DESIGN EDUCATION FOR SUSTAINABILITY (I)
A Survey of Product Design Students’ Attitude Toward Environmental Consciousness

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Abstract: In order to disseminate and promotion of design education in the sustainable (DES) context in the academic and professional field, this research introduces the theoretical study of DES and a case study of 620 product design students’ attitude, knowledge and viewpoint toward environmental consciousness. According to the results of the survey, the students’ strong consideration of socio-cultural principles is the most important factor for solution of the present environmental issues, showing a pro-environmental consciousness that was also evident in the students’ capacity as consumers since they consider environmental aspects when purchasing products. The majority of 491 students who did not receive environmental education expressed a strong desire to receive environmental information, with the primary topics related to examples of environmentally friendly products (eco-products).

Key words: EcoDesign, Design Education for Sustainability, Environmental Education

1. Introduction
The main title of this study is part of a series related to design education for sustainability (DES), which is a new field for industrial design educators and design professionals [1-4].

The objective of the series is to disseminate and promote design education in a sustainable context in the academic and professional fields.

This research introduces the theoretical study of DES and a case study: a survey for product design students’ attitude toward environmental consciousness.

The knowledge, attitudes, and viewpoints of undergraduate students toward environmental consciousness are analyzed. This case study can be justified through the argument that students will be the professionals of the future and leaders who could influence the direction of the development of sustainable products and services.

Previous studies [5-7] have reviewed the activities of industrial designers, demonstrating that they play a key role in linking the manufacturing process and the consumers as well as technology and marketing; they are the central figures in product and services development for many companies. Industrial designers play a significant role in seeking alternative solutions to the wasteful lifestyles of contemporary society, and in influencing positive change through the creation of more responsible goods and services. Toward those facts, experts [8-9] have stressed that current design education should be redirected to the development of an ethical industrial designer, one who could rethink and radically design products that deliver environmental problems. DES can help usher in a promising future by transforming the industrial designers of tomorrow [10].

However in order to do this, industrial designers need both knowledge and understanding of environmental issues, along with the ability to seek guidance and a technical understanding of production processes and the properties of materials [2, 11, 12].

Based on these facts, in the following sections we describe the selection process of the theme and case study, theoretical principles and research methods employed in order to motivate and direct industrial design educators and professionals toward a more coherent...
direction of development of products and services that are environmentally conscientious.

### 2. Justification for Choosing the Theme and Case Study

Complementing the important facts described in Section 1, in this section we argue that there is a lack of specific relevant literature that pertains to DES, which is confirmed in the papers published between 1999 and 2013 by the International Symposium on Eco-Design [13] and between 1997 and 2011 by the Special Issue of the Japanese Society for the Science of Design [14, 15]. There are no specific studies on DES in the academic field, and the majority of papers published focus on environmental technology and impact assessment in products, and are therefore from an engineering rather than an industrial design perspective.

This research thus aims to prompt discussion about the current students and their environmental education within the industrial design field. This discussion could stimulate design educators to conduct more pedagogical studies of DES and ascertain new ways to implement it in both undergraduate and graduate design curricula.

### 3. Reviewing the Theoretical Principles of DES

Before introducing DES, it is necessary to understand the theoretical and practical approach of sustainability principles. Sustainability is described as a development that meets the needs of the present without compromising the ability of future generations to meet their own needs [1, 4, 11]. The concept of sustainable development was introduced in 1987 and reviewed at the Earth Summit in Rio de Janeiro in 1992 [4].

Based on this definition, education for sustainability (ES) can be described as the practice of teaching sustainability and learning how to achieve sustainable communities globally and locally. ES also refers to the promotion of and transition to sustainable development, through all forms of education, public awareness, and training. The aim of ES is to use education as a catalyst to stimulate changes in values, attitudes, knowledge and skills in order to ensure a sustainable future and the evolution of just societies [4, 11].

