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Shannon Chance
Technological University Dublin, shannon.chance@tudublin.ie

Pearl O'Rourke
Technological University Dublin

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PROMOTING ENVIRONMENTAL SUSTAINABILITY BY FOSTERING A CULTURE OF MATERIAL ETHICS

Shannon CHANCE[1] and Pearl O'ROURKE[2]
[1]Hampton University; The College of William and Mary; Dublin Institute of Technology
[2]Dublin Institute of Technology

ABSTRACT

Creating a culture of 'material ethics' can help engineers and product designers in the quest to achieve environmental sustainability. By framing this particular issue and focusing attention on it, Engineering and Product Design educators can help establish a shared language to undergird students' conceptualizations of the natural world and instil a healthy sense of interdependency and responsibility. Overall, this paper explores the idea of 'material ethics' and presents arguments and applications for building such a culture at the tertiary level. As design educators, the authors of this paper aim to provide a broad and useful overview of environmental issues relevant to Engineering and Product Design Education (EPDE). They examine the role of the university in general and of EPDE programmes in particular in working toward environmental sustainability. They identify ways to integrate environmental topics into university activities and curricula, and they cite a variety of sources to back their arguments. They note that, today, digital environments inform many students' perceptions as strongly as physical environments. Students' understandings of the natural environment are now weak due to factors that include digital immersion. In response, the authors urge educators to prompt students' exploration of issues of environment and materiality. They provide examples to serve as points of reference and inspiration. By helping students recognize moral imperatives, such as achieving environmental sustainability, and helping them assess and implement 'best practices' into their design processes, teachers can help shift the prevailing paradigm and prepare students to tackle society's most pressing environmental issues.

Keywords: Materials, Resources, Ethics, Values, Design

1 INTRODUCTION

> *Design responsibility means that designers always should be conscious of the fact that, each time they engage themselves in a design project, they somehow recreate the world.* [1]

The 'ethics of materiality' is also referred to as 'material ethics'. It encompasses the way societies behave with regard to the things they make, how they manage resources, and how their attitudes change over time. It provides a helpful framework for helping address current deficits in Engineering and Product Design Education (EPDE). In general, scholars of material ethics consider how groups of people deal with material culture, and more specifically, how they value and construct objects and how they speak and teach about the material world [2].

In this day and age, students use diverse technologies, virtual simulation, and digital fabrication. As a result, getting them to understand, interact with, and respect physical materials has become more challenging. By pulling the issue of material culture into focus, educators can help their students and their professions in establishing a healthy, shared sense of the natural world. This can help students and society achieve a more effective balance between human activity and natural context.

Warwick Fox [3] has argued: "we simply have one big problem in regard to the ethics of the human-constructed environment, namely, the fact that there presently isn't one!" (p 122). An Emeritus Professor of Philosophy and a bio-ethicist, Fox has identified the three specific realms of ethics. As illustrated in Figure 1, Fox labelled these realms as: (1) bio-physical, (2) symbolic, and (3) material. Biophysical ethics relate to ecosystems, as well as the animals and plants that live within them. The symbolic realm of ethics, Fox says, grows out of the moral agents embedded in human language. Material ethics has to do with "all the 'stuff' that humans intentionally make". Although most cultural groups have developed coherent values that relate to symbolic and bio-physical aspects of life, the same cannot be said for aspects related to materiality. The ethics behind what (and how) we *make* remains ill considered today - despite the fact that material ethics has historically been a central topic of architectural philosophy [4] as well as architectural and industrial design (see the Bauhaus movement). “We clearly need an ethics that can directly address concerns at the relatively intangible level of design,” says Fox. To fill the void, he suggests that humans work to develop a more effective code of ethics regarding the material world. Those who enjoy the highest levels of material wealth have the greatest obligation to develop effective responses; however, they are often the most oblivious to the impact of their decisions. They also tend to generate the most waste and to consume materials at the highest rates.

