aesthetics:

Envisioned and perceived aesthetics coincided.



125

Hot-formed epistemic artefacts (fig. 5.1.8.5).

Form:

Organic solid shapes with indents on the top surface. Clear surface, round bottom. Sizes  $\emptyset$ : 7 – 11 cm.

Colors: Light green, light blue and dark greyish.

Optical qualities: Transparent with refraction and reflection.

Conceptual references: Function, decoration and play.

Material cultural reference: Their formal language evokes associations to paperweights, wobbles and souvenirs.

Reference to envisioned aesthetics: Envisioned and perceived aesthetics coincided.



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Cast epistemic artefact (fig. 5.1.8.6).

Form: Solid shape with geometrical and organic elements. Size 25 x 35 x 40 cm.

Colors: Green.

Optical qualities: Transparent and translucent.

Conceptual references: Dramatic, heavy, complex, organic and geometric, dynamic, aggressive.

Material cultural reference:

The formal language evokes associations to ice, accidents, decoration and sculptural objects.

Reference to envisioned aesthetics: Envisioned and perceived aesthetics did not coincide.



129

Fused epistemic artefact (fig. 5.1.8.7).

Form: Solid geometrical square shape composed of square components of varying sizes. Size 30 x 7 x 50 cm.

Color: Light green.

Optical qualities: Translucent.

Conceptual reference: Stability, solidity, heavy, static.

#### Material cultural reference:

The formal language evokes associations to building blocks, ice, elephant skin, gravestones, decoration and sculptural objects.

Reference to envisioned aesthetics:

Aesthetic derived from process and material, as well as from envisioned aesthetics. Envisioned and perceived aesthetics did not coincide initially.



The comparison of the analysis of the aesthetic values of the epistemic artifacts reveal that the artifacts do cover a range of different aesthetic qualities with regard to all the five elements of the analysis, the color range being the most limited. This indicates that aesthetic variety can be achieved in the recycled soda lime glass, while the question if *aesthetic innovation* may be achieved on the basis of sustainable principles remain unanswered.

The comparison between the envisioned and the perceived aesthetics show that the envisioned aesthetics in certain experiments was something that would reveal itself in the process and therefore became manifest as aesthetics only through the epistemic artifacts. Hence, the envisioned aesthetics turned out to have a dual character. There were envisioned aesthetics that express preconceived envisioned aesthetics and there were envisioned aesthetics that were revealing themselves through the creative process where the aesthetics of the endresult was determined by something other than the practitioners' preconceived aesthetic notions. In the latter instance it can be argued that the aesthetics did not exist already and thus was new, which indicates that expansion of aesthetic spaces of opportunity occurred. Here. the classifications of the meta aesthetics, the normative aesthetics and the applied aesthetics become relevant, since the discussion in this incident has moved from the category of applied aesthetics to the category of normative aesthetics, since a new aesthetic conception has emerged that can contribute to the definition of a new aesthetic norm. If we use this definition as a criterion for assessment of aesthetic innovation, the aesthetics of the artifacts where envisioned and perceived aesthetics do not coincide may be innovative, and the artifacts where no envisioned aesthetics were pursued may be innovative and hence, may contribute to a change of our aesthetic norms. Whereas the artifacts where the envisioned and the perceived aesthetics are coinciding may not be innovative.

According to this criterion the experiments in the subsections 5.1.2, 5.1.3 and 5.1.6 are examples of experiments that has generated aesthetic innovation. This does not necessarily mean that the new aesthetics are good or bad, but it is safe to conclude that the strategy of introducing sustainable principles in creative processes can indeed contribute to aesthetic innovation.

The question of *how* sustainable principles may lead to innovation is connected to the discussion of artistic research vs. scientific research, and can be described by taking a closer look at the three experiments that show signs of innovation.

The experiments in subsections 5.1.2 and 5.1.3 were performed without envisioned aesthetics, which can then be concluded to be a strategy for generating aesthetic innovation. The experiments in subsection 5.1.6 did have envisioned aesthetics as described in the beginning of the same subsection.

These experiments, rudimentary and revealing my lack of experience and routine with the casting technique, still brought about epistemic artifacts, with aesthetic value that did not exist before they were created, and therefore could contribute to aesthetic reflection. At the time when all the accidents happened, I was so frustrated that my exploration of this particular envisioned aesthetics had failed. So, I called Artist Jørgensen, Martin Nannestad who generously accepted my plea for help. He asked me why I did these experiments, and why I did them in this particular way and lots of other questions and I showed him all of the epistemic artifacts I had already produced and explained the intentions with all the different experiments. First he was nice and listened, and then he commented that I just had to present the facts i.e. what I had done, why I had done it and what came out of it. And besides he thought the biggest of the failed experiments was interesting!

This incident paraphrases the difference of attitude in scientific research, artistic research and practice. Adopting a scientific attitude, I would seek an explanation for the cracking. In this case, the explanation could have been wrong annealing temperature, too sharp corners in the mold or contaminants in the glass. Another explanation could have been that the formula used to calculate the annealing cycle was wrong and had to be adjusted which would be to adjust the theory of annealing. When the theory and the results of the experiments came to correspond, I would have produced new knowledge about annealing that could have produced new theory. Then I could subject the new scientific theory to testing, and until it was tested wrong I would trust it.

The attitude of the professional practice would be to employ the knowledge attained through the experimentation and many years of experience possibly but not necessarily along with literary research, which would enable fixing the cracking so that the pieces of glass could be as intended.

The artistic attitude completely is autonomous and therefore can respond to in unexpected ways. reality When confronted with the possibility that "the failure" might be interesting from an artistic point of view, I realized I had been trying to produce a correct answer to how sustainability could inform aesthetic innovation in my attempt to produce knowledge. Instead if an artistic point of view was adopted I could understand the experimental process as a way to make the world appear in a new way. To find out through experience what sustainability in glass design and craft was all about. In her practice based Ph.D. thesis about Højlund, whose artistic practice is drawing (2011) describes drawing as something that can approach the world and make the world appear and at the same time create a gap, a lack of meaning. The epistemic artifacts resulting from the experiments in subsection 5.1.6 were like Højlund's drawings. They approached the world and made the world appear and at the same time created a "lack of meaning".

Højlund's description of how drawing relates to the world by connecting the interference between that which has been and that which is and that which is to become pinpoints the nature of artistic research. It is about embracing that which we cannot understand, the incomprehensible, the failures, the sublime, zero and infinity and create new realities from it, make sense of it and make non-sense of it. It is about accepting what is coming back to us when we send something out. It is about being attentive, to materials and to how aesthetics become manifest through our interaction with them in processes over time.

When we recognize the difference between the artistic research, the scientific research and our practice we can begin to address how to evaluate our experiments from the three different perspectives. What is a mistake that calls for correction from the point of view of scientific research may be creating a gap that is significant from the point of view of artistic research and what is insignificant in artistic research may be quite relevant in practice etc.

The initial research question asked if and how sustainable principles may contribute to aesthetic innovation, and through the experiments I have attempted to answer these questions. In some instances, the sustainable principle of using recycled glass led to aesthetic outcomes that I would not have generated without the use of recycled glass. In other instances, the aesthetic outcomes could have been made with any type of glass. When evaluated from a glass practice point of view it could be relevant to ask if these artifacts would look different if they were made in e.g. green crystal. Or, if the particular material is adding something to the artifacts that could not be expressed in any other media. The answer to those questions are that they could probably all be produced in green crystal and look more or less the same. Without an explanation, nobody would know the difference. From this point of view, the glass being recycled can therefore be rendered insignificant. From a point of view of artistic research, a relevant question would be if it is important that the aesthetics is dictated or even informed by the glass being recycled. As discussed in section 3.4 the "sustainable aesthetics" strategy is indeed considered relevant by several practitioners and theorists, Harper, Walker and Skriver to be the "correct" solution to the question of sustainability in the creative arts. The epistemic artifacts that was sent in to the juried exhibition were both accepted, which indicate that the artistic value of the work was recognized regardless of the glass being recycled by the five jury members of the Charlottenborg Springexhibition artist FOS, artist Molly Haslund, architect Anders Abraham, designer Anton Alvarez and curator Thorsten Sadowsky.

The results of the experiments done in this research thus suggest that there are several answers to the question of *how* sustainable principles may inform the creative processes and contribute to aesthetic innovation is. One answer is that it can be used as a deliberately generated obstacle to inform the

creative processes and contribute to aesthetic innovation as in the experiments described in subsections 5.1.2 and 5.1.3, that would not have developed that way without the use of the recycled tools and materials. This result strategy may in "sustainable aesthetics" or it may not, depending on the envisioned aesthetics of the individual practitioner. Hopefully, one day all practices will be sustainable which would render the obstacles obsolete. Another answer is that sustainable principles can be included as a part of a philosophical and ethical foundation for artistic practice, as in the experiment 5.1.6. where the glass being recycled is just that, it does not justify the work, it does not feed the work, the material just happens to be recycled, and the aesthetics are derived from the experimental creative process and the lack of good craftsmanship causing the failure.

This way the issues of ethics can be divorced from the issues of aesthetics and each can be recognized in its own right the ethics for addressing our behavior, and aesthetics for being more like a language that would be insufficient if it was decided that only one phrase was proper and correct, which would also be unethical.

From the point of view of the science of material culture, a relevant question could then be how to handle the relations between ethics and aesthetics. From the point of view of practice-based research in glass craft and design it would be relevant to further research expansion of the aesthetic spaces of opportunity through experimentation with this material and the different techniques that have only been briefly researched in this study.

#### Contribution to sustainable development

The practicalities of establishing а sustainable technical foundation for the aesthetical aspects of the experiments has first of all brought attention to the difficulty of finding materials, tool, techniques and processes that are fully sustainable financially, environmentally and socially. Some materials are extremely harmful e.g. lead and barium carbonate, and can and should be avoided completely. Others are less harmful while they should still be handled professionally and with precaution. This includes the vast majority of the oxides used for coloring the glass. The recycled glass is less harmful to handle than batch (new raw materials), because most of the toxic fumes from the raw materials are released in the first melting procedure, still e.g. the shoveling of cullet into a furnace generates dust that is unhealthy to breathe. The mold making processes involved especially in the casting and pressing techniques requires extra precautions both with regards to firing natural and synthetic materials and with regards to the processes by which the molds are fabricated. The use of EPS for mold-making is an example of the dilemma between using a recycled material, while having to deal with the toxic fumes it gives off when fired. In each of these dilemmas the benefits have to be evaluated against the draw backs, and often it is difficult to determine which one is the least harmful solution.

To illustrate such a dilemma of not having access to the necessary knowledge to be able to judge on an informed basis I will use the example from this research: I have proposed replacing modern crystal with recycled soda lime container glass. The recyclability of the substitute material being the sustainable aspect of this proposition. The recyclability of the container glass has to be held up against the fact that that it requires a higher melting temperature. In order to determine which material is more sustainable a detailed lifecycle analysis would have to be conducted for each design and craft product. Such an analysis is expensive and hence, relevant for container products that are so high in numbers that statistics actually matter. Handmade glass design and craft products are so small in numbers that it would not be financially sustainable to conduct LCAs for them, and without hard statistical facts determination of the most sustainable procedure can only be based on a common sense and roughly estimated judgment.

Here it is relevant to note that the energy consumption issue is different for fully industrialized design products and craft products. The glass for many industrialized design products is made from raw materials cf. container glass where the energy consumption is lowered dramatically by using cullet (Glass Packaging Institute [GPI], 2016), while most craft businesses (in Europe) are using pre-melted modern crystals that can be melted at much lower temperatures than recycled container glass. Another dilemma is illustrated by the development of the concrete press molds. The plaster turned out to be the least toxic and the cheapest and easiest material for creating the positives for casting the concrete press molds but the plaster required biscuit firing of the molds for the plaster positives to come out which is energy and time consuming and could be avoided using other more toxic materials such as silicone. Hence, before assessing whether sustainable principles may inform aesthetic innovation it is important to be aware that such dilemmas make it difficult to determine what principles are factually the most sustainable.

The development of molds from waste materials for production of tiles is an example of an experiment that was easier to evaluate in terms of the sustainable contribution. This experiment included an additional sustainable principle of using waste materials for making the tool for the development of the aesthetic outcomes. The tool like the material could also be recycled after serving as tool for a while. The combinations could be altered indefinitely adding a unique quality to the results, which would improve their market value and enhance their up-cycling value.

## **Concluding remarks**

The approach of both aspects of the explorations is derived from the artistic tradition I am rooted in which is characterized by its autonomous nature, and unwillingness to succumb to any system or structure other than self-inflicted ones. The

framework of the technical explorations may be characterized as scientific in-as-much as the results can be replicated, and thus validated or refuted by others. The content of the aesthetic explorations being artistic by default cannot be judged true or false. They are epistemic artifacts that illustrate options that may inspire other practitioners to include sustainable principles in their practices, and they may be refined in future work. I do not regard the epistemic artifacts scientific results or finalized works of craft or design. I view them as empirical materials supporting my artistic and scientific research.

To avoid aesthetic conformity in the empirical material that may result from my personal aesthetic preferences and artistic position, and to support my proposal that sustainable principle may be included as a foundational part of any artistic practice explorations of other designers' project ideas has been conducted and will be reviewed in section 5.3.

