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Development of A New Curriculum for Bachelor's Degree in Sustainable Design – An Experience in UiTM Kedah

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ABSTRACT

Since the 1900s, sustainable design has been developed as an interdisciplinary study in Malaysian education. In the early stage of its development much emphasis has been placed on innovation (also known as green design, ecodesign or design for the environment) and now it has gained sufficient critical mass in academia to be identified as an academic program and a distinct research area. This area has expanded very much from a group of opportunistic eco-pathfinders trying to establish products' recyclability into a recognized scientific research area concerning technology transfer and commercialization. This paper proposes that a new curriculum of sustainable design should be developed in order to meet this discipline requirement, which also provides a historical account of how academic research into sustainable product innovation. Moreover, we have conducted an initial case study based on a final year industrial design student project on the topic of sustainable design in Universiti Teknologi MARA in Kedah in cooperation with the a multi-national company ABB (M) Sdn Bhd in Subang Jaya and the Norwegian University of Science and Technology in Norway in order to see the possibility of structuring and designing the curriculum towards sustainable issues in Malaysian context. In conclusion, several possible future considerations of the program of study and research area are discussed.

Keywords: Curriculum, design for environment; design research; innovation; sustainable product design

1. Introduction

In the Malaysian education system, the awareness of Sustainable Design in local universities has become popular since the 1900s. At that time, educators and students created designs that were very related and highly influenced by products from Europe. Examples of these projects at academic level can be seen at the "Diploma show of Industrial Design in 1995" at the Institut Teknologi MARA (now known as Universiti Teknologi MARA). Several products have been created by students and many of them were based on green and environmental issues. Many were seen emphasizing one of the most popular themes for that era: Save the planet." Many of the proposed products were also using common colors of either green or white.

Today, the awareness of these green and environmental issues is still significant. The new terms of Sustainable Design has been used dramatically. Even the government of Malaysia has decided to give more attention to this program. Since the government of Malaysia has created the Center of Green Energy in Malaysia has brought foreign investors to invest in this area with a total investment value of up to RM12 billion to date. (Baharin, 2010). The sustainable design becomes popular when the main issues on "oil and gas," which is the supply of that mineral resource will be finished in Malaysia in 10 years time. The government of Malaysia is trying to explore many other new alternative resources to replace oil and gas as the source of energy. It seems that the use of "solar energy" is very likely to replace the use of oil and gas at this moment. At the same time, the government of Malaysia is considering the merging or integration of solar energy with other alternative resources.

A lot of funds or grants to support research on the sustainable areas are made available from the government of Malaysia through the Ministry of Science, Technology and Innovation and the Ministry of Energy, Water and Green Technology.

On the academic side, many local universities such as Universiti Teknologi MARA (UiTM), Universiti Sains Malaysia (USM), Universiti Putra Malaysia (UPM) and Universiti Teknologi Malaysia (UTM) are in conducting seminars on the issues of Sustainable Design, formulating a new curriculum for Sustainable Design, and encourage their staff and students to carry out research on Sustainable Design and trying to establish a common ground for the program. However, a lot of issues on Sustainable Design in education are still fuzzy in nature. In most cases the curriculum is designed as an inter-disciplinary and a cross-disciplinary study. A large amount of issues revealed from the basic transitions issues are not clear in the directions.

This paper starts with a proposal that three transitions have to take place in a consecutive manner:

- 1) from the use of English Terminology to Malaysian Terminology
- 2) from Inter-discipline to a New Discipline
- 3) from Green Design Awareness to Sustainable Design Context

The proposal is then followed by discussions of our experience in the development of a new curriculum for Bachelor's degree in Sustainable Design at UiTM Kedah. Finally, we sum up the paper with a few suggestions in the conclusion.

2. First transition: From English Terminology to a Malaysian Terminology

Sustainable design is a large area of study. Applications of this philosophy range from the microcosmic level - small objects for everyday use, to the macrocosmic level - buildings, cities, and the earth's physical surface. It is a philosophy that can be applied in the fields of architecture, landscape architecture, urban design, urban planning, engineering, graphic design, industrial design, interior design, and fashion design.