Many universities across the globe offer courses focusing on the dimensions of sustainability. Increasingly, academic initiatives are taking place to collect and disseminate the experiences of the scholars and teachers involved. Examples are dedicated conferences and even a dedicated peer-reviewed journal [12].

According to expert [2], ES has contributed to publications related to design and sustainability. Furthermore, it has developed a framework that can be used as a foundation for a sustainability curriculum for design education.

The term design for sustainability (DS) has emerged in the field of industrial design, and is now well established although it can still be considered to be an emerging field. DS takes the environmental, social, and economic aspects (triple bottom line) of the total lifecycle of a product or service into account during the development stage [1, 16].

Based on the description of ES with the principles of DS, the DES could be described as a practice of teaching and learning how to achieve sustainability in the design field, and also research design that contributes to sustainability [16].

The most recent research [17] on DES relates to existing design courses (undergraduate and postgraduate) that integrate sustainability and eco-design concepts into the curricula in the United Kingdom, Finland, Italy, the United States, South Korea, Japan, India, the Netherlands, and Australia.

In the case of Japan, the Department of Design within the Faculty of Engineering at Chiba University is referred to as a unique design program that offers eco-design theory as
part of postgraduate education. Introduced in 2007, the eco-
design theory class is conducted by us and provided to both
masters and PhD students, and the number of students has
increased year on year. However, the class has not yet been
included in the bachelor’s course and there are no practical
activities that focus on eco-design.

The eco-design theory class is conducted in the first
semester and each session is an hour and a half in length.
The course is worth two credits and runs for a period of 15
weeks. Masters and doctoral students are also encouraged
to participate in workshops and other relevant events related
to sustainability and eco-design that might be happening
inside and outside the university.

A more detailed research on the Japanese universities that
have implemented eco-design and sustainable design in
their programs will be studied in the next series of research.

In conclusion, DES represents a challenge for design
educators [4], and an extension for the design profession. In
general, DES is not only about things, but also about how
we relate to them and how one’s daily life is organized [3,
4, 11]. This represents a particular area where design has an
important role, as the ability to imagine and communicate
the unknown is the strength and potential power of the
designer’s contribution. Indeed, designers have the capacity
to envision and materialize new avenues or possibilities,
and in that sense contribute to creating a better, more
sustainable world. As such, DES is a new and complex
field that requires further study [2, 3].

4. Research Objectives

As described in Sections 1, 2 and 3, DES is a new field in
industrial design, especially for design educators teaching
on undergraduate and graduate courses.

An appropriate collection of references to understand
the current situation of product design students toward
environmental consciousness appears to be lacking, and
based on this fact we have identified the following five
questions (pertaining to the attitude, knowledge, and
viewpoint of students):

1. How can we characterize the attitude of students
towards an overview of environmental issues?
2. How can we characterize the attitude of students
toward environmental aspects during the purchase of a
product?
3. How can we characterize the opinion of students
toward a new product with radical environmental aspects
in marketing?
4. How can we characterize the knowledge of students
about sustainable development?
5. How can we characterize the present environmental
education and learning from the students’ perspective?

5. Research Design and Methodology

Figure 1 shows the phases overview of the research
structure, including its main keywords, methods, and goals.
To answer questions 1-5 listed in Section 4, the following
paragraphs we describe the phases of research.

We initially review the important aspects of sustainable
development, ES, and DES. Based on this stage, we
formulated a survey related to environmental consciousness,
which explored students’ personal and consumer attitudes.
Specific topics related to environmental product development
were also asked of students, such as environmental issues,
sustainable development, knowledge, and ISO 14001.

The questions explored environmental consciousness and
were based on previous studies conducted by experts [18,
19], which were defined as complex and built upon internal
factors related to four dimensions: affective, cognitive,
dispositional, and active.

Due to time constraints and restrictive conditions, we
focused on the cognitive and dispositional dimensions; in
other words, the knowledge, attitudes, and viewpoints of
students in relation to environmental consciousness.

