

# The User Experience and Perception of Sustainable Ceramic Design

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**Abstract:** This research focused on development of sustainable ceramic design research which is an important issue in Sweden and in the larger global perspective. Significant results in this research can be important to new growth in the Nordic ceramics industry, a sector that has been losing world market share to international competitors. The methodological issues in this research have two important outcomes. While this study has been based on artistic research and applied technological research, these questions involve social science research methods. To answer them, this study worked across the boundaries of disciplines to promote dialogue between art and sciences. Ceramic design products are finding it harder to compete on global markets. In Sweden, most of the ceramic materials have to be imported and ceramic industries are in hard of competition, since the country has a small domestic market and high labour and production costs in comparison to the rest of the world. This phenomenon is not only limited to the Swedish domestic market, but can also be seen throughout all Scandinavian countries, where there are small populations with small domestic markets. However, the production of eco-ceramic design objects based on sustainable materials may lead them to assume a unique position on the world market. In spite of this, clay-based ceramics is one of the longest used and most traditional of all the materials we use nowadays. Because of its long history, people's reluctance to use sustainable materials in ceramic products, i.e., those made from recycled materials or process by-products, may not easily be changed. This means that it is important to understand how such products are viewed by the public, not only for the creative part of the design, but also for the future design markets. The study is based on investigate the public's attitudes and aesthetic experiences about eco-ceramic design use prototypes produced with sustainable ceramic materials. The responses obtained from the quantitative analysis questionnaires were used to assess the experiences and theoretical interpretations of the both public and designers.

**Keywords:** *Aesthetics and Experience in Design, Ceramics, Perception, Semantics, Sustainability.*

## 1. Introduction

Sustainable design, eco-design, or environmentally-conscious design is a concept of designing physical objects, the built-up environment and services to comply with the principles of economic, social and ecological sustainability. The key to sustainability is to establish the capability for natural and cultural systems to evolve over time. A sustainable approach to design considers the impact of each design choice on the natural and cultural resources of the local, regional and global environments. This idea can be applied not only to the field of ceramic art and design, but also to entire academic areas.

The developments of sustainable products and environmental issues have become increasingly important in Sweden and Europe. In the field of ceramics, this issue is particularly problematic.

In Sweden, most ceramic materials have to be imported. Furthermore, ceramic industries are in stiff competition, since the country has a small domestic market and high labour and production costs. This phenomenon is not only limited to the Swedish domestic market, but can also be seen throughout all Scandinavian countries, where there are small populations with small domestic markets. As a result, most of the major ceramic industries have moved their factories to Asia and other countries with lower production costs, leaving only the management and design units in Sweden.

The challenge of sustainability is a source of pressure to the ceramic industry because ceramic production has certain limitations in regards to the concept. Ceramic production is heavily based on the use of natural resources. Clay comes from soil, which is a mixture of various minerals, the mining of which can cause changes in the ecosystem. The materials are transported from one country to another via polluting transportation. Chemicals from the different materials used in ceramic production can pollute water. The firing process requires energy and can cause air pollution and damage the environment. In addition, traditional ceramics are fragile and difficult to be renewed, recycled or repaired; for this reason, it has a limited product lifetime. The production of sustainable ceramic art and design product is therefore a challenge to both artists and industry.

Ceramics, based on clay, is one of the longest used and most traditional materials among all the materials we use today. Because of its long history, people's hesitation to using recycled materials in ceramic products may not easily be changed. For example, not everyone will be willing to replace their everyday dining tableware, such as traditional porcelain coffee cups and saucers, with eco-ceramic products produced from recycled materials. However, an approach with a good design concept and related products would be invaluable in removing barriers between users and designers. This means that it is important to understand how such products are viewed by both artists and the public, not only for the creative aspects of ceramic practice, but also for the improvement of ceramic art and design education, research and the industry.

Although Sweden and EU governments are encouraging the use of environmentally friendly products and all educational sectors are involved with sustainable issues, it appears that there is a lack of information about both sustainable ceramic materials and related products, whether in the educational sector (educators, students, researchers and other academic staff) or in the public sector (artists, the public and public

officials). As in many other design-related fields, the user experience is also of importance in ceramic art and design. This raises the question of identifying both artists' and the public's experiences and perceptions of sustainable ceramics in order to support the artistic practice, industry, education and future research in the field of ceramic art and design and promote the development of sustainable ceramics.

## 2. Paper-composite porcelain and ash-combined porcelain

In the ceramic practice, clay is a major tool with which artists and designers create artefacts and design products. Many clay bodies are being developed for various purposes and artists are applying these to new creations. Recycled and other sustainable materials have received much interest from ceramic artists in recent years. This study looked at two types of sustainable clay bodies, paper-composite porcelain and ash-combined porcelain. The study on paper-composite porcelain focused on the options for design applications, the material characteristics and physical properties, while the ash-combined porcelain focused on the testing of its workability in artistic applications.