In this context, we intended to interpret the Sustainable Design terminology under the "art-based" domain. This covers any relevant areas of study under the school of art and design. Under the school of art and design, the emphasis is more towards the artistic quality approaches in design.

Merriam-Webster's (n.d.) dictionary and Dewan Bahasa dan Pustaka (2008 - 2011) dictionary do not provide a direct meaning of Sustainable Design terminology. These two dictionaries seem to separate the term into "sustainable" + "design, For example, we can take a look at the definition of sustainable and design in Merriam-Webster's:

Definition of Sustainable

1: capable of being sustained

2 a: of, relating to, or being a method of harvesting or using a resource so that the resource is not depleted or permanently damaged <sustainable techniques> <sustainable agriculture> b: of or relating to a lifestyle involving the use of sustainable methods <sustainable society>

This term can be described as the usage of nature elements in through agricultural activities being revised as a method of maintaining a lifecycle without jeopardizing the core nature content. This is in relation to a green lifestyle where substitute method of living in a society that is not too dependable on nature resources and alternative solution are identified.

Definition of Design

transitive verb

1: to create, fashion, execute, or construct according to plan: devise, contrive

2 a: to conceive and plan out in the mind <he designed the perfect crime> b: to have as a purpose : intend <she designed to excel in her studies> c: to devise for a specific function or end <a book designed primarily as a college textbook>

3 archaic : to indicate with a distinctive mark, sign, or name

4 a: to make a drawing, pattern, or sketch of b: to draw the plans for <design a building>

intransitive verb

- 1: to conceive or execute a plan
- 2: to draw, lay out, or prepare a design

Design as a term being means to create and construct or as an independent entity conjuring a phase of a plan executed throughout the mind. It is also been widely use for drawing, pattern, or sketch relevance planning, for e.g. plan to design a building. Intransitively the verb can be recognized to conceive drawings for a plan execution and giving a lay out overview, or a preparation to design.

Meanwhile, if we translate the word of Sustainable Design to the Malay Language, according to the Dewan Bahasa dan Pustaka dictionary (2008 - 2011), Sustainable has been translated as "Mapan or Mampan" and design has been translated as "Reka Bentuk." For example, we can look at the Dewan Bahasa dan Pustaka as following:

Definition of Mapan or Mampan

1: under the engineering interpretation it means the concept of using resources in an appropriate manner to ensure that it is long-lasting.

Definition of Reka Bentuk

1: (gen) design: ~ dress, clothing design, a machine of faulty ~, machinery design flaw Posted: Lacks ~ the building, building design is unsatisfactory; ~ graphic, graphic design, industrial ~, design firm.

2. patterns, patterns: a piece of material with a \sim of roses, a piece of cloth who has a pattern of roses.

3. the art of designing, art-design: a course in graphic \sim , art graphic design courses.

4. intention, purpose, meaning: his \sim to defraud the company was forestalled, the goal was intercepted for fraudulent companies.

If we look at the terminology above, no standard "term" are used as a representation of the words of Sustainable Design in both dictionaries This is more crucial especially in the Malaysian design context where we relate it to the academic discipline of study.

3. Second transition: From Inter-discipline to New Discipline

Sustainable Design is an exciting call for change to encompass all design disciplines. Many of the problems that humanity is facing today are the legacies of outdated, industrial-age thinking, now seen as flawed. Sustainable Design can give us what we need most: a creative response to the challenge of sustaining human life in harmony with Earth and her natural support systems.

Throughout human history, from the age of stone tools to laptops and virtual realities, present time design has always reflected "who we are," while "who we want to be" informs the next generation of design ideas. Each new age brings a new mindset, a new paradigm. In possible future facing the remarkable challenges of the 21st Century, design will play a critical role. In many universities in Malaysia, studying the inter-disciplinary design exposes the students to revolutionary Sustainable Design strategies: Biomimicry, Inventive Reuse Design, Design for the Real World, Permaculture Design and others yet unnamed. For example, UiTM is preparing the next generation of designers to operate confidently in the face of accelerating changes and unpredictability. The students will need to be specialists at being non-specialists. They must be confident to be involved in crossdiscipline course if needed and feel free to forge diverse collaborations. They will be called upon to create comprehensive solutions and move humanity towards a sustainable future. They will make upa new breed of designers who are flexible, creative and empowered to respond to a widening variety of challenges.