The results of my personal experiments may additionally be interpreted as physical epistemological manifestations incorporating the "circular economy" approach in terms of utilizing trash as a resource (Pearce & Turner, 1990). They are not exhaustive of the aesthetic opportunities offered by the recycled soda lime glass, but merely illustrate a small selection of aesthetic outcomes while at the same time suggesting some approaches to change of habitual practice that can be copied and/or further developed by myself or others. I find it safe to claim that my personal experimentation with the different techniques has altogether supported the thesis that introduction of sustainable principles as deliberately generated obstacles in creative processes can indeed support expansion of aesthetic spaces of opportunity, in spite of many limitations. While this may not be the only approach to incorporation of sustainable principles in artistic practices.

The pressing technique has produced a new method for experimentation involving high fired concrete pressing molds, which is a contribution to the practice of glassmaking in general. The experiment involving pressing into sand has shown promising results seen from a business point of view. Experimentation with blowing and hotforming the glass proved less difficult than expected. Development of color options showed promising possibilities for working with powdered colors as well as with dyeing entire melts. The making of the tool from waste metal is a conceptual strategy that is not new, but there is reason to believe it will grow in the future as we become more and more dependent on waste as a resource. Casting the soda lime glass and the process of making the molds turned out to produce aesthetic innovation. Fusing recycled container glass turned out to display a high degree of devitrification, which is a strong limitation, while also an aesthetic option.

The introduction of the sustainable principle of recycling waste in my personal experiments has revealed possibilities as well as obstacles. Both have informed the experimentation carried out in the student workshops, the collaborations with individual students and professionals and the interventions, that in turn have influenced the development of ideas for new experiments.

## 5.2. Workshops with students

As discussed in subsection 3.3.2 sustainable development may be enhanced periodically by trends and fads, but what is called for are radical and lasting changes and therefore we need to address the issues in the education of future generations of designers and crafts practitioners. As a teacher and teacher-cum-Ph.D. candidate at the KADK I have had the opportunity to influence the education of the next generation of glass designers and craft professionals, by including elements of my research in my teaching activities. I have used this opportunity during the project by leading period two workshops specifically on glass and sustainability and contributing to a workshop on digital modelling led by my colleague Flemming Tvede Hansen.

The first workshop included students without previous experience in glass making, the second students with basic to intermediate experience and the last included ceramic students with knowledge about glazes but not about glass as the primary medium. The section is divided into three subsections describing the purposes, proceedings and outcomes of the workshops. The findings are evaluated and concluded in subsection 5.2.4.

## General purposes of the activities

A glass-maker may have spent a lifetime developing personal competences that only works with particular materials, colors, tools and timing. Therefore, changing from one material to another can be an overwhelming endeavor. If one variable is changed in a process that rely on the accumulation of practical tacit, explicit, scientific and artistic knowledge and insight the process may be interrupted to an extent that the level of refinement cannot be upheld causing the artist's business to fail the customer's demands. Rising prices of raw materials and energy may force some to change their equipment and materials, and increasing awareness of the environmental state of the earth may provoke change where financial issues fail to force it on people. In both cases, knowledge and insight about the consequences of such a change may influence the success or failure of implementation of new sustainable methods, materials or processes.

At the recent Glass Art Society Conference, I attended the Green Panel discussion forum and posed the question to the equipment manufacturers on the panel whether the market is mature for launching new equipment that runs on renewable energy. The answer from panelist Fred Metz, Founder of Spiral Arts Inc. (2016), was that whether or not the market was ready, the relatively small businesses specializing in building equipment for glassmakers did not have the necessary resources to carry out the research and development it would require to launch that type of equipment. The focus of these businesses is on optimizing energy use by building energy efficient new equipment and optimizing their customers' existing equipment. These conditions speak for setting in before the practitioners build their businesses and their production facilities. If the new generations acquire knowledge through their education, demand sustainable solutions and join forces with the equipment manufacturers to find the recourses for research and development, the field will be better equipped to make contributions on the practical level.

In the community of creative glass professionals, there is a tradition of young generations working as assistants to older generations. This secures a strong cultural field-specific identity and an international network of knowledge sharing. But, as long as the available equipment is running on non-renewable energy sources and the masters are using non-renewable materials the new generations will learn practices based on these foundations. Most glass designers and craft professionals do attend an academic glass program at some point in their career, and thus the schools can influence how the new generations develop their habitual practices. This places responsibility as well as opportunity in the hands of the educators.

Fry (2009) describes how a sustainable development must entail a shift in paradigms to an approach to design that starts with a deep understanding of the full holistic impact of design on our planet. He claims that the current mainstream understanding of design is simplistic and concerned less with impact than with form. The student workshops I organized, addressed how such a shift of paradigm, towards a practice that is concerned with form, based on a deep understanding of impact, could be initiated. During the workshops practical, creative, hands on experiments with recycled and sustainable materials, tools and methods were complemented by discussions of issues of sustainability, how to go about initiating a paradigm shift, whether they believed we can make a difference etc.

The education of young practitioners of glass design and craft involve engaging the students in creative processes ideally with relatively free experimentation in the material in order to secure that the students acquire knowledge of the characteristics of materials as well as a skill level that enables them to generate innovative ideas. The personal experiments with materials, tools, techniques and technologies described in the previous section accommodated such experimentation in recycled soda lime glass, and the findings from these experiment were therefore, introduced to the students in the workshops.

Thus, the results of my own experiments worked as a starting point for the students' experimentation, and they were asked to share and elaborate on each other's ideas in a similar way. The results of the experiments carried out by workshop participants fed back into the next series of my own experiments and occasionally unanticipated results beneficially influenced the approach to a following series of experiments.

The activities had multiple purposes. Sustainable development, as discussed in section 3.3, balances environmental, social and economic conditions. Accordingly, the collaborative format was intended to give them competences in teamwork and research and to make them focus on the social aspects of the trade. The workshop format was chosen for the two activities to secure that the research project as well as the workshop participants could benefit from the results of the extended line of experiments. Experimentation with hot glass in particular required group efforts for experiments that would be impossible to carry out as a single person. The project benefitted from the expanded empirical material produced by letting the students inform their creative processes with sustainable principles, and evaluate the aesthetic outcomes of their efforts with regard to expansion of aesthetic spaces of opportunity. At the same time the students acquired knowledge about sustainable alternatives to the existing materials, tool, techniques and technologies, which they would need in case they chose to dedicate their future work wholly or partly to sustainable practices.

By engaging students in the workshops, I could simultaneously, explore how the

issues of sustainability was received by students with different levels of artistic mastery as well as different levels of habitual practice and different attitudes toward inclusion of principles of sustainability in their own artistic practices. This provided qualitative information about pedagogical, motivational and structural conditions that could influence generation of ideas for operational practical strategies for future implementation of teaching activities with sustainable development content within the educational framework.

## 5.2.1. Workshop with non-glass majors

The first workshop was held at the KADK in the spring of 2013. The workshop participants included three students from the KADK's own graduate program, with little or no experience with glass as a form giving material, and seven international exchange students without any experience with glass. The group was selected to represent nonglass majors in order to detect possible differences in viewpoint between novices and more advanced students. I was assuming the novices would be more open to the ideas of sustainability than the experienced students, which turned out to be true.

# Specific purpose of the Experimental Glass Workshop

As stated in the general purposes of the section the workshops had a dual aim of contributing empirical material in the form of epistemic artifacts as well as in the form of contributions to sustainable development.

As mentioned in section 3.3 Walker (2006), Fry (2009) and others are calling out the design fields to initiate and implement the sustainable development, and some of them are proposing ways in which the changes may be facilitated. As proposed in the same section, this workshop aimed at sharing ideas across field specific boundaries by including non-glass majors in the research efforts. The students came from industrial design, architecture, textiles etc., and the knowledge they acquired through this workshop can be directly and indirectly applied and further developed in their future projects, both on a theoretical and a practical level.

#### Procedures

The students had chosen the workshop amongst a series of competitive modules in the elective module system existing at the institution at the time. The content of the workshop was described as follows:

## Experimental Glass Workshop Experiments in glass and sustainability

"Could sustainability be a source of inspiration in the design process?"

This question is the starting point of a collaborative research project where students at the Designschool will get an opportunity to experiment with glass focusing on sustainable principles and methodologies during a five-week process. An introduction to a number of tools and

techniques will form the basis for idea generation and sketching directly in the material. Students define and execute experiments for a material database that enables improvement of existing products and possibly even point to new applications of the material.

#### General learning objectives:

•Ability to handle relevant materials and technologies

•Ability to orchestrate a knowledge production with emphasis on research and idea generation.

#### Specific learning objectives:

Students will become familiar with the use of the kilns in SuperFormLab (a laboratory for silica-based materials), and will acquire access to the use of the machinery for cold working ceramic materials (including glass, stone, concrete etc.). A series of material tests and possibly prototypes that can point towards alternative applications for the materials will be produced

The students were introduced to the theoretical aspects of the technical properties of the three different glass types: crystal, soda lime and borosilicate glass, as well as to environmental benefits of recycling, theories of sustainability and of course safety procedures. They learned a number of techniques such as fusing, slumping, cold working, color decorating, casting and pressing. The assignment was to produce a database of experiments rather than finished products.

Most of the international students were novices in material specific subjects, new to experimental practice, and mainly used to draw their work and present digitally rather
than physically, which is common for design students today.

During the first week the students created material samples using cutting, fusing, slumping and color decoration, and they learned the basics of kiln programming (fig. 5.2.1.1 - 12).

























Fig. 5.2.1.1 - 12 Collection of samples with window glass and lead free water based colors for printing on glass and ceramics.

Through these tests the students were provided general knowledge of decoration opportunities of working in flat glass using color, inclusions or layering of the glass. They became familiar with cutting, grinding and polishing glass and gained knowledge of the alterations of the form of the glass when firing at different temperatures. They were introduced to different ways of testing for compatibility, and how to determine the tinside of the float glass. By sharing the tests, they learned from each other and managed to cover several techniques. They learned how to prepare kiln-shelves and bricks with separator or separator-paper to keep the glass from sticking how to set up the shelves using a level and how to place the work in the kiln and secure circulation of the heat. They learned how to program the kilns, how to calculate annealing cycles, how to test the kilns for temperature differences in the horizontal and vertical directions and to

estimate when to open the kilns after the firing.

In the second week, they were introduced to mold making in concrete and pressing molten soda lime glass. In the following 3 weeks, they experimented freely with the different techniques producing a variety of samples (fig. 5.2.1.13 - 23).

















Fig. 5.2.1.13 – 23 Results of student's experiments.

#### Outcomes

The students were encouraged to think of themselves as a research team working together on a project aimed at revealing new aesthetic possibilities for recycled soda lime glass. This framework diverted the focus from the traditional aim of producing products for a portfolio. Instead, an atmosphere of curiosity and explorative attitude brought about a willingness to share knowledge and thus, an ability to generate more ideas and material manifestations of the ideas.

The students were very enthusiastic about experimentation and felt inspired by the interaction with the materials. The research approach was opening up new questions about how innovation may occur, the role of experimentation and of practical interaction with materials.

The students generally agreed that the experimentation led to aesthetic innovation. Whether the aesthetic innovation was a direct consequence of the introduction of sustainable principles or could have been

achieved through interaction with conventional materials and processes was more difficult to determine. Nevertheless, while it is not viable to claim that the sustainable content determined the aesthetic innovation it is safe to claim that it also did not hinder aesthetic innovation.

The epistemic artifacts resulting from the workshop as shown in fig. XX – XX reveal color experiments, experiments with shapes made by cold alteration of recycled container glass and some pressed artifacts. The color samples reveal diversity in combination of colors, development of pattern, compositions and textures, and the cold altered container glass samples also show some promising results. The pressing technique was quite involved for students without previous experience in glass. A few students did manage to produce experiments in this technique though. These experiments were made to test the effects of using kiln shelf primer as a slip agent (see fig. 5.1.1.5 in section 5.1.1). The kiln shelf primer worked well.

Questions that came up during the workshop included what the role of experimentation is in the research project, how innovation may be initiated and how the proposition that a particular principle lead to innovation may be validated.

Discussions of these questions and others were ongoing through the project and since the workshop was held quite early in the project period, they later fed into both the theoretical and the methodological chapters.

#### **Concluding remarks**

This workshop was the students' first encounter with glass as a creative material and their enthusiastic and curious attitude towards everything that concerned making generated a steep learning curve both about the materials and about the subject of sustainability. The visiting critic was impressed with their results and they all received top marks for their work. The assumption that cross-disciplinary activities and inclusive approaches can further dissemination of sustainable knowledge and ideas, as suggested in section 3.3.2 was confirmed through this activity.

#### 5.2.2. Workshop with glass craft students

This workshop was carried out with a group of glass craft students at the KADK Bornholm campus. The name of the workshop was "*Glass and Sustainability*". The workshop has been described and discussed in a paper that was triple blind peer reviewed and presented at the Sustainable Innovation conference in 2014 (Sparre-Petersen, 2016). It is included in this dissertation in appendix A.

This workshop was significantly shorter than the first, and the outcomes were mainly technical and process oriented. Initial tests were done with blowing as reported in subsection 5.1.4.

The outcomes of the results further approved the suggestion that educational activities can

contribute significantly to advancement of sustainable development.