The survey was distributed to undergraduate students
on the Industrial Design course within the Faculty of
Engineering at Chiba University.

An overview of student demographics is provided in Table
1. A total of 620 students completed the questionnaire, with
the majority being male (66.8%). Age range included 19
(42.1%), 20 (20.6%), 18 (17.6%), and 21 (7.7%) years.

The questionnaire was carried out between September
2014 and May 2015. The students were studying in their
fourth and fifth semesters, and in their previous semesters
they had been provided with general knowledge about
product design development and process production, as
well as basic knowledge of ergonomics and application of
materials.

The course offers 12 different design specializations
over the seventy semesters (1.Product Design, 2.Design
Planning, 3.Design Management, 4.Materials Planning,
Design, 12.Contextual Design), however the questionnaires
revealed that the students were not yet able to pursue their
specific interests in design specialization.

In this research the majority of students showed interest
in exploring environmental aspects of product categories of
furniture (17.8%), stationary goods (16.5%), tools (10%),
and packaging (8.9%).

The majority of the students (491; 79.2%) had not
attended education and training programs on environmental
aspects in the last year, with the remaining 129 students
(20.8%) having attended such programs organized by their community and local companies.

6. Survey Results
6.1 Personal Attitudes of Students Toward the Overview of Environmental Issues

The objective of this section is to discuss the students' positions and their personal attitudes toward environmental issues based on the four pillars of sustainable development: technology, socio-cultural, economy, and ecology.

Based on the Ecodesign Awareness Workshop of the Ecodesign Manual by Brezet [20], students were asked to determine their positions toward environmental issues in a field consisting of these four factors of sustainable development.

According to the general results, students considered factors to mean fundamental changes in individual attitudes and changes in consumer lifestyles (28.5%); in other words, socio-cultural factors were considered to be one of the most important solutions when ranking environmental issues (Table 2).

The second and third most important factor groups were developing and applying new environmentally friendly technology (25.2%) and establishing a new system of economic values (23.7%). The last factor was environmental protection, which ranked nature conservation (22.6%) as highest.

Comparing the overview of those factors, there were no significant contrasts between them, and students demonstrated the balance of the four factors in order to solve environmental problems. These results can be complemented with the argument by World Commission on Environment and Development (WCED) in which the principles of sustainable development are the balance of these factors [4].

However, a detailed analysis of this ranking also revealed a proactive position in order to find a solution for today's environmental issues. In other words, students responded toward environment issues with internal stimulus, such as ethics and a sense of responsibility.

In Statement A of Table 3, the same proactive attitudes of students can be found. They considered socio-cultural factors to be more important than technology in order to approach sustainable development.

Based on the results above and the students' answers to Statement B, it can be argued that in order to achieve sustainable development it is necessary to move from production and consumption based on the current technology and socio-economy to the socio-cultural factor, which consequently will influence the re-definition of the current product’s production and consumption.

6.2 Student Attitude Toward Environmental Aspects During Product Purchase

An optimistic attitude during the purchase of a product was evident in almost all of the questions answered by the 620 students, who demonstrated an awareness of environmental issues.

As consumers, students are exercising the power of their purchasing decision in favor of their economic, socio-cultural, and environmental concern. This argument can be noted in the fact that 39.3% and 22% of the respondents generally agree and fully agree, respectively, that the
boycotts by end-users of certain products organized by consumer organizations can have a considerable impact on company behavior (Table 4, Statement A).

In response to statement B, 31.1% fully agree, 28.8% agree, 15.5% disagree, and 7.3% fully disagree that in the near future the cost of disposal of a product will be more expensive than the cost of its production. Judging from these results, it can be concluded that students today are conscientious, showing a pro-environmental attitude to the cost of disposal and boycotting certain products. Students also have contributed to environmental clean-up and preservation primarily through practical action, such as purchasing products that are perceived as environmentally sound (products with eco-labelling) and by recycling (reuse of second-hand products).