In the transition from being inter-discipline to being a new discipline, UiTM will prepare design students for the following:

- Engaging in the user-centered research essential for guiding design decisions.
- Applying inter-disciplinary design methodologies and concept development in design development processes.
- Collaborating with cross-disciplinary teams at every stage of design development.
- Using a balance of critical and creative thinking for ideation and concept development.
- Applying hands-on experience derived from working with a diverse palette of materials
- Applying technology appropriate to specific design development paths.
- Communicating concept solutions, as well as the systems into which they are integrated, through two-dimensional, three-dimensional, verbal, and written presentation skill.

After all, when the new discipline comes into being, the challenges are on how to develop the transition from green design awareness to Sustainable Design context.

4. Third transition: From Green Design Awareness to Sustainable Design Context

According to Boks and McAloone (2009), until around 2002, major companies published mainly the so-called "Environmental reports" (for example, Siemens, Canon, Toshiba, Philips and Sharp in the electronics industry). Around 2003, the names of these reports began to change, with companies adopting titles such as "Green Management Report," "(Environmental) Sustainability Report," "Corporate (Social) Responsibility Report" and "Corporate (Global) Citizenship Report." This process of renaming yearly reports is likely to have been influenced by the emergence of new criteria for carrying out business with corporate responsibility.

In Malaysia, the new "trends" in social corporate responsibility, such as the ageing society, multiculturalism, social job programs and equity for minorities, have likely contributed to the diffusion of these reporting strategies. In "Sustainability" reporting nowadays, different strategies are found even among similar competitors; some choose to focus on social rather than environmental aspects, extensively focusing their efforts to create job programs opportunities adopt-a-highway initiatives and serve Malaysian local communities, whereas others remain focused on the explanation of take-back and recycling efforts. Sometimes, this also creates confusion with the interpretation of a company's progress in sustainability activities: is a company that does not report on a wide range of social activities aware that this might be considered green washing or does it just lag behind in shifting from double to triple bottom-line reporting? In any case, a common "feature" in current reporting policies is the consistent lack of attention to integrating sustainability thinking into individual products; this is what concerns many "academic ecodesign scholars."

The transition from green design awareness to sustainability context consequently significantly affects discussions on evaluation metrics to assess the contribution to the sustainability of ecodesign activities and ecodesigned products. Together, the social, economic and environmental performance components are commonly referred to as the 'triple bottomline'. On a company level, the 2002 guidelines from the Global Reporting Initiative (GRI) provide a frequently referenced guide for triple bottom-line reporting (Nelson & Wilson, 2003). The GRI guidelines aim to provide a voluntary framework for businesses when reporting on actions, outcomes

and strategies for the future (Global Reporting Initiative, 2002). However, as a reporting tool, the GRI guidelines do not provide performance management tools or codes of conduct on how to do so. This is part of the reason why Sustainability (or triple bottom-line) reporting by companies, even within the same industry, is still quite inconsistent. Perhaps the main consistency in these reports is indeed in the lack of attention on measuring the triple bottom-line evaluations of individual products. However, the industrial sector should not be blamed, as academic research has (so far) not been able to provide it with the necessary insights, let alone tools. Then again, although environmental evaluation (on a single bottom-line) is frequently done by the departments responsible for Sustainability, on "the real" corporate level, such metrics are not frequently used, which probably explains why they do not find their way into sustainability reports. This illustrates what remains: one of the crucial obstacles to the true integration of ecodesign in industrial practice: the lack of at least double bottom-line evaluation practices. In an Asian survey, Pascual and Boks (2004b) found that when asked about the perceived advantage of applying ecodesign practices, companies stated ecodesign as relevant in gaining corporate value, but were very doubtful about competitive advantage in terms of sales and market share.