#### 5.2.3. Participation in the masterclass "Experiment and Digital Technology – Wall and Floor Surfaces", organized by Flemming Tvede Hansen.

Parts of my teaching obligations have been dedicated the graduate program in Ceramic Design at KADK. Integration of new and old technology as well as new and old materials informs the teaching as well as the academic research in this program. I contributed to a workshop on 3D form development organized by the program leader Flemming Tvede Hansen, offering the students the possibility of extending their experiments with digital modelling to include high-fired concrete and glass.

#### Purpose

The epistemic artifacts generated through my personal experiments in the previous chapter carry my personal artistic position and therefore indicate innovation of my personal artistic position, whereas the aim of the project is to research options for expansion of aesthetic spaces of opportunity in general. Hence, the purpose of contributing to this workshop was to engage other creative practitioners in the generation of aesthetic range in the epistemic artifacts included as physical empirical material for the project.

#### Procedures

The students' digitally generated positives were routed in expanded polystyrene that was cast in plaster or concrete. The plaster molds were then used for ceramic slip casting and glass casting. This technology opens an array of aesthetic possibilities of creating positive/negative forms in/over of different materials and techniques (fig. 5.2.3.1 & 5.2.3.2).





Fig. 5.2.3.1 & 5.2.3.2 Glass before and after fusing.

#### Outcomes

The outcomes of this workshop convey aesthetics referencing the digital process by which they are conceived, but also landscapes, vessels, toys and patterns. It is not immediately evident that the glass artifacts are made of glass that is recycled. This supports the claim that inclusion of sustainable principles in the creative process of design and crafts students does not necessarily determine a "sustainable aesthetic".

The epistemic artifacts resulting from these experiments have since been included in the material database at the SFL, and have inspired students from several different departments of the school to incorporate glass in their projects (fig. 5.2.3.3-6).









Fig. 5.2.3.3 - 6 Students' 3D generated geometries.

# **5.2.4.** Summary of the outcomes of the student workshop activities

The multiple aims of the teaching activities as described in the introduction to this section was to determine if introduction of sustainable principles in the creative processes could lead to aesthetic innovation, and particularly how inclusion of the theme of sustainability in the teaching of glass design and craft could contribute to sustainable development.

The first aim was pursued by generating epistemic artifacts, the second aim was pursued through generating tools and techniques and through the active engagement with the students.

Particularly the first and the last workshop revealed aesthetically innovative results. The second workshop in particular, contributed to development of practical knowledge about tools and techniques. The activities additionally served to connect theory and practice, and the explorations of how glass craft and design education may contribute to sustainable development revealed several opportunities.

# 5.3. Collaborations with students and colleagues

During the project, I have shared my ideas and the results of my experimental activities with students and colleagues at the KADK, and invited them to join the research by contributing ideas that could be made in recycled glass. Some have been inspired to develop work of their own using the results of my experiments, and some of their ideas have been used to inform my experiments.

#### General purposes of the experiments with students and professionals' individual projects

The results of the personal experiments and the first two workshops showed opportunity for innovation particularly where the sustainable principles were introduced before conceiving the idea for the resulting forms. In craft processes the practitioner often has access to direct interaction with the materials, which is not always the case in design processes. Hence, in the experiments reported in this subsection, the sustainable principles were introduced at other phases in the creative processes to find out how this would affect the outcomes. In accordance with the triangulation methodology, these activities bring an extra perspective to the experimentation with recycled glass that can shed light on how sustainable principles may influence aesthetic innovation in glass, and to the questions of whether and how glass design and craft may contribute to sustainable development. In these activities, collaborative aspects of sharing the knowledge were stressed specifically as the possible key to contribution along with the practical contribution of generating new form from waste materials.

#### 5.3.1. Dammand's glass tiles

Dammand's idea was to explore pattern through three-dimensional modules. The function of the modules could be decoration or they could be applied in architectural contexts. The tiles could be cast in glass and/or concrete and combined with wood modules.

#### **Specific purposes**

Connecting the processes for working in the recycled glass to other techniques and processes available at the KADK were explored in this project, again in order to generate aesthetic innovation and to advance the sustainable development by sharing the knowledge about the sustainable material and its opportunities.

#### Procedures

Dammand initially made a positive and a negative mold from hard cardboard that was laser cut, glued and painted. The cardboard molds were used to experiment with different materials for transferring the shape, as explained in section 5.1.1 on pressing glass. The most successful outcomes of the experiments were two silicone molds that were used for creating a concrete positive as well as a concrete negative (fig. 5.3.1.1 - 4).



Fig. 5.3.1.1 Silicone positive.



Fig. 5.3.1.2 Concrete negative.



Fig. 5.3.1.3 Silicone negative.



Fig. 5.3.1.4 Concrete positive.

The concrete negative was used for casting tiles with and without graphite separator. Additionally, a series of glass tiles were cast in sand using different separating agents (fig. 5.3.1.5 & 5.3.1.6).



Fig. 5.3.1.5 Sand mold with powder sugar.



Fig 5.3.1.6 Sand mold with talc and molten glass.

#### Outcomes

The tile cast in concrete with graphite separator was quite precise although a bit rounded on the edges (fig. 5.3.1.7 & 5.3.1.8).



Fig. 5.3.1.7 & 5.3.1.8 Tile front and back cast in concrete mold with graphite separator.

The tile cast in the concrete mold without lubrication agents had very precise details (fig. 5.3.1.9 & 5.3.1.10).





Fig. 5.3.1.9 & 5.3.1.10 Tile front and back cast in concrete mold without graphite separator.

The sandcast tiles came out rounded on the edges (fig. 5.3.1.11 - 5.3.1.18).



Fig. 5.3.1.11 & 5.3.1.12 Tile front and back cast in sand.



Fig. 5.3.1.13 & 5.3.1.14 Tile front and back cast in sand with sugar as separator.



Fig. 5.3.1.15 & 5.3.1.16 Tile front and back cast in sand with talc as separator.



Fig. 5.3.1.17 & 5.3.1.18 Tile front and back cast in sand with graphite separator.

The tiles were acceptable as prototype-level experiments but would require more development before they would be fit for production.

The different textures were very subtle which could be beneficial for creating variation in a small scale production (fig. 5.3.2.19).



These epistemic artifacts were meant to be made in a series of different materials to generate patterns. The option of creating form using the laser-cutter, is a relatively new possibility at the school and has informed innovation of form in several field specific contexts at this institution. Thus, the form and the concept of making architectural components of waste materials is innovative, but the innovation is not directly derived from the material being recycled. The

Fig. 5.3.1.19 Tiles made from recycled glass by Peter Moëll Dammand.

contribution to sustainable development is by upcycling materials in new products in accordance with the circular economy strategy.

#### 5.3.2. Rabinovitch's glass plates

Rabinovitch was a first year student in the Master Program Ceramic Design. Rabinovitch had created a series of porcelain plates for her semester project and wished to accompany them with glass underplates.

#### Specific purpose

As with Dammand's tiles the purpose of this experiment was to generate aesthetic innovation and to advance the sustainable development by sharing and developing new knowledge about the recycled container glass and its qualities and aesthetic opportunities. This experiment specifically explored the use of prefabricated components for fusing into plaster/tennis sand molds (fig. 5.3.2.1).



Fig. 5.3.2.1 Pre-fabricated component.

#### Procedures

The glass components were made hot from molten glass using a puntil iron. The positive mold was made in laser-cut MDF board. The plaster was cast over the MDF board that was removed by firing the mold to 600°C (fig. 5.3.2.2).



Fig. 5.3.2.2 Mold with ashes from burning away MDF positive.

The components were arranged into the plaster mold (fig. 5.3.2.3).



Fig. 5.3.2.3 Glass components arranged in plaster/tennis sand mold.

The setup was fired to 950°C and brought down without crash cooling to allow for the glass to devitrify (fig. 5.3.2.4).



Fig. 5.3.2.4 Glass plate with devitrification.

#### Outcomes

The devitrification highlighted the shapes of the components and created a pattern structure in the results (fig. 5.3.2.5 & 5.3.2.5).



Fig. 5.3.2.5 & 5.3.2.6 Glass plates with porcelain parts by Yaara Rabinovitch.

The details of these plates came out quite sharp, but other tests with more intricate details resulted in the molds breaking in the biscuit firing (fig. 5.3.2.7 - 10).





Fig. 5.3.2.7 - 10 Fused glass plates by Yaara Rabinovitch.

The contrast between the porcelain and the glass defines the shapes, and makes each material stand out.

The results, like Dammand's tiles, are contributing to circular economy product categories. The material would be considered upcycled as it has gone from being a container with relatively low market value to being a long life commodity with a much higher value. The devitrification is a specific feature of this particular glass and process, which means that in this case the outcome could not have been achieved in any other material. Hence innovation of aesthetics has been produced.

#### 5.3.3. Johnsen's aluminum casting

Johnsen is workshop leader at the metal workshop at the School of Architecture at KADK. He is working with and supervising projects in cast aluminum. He uses two-part mold sandcasting for casting the aluminum. This means that the shapes have to have 180° slip. When I visited the workshop to find metal waste for the tile mold reported in section 5.1.3., we discussed the similarities between metal casting and glass casting and the possibility for transferring methods for casting non-slip forms.

#### Specific purpose

To enable casting of complex shapes without 180° slip in aluminum we tested the technique used for lost wax glass casting, replacing the wax with a 3D plastic print, printed by the school's printer.

#### Procedure

The plastic print with a casting funnel was placed in a bucket and invested into plaster (fig. 5.3.3.1).



Fig. 5.3.3.1 Set up for casting plaster around a 3D printed plastic object.

The setup was removed from the mold (fig. 5.3.3.2).



Fig. 5.3.3.2 Removing setup materials from plaster mold.

The plastic positive was removed by biscuit firing the mold to 600°C (fig. 5.3.3.3).



Fig. 5.3.3.3 Casting mold after biscuit firing.

#### Outcome

The technique worked well, the definition of the details could be enhanced by adding extra material that would add pressure and push the molten aluminum better into the mold (fig. 5.3.3.4).



Fig. 5.3.3.4 Cast aluminum by Mads Johnsen.

This experiment is an example of how research into one subject matter can bleed into a completely different area transferring knowledge that can be useful to others. The experiment did not have a direct input to sustainable development or to aesthetic innovation but it generated useful knowledge that can benefit the students in our architectural programs in years to come, and it would not have happened unless I had been scavenging for waste in the metal workshop.

#### 5.3.4. Steffensen's log

Steffensen was a BA student in our department Architecture and Design: Whole and Part, working on a table project that included ceramics and glass elements. He found a half-burned chunk of wood that he thought was very attractive and inspiring and he would like to cast it in glass. To find out if we could avoid devitrification we decided to hot-gob the piece rather than kiln casting it.

#### Procedure

After investing the log in plaster/tennis sand with a chicken-wire reinforcement the log was burned out at  $600^{\circ}$ C (fig. 5.3.4.1 - 3).



Fig. 5.3.4.1 Burned wood log in casting setup.



Fig. 5.3.4.2 Casting mold with remains from wood log.



Fig. 5.3.4.3 Casting mold ready for casting.

The mold was placed in an annealer that was taken to 980°C, and the recycled container glass was hot-gobbed into the mold (fig. 5.3.4.4).



Fig. 5.3.4.4 Plaster/tennis-sand mold with glass inside the annealer.

The piece was crash cooled and annealed and it came out with only very little devitrification (fig. 5.3.4.5).



Fig. 5.3.4.5 Casting without devitrification.

#### Outcome

The details of the object translated with a high degree of definition. The transparency was high and refractory qualities medium to high (fig. 5.3.4.6 & 5.3.4.7).





Fig. 5.3.4.6 & 5.3.4.7 Hot-gobbed glass log by Kasper Steffensen.

The object looks like a glass version of a half burned wood log. Hence, it brings associations to fire, nature, "freezing" time, treasuring the natural environment before it goes up in smoke.

This could lead thoughts to environmentalism and a "green aesthetic", but also to an "aesthetic of decay" or religious symbolism. The aesthetics of the piece writes it into a tradition of cast work that has been explored extensively by glass artists. Bertil Vallien, Karen La Monte, Stanislav Libenský and Jaroslava Brychtová being some of the great masters of casting glass.

Hence the contribution to aesthetic innovation is questionable, and if present it

was not derived from the glass being recycled.

contribution to practical/scientific А knowledge about the thermochemical qualities of the glass is present between this experiment and the cating and fusing experiments. A comparison of this piece to the casting and fusing experiments reveals that the casting that was heated and cooled slowly developed extreme devitrification. The fusing that was heated slowly and crash cooled from top temperature to 600°C only developed a thin layer of devitrification. This piece did not come through a heating cycle since it was hot-gobbed, it was crash cooled like the fusing and came out without devit. This indicates that the devitrification that occurred in the kiln casting and fusing experiments must have happened both in the heating and the cooling process of the firing cycle. The experimentation with different techniques thus proved instrumental for development of knowledge of the qualities of this particular glass.

#### 5.3.5. Tingskov Mikkelsen's lamp foot

Tingskov Mikkelsen is an artist and workshop leader at the wood workshop at the School of Architecture at KADK. He had developed a shape for a lamp foot that was made in two different versions of glass, a fused and a hot-gobbed.