Question B in Table 5 reveals that 59.5% of the participants have previously bought a product(s) from a second-hand shop. From the general results of Question B, 41.1% and 44.2% of students read and sometimes read, respectively, the labels on a product before purchasing it, and 48% have previously bought a product with eco-labelling (Question C). These results show that the students have a pro-environmental tendency as consumers. However, it can be argued that environmental aspects are not always the most important factor in the decision to purchase a product. One argument that could justify the motivation of students in buying from a second-hand shop are factors such as price, fashion, and aesthetics of old products with long life expectancy.

Question A in Table 6 shows that 55.9% of students responded ‘yes,’ 36.8% responded ‘sometimes,’ and 6.3% responded ‘no,’ which reveals a proactive attitude.

However, the general results of Question B show that 24.5% of students responded ‘yes,’ 48.1% responded ‘sometimes,’ and 25.3% responded ‘no.’ The fact that the majority of students responded ‘sometimes’ to the latter question shows an uncertainty in relation to this question. These results can be justified with the argument that initial leasing is essentially a long-term rental and also varies from product to product.

6.3. Student Opinion Toward New Products with Radical Environmental Aspects in Marketing

According to International Consumer Behavior [21], Japan is a country with a relatively homogeneous society that tends to accept new products rapidly in their daily life; 82% of Japanese consumers accept high-tech products, electronics, and appliances very quickly. Conversely, this research finds that the relationship between students and new products with radical environmental aspects is quite different.

In Table 7, from the general results in Question A, the majority of students (44.1%) responded that the public would accept a new product with radical environmental aspects very slowly, whilst 35% believed that acceptance would vary between very quickly and very slowly. Only a small percent of respondents (2.6%) believe that the public would not accept it. These results suggest a general doubt in relation to this question, which can perhaps be justified with the fact that students still have low experience in the purchasing of new environmental products or services. There is also a lack of alternatives that are deemed acceptable by users in the current system of production and consumption, which allows the students choice in the marketing stage.
However, Question B found that the context of students in relation to new environmental products is different, with 53% affirming that if a company (ies) introduces a new product with radical environmental aspects in marketing, it could change the lifestyle of the consumer. Here, students showed a pro-environmental position, accepting new eco-products and service alternatives and giving their opinion for changes in their lifestyle. If students really put this attitude into action, it could contribute to reducing the environmental impact. The above result can be complemented by research conducted by Japan’s Economic Planning Ministry [22], which shows that 31% of Japanese consumers believe that an individual's lifestyle contributes directly to environmental issues, whilst 50.8% believe that industry is the main source.

Other important data also can be complemented here; a survey by Nissei Research Institute [22] showed that 35% of Japanese consumers gave the lack of nearby environmental products and services as a reason for not taking ecological steps.

Based on the above results, new possibilities of eco-business can be proposed in the current Japanese marketing climate, benefiting both consumers and companies. This affirmation also can be complemented by the general results of Statement C, where the majority of students fully agree (31.1%) and agree (31.8%) that environmental issues will be one of the most important themes in the future and will be drivers for innovation and new business.

6.4 Student Knowledge of Sustainable Development

The goal of this section is to analyze student knowledge of sustainable development. According to the answers to Question A, the majority (80.9%) know the meaning of sustainable development and only 19.1% did not know its meaning (Table 8). This result can be confirmed through the previous results of Section 6.1, in which students showed a balance between the four factors of sustainability: socio-cultural, technological, economic, and environmental protection.