Figure 1. Proton Emas

Source: Proton Sdn Bhd

It was stated that measuring the economic benefits of environment-oriented activities is problematic. On the other hand, it was found that the existing (academic) paradigm concerning the importance of measuring environmental performance to improve products from an environmental perspective is regarded more far less important from the company perspective than compliance with legislative requirements, improving competitiveness, enhancing legitimacy and imitating what others do. These latter activities can be interpreted under the numerator "risk management," i.e., reactive behavior, whereas ecodesign is more commonly associated with proactive behavior. In the same survey, Pascual and Boks (2004a) also concluded that there is a need to integrate environmental accountability with regular financial accountability practices and that stricter definition on guidelines would lead to better comparability between companies' environmental accounting performance.

Obviously, the situation for the period sketched above also affects the discussion on Life Cycle Assessment (LCA)'s utility. The inclusion of non-environmental Sustainability criteria highlights the limited perspective of LCA, as it only draws up a precise map of the environmental effects and impacts generated by a product or process. Nevertheless, as environmental legislation still focuses on environmental rather than sustainability criteria, LCA use can be justified for this purpose, as long as it can be successfully embedded in the product development processes. In that light, Hunkeler and Rebitzer (2005) concluded that LCA methods, operational procedures and concepts for implementation into business processes still need more attention and research to enable the wide-scale exploitation of LCA's potential.

Also from a design perspective, increasingly more attention to the other dimensions of Sustainability has been given. A well-known example is Proton Emas, a totally new concept of a car for urban areas to fulfill the needs of users in a more appropriate way while reducing the environmental impact at the same time (Figure 1).

5. Discussions

Within the three transitions that have taken place in consecutive order at the previous section, we now explain on the initial case study that we have worked with our students at UiTM Kedah. It began with the directive given by the UiTM Vice-Cancellor Dato' Prof. Ir. Dr. Sahol Hamid Abu Bakar and the UiTM Kedah Campus Prof. Dr. Zaliha Hj. Hussin that every branch campus should propose a new program of study that has a high impact on Malaysia development and the job market, and with the intent to develop self-employed graduates create a student that can become employer rather that employee.





In the initial case study, there were three elements involved. First is the expertise from the academia, second is the collaborations with people from the industry, and third is the design out come from the students at the university level (see Figure 2).

We started to work on the planning of the Sustainable Design curriculum since Jun 2010. Since the beginning, we have been in contact with Professor Dr. Casper Boks at the Norwegian University of Science and Technology in Norway. Professor Boks holds a PhD in Industrial Design Engineering: (2002) from Delft University of Technology (TU Delft) in Netherlands, where he was an Assistant Professor at the Design for Sustainability Program of Industrial Design Engineering School until 2006. In 2004, he was a Visiting Professor at the IIIEE at Lund University, Sweden. He is currently a Professor of Sustainable Design at the Norwegian University of Science and Technology. His research interests include sustainable product innovation and education and focus on the organizational and managerial aspects of the successful implementation of sustainable product design in the electronics industry. We are fortunate that he has agreed to be part of the team to develop a new curriculum for Bachelor's degree in Sustainable Design for UiTM.

Next, we contacted ABB (M) Sdn. Bhd. ABB is a leader in power and automation technologies that enable utility and industry customers to improve their performance while lowering their environmental impact, ABB integrates high technology products from Europe and the United States of America, with cost-efficient engineering and manufacturing capabilites into Malaysia. The transfer of ABB's leading technologies began in 1981 in the substation business and today, they include industrial process automation, robotics and drives systems. Like Prof. Boks, the ABB management and technical team agreed to be part of our team as well.

Finally, we included 15 industrial design final year students at UiTM Kedah in the initial case study. We have given them a brief of the projects on the topic of Sustainable Design. The students need to design their projects and carry carry them out following the a common practice of industrial design process.