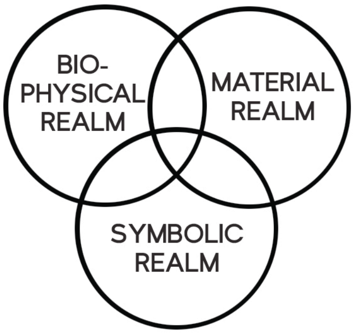

Figure 1. Venn Diagram of Fox’s Framework

Matt Ridley [5] claims society has prospered as a result of its ability to accumulate collective intelligence. Ridley references common products—such as the computer mouse—to illustrate how today’s processes for mass-production are not using adequate life-cycle perspectives. He explains that we live in a globalised world of isolated industrial silos that integrate with one another in limited ways. With regard to the computer mouse, the people who extract the oil to make a computer mouse have different knowledge and skills than those who produce the plastic, transport the materials and components, design the hardware and software, develop the tooling, manufacture the product, assemble it, deliver it, and ultimately sell the product. These different players often have little awareness of where the components they use originated and little understanding of the complex web of relationships of energy and elements used to create the object.

Every choice a designer makes can have huge social and environmental affects throughout the process of producing, using, and disposing of the product. Society has now reached a point of crisis, and the educational system is largely to blame. Reynolds, Brondizio, and Robinson [6, p xiv] assert:

> *the American educational system has been turning out ‘environmental illiterates,’ ill-equipped to understand emerging information about the environmental, social and economic dimensions of human-environmental interactions and make informed choices on the suite of issues, from lifestyle to politics, that will decide whether and how society moves toward a more sustainable economy.*

Exacerbating this problem, most curricula on university campuses short-sightedly “condition students to view the natural world as a collection of objects that can be manipulated through science, technology, and human economic interests” [7, p193] rather than part of an interdependent system. Most engineering, product design, and architecture curricula impart such values today, in implicit and explicit ways. As design educators, we can start by addressing this problem head-on. We can instil more effective values and behaviours in our students, with regard to materials, their value, and their use.

2 ROLE OF THE UNIVERSITY

We believe that to achieve environmental sustainability, all institutional planning, action, and decision-making should be informed by a coherent set of ethics—one that includes the environment to a much greater degree than has been the case since the Industrial Revolution. The overall role of the university is to generate knowledge at the level of the individual and to help address the most pressing issues facing society. To do this, universities are charged to create and test new solutions to emerging and/or newly identified problems [8]. A core purpose of the university is to produce citizens who can contribute to society in big and small ways [9] and it is hoped that third-level institutions provide students and faculty “cultural and intellectual space where critical reason may develop” [10, p4]. Today, many universities are implementing environmentally sustainable practices and working to foster engagement, participation, and collaboration from their constituents [11]. Study of the environment, which was once confined to the pure and nature sciences, is now being seen as a central issue that requires input from many fields. Institutions that adopt comprehensive approaches to design curricula understand that bridging liberal arts with technical sciences enriches coursework overall [2]. Course work, as well as the buildings and environments that courses are taught in, can help convey information and change behaviour [12]. Buildings themselves “ought to demystify the world, making us mindful of energy, food, materials, water, and waste flows” insists David Orr [2, p220]. Working at Oberlin College, Orr and his students helped set a new standard for the design of buildings. They sought to embed values into their new study centre for environmental studies. This building has served as a precedent for LEED Green Building Rating system and for hundreds of subsequent built artefacts that have been designed to serve as tools for teaching and learning about the environment.

3 THE UNDERLYING PARADIGM

Third-level educators can begin to raise questions of materiality in projects in formal, as well as informal, learning environments around campus. In doing so, we can inspire our students to confront difficult challenges. We can help transform “the way our students interact with the world and one another” [13, p5]. According to this constructivist paradigm, teachers and researchers serve as collaborative participants who engage with their students in the iterative and on-going process of identifying crucial problems and defining possible solutions. In this way, educators can prompt students to become “active generators of new knowledge” and help students become “participants in new problem-solving networks” [14, p147]. “Each of us has a part to play” in efforts to change human behaviour and achieve environmental sustainability [15, p22]. The curricula we offer can weave together issues of values, ethics, and human-environment relationships to help students gain a healthy sense of interdependence [16].

4 ROLE OF DESIGN PROGRAMMES

Design programmes prepare students to shape the physical world. They help their students understand where materials come from, what properties they have, and how they can be used to create structures and artefacts. As design educators, we can help students learn to value, experience and express “materiality”. We can encourage students to track material flows and consider the transformation of materials over time as they pass through the production cycle.

