Teaching Strategies Considering Interdisciplinary Practice in Industrial Design Curriculum

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Abstract. In order to prepare Industrial Design students for the realities of practice, it is essential they learn to collaborate with other disciplines as well as communicate and analyze context and information in various professional languages. This paper explains the theory and outlook shaping ID teaching methods, using some examples (research and design projects) from the ID program at Virginia Tech. Through these projects, we show the tools and means designed based on interdisciplinary approaches in teaching and also discuss their direct and indirect results. These examples include topics in healthcare design, public health, and user interaction design and evaluation; in collaboration with other academic fields and sectors, industry professionals, nonprofit organizations (or teams), with a community-based participatory approach. Within this study, we describe the process of investigating, practicing, and evaluating non-traditional teaching strategies to expose the students to experiential learning with a focus on an interdisciplinary professional environment.

Keywords: Industrial design · Interdisciplinary teaching · Experiential learning · Interdisciplinary teaching · Community-based participatory research and design

1 Introduction

Students majoring in Industrial Design (ID) get hands-on experience in systematic thinking, design thinking, and human-centered design [1] and are expected to have a variety of knowledge integrated from different disciplines and professions such as engineering, social and environmental issues, sustainability, ergonomic, business, aesthetics, etc. [2, 3]. This makes Industrial design an interdisciplinary practice by nature, and studies show that having experience in interdisciplinary-based projects during their education can become a crucial skill for ID graduates. This style of projects will prepare them for the reality of professional practice with the ability to collaborate with other disciplines

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as well as communicate and analyze context and information in various professional languages. These experiences will also prepare them for a wide variety of professions in various fields such as service design, interaction & user experience design, IoT, sustainable design, and virtual & augmented reality [4, 5]. While integrating different outreach paths and plans to collaborate with external resources (academic and professional practice) has been transforming the traditional ID curriculum, it also comes with various challenges that require designing strategies that consider students' learning effectiveness [6]. In order to simulate the industry's existing expertise interconnections in an academic setting embedded in curricula, having a cohesive team of collaborators is one of the primary requirements for such a project [7] which can turn this process into a time-consuming task for faculty. In this paper, we explain incorporating available resources, and strategies for a sustainable format in teaching interdisciplinary-practice principles using some examples (course, research and projects) utilized in the ID program at Virginia Tech. These examples include topics in Healthcare Design, Public Health, and User Interaction Design and Evaluation; in collaboration with other academic fields and sectors, Industry professionals, nonprofit organizations (or teams), with a community based participatory approach.

Within this study, we describe the process of investigating, practicing, and evaluating two teaching strategy categories aligning with the interdisciplinary concept; including a) Interdisciplinary Course Design (e.g., a nationally-funded interdisciplinary teaching program for team-based design with biomedical engineers), and b) Sponsored Project-Based Research, and/or Design. The overall goal of utilizing these non-traditional teaching strategies is to expose the students to experiential learning with a focus on an interdisciplinary professional environment.

2 Interdisciplinary Course Design

Incorporating interdisciplinary projects in academia is a common tool, but in industrial design programs they usually are limited to graduate students or a small group of undergraduate students selected by faculty, and in some cases short term independent projects initiated by students which makes this opportunity very non-inclusive for students and unsustainable for programs. On the other hand, turning an interdisciplinary practice into a course can become an inclusive opportunity for a wider range of ID students to gain experience in collaborating with other disciplines and can be applied to various topics. Within each topic of such a course, the students get the experience of not only working with other disciplines (students, and professors) but also possibly working with professionals and experts on the topic. Although, designing and creating courses like this requires commitment from different parties (academic and professional) and in some cases dedicated budgets in order to turn it into an experiential learning experience; various channels exist to obtain the required budgets and here we will discuss two of the most common ones.

In the first method, private collaborators will sponsor a course in a topic directly related to their practice, and because of their fluid nature, design studios have the potential to be designed based on the sponsoring collaborator's interests. For example, the junior year students (approximately ± 33 students) in the ID program at Virginia Tech have

been collaborating with SFCS Inc. an architecture firm in Roanoke, Virginia, and Warm Hearth Village, a retirement and assisted living facility for the past 11 years. Within this program the students get to work with and learn from professionals dealing with "aging in place" and access to and interactions with experts in this field has been facilitated. They also have the opportunity to experience community-based participatory research and design, and understand the importance of its impact on interdisciplinary practices. In Fig. 1. you can see some examples of the analysis and design process such as participatory research and persona creation that was produced by teams of students during an 8-week project.