#### Procedures

The positive form for the fusing mold was fabricated in routed EPS. The EPS was

removed from the casting mold with acetone - a very effective and toxic procedure that must be performed under observance of proper health precautions i.e. wearing a mask with proper filters for gasses, wearing rubber-gloves, working in a booth with proper ventilation with correct filters for gasses. The mold was filled with glass components similar to the ones used for Rabinovitch's plates, and the piece came out with a similar devitrified pattern (fig. 5.3.5.1).



Fig. 5.3.5.1 Fused lamp foot by Lars Tingskov Mikkelsen.

The plaster mold for the hot-gobbing version was cast over laser cut and glued MDF board (fig. 5.3.5.2).



Fig. 5.3.5.2 MDF positive for casting a plaster mold.

The MDF board was removed from the plaster/tennis sand mold by biscuit firing to 600°C. The details of the plaster mold broke in the biscuit firing. This could have several reasons; the mold could have been too wet when fired. The burning MDF could have attacked the plaster or the details could have broken off when the MDF expanded from sucking the water out of the plaster before the firing of the mold. More tests would have to be done to determine the cause. The procedure of firing the MDF out of the mold has to be done while observing strict safety precautions i.e. ventilation systems with correct filters in the kiln area, and wearing mask with correct filter if staying in the kiln room while firing. The piece was hot-gobbed and came out as expected, ready for some serious cold working (fig. 5.3.5.3).



Fig. 5.3.5.3 Hot-gobbed lamp-foot by Lars Tingskov Mikkelsen.

#### Outcomes

The two procedures compared in terms of footprint illustrate environmental the dilemma mentioned earlier of having to choose between problematic alternatives. The MDF mold for the hot-gobbing had to be removed by firing the mold causing toxic fumes from the wood and the glues used in the MDF as well as from the glue for laminating the thin MDF sheets. Additionally, the extra firing is time and energy consuming. The chemical reaction between the acetone and the EPS is also toxic, but in this case would be the preferred solution since the details survived the procedure, which also saves time in the cold shop. The routing of the EPS is slower than laser cutting the MDF, but the EPS does not require lamination and the extra firing. A more sustainable solution would be making the positive in plaster, or waterjet cutting the object directly in float glass, which would be

convenient for a piece like this but not for a shape like the wood log.

The fused epistemic artifact is the most innovative of the two with regard to aesthetic value This object could not have been made in any other material, (fig. 5.3.5.4).

Fig. 5.3.5.4 Lamp foot by Lars Tingskov Mikkelsen.



# 5.3.6. Summary of the outcomes of experiments with students' and collegues' projects

Fellow researchers and students have been invited to contribute their ideas to the research. The experiments conducted with individual students and professionals have shed light on how the sustainable principles can inform the creative processes, and in some cases lead to aesthetic innovation.

The five experimental activities revealed a variety of possible applications for some of the methods developed through the personal experiments, such as furniture, architectural components, tableware and decoration. The experiments also produced practical knowledge about the specific qualities of the particular types of recycled soda lime glass.

While the contributions to aesthetic innovation is not arrived at because of the glass being recycled the aesthetic contents of the two projects involving the fusing technique are innovative in their use of the particular quality of the recycled container glass. The outcomes of these two projects are similar due to the choice of the exact same technique, color and sizes of the components. Still, they hold significant differences in function, size, context and expression.

All of the experiments using glass are exemplifying how glass craft and design can contribute to sustainable development by using recycled materials for fabrication of products rather than new materials. The range of aesthetic positions of the outcomes support the thesis that this material offers the possibility for expansion of aesthetic spaces of opportunity even if the sustainable principles are not directly dictating the aesthetic outcomes.

The aluminum experiment exemplifies how implementation of sustainable research methodologies within one discipline can lead to development of new ideas and solutions across disciplinary boundaries.

# 5.4. Intervention and user participation

Direct contact with audiences that occurs during interventions in public spaces, often reveals unedited reactions to the work, and provides the opportunity to talk to audiences that is seldom the case when working with other platforms for dissemination of design and craft, let alone the platforms for dissemination of research. Occasionally, design and craft products are covered by magazines and newspapers and reviews are regularly written on exhibitions, but these sources of feed-back are not offering the opportunity for dialogue. They are most often provided by professionals that are advocating personal biases and providing input for - if not directly laying out - the guidelines for the current fads and trends. In the rare incident of being interviewed the platform is dictating a dialogue between like-minded.

During the project I was invited to participate in the "ULTRACONTEMPORARY", an art intervention in the public space, and to initiate a workshop with user participation at the Glasmuseum Ebeltoft. I used these opportunities as additional aspects of the triangulation.

#### General objectives for the two activities

McNiff divides validity checking in action research into internal, external, social, and communication tests. The different levels help building the argumentation and trustworthiness of the research. The internal test is to establish yourself in relation to your research and your methods. The external test is "...to see whether you have contributed to the improvement of others' life experience. Shared validity tests are to seek out peers approval and communication tests are to find out if you "...have made yourself intelligible, so people may engage fully with your ideas" (2013, p. 167).

The activities reported in this chapter falls into two of these categories; the external validity test and the communication test. On the external level I used the two encounters with audiences to bounce ideas and test the validity of my assumptions that glass craft and design can contribute to sustainable development, and that "people" find it relevant even if the contribution is statistically insignificant. On the communication level I used it to practice dissemination. In line with the practice-based methodology, I simultaneously used it to generate epistemic artifacts in recycled glass, that fed into developing my personal aesthetic position.

#### 5.4.1. The "ULTRACONTEMPORARY"

ULTRACONTEMPORARY is a series of spontaneous interventions in the public space arranged by Thierry Geoffrey to draw attention to art that does not fit into the established art-scene. The work is often highly political and confrontational particularly addressing issues rising in the wake of globalization.

#### Procedure

When I was invited, I had approximately a week to generate an idea and produce the work. The furnace was running and I had glass in it, so I cast four "cobblestones" and sandblasted a decoration on them (fig. 5.4.1.1 - 3).





Fig. .5.4.1.1 & 5.4.1.2 Casting glass "cobblestones".



Fig. 5.4.1.3 Design of decorations.

The space we intervened was a construction site. I found a pile of asphalt and installed the "cobblestones" using a fork I happened to carry in my bag. (fig. 5.4.1.4 & 5.4.1.5).



Fig. 5.4.1.4 A pile of asphalt was chosen as the site for installation of the epistemic artifacts.



Fig. 5.4.1.5 The epistemic artifacts successfully installed on the site.

The intervention lasted approximately four hours from the beginning of the installation and to the end of a "walk and talk". Geoffroy inaugurated the talk followed by the participants talking about their work (fig. 5.4.1.6).



Fig. 5.4.1.6 Geoffroy inaugurating the "ULTRACONTEMPORARY" exhibition.

The intervention happened on a Friday and when I came back the following Sunday my epistemic artifacts were gone. No construction workers had been to work that weekend, so they must have been removed by passers-by and not because it was obstructing the construction work.

The people passing by when we were installing, would stop and watch us. Some would ask what we were doing, which gave the opportunity to exchange ideas. We had been asked to contribute with a reaction to what we thought of the state of the world. My idea was to contribute what I believe we need more of in the world at all times, so I had chosen to use the signs  $L \cdot V \to E$  for the of the "cobblestones". decoration the artifacts appealed to Apparently, someone who felt the urge to take them. They were not destroyed - just gone. No one else had left work on the site, and as far as I know, the event was not reported anywhere other than on the site and on Geoffroy's Facebook page.

If I had chosen to set the "cobblestones" in the pavement they might still have been there. They were apparently "too easy" or "easy enough" to get out of the pile of asphalt, depending on whether the intention was to have them stay or go. My idea was to come back every now and then to see how long they were there, and to talk to the construction workers and ask them if they would set them in the pavement when the work was over.

An intervention of this type that is experienced by immensely few people has layers of experience that cannot be covered through documentation - much like the difference between a concert and the recorded version, but the people experiencing will often remember it because it is a bit out of the ordinary.

For my part the experience was quite different in that I normally work alone, and this time I was working alongside 13 other artists. My communication skills were certainly tested. A member of the participating artists asked if I was aware that my work was referencing craft and how I felt about that! I answered it was not referencing craft; in fact, it was craft - how the person felt about it? The persons' response was that it looked cute, sweet and decorative! Apparently, the perceived and the envisioned aesthetics did not quite match, but it is important to acknowledge that any real life perceived interpretation of the work is as valid as the envisioned interpretation.

# 5.4.2. "The Pennylaw Meets the Walk of Fame" at Glasmuseet Ebeltoft

I was invited by Dan Mølgaard, Director of Glasmuseet Ebeltoft, to arrange a workshop at the museum hot shop. He was interested in my ideas of taking a participatory usercentered approach to glass design and craft.

The workshop was part of a strategy the museum has implemented to reach out to potential visitors as well as to the community of Ebeltoft. An advertisement was posted in the local newspaper to attract participants, and local journalists and VIP's were invited to an official celebration of the conclusion of the project.

The "cobblestones" were not meant as a sustainable alternative to regular cobblestones, which would be down-cycling according to the monetary value of a cobblestone compared to the new containers that could be produced from the same amount of glass. The value of them consisted of the time and effort put into them by the participants in the workshop (and myself). They were carriers of these makers' intentions and efforts. When they were set into the pavement they became the particular individuals' more or less permanent mark on the city scape. In a world that is dominated by images of corporate society like commercials and logos, personal images most often are removed because they are considered vandalism. The idea of the cobblestones was to question who has the right to make their mark in the public realm and introduce marks made by private people.

#### Procedures

The workshop was held over a three-day period in connection to a local holiday in the spring of 2015. The participants were museum guests, who were each invited to decorate a glass "cobblestone" (fig. 5.4.2.1 & 5.4.2.2).



Fig. 5.4.2.1 Cobble-stones created by museum visitors.



Fig. 5.4.2.2 Museum visitors at work, decorating cobble-stones.

The participants were engaged and expressed sympathy for the glass being recycled. Most of them discussed and debated what they would make as their mark, and once they started the actual work they became introverted and concentrated. The sound of the engraving tools made it impossible to have a conversation, and they all had unskilled hands and needed to familiarize themselves with the tools.

#### Outcomes

Twenty stones were produced by twenty different people, with very different ideas (fig. 5.4.2.3 - 10).









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Fig. 5.4.2.3 – 10 "Cobble-stones by museum visitors.

On the last day of the workshop the stones were set into the pavement in front of the museum, an activity that made passersby stop and ask questions (fig.5.4.2.11).



Fig. 5.4.2.11 People stopping to ask questions.

Not a lot of people were around. The few that walked by and stopped were positive and curious. There are certainly good reasons for trying to attract more attention to this amazing glass museum. It would also have been interesting to see how people would react if it was the participating users that set stones in the pavement rather than myself, but that was not possible because the participants were not around all weekend. The "cobblestones" that were set into the pavement in Ebeltoft are still there (fig. 5.4.2.12).



Fig. 5.4.2.12 Cobblestones set into the pavement.

### **5.4.3.** Summary of the outcomes of the interventions

Through these two activities, I have immersed myself into situations where I had the opportunity to interact with audiences outside of the academic world and test the validity of my assumptions. It was also an opportunity to step out of the lab and into the material world where issues are dealt with rather than debated.

The events were contributing to sustainable development on several levels, the artifacts

were produced from a recycled material, and can be recycled back into the recycling system at the end of this incarnation, hence representing circular economy. They contributed to debate, interaction and improvement of the participants' lives on the same level as makers' movements, repair cafés, sharing economy and "freeganism". The conceptual contributions of involving users in the making of craft and design are empowering and holistic activities and part of the social aspect of sustainable thinking.

The events offered platforms for dialogue and facilitated sharing the knowledge and insight I produce and collect as a researcher and practitioner, with other people through everyday experiences where issues could be debated without the pressure or editing of institutionalized contexts. I had some interesting conversations that confirmed some of my assumptions about users' opinions about sustainability as well as about glass craft and design, and deconfirmed others. The assumption that "people" believe that craft can contribute to sustainable development was disconfirmed by the conversation with the person who thought of it as a merely decorative format with no critical voice. But, it was confirmed in the workshop at the Museum Ebeltoft where the participants thought it was interesting and meaningful to participate in the event and the production of a permanent installation in the public space with sustainable components. The assumption that "people" are interested in their social and ecological environment and wanting to participate in meaningful activities was positively confirmed in both events.

The contribution to aesthetic innovation through development of my personal aesthetic position was conceptual rather than formal. The cobble stones in and of themselves look cute, sweet and pretty as the person already mentioned, very accurately recognized. It is the "out of context" placement of the cute, sweet and pretty images, the fact that they are cobblestones that are commonly used as weapons by delinquents and the reference to craft media that embed them with contradictory information and make them commentary rather than primarily decorative.

#### 5.5. Dissemination of results

establishment of Through the the triangulation framework I have attempted to supply a trustworthy array of viewpoints to accompany the qualitative empirical material; consequently, the results of the have been explorations disseminated through several sources including: two juried exhibitions, a design talk, a lecture, a conference paper, a magazine article, contact to several businesses and a series of teaching obligations.

#### Juried exhibitions

The participation in the juried exhibitions has been a complementary way of receiving feedback on the subject matter of the project. By submitting the epistemic artifacts to juried exhibitions they have been judged as works of craft or design. This has been for the sake of receiving evaluation of the artistic merit of the work, even if the objects are considered epistemic artifacts in the context of the research.

