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CREATING ADAPTABLE, HOLISTICALLY MINDED LEARNERS USING DESIGNER PROFILES AND SYSTEMS THINKING TO EMBRACE COMPLEXITY

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ABSTRACT
Disruptive influences of technology on learning systems together with the complexity of designing human experiences within expanded ecosystems has required many design education programmes to rethink their missions. This was the case for the School of Design at Carnegie Mellon University, USA where recently its entire curricula – undergraduate, masters, and PhD was reconceived. The purpose was to create a social and environment-focused framework that better prepares systems thinkers who are able to see, structure, and address complex problems within a globally connected and interdependent world. This paper shares how pedagogical goals were translated into a fifth-semester undergraduate product design experience. Specifically, the paper focuses on two aspects: using a team formation approach based on student "Designer Profiles" and the establishment of a systems challenge where each student had responsibility for a complex part as well as collectively resolving the interdependent needs of the system. Compared to a previous version of the same project where students teamed to conduct research then developed independent responses, the qualitative outcomes assessment of this approach resulted in: 1) better holistic systems thinking and understanding across research and conceptualisation activities; 2) directed and natural collaboration activities that helped students negotiate and establish functional criteria for each of their product areas and the defined ecosystem; 3) increased depth in the design of features and interactions towards shaping a more holistic experience; 4) clarity for developing their products and system as an opportunity for educating and motivating user behaviour modifications towards new sustainable social practices that are friendlier to the environment.

Keywords: Industrial Design Education, System Thinking, Design Thinking, Collaboration, Sustainable Design, Individualism-Collectivism

1 INTRODUCTION

Design has seen significant change over the past 20 years. What once were clearly defined areas of education and practice today are being transformed by ongoing accelerations of technology, innovation and globalisation. In design education, more programmes are rethinking traditional curricula models and are maturing to realise the greater value of design – preparing holistic systems thinkers. In the process, some programmes are working to define their unique responses to future professional needs through ongoing curriculum and classroom/studio experimentation.

In recent years the School of Design at Carnegie Mellon University, USA, redesigned its entire curriculum framework which includes; undergraduate (products/industrial design, communications, and a new environments track), masters (UX/interaction design), and PhD (transition design). The goal is to better prepare holistically thinking and practicing designers and systems thinkers able to see, structure, and address complex problems in a globally connected and interdependent world. In this regard it sees design as an important part of problem identification and a key contributor to solution creation, including those of social and environmental contexts, through collaboration across many domains including business, government, not-for-profit sectors, and grassroots activism in order to address one of the biggest challenges confronting us in the 21st century, transitioning to a sustainable society [Irwin].

The ambition of the new curriculum means that faculties have to be more flexible and active in creating smarter and more efficient ways to deliver more robust educational experiences. This paper highlights how using an experimental method for team collaboration that the I have termed Designer Profiles, in a fifth semester product design course, has shown positive results in accelerating student and team learning within a complex systems problem, and more holistically resolved design proposals. The next section explains Designer Profiles followed by highlights of the pedagogical underpinnings of the new curriculum framework and a description of how the fifth semester course has interpreted this opportunity using Designer Profiles within a project experience.

2 DESIGNER PROFILES

I define Designer Profiles as a framework for organising teams within the design process. The description of a design profile, in this context, is a list of characteristics, or tendencies that represent the preferences a designer has for practicing within the design process. There are four types of profiles; Flashy, Technical, Analytical, and Conductor (see figure 1). The concept was created in 2009, while serving on the board of a major professional design organisation. These profiles emerged as part of my strategic planning collaborations to define areas of design practice reflective of the broad membership. Around the same time an article titled "4 Fields of Industrial Design: (No, not furniture, trans, consumer electronics, & toys)" [Tharp and Tharp], was required reading for the fifth semester students. The article essentially argued that design practice is highly diverse but lacks a clear taxonomy – a way of organising behaviours in ways that is understood inside and outside the community. In response to the reading, students were relieved by the sense that they had many more options than perhaps had previously been understood. It became clear that cultural pressures, whether from their academic programme or external influences – curated design award schemes, media periodicals, industry promotions, etc. – influenced their sense of value and direction as a designer.