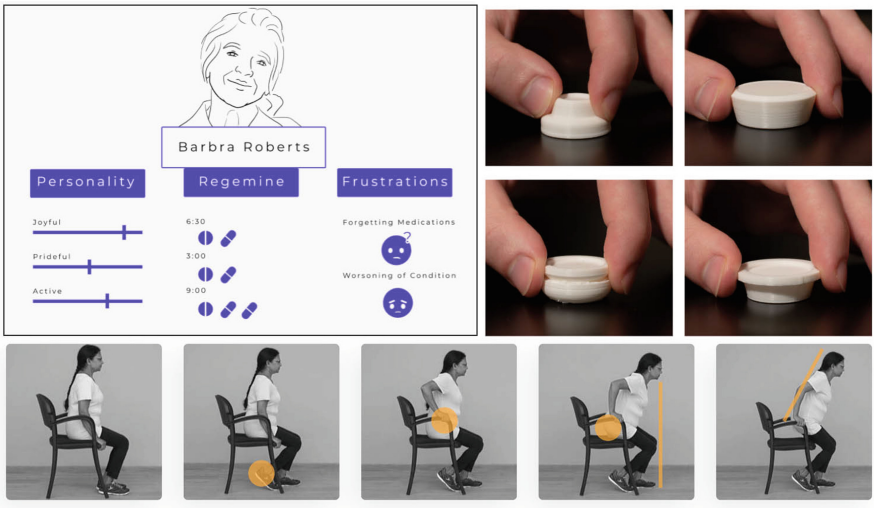

Fig. 1. Top left, Persona profile created based on several interviews with experts and professional collaborators as well as primary users. Top right, Testing the prototype pieces with the users, Bottom, User observation.

In some cases, the course can be funded by scientific or academic organisations. There are various calls for grants and funds that specifically are sponsoring interdisciplinary initiatives in education or that can be used in promoting and exercising interdisciplinary practices. Industrial Design Faculty at Virginia Tech in collaboration with the Biomedical Engineering and Mechanics Department formed an interdisciplinary course for needs identification in healthcare, funded by the National Institutes of Health. Since this is a course designed in healthcare, in addition to the two academic disciplines involved, there are also various professional individuals and healthcare organizations collaborating with us to make this course possible. This course provides the chance for students (approximately ~15 students) to interact not only with users but also to collaborate with the U.S. Department of Defense (DoD) and Veterans Affairs (VA) clinics and laboratories to discover unmet needs and develop innovative solutions related to veterans' healthcare. In this course, we foster an environment that trains industrial design students to experience interprofessionalism, while understanding and exercising the dynamic existing in interdisciplinary practices, and in this case the healthcare industry. This course's

topics are contextual inquiry for medical device design with field immersion in podiatry, nephrology, and tele-gerofit (exercise program using clinical telehealth), data analysis and visualization, and needs prioritization based on regulatory, reimbursement, and market factors [8]. Our post-course evaluation initial results (students survey) indicated an agreement to strong agreement with statements linked to the quality of course learning objectives (Fig. 2).

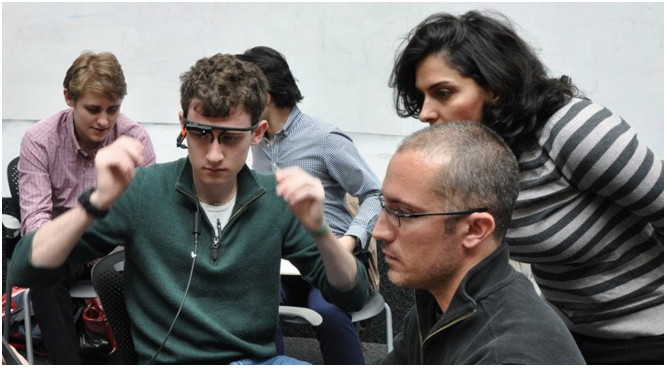

Fig. 2. Faculty and Students using eye tracking tools during one of the classes in "Needs identification in Healthcare" course, Spring 2020.