Ceramics is the oldest and most permanent plastic material used in cultural production. Despite its susceptibility to shaping in its green state, its fired finish remains unspoiled, smooth and delicate throughout thousands of years. This permanence thus becomes a part of the material's essential qualities. However, ceramics has technical shaping limits which have been overcome by adding paper to clay in modern art ceramics.

Clay, in combination with natural fibres, has been used to make unfired bricks since the beginning of the Neolithic period, 10,000 years ago [6]. In the 1970s, the artist Rauschenberg mixed adobe clay with seeds, powdered gum and paper pulp to get dry strength for artistic purposes [5]. In the 1990s, *Paper clay* [1, 7] was introduced to the ceramic art field by several potters. The term "*Paper-composite porcelain*" [2, 3, 4] stands for any kind of porcelain that consists of plant-based fibre pulp and mineral additives. The introduction of *paper clay* to the field of ceramic art has resulted in more independence in the artistic process. Conversely, new problems follow new materials, particularly when the characteristics or properties of the material have remained undetermined. The purpose of this research was to obtain reliable knowledge of the properties of paper-composite porcelain.

In this study, the paper-fibre contents were 50%, 70% and 90% in volume (as 6.8%, 14.6% and 39.8% in weight). Only waste paper was used to produce the paper-composite porcelain and the maximum firing temperature was as high as 1350°C.

The study of paper-composite porcelain involved a combination of practical artistic experiments and laboratory experiments used within material science. The technical studies qualitatively investigated the material characteristics and microstructures using X-ray diffraction and scanning electron microscopy. The qualitative physical properties tests involved different casting body recipes, production methods and firing

temperatures. Quantitative studies were used to measure and analyse the properties of porcelain and paper-composite porcelain. The artistic experiments involved the development of a slip casting method which recycled the excess water from the process.

The results provide new knowledge of paper-composite porcelain by identifying the reinforcement role of paper fibre in the formation and fabrication stages. The study revealed that a fibrous structure was created in the paper-composite porcelain body in both its green and fired states. The fibrous structures displayed strongly binding, interlocking fibres and fibrous bridging, forming a support structure for the ceramic objects. It was found that mineral compounds in the added paper are transformed during firing and make an essential contribution to the special properties of the paper-composite porcelain. The calcite from the recycled papers melted with the kaolinite during the firing process and transformed to anorthite, which was identified in the microstructure of the paper-composite porcelain in the fired state. The structures of fired paper-composite porcelain bodies had special fibre binders covered with anorthite. Slip casting of various tableware models showed that there was significantly less cracking, warping, bending and deformation of the paper-composite porcelain than of the mother porcelain. Furthermore, sharp angles and fine lines and surfaces were obtained even with the highest paper-fibre content used (90% in volume). Paper-composite porcelain had the same whiteness as ordinary porcelain, but it had a silkier lustre and was more translucent when glazed (Figure 1).

	
<p>Figure.1 A serving set consisting of four different items. Paper-composite porcelain 90% in volume.</p>	<p>Figure.2 A ceramic sculpture. Ash-combined porcelain 50% in weight.</p>

The artistic exploration of ash-combined porcelain looked at mixing the by-products up to 50% in weight with a traditional porcelain body to test the workability and application as a sustainable clay body for aesthetic expressions.

A major material of ash-combined porcelain in this study is based on the by-products of a bio-energy station (ENA Energi AB in Enköping) in Sweden. Two types of by-products were used: Fly ash and bottom ash. The recycled substances were mixed with a clay body ranging between 5% and 50% in weight and the main firing temperature was as high as 1360°C.

According to the recalculated oxides (wt.%) of the fly ash and bottom ash,  $\text{SiO}_2$  was the largest chemical component in both ashes, with the fly ash having 30% and the bottom ash having 66%. The CaO content was 25% in the fly ash and 9% in the bottom ash. Undesirable substances from the bottom ash were removed by sieving before mixing with the porcelain slip. The bottom ash mixed slip gave a tougher texture after firing than the fly ash mixed slip, however the latter was stronger in both the green and firing states. The bottom ash was easier to mix with slip than the fly ash; it was also easier to remove the bottom ash casting body from the mould than that of fly ash. The fly ash gave a very shiny and fine texture and a smooth surface after firing (Figure 2). The weight loss was higher in fly ash than in bottom ash in all the quantities of mixtures.

To maintain the sustainability in this study, only raw materials produced within Europe were used in the production of both the paper-composite porcelain and the ash-combined porcelain so as to limit transportation, use less fuel, cause less traffic-related environmental damage and make use of local labour. Paper-composite porcelain and ash-combined porcelain, with their applications in artistic practice, can be developed in an artistic context to produce sustainable ceramic products.

### **3. User experiences of sustainable ceramics**

In order to understand the perceptions of artists and the public of products produced with sustainable ceramic materials, as well as their experiences of such materials, interviews and surveys were conducted between November 2008 and April 2009 in Sweden. The total number of respondents was 100, of which 50 responded in interviews and 50 responded via questionnaires. The interview and the questionnaire both contained the same questions in order to enable the results to be compared on an equal footing. Instead of voice recordings, interview responses were entered on the questionnaire form while the interview was conducted. The questionnaires were distributed in two languages, therefore the respondents could choose between English and Swedish depending on the language with which they were more familiar.