My strategic planning experiences, the Tharp and Tharp article, and the responses of students collectively motivated the development of Designer Profiles as a framework to support learning in the classroom. The goal of using the framework was to explore a tool for addressing what researches refer to as individualism-collectivism. As defined by Wagner, "individualism is the condition in which personal interests are accorded greater importance than are the needs of groups. Individualists look after themselves and tend to ignore group interests if they conflict with personal desires. The opposite of individualism, collectivism, occurs when the demands and interests of groups take precedence over the desires and needs of individuals. Collectivists look out for the well-being of the groups to which they belong, even if such actions sometimes require that personal interests be disregarded." It has been my experience that design students in the fifth semester are still developing their identities and confidence in understanding and managing research, conceptualisation, development, and presentation areas together as a design process. This is evident in both individually-focus and team-based project efforts. Individually, students can default to aspects of the process where they exhibit the most skill and confidence and therefore don't meet project goals or learning and development objectives across the process. This has been apparent in individually-focused and team-based projects where individual outcomes can be well developed but narrow or disconnected. Collectivist emerge in team-based projects giving priority to team goals and avoiding development of personal interests that allow them to appropriately engage in assigned responsibilities of learning and development objectives across the process. Outcomes here can be well developed narratives of higher-level collaborative work but limited development of personal work.

In addressing individualism-collectivism, the goal is to create "a relatively permanent change in the team's collective level of knowledge and skill produced by the shared experience of the team members" [Ellis], and to elevate students' openness to experiences and a willingness to try new approaches that challenge tendencies and development of their individual work [Costa & McCrae]. Since then, and for nearly a decade, I have used this framework to conduct a basic survey at the beginning of each fifth-semester course asking students about their alignment with the Designer Profiles, as they see themselves at that present day. They are asked to rank one through four with one being the profile that most aligns with their profile and four the least. Thereafter, and without further communication on the subject, students were informally monitored on their development over the semester. Observations found remarkably consistency between what students self-identified as their Designer Profile and how they behaved in design activity. This knowledge assisted in identifying student strengths and weaknesses, interests and disinterests, and has enabled me to assist students in

developing into more effective design thinkers and communicators. Recently, however, with the School's curriculum redesign, the author integrated Designer Profiles more directly into team formation.

Flashy	Adjectives: visionary artist, concept generator, image-based energy driver; Description: a person who is passionate about form-giving
Technical	Adjectives: implementer, design concept translator, responsible developer Description: a person who is passionate about concept development
Analytical	Adjectives: led by research, scientifically minded, cognitively focused Description: a person who is passionate about research; is more interested in defining what should be designed rather than conceptualizing or developing designs
Conductor	Adjectives: concerned with team health and performance, strategically minded, big picture thinker Description: This person likes to bring it all together; is most comfortable in leading and facilitating

Figure 1. Designer Profiles

The next section highlights the School's pedagogical framework in order to contextualise the product systems challenge that students were given as a project and how the use of Designer Profiles to formulate teams supported their learning, management of complexity, and overall design results.

3 PEDAGOGICAL FRAMEWORK

The School of Design describes the new curriculum model as representing emerging and nascent design theory and practice areas that intends to build a flexible and adaptive framework for projects and research that is responsive to dynamic changes in industry and society and aimed at re-conceiving entire lifestyles to be more sustainable https://design.cmu.edu/content/program-framework. At the undergraduate level this framework is introduced in the first year as students learn about the "built world". It is then expanded throughout subsequent years of their education through design studies courses intended to develop awareness and perspective in the areas of: Design for Service – defined as ways of framing and solving problems that can lead to moderate change; Design for Social Innovation – significant change over time; and Transition Design – radical change over a long-time span. The pedagogical framework "introduces students to the elements of a holistic/ecological worldview and provides grounding in living systems principles, ecology, indigenous/place-based wisdom, alternative economics/politics, and climate change to name a few" [Irwin].