3 Collaborative/Sponsored Projects

Industrial designers usually are members of interdisciplinary creative teams as user researchers and problem solvers. Academic space provides great chances of working with other disciplines for the ID programs to foster experiences working in interdisciplinary projects. Project-based interdisciplinary collaboration is a common tool that has been used in ID programs in various formats and lengths, for example sponsored independent projects brought by external resources, or collaboration in community-centered research based projects to improve public health. Usually these types of projects require a lot of additional effort on the faculty's side in order to make it applicable to ID students' pedagogical learning needs and the program's curriculum. Although these types of interdisciplinary works can turn into exceptional learning experiences for a group of students, usually they are short term (a semester or yearlong) and it might not be a top priority on the program's or faculty's list if it is not related to their research area. In order to maintain these types of projects as teaching tools and be efficient about the effort behind creating each of them, establishing a longer term infrastructure with collaborators to plan these types of projects creates a relatively more sustainable plan for students learning that is consequently more inclusive for a wider range of students during several years.

We can define these independent interdisciplinary projects in three main categories. The first and most usual category is faculty research related projects. Although graduate students are usually the ones involved in these research and design projects it is

also possible to get undergraduate students to engage in them. In all research studies graduate students usually have a degree, set of skills and knowledge related to the topic that makes them qualified to be a part of the team; whereas in the case of engaging undergraduate students they need to become familiar with the context of that interdisciplinary project and be trained in the proper and needed skills related to the topics. As has been mentioned in Sect. 2 one of the tools that can help the students to become familiar with interdisciplinary projects is to create an introductory course that prepares them to become a qualified member of a research team. For example, in our case the students who were trained and educated in "Needs Identification in Healthcare" courses were able to become an important asset in a research study in pediatric telemedicine that later was awarded by the National Center for Advancing Translational Sciences of the National Institutes of Health under Award Number UL1TR003015 (Fig. 3).

Fig. 3. Pediatric Telemedicine Research. In this picture, you can see one undergraduate ID student and one undergraduate Bio Medical Engineering (BME) student working with nurses and a pediatric physician in a simulated clinical environment. Also behind this scene, there are faculty members from three different disciplines and one more undergraduate student. (Summer 2020)

One other way to turn an interdisciplinary project-based collaboration into a long term plan for students involvement in an interdisciplinary project is to recognize the importance of the communities involved in interdisciplinary projects and create the necessary basis for access to a connected web of community and professionals through different partnerships. This arrangement and connection to the community of users and professionals can foster a variety of upcoming projects for students' involvement. For example, TEAM (Technology–Education–Advocacy–Medicine) Malawi which is a transdisciplinary, collaborative team of academic and healthcare professionals is one of the organizations that the industrial design program at Virginia Tech has established a partnership with.

Various project topics and needs have been brought to students and we have made it our goal to provide these students with access to an interdisciplinary source of community members and professionals. These stakeholders have been paired with students and

faculty from different disciplines as a team, which provides the industrial design students with a variety of different resources, both internal (academic) and external (community resources and professionals) which fulfills the original goal for conducting community-centered participatory research and design. (Here in Fig. 4 you can see two versions of a neonatal harness designed and prototyped by two interdisciplinary teams of undergraduate and graduate students within two academic years. The ID students, besides working in an interdisciplinary student team, were also able to experience communication and collaboration with various healthcare and community experts. This is an example of an ongoing project that although the initial group of students who started this study have graduated the project is still in progress with new versions working with a new group of students.

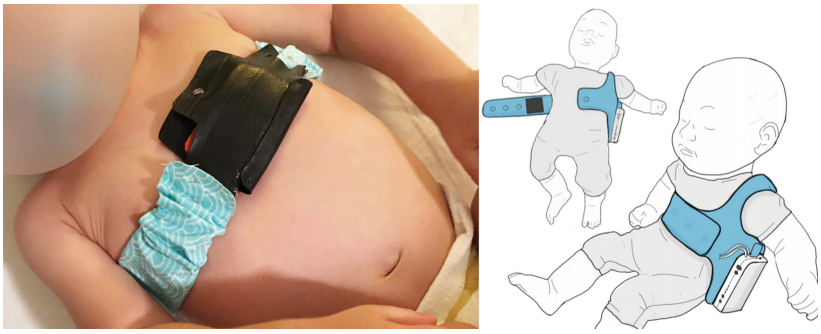

Fig. 4. Left: Second version of the "Neonatal Harness", designed by Dana Werlich, Sam Rodgers, and Lauren Harrison, Faculty Advisors: Elham Morshedzadeh, Andre Muelenaer John Bird. (2019–2020), Right "ZIDA Neonatal Harness", designed by Amber Baden Lopez, Shiva Challa, John Harris, Kristen Merrifield, Emilie Baker, Colleen McDonald, Caitlin Steen, Judy Chen. Faculty Advisors: Elham Morshedzadeh, Andre Muelenaer, Akshay Sharma, John Bird. (2018)