#### "The Spring Exhibition" at Charlottenborg Kunsthal

"The Spring Exhibition" at Charlottenborg Kunsthal is the leading juried exhibition in Denmark and attracts 6-800 international applicants, of which 70 - 10 are accepted. The Jury is also international and feature new artists every year.

The epistemic artifacts submitted and accepted for "The Spring Exhibition" were titled Epistemic Artifact CK2\_2015\_11 and Epistemic Artifact CK4\_2015\_11. These titles were made up to communicate that the pieces were samples rather than works of art. It was not communicated that they were made from recycled container glass, to avoid biases based on ethical preferences and instead get an evaluation based on the formal aesthetic content of the pieces. Based on the participation in this venue, I assume it is safe to claim that these two works have proven successful judged by the merits of aesthetic innovation.

#### "GlassLab" at Officinet

Officinet is an exhibition space run by the Danish Craft and Design Association (DKoD). The work submitted for the Officinet exhibition space consisted of the entire collection of epistemic artifacts. The conceptual framework orchestrated by the exhibition committee was to present a series of four projects as work in progress, over a period of one month where my project, titled "GlassLab", was one of the featured projects. Officinet only show the work of members of the organization DKoD, with few exceptions of invited exhibitions. Becoming a member of the organization requires graduation from a recognized BA level or MA level design or crafts school or passing a juried selection procedure. The members can submit applications for exhibiting in the Officinet, and projects are chosen based on an evaluation by an exhibition committee. Hence, it is quite competitive to get an exhibit in the space, which makes it prestigious even if the exposure does not attract a large audience.

This project was selected on the basis of an application including a project description and visual documentation of a selection of the epistemic artifacts. The project description included a description of the research project and a description of my idea for the format for the exhibition. The idea was to have the epistemic artifacts exposed as a series of scientific samples organized into types on low plinths with the tools by which they were made presented under the plinths.

The space is on the gallery strip of down town Copenhagen, but few visitors show up outside of the opening night where mainly my own network showed up. The few visitors that came were interested and respectful, and asked questions as I had expected. My preconceived assumptions about art-interested audiences were positively affirmed.

To get feedback from strangers the street intervention format is more effective. To get attention from like-minded audiences the established venues offer good opportunities.

#### Lecture, paper and article

The paper "Sustainable Innovation of Glass Design and Craft" has been subjected to triple blind peer review, and was accepted and presented at the conference "Sustainable innovation 2014" (Sparre-Petersen, 2016) (see appendix A).

I was invited to submit an article to the special edition of the journal KUNSTUFF published in celebration of the 40<sup>th</sup> anniversary of the DKoD. The article "Glass and Sustainability" offers a short user friendly glimpse into the experiments done with pressing glass and casting glass in this project (Sparre-Petersen, Glass and Sustainability, 2016) (see appendix B).

# Contact to businesses, practitioners and other partners

My glass peers as well as businesses partners in and outside of Denmark have helped me at several occasions, and I have been able to show and discuss the work with colleagues inside and outside of the academic realm, students, editors, suppliers and production companies. This exposure has secured reflection upon the entire lifecycle of the realm of glass craft and design as well as upon detailed aspects of the subject matter.

#### Teaching

It has not been possible to dedicate all of my teaching directly to the project, but I believe my ideas and approaches have fed into my teaching philosophy and influenced my work as a teacher. The activities have included a cross disciplinary course on ethics, two courses specifically on glass and sustainability described in section 5.2, two courses on design strategies and business collaborations, advising several graduation projects, ranging from visual communication to glass and a class on history and theory of craft and design. I have taught smaller workshops on creative writing, professionalization, cold glass, cutting glass, fusing and slumping and contributed to Hansen's digital/analogue techniques workshop. I have offered specialist consultant support to students and colleagues at the KADK, as well as anyone else with questions regarding glass that I have been able to answer or direct to someone else who could.

In hindsight, the teaching has been rewarding both for the project as they have contributed to the empirical findings and because they are a future generation that the project aims to support and sustain. The students at the KADK Copenhagen Campus have shown interest in and motivation for the project throughout the entire four years. Their curiosity, openness and enthusiasm for the project have been most inspiring and has provided the possibility for collaborative experimentation and feedback throughout the project period. The glass students at the KADK Bornholm campus had the necessary skill level and artistic inclinations to respond to the issues raised in the workshop in a critical analytical manner. The discussions and the experimentation, although rudimentary, and with only four days of actions, were informing the project at an early stage which enabled a jumpstart that I could not have accomplished alone.

The framework of the education based research methodology enabled testing the relevance of the research on the target group in focus in the project. The positive feedback from the students in all of my teaching activities have confirmed my assumption that the work is relevant and that the findings are useful for others.

# 5.5.1. Summary of the outcomes of communication and distribution of results

A premise for scientific projects is that they must be disseminated to gain relevance, which is also given by the requirements for the fulfillment of the degree. Where artistic practice-based projects, like the one reported in this dissertation, are differing from other research projects is in that they have to prove their relevance both in the scientific realm, in the artistic realm and in practice.

Therefore, the work has been subjected to juried exhibitions, to the judgments of my peers in the Danish Craft & Design Association, to a design executive, a magazine editor and to the students. The positive feedback has contributed to rendering the contribution of this project viable and relevant.

#### 5.6. Discussion of research activities

In this sub-section the aims and outcomes of the empirical research will be summed up and discussed with regard to the three basic components of practice-based research that is proposed in section 4.1: scientific research, artistic research and professional practice. The structure of the sub-section is built up around the four different activities reported in section 5.1 - 5.4.

#### Summary of aims

The aims of the activities were to explore if and how introduction of sustainable principles in creative processes might influence expansion of aesthetic spaces of opportunity, and how glass craft and design might contribute to sustainable development.

#### **5.6.1. Discussion of personal experiments**

Jan Kock brought forth the idea that if a piece of glass craft or design stands the test of time, it is an indication that it is sublime (personal communication, June  $22^{nd}$  2016). Others think that it is good if it sells in large quantities. And yet others believe it is good if it "speaks" to them. These aspects can be used as criteria of assessment, but whether a piece of craft or design is good entirely depends on exactly those kind of criteria and

they can vary depending on the context. Disposable plastic cutlery sells in large quantities and they are handy to bring around, because they are so cheap that they can be thrown away after use, and they have been sold in large quantities around the world since plastic entered the market, but does it make them good design? Reasonable arguments can be held forth for and against them being good design. Whether this project has produced artistic knowledge and insight also depends on the criteria of assessment, and since an established system with well-defined sets of criteria of assessment for this type of knowledge and insight do not exist, I have relied partly on established venues for dissemination of artistic works to evaluate the contributions to artistic knowledge and insight, and partly on my own evaluations of the experiments and activities carried out during the project.

By introducing recycled soda lime glass as a deliberately generated obstacle in my creative process, I explored technical and aesthetical consequences of working in this material as an alternative to crystal that I am more familiar with. Several different techniques were explored developing a broad foundation for further research and teaching activities (see section 5.1).

#### If and how aesthetic innovation may be derived from introduction of sustainable principles in the creative processes in glass craft and design?

There were a number of reasons to work in different techniques rather than exploring one technique in depth. Practical reasons were to uncover as wide a range of aesthetic expressions as possible within the techniques available at the SuperFormLab, and to use the facilities efficiently, which is also a core incentive in sustainable development. While a casting was running through an annealing cycle I could work on blowing or fusing. Artistic reasons were to support my artistic practice which is concept-oriented meaning that I usually select the appropriate techniques based on the theme of the project. Strategic reasons were that since the institutional framework for the project was a four-year qualification project for faculty I had to deliver research in support of the education. By choosing a broad technical foundation I was aiming to make the project benefit from the teaching activities as well. This strategy succeeded particularly with the student workshop activities described in section 5.2.

An additional motivation to explore aesthetic range was to debate a common assumption in the field of glass craft and design that the use of recycled container glass dictates a certain "green aesthetic". How this assumption has been established may have something to do with a common practice within the field of using a green aesthetic as a marketing asset in promotion of the products. A study from Plymouth College of Art showed that consumers' view of the value of a particular glass tile changed for the better when they were informed that the product was made from fused recycled bottle glass (Oseng, Donne, & Bender, 2009). The fact that consumers value conscientious products is likely to have

influenced the trend of producing craft and design with a "green aesthetic". It is easy to sell and it is easy to make, but, it does not necessarily satisfy a designer or craft professionals' desire to innovate, and it contributes to a reluctance towards the use of recycled glass, that is counterproductive to sustainable development.

The epistemic artifacts produced during the project are referencing such a "green aesthetic" to various degrees. The sand pressed artifacts are rustic and plump like many of the products marketed on displaying the "green aesthetic". The blown artifacts could have been made from any type of glass, the tertiary colors are the only indicators that the glass might be recycled. The artifacts that were produced using the tool made from recycled metal waste also do not immediately signal that they are made from recycled glass. A person with knowledge of glass design and craft would know that the green color is indicative of recycled glass but it could also be a design decision to include pale green in the color range of the particular product. The same is true for the rest of the artifacts. Hence, this type of glass may express a range of aesthetic choices that does not per se reference a "green aesthetic".

The research initiated an exploration of possible connections between introduction of sustainable principles in the creative processes and generation of aesthetic innovation. The explorations revealed a connection in some experiments, but not all the explorations led to aesthetic innovation and in the ones that did, all of them did not reveal a connection. Hence, introduction of sustainable principles as deliberately generated obstacles in creative processes *may* generate aesthetic innovation, but does not *necessarily* do so. It is safe to conclude that introduction of sustainable principles does not *hinder* aesthetic innovation, which is evidence in favor of attempting a change.

To begin to establish how sustainable principles may generate aesthetic innovation is complex and will be discussed in relation to the scientific, the practical and the artistic aspects of this practice-based research. In section 5.1.8. the evaluation of the personal experiments revealed that aesthetic innovation was achieved in the sand pressed artifacts, the cast artifacts and the artifacts made from the recycled metal waste mold. The discussion of how sustainable principles may generate aesthetic innovation is building upon the evaluation of these experiments.

The descriptions of the procedures of the experiments (see sub-sections 5.1.1 - 5.1.7) explain the events of how the different aesthetic values were arrived at, while there are aspects of these events that cannot be accounted for. The tacit knowledge that has been applied in the procedures have been built up over a lifetime of interacting with tools and materials and cannot be captured in words, as it is tacit. My personal tacit knowledge fed into the procedures, by which the experiments were conducted, and constitute an unknown quantity of the equation.
The artistic knowledge and insight that I applied in the procedures may be described as far as for the knowledge part. We can assess the aesthetic outcomes and to some degree determine that a form or a concept has novel aspects of e.g. complexity, flexibility, traces of use of new technology or new materials. When it comes to the insight part the words fall short as well. The insight applied artistic is in the "conversation" with the materials through reflection-in-action (Schön, 1983) but the sensibility for the relationships between that which exists and the "voids" cannot be understood; it can only be manifest in the work itself while it comes into being. Højlund, in her research on drawing, is describing this sensibility. "The drawing of the drawing not only creates a clarification but also endless tracks and holes in the world. These absences and tracks are the essence of the quality of the artistic language. Drawing is a way for us to relate to this quality. [...] If we take our point of departure in this paradox, drawing and drawing are not a way of depicting but of relating to silence and potentialities. Drawing and drawings establish a relationship" (2011).

The scientific knowledge in terms of the chemistry and the technical parts can be accounted for. Scientific knowledge concerning methods and the qualitative aspects have been accounted for in the theoretical and the methodological reviews (chapters 3. and 4.), and they have been exercised in the framing of the questions and the explorations.

Of the different types of knowledge and insight employed in the processes only a few can be assessed relatively objectively, which leaves us with a problematic starting point in order to detect how a connection between sustainable principles and aesthetic innovation may be established.

The aspect of innovation is another problematic issue in the question of *how*. This concept is about something, which is not there yet. We can experiment, we can make bold conjectures that can be tested (Popper, 1991), and we can reflect upon past examples. But, the descriptions of the processes and the resulting epistemic artifacts can merely give us a vague idea of how innovation may have happened.

The sand pressed objects and the artifacts cast in the recycled metal mold both derived from a process that was led by the materials and the technique. This could indicate that innovation can occur through interaction with new materials and techniques, a central theme in Hansen's (2010) research.

The cast objects derived from a process that failed. The aesthetic of failure has been explored by e.g. Priest (2013), but here the agenda is not to develop an aesthetic position but rather to point to a possible connection between failure and innovation. The use of failures as a strategy for creativity has been explored by e.g. the artist corporation Superflex, while designers are traditionally more concerned with elimination of failures (Johansson, 2007). and

A third possible key to a connection between sustainability and aesthetic innovation is the method I chose as a suggestion for how the sustainable principles could inform the processes: the deliberately generated obstacle. This strategy is a way to bypass both knowledge and insight and force ourselves to let go of the past and the now and tap into something that we do not already know. This strategy has been described as an interaction between an artist who submits to a set of self-invented rules, an artwork in an explorative experimental dimension combined with a reflective self-critical dimension. Like a transparent laboratory-process where the outcomes are not results of a creative processing of a content substance but rather from a negotiation with the rules (Christoffersen, 2011).