Brezet [20] adds that sustainable development requires a radical reduction in the use of raw materials and fossil fuels, and of wastes and emissions of (hazardous) substances in...
Table 8: The Students and Their Knowledge of Sustainable Development and ISO 14001

<table>
<thead>
<tr>
<th>A. Do you know the meaning of &quot;sustainable development&quot;? The definition of &quot;sustainable development&quot;: &quot;We preserve the environment and resources, current and future development that can meet generations of the need both.&quot; WCED, 1987.</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Yes</td>
<td>80,9</td>
</tr>
<tr>
<td>2. No</td>
<td>19,1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>B. Do you know the meaning of the ISO14000? Definition: ISO14000: provision of the International Standards Organization as a reference for addressing environmental issues.</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Yes</td>
<td>57,0</td>
</tr>
<tr>
<td>2. No</td>
<td>32,6</td>
</tr>
<tr>
<td>3. I do not know</td>
<td>11,4</td>
</tr>
</tbody>
</table>

industrialized countries (by 70% to 90%), which in turn will require changes in production and consumption patterns.

6.5 Student Knowledge of the International Organization for Standardization (ISO 14001)

From survey Question B (Table 8) regarding ISO 14001, it was noted that 57.1% of students know the meaning of the ISO. This could be because Chiba University has implemented ISO 14001 in their campus life and has become one of the leading academic research centers in Japan. One of the basic aims of ISO 14001 is to reduce the environmental impact of chemical waste from laboratory experiments, plus waste and energy use from everyday campus life. The university has also set up an environmental management system (EMS) organization comprising a president, ISO 14001 secretariat, and representatives of the faculties, departments, and other affiliated groups that sit on executive, student, and planning committees. Opportunities in environmental education have gradually increased, with two EMS training courses now open to students, who are also eligible to participate as tutors in joint EMS education programs and become involved in issuing a monthly leaflet to exchange information with students, teachers, and parents [23].

6.6 Students’ Perspectives on the Present Environmental Education and Learning

According to Gardner [24], the lack of environmental information can be a serious barrier to pro-environmental action, because it is not always obvious to an individual how to alter his or her attitude effectively. This is especially the case for environmental protection, because it is impossible to discern from personal experience the connections between behavior and its environmental effects.

The Japan Environment Agency [22] in its report stresses that one way for consumers to achieve a lifestyle with less environmental load is to provide information based on daily activities and examples of load-reduction measures. For this, a focus on education and the learning of consumers are key to establishing environmentally friendly lifestyles. Based on these arguments and suggestions from experts, in this section we analyzed the present environmental education and learning of students.

According to Table 9, 491 out of the 620 students (79.2%) had not received education and learning on environmental aspects over the last few years. Of these 491, only 129 (20.8%) have attended education and learning programs on environmental aspects from the workshops promoted by local companies and their local community seminars. The initiative of local companies and communities to promote environmental education was voluntary. We see from these results that students did not receive education on environmental aspects formally in their education program until the fourth and fifth semesters.

Table 9 shows the ranking topics on environmental aspects that the students have studied in either education or training programs, as well as the most important environmental costs (for waste disposal, recycling, etc.) (19%). The second most important topic was environmental legislation (18.7%), followed by examples of environmentally friendly products (15.8%) and eco-toxic substances used and emitted during production of materials and components (15.1%). Based on the first and second topics of those results, we can observe that the environmental education programs of local companies and communities have focused on the topics related to the cost and rules on waste collection programs. It can be also argued that those topics are directly related to the amount and consumption of household products and household waste. In particular, the increased volume of waste and the diversity of waste components, including increasingly varied quantities of toxic chemical substances, are causing additionally complicated environmental problems.

Table 10 shows that 491 students (79.2%) who did not attend environmental education expressed an interest in learning about examples of environmentally friendly products (20.7%), recycling and disassembly (17.3%), energy conscious design of products (16.6%), and green marketing consumerism (11.9%).

The students also showed an interest in acquiring job-related knowledge about eco-design principles related to product development through the examples of eco-products and the recycling process. Another aspect noted was the energy-conscious design of products, which has been the focus of many experts [25, 26] in order to explore energy use and environmental impact of the product during the usage phase. The strategy known as design for sustainable
behavior has also been explored, and involves user behavior during the usage phase of a product [27].

The relationship with the large number of students who did not attend environmental learning could be complemented by the details described in Section 2, which include a lack of concrete examples and references for the industrial design field to use to stimulate students and design educators and ultimately develop and research more sustainable products and services. Those facts are some of the major barriers in both the academic and professional levels.