5.1. Experiences in Curriculum Development Structure

In the development of a new curriculum of Sustainable Design, we found that it was difficult to formulate the structure. This is because there is no common curriculum structure of the program of Sustainable design at the Bachelor's degree level that we could base on either via websites or books. Many universities in the world place Sustainable Design as a subject or course of study under their existing design curriculum and it does not stand as a program by itself. For example, TU Delft in Netherlands, Norwegian University of Science and Technology in Norway and TU Denmark in Denmark offers the subject of Sustainable Design in their existing course of Industrial Design Engineering. Some other universities even offer Sustainable Design as inter-disciplinary studies and collaborate with other organizations that have same intent. For example, Finlandia University in the United States offers inter-disciplinary studies in collaboration with Sustainable Keweenaw Resource Center (SKRC) which is the organization that concerns itself with the "Green" issues.

In our discussions with Prof. Boks, he suggested we should first conduct several types of surveys and review relevant journals that are related to the curriculum development on Sustainable Design. The feedback from the surveys and the reviews of the relevant journals can then be used to establish a framework when we design the curriculum.

We examined and compared the existing curriculum of Sustainable Design from 4 Universities: Finlandia University, TU Delft, Norwegian University of Science and Technology and TU Denmark. We found that all four universities offer Sustainable Design as inter-disciplinary and crossdisciplinary studies. We found that the structure of curriculum does not represent the substantial elements on the Sustainable issues based on artistic aspects. All the above universities only structure Sustainable Design as a normal elective subject. This is in agreement with Prof. Boks' statements in his email to the first author on July 2010 that the curriculum of Sustainable Design for the "school of art" is not well established at this moment.

Most of the curriculum for sustainable design in the world is related to the "school of engineering" which offers a degree of BSc and MSc. Only Finlandia University offers BFA in Sustainable Design with interdisciplinary approaches.

5.2. Experiences with Student Project

We have 15 final year Industrial Design students in UiTM Kedah under the supervision of the first author and the third author of this paper, who is in charge of the subject of IDH317 on Sustainable Design; all students have chosen projects related to Sustainable Design area (see Table 1).

No	Name	Project title
1	AHMAD NADZRIN BIN	ALAT MENGHALAU BURUNG DI SAWAH
	ZARIFFUDDIN	(SCARECROW)
2	MOHAMAD AZWAN BIN BASARI	ALAT MEMOTONG GETAH (RUBBER TAPPING
		DEVICE)
3	MOHAMAD HAZRIEQ BIN MD	OFF-ROAD SEGWAY UNTUK PERLADANGAN
	HANIFF	(OFF-ROAD SEGWAY FOR PLANTATION)
4	MOHD HAMDAN BIN ABIDIN	BOT PESISIR PANTAI (COASTAL BOT)
5	MOHD KHAIRUL AZREEN BIN	ALAT PENGESAN LEMBU (COW DETECTOR
	MOHD SOM	DEVICE)
6	MUHAMMAD AFIQ REDZWAN B	ALAT PERAM TELUR AYAM (SOLAR
	ROSTAM EAFFENDY	INCUBATOR)
7	MUHAMMAD FARID BIN SAHAR	IRIGASI: REL PANCURAN AIR UNTUK TUJUAN
		MEMBAJA (IRRIGATION: FERTILIZING
		SPRINKLER RAIL)
8	MUHAMMAD HAKEEMUDDEEN	MESIN PENUAI PADI (PADDY HAVERSTER)
	BIN MOHD ALI	
9	MUHAMMAD SHAFIQ HAZIM BIN	KENDERAAN ATV MENGGUNAKAN SOLAR
	ABD HALIM	(SOLAR ALL TERRAIN VEHICLE)
10	MUHAMMAD SYAFIQ BIN	KENDERAAN PEMUSNAH PELEPAH (FROND
	ZAINURIN	DISPOSAL VEHICLE)
11	NEDZARUL B MOHD NAWIAH	KENDERAAN UNTUK PENGAWASAN DI
		LADANG (VEHICLE FOR ESTATE
		SUPERVISION)
12	NUR AMIRA SYAFIQAH BINTI	PEMETIK BUAH KELAPA (COCONUT PICKER)
	MUHAMAD	
13	NUR HAFIZZAH BINTI AZMAN	KAPAL TERBANG LAYANG UTK KEPERLUAN
		MEMBAJA (GLIDER FOR FERTILIZING
		PURPOSES)
14	SAIFUL AMIRIN BIN MOHD PAUZI	MESIN RUMPUT (GRASS MOWER)
15	HISHAMUDDIN BIN MOHD	PEMETIK BUAH (FRUIT PICKER)
	AMINUDDIN	