Any of these strategies can be activated in the pursuit of aesthetic innovation and consequently also in projects concerning sustainable development, which leaves the second question of how aesthetic innovation may derive from sustainable principles, answered only through the description of the events around and the epistemic artifacts produced through the experimental activities. The epistemic artifacts are physical manifestations of the processes that caused the aesthetic innovation, and in this respect the argumentation here fits Candy's definition of practice-based research as cited in section 4.1 (2006).

# How glass craft and design may contribute to sustainable development?

The idea of circular economy is about using waste as a resource. By actively using waste soda lime glass as an alternative to modern crystal, I wanted to explore if and how it would be possible to realize circular economy within my own field. Speculation about how finalized and produced objects could contribute to a trend that would enhance the effect of the efforts have been discussed in section 3.3.2. If glass designers and crafts professionals are part of creating a trend, it is important that this trend is about real change and not merely celebrating a "green aesthetic". If the aesthetic and the content of the products we produce is not coherent, it is merely "greenwashing".

With the personal experiments, I have not solved all the issues of sustainability connected to glass craft and design. I have merely tested a more sustainable solution to the glass material. The container glass is indefinitely recyclable as opposed to the traditional modern crystal, but many of the support materials are not. Some of them are toxic when fired, and some can only be down-cycled e.g. plaster and concrete. Hence, these experiments represent an increment of sustainable development, not a fully developed system of a circular economy where all the problems are solved and all the materials and technologies are fully recyclable.

### 5.6.2. Discussion of student workshops

The aims of the student workshops were to explore the research questions from another vantage point than my own practice in order to gain leverage by exchanging knowledge with students and learning together with them along the idea of education-based research (Johansson, 2016). I also wanted to find out about the students' motivation and biases for and against the subject, discuss possible strategies with them, and research existing initiatives. The social vantage point of the triple bottom line (the social, the environmental and the economic), of sustainable development, was stressed in this group of activities by disseminating and developing knowledge about sustainability to and with the new generation of practitioners.

# If and how aesthetic innovation may be derived from introduction of sustainable principles in the creative processes of glass craft and design?

In the workshops, the students produced epistemic artifacts of varying innovative quality as accounted for in section 5.2. As already discussed in the previous sub-section the innovative aspects of these outcomes, like the outcomes of my personal experiments cannot necessarily be ascribed to the introduction of sustainable principles in the creative processes. Nevertheless, the sustainable principles *have* informed our creative processes and we have generated practical, scientific and artistic knowledge and insight about how the waste glass performs in different situations and what the resulting aesthetic options are. The results of a teaching activity may not surface immediately, but the knowledge we have generated will inform our future work and become part of our professional toolbox of tacit and explicit knowledge and insight. This way it may feed into future innovative solutions.

Starting early in the students' educational development proved productive in order to establish the knowledge and insight as a foundation for the students' creative competences. Working with non-glassmajors in the first workshop was an opportunity to share insight in а multidisciplinary context. Exposing students to the subject matter as part of their field specific studies in the second and third workshops strengthened awareness and feeling of empowerment with regard to being able to contribute to sustainable development. Introducing the sustainable material, in Hansen's workshop, as an option that was compatible with the students' other creative processes proved productive for the integration of knowledge areas, and hence to the dissemination and accumulation of practical knowledge about sustainability.

Research of existing sustainable glass practices was done together with the students in the second workshop. This research provided information about e.g. Studio Xaquixe, Kitengala Glass Works and many initiatives within cold glass techniques. We discussed the aesthetic of the different initiatives and found а predominance of projects representing the "green aesthetic", particularly in the products using cold or semi-hot techniques (The Green Glass Company, 2016)(fig. 5.6.2.1).



Fig. 5.6.2.1 Design by The Green Glass Company.

This product is upcycling a cheap bottle, but whether it is better to keep it as a bottle that is part of a refund system is difficult to say, and the aesthetic are not innovative, even if consumers generally love the idea. The research confirmed the need for development of tools, techniques and technologies for melting recycled waste glass to create entirely new forms as an alternative strategy to cold and semi-hot alteration, and provided knowledge and insight about existing aesthetic positions within the realm of sustainable glass craft and design.

# How glass craft and design may contribute to sustainable development?

With regard to contributions to sustainable development, the student workshops like the personal experiments added to an incremental sustainable development, as well as to the building of tacit and explicit knowledge about the recycled container glass which is a contribution to the practice.

On the scientific level the educational activities contributed to building a portfolio of education-based and practice-based research at the KADK. The procedures and results of the activities of the second workshop were reported in a paper that was triple blind peer reviewed and accepted for an international conference on sustainability (Sparre-Petersen, 2016) as mentioned in sub-section 5.2.2. This was a contribution to scientific knowledge production within the glass craft and design field in general. The paper has been included in this dissertation as appendix A.

Artistic insight was produced through the interaction with the materials and the research of the aesthetic opportunities of the recycled container glass. This insight has been reported through the students' work as well as in this thesis.

# **5.6.3.** Discussion of collaborations with students and colleagues

Through this specific group of experiments, a range of aesthetic outcomes were developed based on students' and colleagues' creative ideas and using the recycled container glass for experimentation as well as for production of the work (see section 5.3). In one of the collaborations the methods were transferred from glass casting to metal casting to improve technical performance. Glass practitioners may not have their own studios where they can develop their ideas. To develop new work, they often have to rent bench time or workshop facilities, which is expensive and therefore does not allow for much experimental practice. Also, glass design is often created by designers without crafting skills, who rely on others to make prototypes which calls for practices that can facilitate development through collaborative efforts. This series of experiments are set up to meet such needs.

# If and how aesthetic innovation may be derived from introduction of sustainable principles in the creative processes in glass craft and design?

We have already established that aesthetic innovation may be developed by a person or group experimenting with sustainable materials. I will now address how innovation may happen in situations where design ideas are conceived by someone other than the person carrying out the experiments.

In the past, glass factories in Scandinavia employed designers who worked in close collaboration with the glass makers in the production. An example of an innovative design solution that was developed this way, though without the use of container glass, is the "Provence" bowl by Lütken (Holmegaard, 2016)(fig. 5.6.3.1).



Fig. 5.6.3.1 Provence bowl by Per Lütken.

For the experiments made in this project the participants have been working together with me, and have been involved in the processes to varying degrees, which illustrates different strategies that can be applied in future projects for the benefit of more students and colleagues at the KADK. Artistic insight has been produced, through these collaborations, both on their part and on my own. The resulting outcomes are contributing novel aesthetic form, adding to the catalogue of strategies for achieving aesthetic innovation sketched in the previous subsection. The aesthetic outcomes could not have been achieved in any other way, since the ideas for the designs and the ideas for the material execution of the designs came from two different creative sources.

# **How glass craft and design may contribute to sustainable development?** Regardless of whether aesthetic innovation

has occurred, the epistemic artifacts produced through the experimental activities are contributing to sustainable development by using trash as a resource and upcycling the material. Social, structural and economical aspects of sustainability have been applied by engaging in these interdisciplinary activities where the tools and techniques from one discipline have been used to develop tools and techniques for other disciplines. Thus, the money spent on the research has contributed to knowledge production in more than one area.

The collaborative aspect of the experiments contributed to exchange of ideas between related but different practice fields; e.g. furniture design and interior architectural design. At the same time, by taking the role of manual laborer producing the ideas of other practitioners, the roles of the scientist were expanded. This way the research has contributed to an interdisciplinary inclusive hybrid research format between practicebased, education-based and action research, based on attributing equal value to the scientific, artistic and practice oriented aspects of knowledge and insight production, acting out academic social responsibility.

# **5.6.4.** Discussion of interventions and user participation

The interventions described in section 5.4 constituted part of the strategy of triangulation, drawing on action research methods for external validation of the qualitative aspects of the issues of sustainability in relation to glass craft and design.

The interventions aimed at generating a dialogue with an audience through the use of glass as intermediary objects while at the same time creating aesthetic statements using a recycled material in the public realm.

Glass craft and design professionals have problem-solving competences developed practical, through artistic, scientific. emotional and philosophical engagement with the material. We know how to make beautiful things from it, that at the same time serve a purpose. We are also autonomous, self-indulgent and capable of generating non-sensical outcomes. We find constructive as well as disruptive ways of engaging ourselves creatively and incorporate the results of our engagement into invention of new realities.

Today, sustainable development, is generally considered constructive а approach to the major problems generated by human activities. Every business needs, at least apparently, to care about sustainable development. In most developed countries legislation demands reporting of sustainability and CSR strategies by large enterprises and while most glass design and craft enterprises are small or micro sized they still may offer knowledge and insight that could potentially contribute to the development.

But if Fry right, it is not sufficient to act according to the mainstream legislative guidelines if we are to substantially change the course we are following at present. He calls for re-directive practice (Fry, 2009, pp. 53-70). Mau on the other hand claims that humanity already possess the capacity to design the massive changes needed to gain peace and prosperity within a sustainable future for all of humanity (Mau & et. al., 2004).

Mazanti claims that craft is taking a position between the object of material culture and autonomous art (2006), and Walker argues that design has the capacity for "a setting aside of the intellectual self" (2006, pp. 186-187). The interventions explored how glass craft and design has the potential to bridge the gap between the two positions in the discourse of sustainability through its engagement with material culture as well as through its autonomous character. While proposing that autonomous disruptive action is to artistic research what critical analytic thinking is to scientific research, the idea of these interventions was to bring together the disruptive action and the problem solving capacity, sense and non-sense, to cope with the dilemmas that exist between the two positions in sustainable discourse, much along the ideas presented in Walker and Mazanti's accounts.

# If and how aesthetic innovation may be derived from introduction of sustainable principles in the creative processes of glass craft and design?

The interventions followed the ideas of action research, about "a real-life dialogical practice within real-life socio-political contexts ... [where]... all practitioners may and should engage in knowledge creation

with potential for personal, social and institutional hope for transformation" (McNiff, 2013, p. 188).

During the two interventions, acting out reflection as well as reflecting on the actions were done together with other practitioners, participants and audiences. The formats of disruptive action in public places, installation design and user-participatory design are already well established and the ideas of private people claiming the right to use the streets as a stage for artistic purposes are also not new.

Nevertheless, the format of the "ULTRACONTEMPORARY" (see subsection 5.4.1) provided an opportunity to introduce objects, made from a recycled material and spelling out the word "love", into the public realm and learn how it would be received in a socio-political context of an artist intervention in a public place. A person asked if I realized that my work was referencing craft, and stated that the work was cute, pretty and decorative, pinpointing an issue that stems from a traditional conception of craft as an inferior art form.

The group was acting out a critical attitude toward political currents in society and toward the established art-scene, but if the critique was formulated as a statement of hope in a material that referenced craft, it was not really taken seriously. It did not occur to the person that my piece could be critical of the elitist and non-inclusive way of intervening that we were practicing as a group of well-educated and privileged people, feeling a right to impose our work on strangers in the streets.

The idea of sustainable development includes economic, environmental and social issues. In this intervention, the social aspect was stressed in terms of applied ethics. The event showed that the exclusive hierarchical thinking that is justifying inequality - one of the major causes of nonsustainability in the current economical paradigm (Mau & et. al., 2004), is so deeply rooted into all realms of our society that even the realm of art that supposedly holds a disruptive autonomous potential for change is caught up in stereotypical preconceptions of the critical potential of craft. The piece was cute, sweet and decorative, but the context it was presented in could lead to another interpretation, i.e. that criticism has many voices.

The fact that it was removed from the site can also be interpreted in multiple ways. It could have been removed by the authorities, in which case the interpretation of the piece would be that it was vandalism, which could be interpreted as an aesthetic position: the aesthetic of destruction. It could have been removed by someone who wanted to keep it, in which case it was interpreted as an aesthetic value. Or it could have been removed by someone who wanted to destroy it, in which case it was interpreted as a target for vandalism, or an aesthetic position that evoked the aesthetic of destruction. All of these options would assign a different aesthetic meaning to the installed artifacts. In any case, someone took the time and effort to dig it out of the asphalt, so the artifacts have had an aesthetic impact on someone in addition to the participants and the audience of the intervention.

In "The Pennylaw Meets the Walk of Fame" (see sub-section 5.4.2) 22 glass "cobble stones" were decorated by museum visitors who had signed up to participate. The stones were subsequently inserted into the sidewalk outside the museum. In this intervention the reactions were quite inclusive. The museum staff participated, the media were invited and passers-by would stop and ask questions. This way the artifacts became a point of connection in a real-life situation where the participants worked together on a common goal and in respect of the individual abilities and ideas.

In terms of aesthetic innovation understood as expansion of aesthetic spaces of opportunity, the conceptual aspect of this intervention accentuate and encourage artistic activity. The aesthetic spaces of opportunity are expanded every time someone develops a personal aesthetic position. This is not done by decorating one stone, but the ideas of exercising one's creativity and of claiming the streets are steps toward aesthetic innovation that include people beyond the creative class. By placing the "cobblestones" in the pavement the participants embraced the permanence of the work and acknowledged their own collaborative efforts, which is an act of aesthetic empowerment and innovation.

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How glass craft and design may contribute to sustainable development? Glass craft and design is part of most people's everyday life, and according to Attfield, things we surround ourselves with are laden with meaning that all together makes up our reality (2000). During the installation the of "ULTRACONTEMPORARY" I spoke to a number of people passing by. People were generally curious, and wanted to know what we were doing and why we were doing it. Some would even stay and join the presentations of the works. In that sense the idea of using the streets as a stage for a dialogue was successful, and generating meaning in the dialogue with people that might not have felt inclined to visit a museum or a gallery, but were intrigued by the unexpected experience.