Ethical design is an ideology that can be fostered rather than a tool or skill that can be taught. It requires the designer or student to sense a duty of care, which surpasses the notion of designing products that are simply safe to use. Under the emerging paradigm, products can be holistically considerate of society, culture, *and* the natural environment. Environmental issues can be integrated into design projects and well as specialized technology-focused courses. “Unless sustainability engages with the [design] culture, it fails to address the process and philosophy of design education” [17, p136]. It cannot be confined to seminars and other support courses if it is to affect the way designers think and act. In support of this idea, the American Institute of Architects [18] now recommends that design schools take a holistic approach, integrating issues of social justice with ecological sustainability [19].

Hands-on, experiential design pedagogies, like those used to teach architecture and product design, are very effective in imparting such values. Education researchers have found that hands-on problem solving and active inquiry-based learning facilitate high-quality learning [16, 20]. These practices help students learn more deeply and retain what they have learned longer than traditional delivery formats. Still, design educators and students can set a positive example and do more to promote material ethics across campus. By carefully considering Fox’s [3] claims as discussed, we can become more intentional in our actions. We can speak and act in ways that addresses society’s lack of material ethics. In doing so, we can come to serve as examples for other professors and programmes on campus—challenging more and more educators to address Fox’s ethical challenge.

Teaching designers about materiality

Researching applied topics elicits strong involvement and productive learning among students Hopkinson, James, and van Winsum say, citing transportation, energy, water management, and waste handling as research topics that spark enthusiastic engagement [21]. Students “learn a great deal not only about the technicalities of the topic, but also about how what happens in practice is influenced by organizational and personal factors” [21, p91]. A holistic approach to the teaching and learning of material ethics facilitates "an integrated effort," towards ethical design, rather than "a piecemeal activity involving tacked-on concepts and technologies" [22, p78]. Designing with respect to nature as well as people and economic forces requires making choices about everything from energy to agriculture and land use, from settlement patterns and methods for distributing water and handling waste to the use of materials and other resources [2].

Assignments Stimulus

With regard to product design, useful topics to consider after evaluating the social implications of the functionality of the product include: DFE (design for the environment), LCA (life cycle analysis), adaptive mass customization, modular product design, and design for disassembly. An example assignment in this realm involves storyboarding. The educator can ask students to storyboard a product's life cycle while considering: material extraction, material production, manufacturing and assembly, product use, transportation, and end-of-life disposal (see Figure 2).

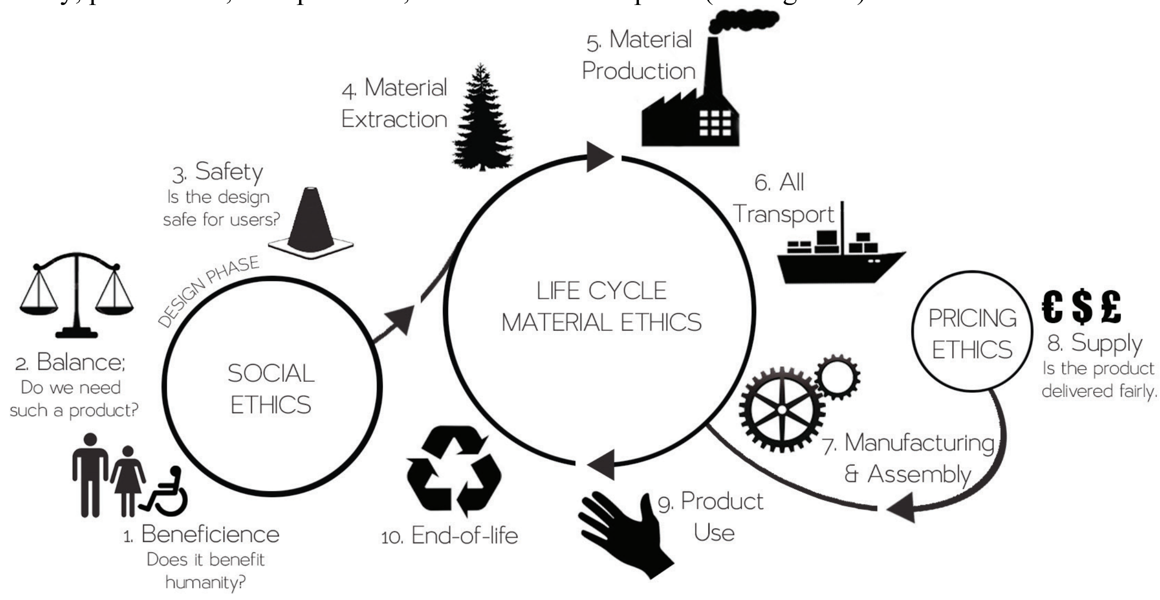

Figure 2. Design Ethics Landscape

Although the resulting storyboards may be relatively superficial when undertaken by undergraduate design students, they can serve as a useful stimulus for group dialogue and may highlight students' responsibilities as designers.