The responses were obtained from a natural selection of people and the interviews and questionnaires served as qualitative and quantitative methods of evaluation. The collected data was evaluated as a comparative analysis in order to obtain a more objective view of the results.

The ages ranged between 23-78. 27% of the samples were men and 73% women. 69% of the respondents were Swedish and 31% were non-Swedes. 66% of the respondents had Bachelor's and/or Master's degrees.

#### **3.1 Experiences by ceramic artists**

In the results of this study indicate that 90% of the ceramic artists who participated in the investigation had another job alongside their work as ceramic artists. The artists have from 2 – 22 years' experience in the practice of ceramic art. 90% of them have used some type of sustainable or recycled materials in their

artistic practices, however only 10% of the artists used those materials regularly. 70% of the artists mix the materials with either stoneware or porcelain clay themselves. 80% have worked with paper clay and 90% mix the paper clay themselves. 50% use paper clay or sustainable materials when they making sculptures and 10% use it for making large plates, reliefs, large tiles, etc. Although 53% of the artists were either very satisfied or satisfied with paper clay (material quality, technical functions, working and forming process, and aesthetics, e. g., shape, colour, texture), 90% of the artists said that they had problems with the texture or colour of paper clay, difficulties working with the high amount of paper, or difficulties in making the surface smooth. 60% of the artists want to use sustainable materials in the future and wish for stronger as well as lighter weight materials. The result showed that much of the previous research on paper clay or sustainable materials were not well applied or distributed in their artistic practices.

### **3.2 The public experiences**

This study was based on a need to investigate the public's attitudes to, and experiences of eco-ceramic products made from sustainable materials, to capture the problems experienced with current sustainable ceramic products and to discover the potential of new sustainable design concepts and products. The results of this investigation are significant, particularly since 67% of the respondents had either never heard about eco-ceramics or had not got any information about ceramic products made from sustainable materials. 100% of those who had bought eco-ceramic products and thus could relate their experiences (mugs and bowls only) responded that they were either very satisfied or satisfied with the material quality, physical functions and aesthetics of the products. 50% of them thought the products were too expensive. 78% were willing to buy eco-ceramic products if they knew such products were in the market, although 22% were hesitant to buy products that were made from recycled materials. While 78% of the respondents said that they were aware of environmental issues, 11% still said that they did not care about the issues. 56% wished to get better information about eco-ceramic products and wanted them to be visible in the markets. 44% wished to be motivated to buy eco-ceramic products: not only should the price not be more expensive than other usual products, but the eco-ceramic products should have better functionality and better aesthetic forms.

The results of this investigation showed that the most serious problem is the lack of information about eco-ceramics made from sustainable materials and communication with the public. Furthermore, most eco-ceramic products are comparatively expensive for consumers to purchase. From the results, limited understandings of sustainable materials notwithstanding, consumers are apparently not only put off by the prices, but also by other aspects. Eco-products made from recycled materials are apparently less attractive, the physical strength or quality is considered to be worse, and there is too little information available to consumers about sustainable materials and eco-ceramic products in comparison to the usual products.

## 4. Conclusions

This paper identified a variety of problems including the perspectives of artists and the public on using sustainable materials in the practice of ceramic art and design, the current position of sustainable ceramic products in the market, research and education. It is still difficult to incorporate recycled eco-products into the field of ceramic art and design, since there are no established forms of education or research in this area compared to the other design fields. For this reason, ceramic artists and the public do not have a sufficient grasp of sustainable ceramic materials and eco-products to be able to use them in their professional practices or to choose to buy them.

The results of this paper are: (1) the revelation of user experiences of sustainable ceramics which could lead ceramic artists, academics and industries to develop new ideas, (2) the provision of insight into people's expectations and experiences, inspiration to improve organisational thinking and the innovative processes of ceramic creations, and (3) suggestions for further development of sustainable ceramics. The results of the investigation of user experiences can therefore be used as valuable information for future research, education and practice and education in the field of ceramic art and design.

With respect to research on eco-ceramic products, the development of sustainable materials has a high potential, since the composite can be mixed with a variety of wastepaper and plant ashes to improve or reinforce the absence of certain materials. There are many other sustainable materials in ceramics than just recycled paper. However, it is important to maintain sustainability in the production process. In some cases, the use of recycled materials in ceramic creation is far beyond where purely technological and economic considerations would have led. Moreover, it is not true that increased recycling is always environmentally better.

The results of this study show that efficient communication between artists/producers and consumers is urgently needed, as is the sharing of knowledge between academics and artists. It would not only enable ceramic artists and industries to meet the current demands of sustainable ceramic products in markets, but also provide a base for a more effective form of sustainable ceramics research and improved pedagogical approaches in the field of ceramic art and design.

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