In Fry's words the things we make also have the capacity to go on making (2009). He proposes a strategy of taking action from outside of the established systems for sustainable development as mentioned in sub-section 3.3.2. This strategy was exercised in "The Pennylaw Meets the Walk of Fame" where objects were made partly by the participants in the workshop and partly by me - the designer/crafts professional. They were set into the sidewalk as a miniature disruptive action placing agents of disruption in the public realm. A small step, perhaps, towards coming together as a community, and taking over the world with sustainable carriers of meaning that will go on making more sustainable communities and societies.

In summary, glass craft and design can contribute to environmental aspects of sustainable development by using recycled materials. It can also contribute to sociopolitical aspects of sustainable development, by occupying a creative space of opportunity between material culture and autonomous art that holds capacity to critically reflect on and through both.

# 6. CONCLUSIONS

### Structure of the chapter

Through the epistemic artifacts and the interventions artistic, scientific and practice knowledge and insight has been generated. In accordance with my model of the three different aspects of artistic practice-based research, and for the sake of clarifying the value of the different aspects of the contributions, I have structured the conclusions with regard to contributions to practice, scientific knowledge and artistic knowledge and insight.

I have attempted to report the procedures and outcomes as soberly and accurately as possible, as the project has been completed scientific as а research. while acknowledging that it may be regarded as a contradiction to report a subject matter of artistic content within а scientific framework

The conclusions are summed up in table 6.1. at the end of the chapter.

# **General contributions**

The activities have produced epistemic artifacts and works of glass craft and design, some of which has contributed to aesthetic innovation while others have not. The full understanding and insight contributed through the works can only be experienced through real life encounters, while the photographical representation provided in this document is the best possible option for disseminating the contents within this format.

The physical objects can be recycled into the regular waste stream when they are discarded, if they are made into the same product again it would be called a closed loop cycle; but given that they would probably be recycled into container glass it would be identified as an open loop cycle. An added benefit of this is that it prevents the recycling stream from accidentally being contaminated with modern crystals being tossed in the recycling containers by well-meaning recyclers who are not aware that it is not compatible with the soda-lime container glass.

# **Contributions to practice**

### Contribution to aesthetic innovation

The contribution to aesthetic innovation has aspects of tacit knowledge and insight and aspects of explicit aesthetic knowledge and insight. The tacit aesthetic knowledge has built up in the minds and bodies of the makers the explicit aesthetic knowledge is manifest in the objects created from the recycled waste glass.

# Contribution to sustainable development

The contribution to sustainable development of the practice is in the form of knowledge and insight about the recycled waste glass.

The development of high temperature castable molds as well as the principle of using recycled metal waste for molds, enable quick and cheap experimentation of pressed and cast glass. These methods are technical contributions that facilitate sustainable experimental processes.

#### Contributions to scientific knowledge

#### Contribution to aesthetic innovation

The scientific contributions to aesthetic innovation in this project has been through a generation of theoretical and methodological frames of reference for understanding aesthetic issues. Analytical tools for understanding the realm of aesthetics has been suggested in section 3.4 and for the understanding of artistic practice-based research in section 4.1 particularly with regards to the understanding of the values of the artistic aspects.

#### Contribution to sustainable development

The project has contributed to sustainable development on a theoretical level in the form of generating knowledge around the subject in relation to glass craft and design and reporting it in this thesis as well as in the scientific article (see appendix A).

On a methodological level, the research has contributed to the development of sustainable research practices as accounted for in sub-sections 5.6.1 - 5.6.4.

# Contributions to artistic knowledge and artistic insight

### Contribution to aesthetic innovation

The epistemic artifacts resulting from my personal experiments have been subjected to evaluation by artistic criteria of assessment in three different contexts: a juried exhibition, a peer review and a meeting with a design executive from an established glass design brand. Hence, I find it safe to propose these artifacts as contributions to artistic insight and knowledge. The Epistemic Artifact CK4\_2015\_11 and Epistemic Artifact CK2\_2015\_11 that have been included in a juried exhibition I propose as contributions to expansion of aesthetic spaces of opportunity.

Additionally, the philosophical aspects aesthetics and practice-based around presented in this text methodology particularly in section 3.4 and 4.1 are proposed as contributions to artistic knowledge.

The contribution to sustainable development The artistic aspects of the contributions to sustainable development has been generated by acting out artistic autonomy. In some cases, this behavior has led to new sustainable futures or practices as requested by the theoreticians; Fry, Walker, Harper etc., e.g. in the transfer of knowledge between related fields as described in section 5.3.3. At the same time, it has produced nonsense e.g. in the failed experiments. The thesis in this interpretation could suggest the contours of a philosophy of sustainable glass craft and design that embraces sense and non-sense.

Contributions	General	Glass craft and design practice	Scientific research	Artistic research
Aesthetic innovation	Epistemic artifacts (see section 5.1) and glass craft and design (see sub- sections 5.1.6, 5.3.2, 5.3.5, 5.4.1 and 5.4.2).	Tacit and explicit knowledge and insight about aesthetic opportunities of recycled soda lime glass (see sections 5.1 - 5.4).	Knowledge about aesthetic theory (see section 3.4) and creative methodologies (see section 4.1)	Knowledge and insight about aesthetic opportunities of recycled soda lime glass (see sections 5.1 - 5.4). Philosophical aspects of aesthetics and methodologies (see section 3.4. and 4.1).
Sustainable development	Recyclable glass objects, more effective recycling and less errors in existing the recycling system	Tacit and explicit knowledge and insight about materials, techniques and technology (see sections 5.1 – 5.4)	Knowledge about glass craft and design and sustainability (see section 3.5) Methodology for research practice (see sub-sections 5.6.1 – 5.6.4).	Insight about sense and non-sense of sustainability in glass craft and design (see section 5.6.1 – 5.6.4).

Table 6.1. Contributions.

# 7. PERSPECTIVES AND REFLECTIONS

The initial motivation for this project was that I found out that large parts of the collected container glass ended up in landfills especially in the US. This is obviously problematic because valuable material is lost and also because of the de motivating effect it has if citizens become aware that their efforts to make a difference are in vain.

Therefore, I thought that I could make a difference as a creative person, as a teacher and as a human being by finding ways in which this waste could be turned into a resource. In the process of generating ideas for how we can utilize this material as a resource, I have had the opportunity to work with it in many ways and found out more about the obstacles and opportunities it offers. I have been able to meet some of the people who have years of experience working in the material, and I have exposed some new people to the wonders and complexities of it.

The strategy of recycling waste container glass in this project has brought successes and failures along. I have become artistically and scientifically familiarized with the soda lime glass through practice and learned a little bit about both the limitations and the possibilities of this material. The resulting epistemic glass artifacts illustrate a range of directions that call for further analysis, reflection and development. The processes revealed challenges beyond what could be dealt with, within the limitations of this project. Hopefully, the future will bring more time and recourses to take up these challenges.

Since the project was initiated, the recycling trend has caught momentum. An array of products utilizing recycled container glass, both in cold and hot techniques are now on the market, some designers may have contributed to starting the trend and some may just be riding it, making profits from "green aesthetic".

An example of a design already on the market that is resembling the strategy of recycling container glass is the "Bottleware" designed by nendo and produced in collaboration with Coca-Cola (nendo, 2016) (fig. 7.1).



Fig. 7.1 Design by nendo.

This product intentionally uses the reference to the coke bottle, introducing tiny bubbles in the glass as an "added value" of "green aesthetic" (fig. 7.2).



Fig.7.2 Glass by nendo with tiny bubbles.

I realize that I too, have been influenced by the very issue that I raise in this text: that institutionalized research has a tendency to separate things, in order to understand them, and make sense of them. Critical thinking being the core of academic discourse, must question existing "knowledge" and produce new. We strive to produce more knowledge and pass on this knowledge to the next generations, hoping they will learn from our mistakes and believing knowledge will empower them and enable them to thrive.

The problem with this attitude is that knowledge so far has led us down the path of self-destruction. Our knowledge has enabled our survival, but in the process we have become a threat to our own species and to the environment. This development cannot be reversed - everything about our existence is part of it. But while we may not be able to solve the problems we have created, we are able to make both sense and non-sense of it. In this project, I have proposed ways of doing that by using some of the glass that is continuously being piled up in landfills. Though I do not think that it is the glass craft and design profession's job alone to clean up the waste container glass produced by our consumer culture, I do think we can participate in the "cleanup" and make more sustainable businesses doing so.

The experiments and interventions made during this research have revealed that sometimes we may be able to solve one issue while the solution may cause new issues. Also, we may be able to solve things in theory, while practice proves the same theory insufficient. We may be able to make a contribution in a "constructive" direction, but the overall problem has already become the premise of our existence. While a new sustainable paradigm may be achieved theoretically, practice reveals that it is not so easy. We have to accept the premise our existence and live our lives as ethically as possible within the framework of the nonsustainable paradigm we have created for ourselves while attempting to change it.

In this project, the aim has been to establish whether it was possible to achieve aesthetic innovation by introducing sustainable principles in creative processes and how this could be facilitated. Some of the outcomes of the research have proven innovative in terms of aesthetics – some have not. The question is if a lack of aesthetically innovative results in this project should have stopped the pursuit of research into the aesthetic possibilities offered by recycled container glass. On the basis of the research I do find it safe to assume that contribution to aesthetic innovation *is* possible, and artistic research into the options offered by waste container glass *is* relevant because recycling waste glass serve sustainable development of the field as well as of the society in this time of need. But, I would have continued to make nonsense and sense of the un-sustainable if I had come to another conclusion - because of my autonomous artistic disposition for creating sense and non-sense of all kinds of materials.

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# APPENDIX A

Paper for the Sustainable Innovation Conference 2014

# Sustainable Innovation of Glass Design and Craft

# Introduction

The aim of the research reported in this paper is to reveal a possible connection between aesthetic innovation and implementation of ideas of sustainability into glass design and craft processes. To do so the following research question is currently under investigation:

In what way, if any, can principles of sustainability inform the creative process and contribute to generation of aesthetic innovation within glass craft and design?

The basic assumption is that sustainable practices along with more focus on cross disciplinary international interaction and collaboration, information and communication technology, networking and entrepreneurship will supply the tools for the next generation to develop new ways and possibilities for maintaining and sustaining human life as well as natural diversity on our planet.

As opposed to other creative fields, e.g. fashion, textiles, furniture and more, barely any research has been done into implementation of sustainable principles in the field of glass design and craft. A common tendency among students and practitioners is to consider it desirable but problematic if not impossible to develop a "truly sustainable practice". Generally, glass crafts people and glass designers aim to explore new aesthetic possibilities for the material, and see sustainability as a hindrance for aesthetic freedom, thus contributing to what Fry, in his book "Sustainable by Design" (2009), observes as the mainstream understanding of design that lacks deep understanding of the full holistic impact of our actions on the planet. This is counterproductive to sustainable development and combined with the fact that only few countries in the world are effectively recycling their waste glass there would seem to be reason to examine the current practices from a critical analytical perspective.<sup>1</sup>

<sup>&</sup>lt;sup>1</sup> In Denmark 88% recycling of waste container glass was reported in 2009 (Miljøministeriet 2014). In the US around 34% of the used glass was recovered for recycling, according to the US Environmental Protection Agency (2014), in England 60 % is recycled according to the national recycling campaign "Recycle Now" (2014). Glass that is not recycled end up in landfills or in incineration plants where it produces clinker that cannot be upcycled.

A critical analysis of the existing practices as well as development of a new best practice may imply changes across the national and field specific boundaries toward a more rational sustainable behavior, and may be an incentive to begin to unfold the glass field's possibility to make a contribution to the general sustainable development.

By changing the practice of the researchers in the main educational institutions and especially by changing the way we teach the subject of glass design and craft from using non-sustainable methods, materials and techniques to include sustainable principles, the new glass designers will learn skills that will enable them to change an immediate future that will be increasingly influenced by over population, mass migration, massive environmental devastation, and accelerated garbage accumulation.

The practical approach of engagement of students in hands-on experimentation with sustainable materials and techniques may imply or provoke a shift in the attitude of my peers from believing that sustainability automatically fosters a specific "green aesthetic", toward envisioning or at least acknowledging the possibility of aesthetic freedom generated by using sustainable ideas as triggers for innovation. This paper will address *how* we may implement sustainable ideas in our material specific creative practice and *how* this may initiate a shift of paradigm away from the current common practice of the field mainly focusing on concept and form and towards a practice that is concerned with form on the basis of a deep understanding of impact as Fry (2009) calls for.

The sustainable impact of recycling is evident. Glass can be recycled indefinitely and no new materials are needed in the melt. By using recycled glass instead of new raw materials a reduction of the energy consumption for melting the glass can be obtained, resulting in a reduction of the CO2 emission of approximately 315 kg per ton glass (Waste Online 2011).

Today glass production predominantly consists of window glass, glass wool for insulation and containers such as bottles and jelly jars. Glass household products and artistic work hold only a fraction of the market. Still there is reason to believe that generation and implementation of new knowledge about sustainability in the fields of glass craft and design is desirable since, according to Friedman (2004), these fields influence trends in the patterns of consumption, through what is defined as the trickle-down effect.