Table 1: List of students and project titles

Source: UiTM Kedah

The industrial design students were required to carry out research surveys on their proposed projects. We had 15 students; we were able to collect 15 types of survey questionnaires with a total of 450 respondents who participate in the study. Here, we show an example of the questionnaire results based on frequency distributions on the question related to the designing of : a rubber tapping device by Mohamad Azwan Basari (Figure 3), "Which of the renewable energy is suitable to generate energy for rubber tapping knives automatically?" :





The above bar chart shows an example of a survey question by Mohamad Azwan Basri, which found that out of the 30 respondents, 23 people chose solar energy to generate energy for rubber tapping knives automatically, and 20 people like to use electrical energy and followed by wind, water, fossil fuels, and wave.

Figure 4: Design Brain-Srorming Session between Lecturer and Student



Source: UiTM Kedah

Many questions were given by the students to their target respondents. After the survey had been done, the students established a guideline for their designs. From the guideline, the students formulated a design concept for their proposed project. Then, they prepared the materials, that is, 1) Image panel (the panel shows the environment of the project); 2) Influence panel (the characteristics of existing design that can be used upon as references); and 3) Product positioning (the target of mapping in the perceptual space to study the trends and the competitors).

Next, the students need to reflect with reference to the guideline from the research finding and the materials that have been prepared for sketches process (see Figure 4). At this stage, the strategies of designing are more toward problem solving and synthesis/analysis. After 3 brainstorming sessions on the project of design done by the students, the students will produce a mock-up. The mock-up is produced in order to see the threedimensional level of the preliminary idea.

We, temporarily stop the development of this project at this moment at the mock-up stage. This is because the semester of Jun 2010 has ended. We will continue with the development of this project in the next semester, beginning January 2011.

5.3. Experience in Co-operations with the Industry

The collaboration began with the arrangement of an informal meeting by the second author with the ABB management team in UiTM in July 2010. Present were also the first and third author of this paper. The discussions were more towards the formulation of a strategic plan which can benefit both parties.

This was followed by a visit of the students and the authors to the ABB in Subang on August 19, 2010. The students were exposed to the existing and the new technologies by the ABB technical team (see Figure 5).



Figure 5: ABB technical team demonstrate the product

Source: ABB (M) Sdn Bhd

Apart from showing their product like the Programmable Logic Controllers (PLCs) by the ABB technical team, also demonstrated to the students on how solar energy works; which is one of the important aspects of Sustainable Design. Overall, it was a good exposure especially when the students and the ABB technical team discussed several technical questions. In our meeting at the ABB, it seems that the company wants to diversify its product in collaborations with the local universities. Since UiTM has established its design school since 1969, the ABB total collaboration with UiTM. The ABB technical team also mentioned about their willingness to supply project materials to the students of UiTM Kedah and assist them with technical input.

Here, we can see that people from the industrial sector have strong inclinations toward investment in areas related to Sustainable Design with the academia side.

6. Conclusion

It is the opinion of the authors that the development of a new curriculum for the bachelor's degree in Sustainable Design should consider the transitions of language, discipline of study, green to Sustainable Design context within and in the field of innovation that need to be linked with the triangulations commitment of the expert, industry and student as a valuable asset for product designers. Since the area of Sustainable Design has been established more within the "school of engineering" as compared to the "school of art," the study of the curriculum for the school of art should be looked at fram a holistic perspective. By doing several types of survey, establishing the need and the requirement, working with the student design project in a form of case study, and with the industry, we hope that we are able to formulate and structure the curriculum for Sustainable Design for UiTM. Even though we are in the process of trial-and-error, we should start from now and hope that we will be able to contribute something that may become state-of-the art in the new design curriculum of Sustainable Design for Designers who come from the school of art

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