7. Discussion

Figure 2 shows the overview and main keywords of the survey results of the students’ attitudes toward environmental consciousness and aspects of DES. Based on those main keywords, in the following paragraphs we discuss ways to promote DES as a new field for industrial design educators and design professionals [1-4].

As argued, the students showed a positive attitude toward environmental issues and pro-environmental consciousness during the purchase of a product as both individuals and consumers. They demonstrated their knowledge of the principles of sustainability, but the majority of them had not received environmental education or training, although many showed a strong interest in receiving this in the future. The lack of environmental education and learning programs for students has an effect on their ability to channel their creative activities toward environmental product development.

In general, the lack of environmental education for the development of products and services in the academic program could be justified with the following factors:

Production and consumption: the lack of new and radical environmental products in the market, with high costs and technical problems that have hindered companies during implementation of the environmental aspects into the product development, resulting in a reduction of current economic activities [6, 7, 28].

There is a lack of environmental information within the industrial design field and a dearth of design educators with sustainability design skills. The present environmental education and learning in Japanese universities is still nascent. The promotion of environmental education and learning was established in 1993 with the introduction of the Basic Environmental Law in Japan. Efforts have been made particularly by national and governmental bodies, supporting citizen’s voluntary action, organizations, training leaders, and providing financial support [29]. The Global Environmental Information Center, founded in 1996, has supported different sectors of the Japanese society by collecting and disseminating information on the activities of various organizations, establishment of several networks, organization of seminars and symposiums, collection of public opinion, and establishing NGO projects and activity support [30]. Although those environmental activities in education and learning have to be made, they are unfamiliar to the general public and remain in their promotion phase. Environmental education is still not implemented formally in general schools, universities, and companies, and the majority of those that have implemented it have done so voluntarily and on their own initiative.

According to the experts [31, 32], the need to embed sustainability in design education is linked to the idea that designers actually have more potential to slow environmental degradation than economists, politicians, businesses, and even environmentalists. However, despite the introduction of sustainability in design curricula there is no consensus on how to integrate the subject. As such, there...
The majority of students who did not receive environmental education expressed a strong desire to receive environmental information, with the primary topics related to examples of environmentally friendly products (eco-products).

In the next series of research we will describe a case study of an undergraduate student team learning about sustainable design, particularly the practical activities on eco-design, during their last year of their industrial design course.

We also aim to identify and analyze a study of the Japanese universities that have offered industrial design courses with sustainability and eco-design approaches in their educational curriculum.

8. Conclusions

DEF could be described as the practice of teaching and learning how to achieve sustainability within the field of design, and also research design that contributes to sustainability. Based on these principles, we used a survey to investigate students’ viewpoints and their interest in environmental consciousness.

According to the results of the survey, the students’ strong consideration of socio-cultural principles is the most important factor for solution of the present environmental issues, showing a pro-environmental consciousness that was also evident in the students’ capacity as consumers since they consider environmental aspects when purchasing products. They did so by purchasing products perceived to be environmentally sound (products with eco-labelling) and by recycling (reuse of second-hand products). About half of the respondents stated that if the company (ies) introduced new products with radical environmental aspects in marketing then the lifestyle of the consumer could change.

Whilst the majority of students showed an awareness of the sustainable development concept, the environmental education and learning for students did not show a significant level, meaning that students lacked basic environmental information in order to develop a more environmentally sound product and services for a more sustainable lifestyles.

The majority of students who did not receive environmental education expressed a strong desire to receive environmental information, with the primary topics related to examples of environmentally friendly products (eco-products).

In the next series of research we will describe a case study of an undergraduate student team learning about sustainable design, particularly the practical activities on eco-design, during their last year of their industrial design course.

From the experience of students during the development of eco-products, important considerations such as barriers and the requirements necessary to develop a more sustainable product and services will be described.

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