To assist students in choosing an informed path of study, and to support the development of a more holistically minded designer, within the first four semesters students take introductory mini courses in their choice of two of three discipline track option; products, communications, or environments. They also take supportive design studies courses to shape their broader world view. Thereafter they have the choice to concentrate in one area, such as product design, or customise their degree by taking courses across the three areas. The first cohort under this new framework graduated in the spring of 2018 with the degree designation of Bachelors of Design (BDes). The school has a proud history of successful alumni across broad areas of for-profit and not-for-profit industry sectors; however, this will be the first group where from the start of their studies the question to them was "What kind of designer do you want to be?" The next section describes how the fifth semester product studio contributes to helping students think about this challenging question.

4 DESIGNER PROFILES AND COMPLEXITY IN THE PRODUCT DESIGN STUDIO

The fifth semester product course is a required studio for students focusing or concentrating their study in product design. Up to this point, the focus of their education has been on expanding their world view through various abstracted levels of intellectual and hands-on skill building experiences in the areas of problem identification and framing, user research methods, conceptualisation, and physical and digital prototyping. The goal of this studio is to expand their knowledge, deepen their intellectual capabilities, and provide tools and strategies to manage complexity through hands-on challenges that more closely mimic "real-world" scenarios. There are two main project experiences in this 15-week semester, each about seven weeks in length.

4.1 Project 1: Introductory Commercial Product Design Experience

The first project challenge is "improving the on-the-go meal experience" for millennials. This commercially focused project, which reframes a common human behaviour, has appeal for several reasons: students are able to draw on personal experiences and expertise though the product is not designed to be a response personal to the student; it provides students a more formal entry into designing for others through design research activities that develop empathy; and, while students conduct team research, they develop individual proposals with the marketplace in mind. Additionally, higher levels of complexity are introduced in two ways. First, the requirement is a focus on physical interaction experiences that satisfies user lifestyle needs and desires, based on research findings. Second, the product is contextualised as a new product category for an established corporate brand – requiring investigation, analysis, interpretive coding and formation of visual brand language elements towards the development of appropriate product aesthetics. This first project opens their intellectual and practical minds to a greater awareness and empathy for the needs and desires of others and to the relationships between the user and brand. This foundation is structured to support the leap in product and system complexity designed into the second project challenge. From the instructor's point of view it has also enabled learning about the tendencies of each student in their process of design.

4.2 Project 2: Immersive Product Design and Systems Experience

The second project, "Pursuit of the Perfect Lawn", is where Designer Profiles and a structured systems problem work together. The goals of the project were to have the design students become more socially and environmentally conscious when conceptualising new products and seed (or nurture) a sense of long-term personal responsibility. Overall objectives included having students become more holistic systems thinkers and to realise their opportunities in contributing to creating valuable outcomes. This required helping them to move beyond the notion of isolated product experiences and to envision chances for creating short and long-term positive impacts on relationships between user behaviours, the product/system, and the environment. In this regard the project was connected to a wicked problem – a problem that is highly ambiguous because of unknown, contradictory, and changing conditions [Buchanan]. Irwin writes that wicked problems require new knowledge and the ability to see "its myriad of manifestations and interconnections." This project, however, provided a contextual awareness of the greater challenges while being structured as a "local" design problem; one that students could manage, and to some degree forecast that their outcomes could contribute to the design of better products and systems as part of a larger strategy for positive impact [Mancini].