The last common form of exercising interdisciplinary practice with industrial design students is through independent undergraduate research and design projects in collaboration with other disciplines and professionals. This tool is not as inclusive as others and usually is limited to a small number of students. One way to make the possibility available to a wider range of students is through offered interdisciplinary courses; this way the students not only will get familiar with interdisciplinary practice concepts but will also get exposed to a specific subject (based on the course topic) that can turn into an interdisciplinary-based project/study/design. Our experience with the R25 course showed that more than a third of the students who attended the course (during junior year) continued working on the project as an independent study forming an interdisciplinary team of students and expanding the experience beyond the course limitation and definition.

4 Conclusion

We are taking various approaches to incorporating interdisciplinary practice-based projects in teaching industrial design that are learning experiences not only for students but also for us as educators. The Virginia Tech Industrial design program has approximately ±100 students (sophomore year to senior year) and the variety of interdisciplinary projects offered by faculty gives the opportunity to most students to get engaged with their topic of choice. In our case, during the last 3 years more than 50 students contributed and engaged in at least one form of the projects that we offered in healthcare (±50 through course-based projects and ±15 through independent projects per year). Most of these projects are planned for relatively long-term collaborations which makes it possible for faculty to maintain them efficiently and effectively for a wider range of student engagement with lower coordination efforts. On the other hand, our observation showed some intercorrelations between these criterias. More than 50% of the students who took the designed interdisciplinary courses, stayed actively engaged in similar interdisciplinary projects. For example, in the R25 course the course resulted in 4 students (as a team) working on a student independent research study as well as 2 students continuing to work in healthcare as their senior thesis and finally 3 students contributing in faculty research in an interdisciplinary-based research project in healthcare (Fig. 5).

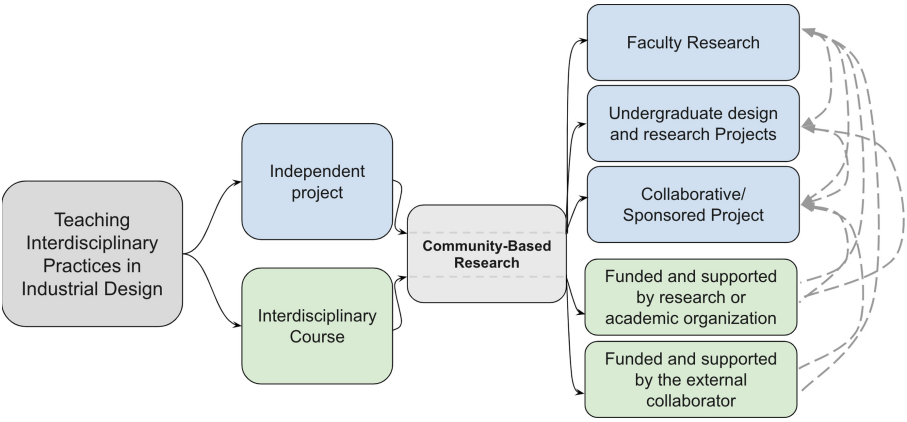

Fig. 5. Different paths in teaching interdisciplinary-practice to ID students and relations and intercorrelations between them

Overall offering interdisciplinary-based courses to ID students familiarised and prepared them for interdisciplinary-practice working environment. Also, a high percentage of them stay engaged continuing the project even after completing the course in different forms such as independent study, thesis, research, etc.

Our observations during the past few years on healthcare focused interdisciplinary-based projects shows that offering this unique experience to undergraduate ID students,

in a course format (specialised in a specific industry) or a studio-wide project embedded in the course syllabus is an inclusive way of student engagement. It also can create a more sustainable teaching medium for faculty to maintain cohesive team collaborators for teaching.

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