Another way educators can encourage consideration of material ethics is by discussing the notion of dematerialization (i.e. how tangible products can be replaced with services or systems). Examples include timeshare systems, products of service [23], and virtual libraries and archives. Service, software, and system conceptualization requires the same creative integrative skills as traditional product design, but the end result is different—and not necessarily a material artefact. For more ideas on teaching sustainable engineering and product design ethically, see Papakek's seminal texts [24, 25].

5 BARRIERS TO MATERIALLY-ETHICAL DESIGN

Identifying and understanding existing barriers is crucial to overcoming them. We characterize some of these barriers as: the perceived dichotomy that places production and economic viability at odds with ethics, lack of clear definitions and standards regarding ethics and green design, and differences between mass production and the prototyping that leads up to it.

The dichotomy between material ethics and production strategy

Design education fosters the practice of perceiving the world through various lenses and integrating those perceptions. The domains of enterprise, aesthetics/UX, and construction/manufacturing each have their own criteria for success. A contemporary designer's ability relies in part on how s/he works at the interface between domains in the process of creating viable, elegant solutions. Assessing the economic feasibility of a design concept is integral to the design's overall success. Post recession, at a time where profit and employment are important metrics for success, the long-term wins associated with material ethics are sometimes less revered. A Finnish study [26] about product purchasing highlights why public interest in material ethics is low. It found that consumers lack knowledge about how their purchases affect the environment and that they believe the onus is on manufacturers to produce—and distributors to screen for—environmentally sound products. Another inherent problem, rooted in the economic side of product development, involves 'planned obsolescence', an idea that has become commonplace and largely accepted across the technology sector. Material ethics is largely concerned with physical obsolescence, which includes products that are designed to fail, are designed for single-use or to be non-repairable, or are designed to aesthetically degrade and become ugly over time [27].

The fuzzy nature of material ethics

The concept of 'green', 'eco', or 'environmentally-friendly' design is unregulated and does not always take the whole life cycle into account. These terms are ubiquitous in consumer landscape and, in our experience, often constitute the totality of many students' knowledge when they begin studying. For example, using materials that are *biodegradable, organic, recyclable or natural* does not equate to being materially ethical. For example, a 'biodegradable' paper bag may not be more beneficial than a plastic bag because a) it is less likely to be reused, b) it requires a lot more material by weight and, c) if it ends up in the anaerobic environment of a landfill, more greenhouse gases will be released as it decomposes [28]. This is not to say that paper is an unethical material, but that when developing paper products, it is important to design and integrate cues for ethical use and disposal.

The dichotomy between prototyping and mass production processes

Technological innovations have changed the product design process over the last thirty years. CAD systems, finite element analysis software and rapid prototyping machinery have made elements of the design process more efficient. However, these technologies have also widened the schism between the designer's domain and the manufacturing environment. For example, the additive manufacturing technique used in 3-D printing disguises the importance of many traditional design decisions that are associated with material selection, assembly, or tooling on the journey to prototyping. We believe that unless the aim is to manufacture with a 3-D printer, design educators should guide students in designing for the intended materials and constructively critique material-based design decisions from the outset. Industrial design programmes deliver theoretical modules about materials and manufacturing, but there is space in many programmes for more first-hand experience of the manufacturing world as part of the curriculum.

6 CONCLUSIONS

Fox and Orr provide important food for thought. Among academic programmes on third level campuses, design programmes are poised to lead change. Because design professors are accustomed to learning about materials—and teaching others to value materials—they represent a valuable human resource. Our review suggests that they need to be part of larger institutional efforts to infuse sustainability and "material ethics" into many different programmes and into university activities in general. Design educators can become increasingly valuable to their communities by focusing more of their attention on the concept of 'material culture' and 'material ethics'. In doing so, design educators can help address an existing hole in the educational systems of the Western world.

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