The specific project challenge was to design product alternatives within an interdependent system experience that better informs US homeowners, who personally engage in their own lawn care, of the proper recommendations of fertilisation use and storage, and related lawn water maintenance through awareness and resource management. In essence, how can product and system design motivate consumer behaviour change? Since the late nineteenth century the number of residential lawns in the United States has grown significantly, particularly in suburbia, with little ends in sight. Today it is estimated that lawns represent over 40 million acres across the United States. Eighty-percent (80%) of residential homes have private lawns with the average lawn size at one-third of an acre and each weekend forty-five million Americans mow their lawn. Lawns communicate social status and social values but can also increase the value of the home. However, many homeowners who maintain their own lawns engage in misguided practices that have negative and significant consequences on the environment. In order to address this challenge within the seven-week timeframe, careful consideration needed to be given to the project structure and the effectiveness of teams.

4.3 Project Structure

This seven-week collaborative project experience involved 15 product design students and followed a design process sequence of research (2-weeks), conceptualisation and development (4-weeks), and presentation (1-week). It relied on teamwork throughout to achieve multidimensional objectives. Teams were formed at two stages and in two ways. In the first stage, I prepared general background information as part of discussion structures prior to having open class discussions. As a result of these activities, four research teams were established to quickly inform the class around the following questions: A) What is the overall history of lawn care in the United States and how has it evolved? B) What are additive products (nutrients) for lawns and how and why are they used? C) What is the history of products and devices associated with applying nutrients to lawns? D) What is the history of

water management and related products and devices used in lawn care? There were four students assigned to each of three teams with the fourth team having three. Students were given the choice of what area they wanted to research. It was made clear that their research team assignments would not define the product focus they could have. At the conclusion each team presented their findings, which became foundational knowledge and references for the entire class. Through instructor led class discussion and analysis of the data, the defined system of products the class would focus on were a fertiliser spreader, fertiliser storage, and water maintenance.

In the second phase of research teams were reconfigured into five teams of three students based on the following: 1) students were assigned products based on their first or second preference; 2) research team members were distributed across all teams to have firsthand knowledge of that information on each; and 3) teams were constructed based on the Designer Profiles framework with the goal to have, as reasonably as possible, a distribution of different profiles while avoiding duplication of the same profile (see figure 2). Based on numbers alone a consistent and sequential distribution of Designer Profiles across all teams is highly aspirational. The goal instead was to provide some qualitative supposition that organising teams in this manner, based on my prior experiences with individual students, would achieve more cohesive teams who could perhaps work in a more fluid way. I acknowledge that no student, or perhaps professional, fits neatly into one category, especially when performing design activity. However, such a grouping leveraged student tendencies, often driven by conscious or unconscious interests that would appear to show benefit.

Research Areas (distributed representatives)	**Students**	**Designer Profiles**				**Product Assignment**
		Visionary	Technical	Analytical	Conductor	
Students in the research teams (see A-D above) were balanced in distribution across each team	First	3	1	2	4	Fertiliser Spreader
	Second	2	1	3	4	Storage + Transfer
	Third	1	3	2	4	Water Maintenance

Figure 2. Team Composition Example

These teams would remain together for the remainder of the project working collaboratively to define personas and a scenario, and a geographic location within the United States on which to focus. This enabled them to work to strategise, plan and manage design activity that included identifying new knowledge needs, using design research methods to interview people who were engaged in their own lawn care, and where possible observe users in context. This work provided insight and guidance and assisted in addressing key project objectives that included: 1) obtaining a deeper understanding of the interconnectedness of their products and the needs and values of their system, 2) for each student to design a physical product experience and use narrative that is interdependent on each of the other products in the system (technology could be considered but only as a secondary consideration), and 3) to deeply consider user needs and desires in motivating proper product engagements that reduce over-fertilisation, over watering, and mitigates fertiliser spillage related to product storage and transfer.

4.3.1 Assessment of Qualitative Outcomes

This project experience has been run on two different occasions. The first occasion was two years prior to the one described here. The goals and objectives of each project were the same. In each case there was initial team research, however, in the first experience students worked as individuals thereafter – though there were occasional group critiques. In the second experience there were two distinct differences: 1) Designer Profiles were used to construct teams, and 2) a system of products was defined and assigned to the teams that represented intentional interconnectedness. An overall assessment of each experience was conducted by the instructor using data collected from ongoing instructor observation and informal interviews of students throughout the entire design process, student work, and a self-assessment rubric that each student completed at the conclusion of each project. The rubric asked such questions as: What did you learn? What serves as evidence? What ways might you improve? It also required students to assess themselves in the areas of breadth, depth and risk-taking within their process.