### Method

Walker (2006) argues that engaging in the practice of designing is a transformative step that distinguishes design from many other types of inquiry, and that theoretical ideas inform the

design of an artefact and in turn, contemplation of the artefact can advance the development of ideas.

Building on Walkers thesis, a practice-based qualitative research methodology is adapted in this research. Hence, the empirical material is generated through experimental hands-on activities carried out by myself in the lab as well as through field work in the form of workshops with a variety of focus groups.

This paper will describe and discuss a specific case study that took place at The Royal Danish Academy of Fine Arts, Schools of Architecture, Design and Conservation (KADK), Nexø Campus, in the spring of 2014 on the Island of Bornholm, a rural Danish region located in the Baltic Sea. The case study consisted of a workshop involving students of glass craft and design in a process that introduced them to sustainable principles. This study will be briefly compared with experiences from an earlier study: a workshop held at KADK, Copenhagen Campus, in Copenhagen, the capital city of Denmark, with students of design with no previous experience in glass making. The two workshops both included 1<sup>st</sup> year students. The first had 10 participants the second had 15, the numbers being average for classes offered in glass making at most higher education institutions, although not sufficient to constitute a broad representational material.

In addition to the discussion of the case study, it is addressed how a research-institution may contribute to bridge a gap between regional and urban sustainable developments. The empirical material is described and discussed in a narrative fashion and the conclusion that is produced is meant to suggest a best practice.

### Bridging the gap between the urban and the regional sustainable initiatives

KADK, Copenhagen Campus has 1500 students at BA, MA and Ph.D.-level, the Nexø campus on the island of Bornholm has 70 students at BA level. The Copenhagen campus is providing the necessary platform for educating researchers on Ph.D.-level; in close proximity to a research environment, fellow students, partner institutions, networking opportunities, exhibition venues, course offers, major businesses of the trade etc.

The Nexø Campus is offering great lab facilities to a group of dedicated glass students at BA level. This enables a symbiosis where the research performed mainly in the city benefits from the regional support for the countryside campus as well as from the opportunity to engage the students in research activities, and the region benefits from the research performed at the city campus that supports the local education.

In the 2012-vision for development of the region of Bornholm, one of the four main focus points was called "Bright Green Island 2014" addressing issues of sustainable innovation (Bornholms Regionskommune 2014). The fact that the island is remote and isolated was considered an advantage for working with sustainable development by the local administration, because it is easy to monitor especially the energy-consumption.

For the purpose of carrying out the workshop where we planned to use recycled soda-lime glass (bottles and jars) as an alternative to the more toxic and less easily recyclable barium crystal preferred by most Danish glassblowers, the intimate relations between the islanders and the regional focus on sustainability constituted a solid platform. The curriculum taught at the Nexø campus has included glass design and craft for almost two decades, using the traditional barium crystal for all educational activities, except for a few occasional recycling efforts initiated by individual students.

The suggestion of infesting the kiln pots with recycled soda-lime glass that had been rejected on previous occasions was now warmly welcomed by the staff members who saw the necessity and potential of the idea. The school workshop manager contacted the local recycling center that supplied the glass for free. The glass had already been crushed and divided into three different color fractions and just had to be washed before the melting could start.

Thus, the conditions for supporting the research were readily available and the research for supporting a BA-level educational activity with sustainable content was enabled due to the collaboration across the boundaries of a regional and an urban context.

#### The workshop "Glass and Sustainability"

The workshop named "Glass and Sustainability" took place at the Nexø campus over a period of four days. The participants were 1<sup>st</sup> year students most of whom had previous professional experience in glass making. As explained in the introduction, the idea was to work together with the students and explore how their aesthetic experimentation could be influenced and innovated by changing from the traditional barium crystal glass to the more environmentally friendly soda-lime glass, and through this exercise begin to find out if it was at all viable to influence the way students think and act in their formative years as creative professionals.

The workshop included the following activities:

- Lecture based on my research
- Discussions in plenum
- Research of existing sustainable glass projects
- Making tools for experimentation

- Experimenting in the workshop
- Tutorials, questionnaire and evaluation

### Lecture and following discussions

During the first presentation it was revealed that most of the students did not actually know much about the different properties of the different types of glass other than the fact that mixing container-glass and crystal in a melting pot will result in glass that is incompatible with itself and therefore eventually will break. They had even less knowledge of the principles of recycling glass although they were aware that colored glass will tint the whole pot of glass if recycled in a clear melt – which is basic knowledge when working in a blowing facility. We talked about natural occurrences of glass, recycling and the positive influence of re-melting shards (recycled glass) on the  $CO^2$  emissions from the melting process.

It became evident that the students had very different views on the subject of sustainability. Some of them were extremely positive others showed up because it was mandatory and one student did not show up at all. Discussion of issues of outsourcing, of how to create a competitive business, of how to make interesting work and of the students' professional interests indicated frustrations about the subject. Some were very personal and others more concerned with their creative practice. A general issue came up when asking about their expectations for the course: they did not think they had the power to change the negative impact of our trade on the environment and the sociopolitical balance of the global community, even if they would like to. Along with the feeling of powerlessness the most common issue was the fear of limiting their creative and expressive freedom.

### Research of existing sustainable glass projects

We went on to find out more about already existing initiatives to expand the knowledge of possible strategies. The most common sustainable idea for recycling glass is to transform existing glass bottles into new products like vases and drinking glasses, by cutting off the bottle neck (fig. 1). This idea can be manufactured by most people with basic technical skills, and a few simple tools. The internet offers a number of do-it-yourself kits for this type of recycling. Results rarely escape the stereotypical recycled aesthetics.





Fig. 1. Cut glass bottle

Fig. 2. Hot manipulated bottle

Glass makers with refined tools and excellent skills can alter container glass by reheating and manipulating existing bottles (fig. 2.). In this case results also mostly fall within the stereotypical recycled aesthetics. Access to a furnace where the glass can be melted enables the glass maker to diversify the experimentation significantly and therefore hopefully will expand the aesthetic possibilities.

#### Experimenting in the workshop and creating tools and techniques

When experimenting with molten glass it is important to be able to carry out an experiment several times to begin to find out how the material reacts to the way it is manipulated. The manipulation of the glass is highly sensitive to small changes in the procedure that cannot ever be exactly the same when working by hand. Occasionally it is necessary to make the tools for manipulating the glass as well as making the actual glass. For mass production extremely expensive metal molds are used. This is not an option for smaller operations and especially not for most students. This calls for creation of cheap tools. Wood and plaster are the most common mold-making materials for small scale production and experimentation. To expand the possibilities of techniques for utilizing the soda/lime glass I had tested high temperature concrete as a mold material prior to the workshop, and it had proven to have great potential especially for casting- and press molds.

The workshop included an introduction to the techniques of glass pressing and glass casting, techniques that are very suitable for working in soda lime glass because this glass stiffens quickly. These techniques are used for crystal glass too, but mainly in mass production processes. They are rarely used by small operation glass manufacturers and in educational contexts because blowing glass is generally thought to be more fun and versatile. By switching

to soda lime glass it became relevant to include pressing and ladling the glass<sup>2</sup> which again made concrete mold making useful. Thus, the introduction of sustainable glass in the creative process caused possibilities for explorations of new aesthetic expressions.

During the experimental phase with the concrete mold making as well as with the glass in the workshop the students' attitude changed dramatically. The fact that the soda/lime glass had other properties than the crystal and the potentials derived from those properties inspired the students to begin to work in different ways which again sparked new ideas and the use and development of different techniques. The opportunity to blow in full colored glass, as opposed to the normal procedure of blowing in clear glass and adding the color on the individual pieces on the pipe was warmly welcomed, as well as the fact that the material was free as opposed to the expensive crystal. Blowing the hot molten soda lime glass proved to be harder than blowing in crystal but not nearly as hard as we had imagined. Some of the students even enjoyed the challenge of having to work faster.

We evaluated the test pieces every day after opening the annealing furnace. The results were promising but needed elaboration and refinement. Therefore, the students decided to continue working in soda lime until the end of the semester, to become better at mastering the material and to make more experiments. One experiment that showed potential was the pressing of the soda lime glass into a concrete mold (Fig. 3.).



Fig. 3. Pressed soda lime glass in concrete mold

<sup>&</sup>lt;sup>2</sup> Ladling hot glass into a mold is a technique used for e.g. production of tiles.

#### Comparison with the previous workshop

In the previous workshop where the students were novices to glass they showed no sign of resistance to working in recycled container glass. But in the group of glass students, they knew the technical and aesthetical differences between the soda/lime glass and the crystal glass, and being used to the qualities of the crystal they did not see why they should "compromise". In the previous workshop the two issues of artistic freedom and powerlessness that concerned the glass students never came up, neither in the introduction nor during the course work and evaluation. The students without previous knowledge of glass believed they would be able to push design in the sustainable direction no matter which materials they worked in and they were much less worried about technical and material obstacles in the creative process. On an individual artistic level this may indicate a difference between being new to a field and being immersed in the culture and habits of a field.

### Conclusion

The workshop was successful in the sense that students changed habits and attitudes. The handson experimental approach was welcomed by all the students who generated a series of innovative experiments with new tools and techniques as well as wonderful mistakes and failures pointing to new aesthetic expressions to explore in their future work. The physical results of the workshop were promising although not taken to a high level of refinement – due to the short duration of the course.

The workshop indicated that when the material is changed, the working habits change too which again leads to potentially new insight about aesthetic possibilities, evidence to support the assumption that principles of sustainability may indeed inform the creative process and contribute to generation of aesthetic innovation within glass craft and design. More experiments of my own and more workshops with focus groups are needed to be able to build a solid argument for the proposition that aesthetic innovation of glass craft and design may indeed benefit from the introduction of sustainable principles in the design process. As of now the results suggest the relevance of further explorations into the subject matter.

The city of Copenhagen involved provided the research environment and the region of Bornholm provided the platform. The workshop contributed to the realization of the regional vison of creating a "Bright Green Island", and this vision paved the way for generation of empirical material for the research that flows back to the research environment in the city.

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# APPENDIX B

Article in KUNSTUFF Danish Craft & Design # 24

# **Glass and Sustainability**

It has become widely acknowledged and indisputable that sustainable development is a necessity for humanity's continued existence on this planet. This is the basis for my PhD project, which examines how issues of sustainability can influence creative processes in glass design and craft, and how glass design and craft can contribute to a sustainable development.

The negative environmental implications associated with the practice of glass design and craft constitute a dilemma for the creative practice, since the inclusion of more sustainable principles in the creative processes may limit the creative spaces of opportunity and thus come across as a restriction of individual artistic freedom. In order to address this dilemma, I am undertaking an examination of the following questions:

• Can sustainable principles influence creative processes and contribute to an expansion of aesthetic spaces of opportunity in glass design and craft, and if so, how?

• Can glass design and craft contribute to a sustainable development, and if so, how?

## Best practice and experiments

In the project I examine a range of techniques and processes, including pressing and casting.

The experiments, and the results of these, form the empirical basis of analysis and reflection, which are coupled with theoretical currents in design and crafts as well as ethics and aesthetics. In addition, I examine best practices by looking at existing sustainable initiatives in glass design and craft.

## A practice-based research method

In order to connect scientific and artistic practices and produce useful knowledge for practitioners in the field of artistic glass, I apply a practice-based research method.

Practice-based research into design and craft includes practical, artistic as well as theoretical aspects and is disseminated both in written reports and through visual representations.

My goal is to develop a foundation for experimental processes, rather than production of actual works of design and craft.

I investigate how principles of sustainability may act as deliberately generated obstacles in the creative processes, and what possibilities may emerge consequentially. This strategy results in a

series of epistemic artefacts that embodies knowledge and insight that occur through e.g. melting recycled container glass as an alternative to virgin materials.

### **Pressing and casting**

Pressing is a good technique for working with recycled container glass, as this is a 'short' material – meaning that it cools down relatively quickly when it is removed from the kiln.

Experimenting with glass pressing requires the ability to prepare relatively low-cost mould tools. Normally, the glass is pressed in mould tools made of metal or graphite, and since both these materials are expensive, they are inappropriate for an experimental process.

After consulting Bendt Sørensen, head of the SuperFormLab (workshop for silicate-based materials at the Royal Danish Academy of Fine Arts), I became aware of high-fired concrete, which proved to be suitable for making press moulds, as it is a cheap and simple material to work with.





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In contrast to pressing, casting is a technique that is not readily appropriate for recycled container glass, which has a relatively low degree of viscosity and tends to devitrify quickly, forming surface crystals as it heats up and cools off.

In the experimental process I found that the devitrification can be reduced by transferring the glass directly from the kiln into a pre-heated mould, a technique known as 'hot-gobbing'.





### New insights and major frustrations

In addition to the written dissertation, the project includes teaching activities, participating in juried as well as self-initiated exhibitions and interventions in the public space, attendance at courses, seminars and conferences and the preparation of scientific articles.

So far, my studies have provided both new insights and major frustrations. As expected, recycled container glass is full of surprises, which bring both failures and successes that would not have occurred without this deliberately generated obstacle.

# **Recycle** About Sustainability in Glass Craft & Design

Ph.D. Dissertation by Maria Sparre-Petersen

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