While there were successful learning outcomes in the first project experience, the greater goals for students to demonstrate more holistic systems thinking and a thoughtful fit of their product within a system was lacking. In this case they were aware of the system but the instructor had not defined specific interconnections with other products. Consequently, as an individually focused project the challenge to think about the product and system together was overwhelming. The unintended

outcomes were product focused proposals. The following two responses by students from their project self-assessments confirmed their mindset: “My concept stayed at a high level and never truly got defined to a point where I'd be comfortable finalising any aspect of the visual design”; and “I feel like I spent way too much time exploring wildly different approaches at first”. By comparison, the second experience of the project yielded a greater sense of student responsibility to their product, the system, and the needs of the team. Comments were more holistic in nature with this example capturing the sentiment of several others “I learned how to design a system of cohesive products. My team and I were very involved with each other's designs and dealt with the consequences, good and bad, of setting up constraints for one another.” Using Designer Profiles to construct teams together with a structured systems problem, in a fifth-semester product studio, has shown to support students in embracing, learning, and managing complexity in an established product system. In this example, several positive outcomes, in comparison to a previous version of this experience, are notable including: research was more meaningful because each were seeking information on individual and collective aspects of the user and system experience; functional connections of each product in the systems were well considered; abilities to create arguments, negotiate, compromise, and make decisions in consideration of self and the system were well established; and a more fruitful exchange of information, ideas, critique, resulted in good team cohesion.

5 CONCLUSION

Industrial design programmes that are evolving to prepare adaptable and holistically minded learners, who are able to respond to dynamic changes, recognise that new approaches to curricula models and classroom learning experiences are needed. This paper focused on a fifth-semester product design studio experience where a new approach to team formation called Designer Profiles, and the structure of an interconnected and interdependent system of products, are complementary to helping students identify, learn, and manage product and system complexity. Designer Profiles is a framework that leverages individual tendencies and preferences in the design process. Through qualitative assessment measures these approaches used together have shown to support student engagement and improve the breadth and depth of learning in comparison to the same project without these approaches. Although the preliminary results for using Designer Profiles together with a structured systems problem is promising, additional research that adds qualitative measures on individualism-constructivism is needed.

REFERENCES

[1] Anderson, E. Maturing or Withering: Opportunities and challenges for Industrial Design education. *IDSA Education Symposium*, 2016 Proceedings

[2] Costa, P. T., & McCrae, R. R. Revised NEO personality inventory. *Psychological Assessment Resources*, 1992.

[3] Aleksander P. J. E. et al, Team Learning: Collectively Connecting the Dots. *Journal of Applied Psychology, Volume 88,* No. 5, 2003, pp 821–835.

[4] Irwin, T. Redesigning a Design Programme: How Carnegie Mellon University is Developing a Design Curricula for the 21st Century. *The Solutions Journal, Vol 6, Issue 1*, pp. 91-100.

[5] McCrae, R. R. Creativity, divergent thinking, and openness to experience. *Journal of Personality and Social Psychology*, 1987, 52, pp 1258– 1265.

[6] Manzini, E. A Cosmopolitan Localism: Prospects for a Sustainable Local Development and the Possible Role of Design. *Design Studies: A Reader*, 2009.

[7] Norman, D. Why Design Education Must Change. *Core77.com.* 26. Nov. 2010 Web. 05 Mar. 2018

[8] Tharp, B. M. and Tharp, S. M. The 4 Fields of Industrial Design: (No, not furniture, trans, consumer electronics, & toys), *http://www.core77.com/posts/12232*

[9] Wagner J. A. Studies of individualism-collectivism: Effects on cooperation. *Academy of Management Journal*, 1995, *38*(1), 152.