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# Assessing the Effectiveness of Open Organizing as a Model for Re-designing Design Learning*

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In this paper we assess the appropriateness of open organizing as a model for re-designing design education. First, we review prior work on open organizing, particularly open innovation, to understand what makes these approaches novel and successful. Next, we draw on empirical findings from field studies of open source software projects that leverage open innovation principles and outline the advantages that accrue from interacting with external communities and participants, thereby increasing the authenticity of projects, and of making the design task the cornerstone of the learning activity—as opposed to structuring learning around a person. Finally, we synthesize lessons for creating open design experiences and offer suggestions that are equally applicable to in-class undergraduate design projects and to informal design projects undertaken by students.

**Keywords:** open innovation; design education; authentic learning

## 1. Introduction

The need for innovative engineers has become an oft-repeated mantra in the current economic climate since entrepreneurial and innovative activities play an important role in creating jobs and fueling economic growth in the fast-paced global knowledge economy [3]. Training engineers to become more innovative is often seen as the purview of engineering design courses within the undergraduate and graduate engineering curriculum. Compared to the science and engineering science coursework that engineering students undertake, design courses provide significant more opportunity to the exercise innovative and inventive thinking. Engineering design is often considered the primary defining characteristic of the profession and, first and foremost, engineers engage in designing technical and socio-technical tools and environments [17]. Therefore, design has been a focus of research in engineering education and research on engineering design thinking and learning has established that design is hard to learn and still harder to teach [48]. Design scholars and practitioners alike realize the importance of design education and of the opportunity to innovate how design is taught [16]. In this paper our focus is on learning from emerging forms of organizing how people work together to synthesize lessons that can assist us in making undergraduate and graduate design courses even more inventive through a re-design of how they are structured. In particular, we look at how design education can be innovated by appropriating advances in information technology and new forms of organizing that have emerged and to which engineers need to respond. The primary difference as compared to previous approaches is to increase interaction with those outside the immediate environments through the use of digital information technology and thereby provide better access to expertise and areas of application. A close attention to this new approach is essential for preparing innovative engineers as open ways of learning reflect the way in which innovation is both conceptualized and implemented in the knowledge economy.

This approach also allows us to leverage the use of technology that now permeates all aspects of the design process. Digital tools are available for sketching, modeling, prototyping, communication, and collaboration; shifting both the nature of design and research on design [17]. Not surprisingly, use of technology has also become the fabric of education; digital tools are used for instruction [34, 49], for managing classes [50], for monitoring class interactions [51] or simulation-based learning [52] and for engineering learning through the internet [11]. However, the use of technology for education itself needs to be revisited within the context of open organizing. The 'net generation', a generation of persons born between 1980 and the present [42], have grown up with computer-based technology readily available and unrestricted access to the Internet. These students are efficient multi-taskers when using electronic and digital devices [30] and are inherently opposed to being passive consumers and have a large appetite for choice, convenience, customization, and control by designing, producing, and distributing products themselves [40]. It is increasingly being documented that their learning styles



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lean towards independence and autonomy and their desire is not to assess what kind of education they buy but to understand what, where, and how to learn [29]. This is a significant departure from prior conceptions of incoming students and suggests that we need to reassess course and curricular development at a more fundamental level, open organizing and open innovation advancement provide as an opportunity to do so. Next, we discuss how we can revisit our ability to work in groups and create new learning environments.

## 2. Open innovation and open organizing

The term 'open innovation' refers to the ability of a firm to leverage external linkages to generate innovative ideas and to improve efficiency [9, 10]. Firms across industries have adopted open innovation, and open organizing more broadly, as means to acquire external knowledge and technologies to overcome internal shortcomings. As compared to the traditional vertically integrated model of the firm, open innovation allows the assimilation and exploitation of external sources of innovation and supports their monetization without having to build complete solutions by themselves [10]. These external relationships can take many forms ranging from collaborative partnerships to community interactions that allow a large number of people to contribute directly through digital technology. For instance, organizations may manage alliance portfolios which allow for privileged access to allies' knowledge bases and relied on external knowledge retention to innovate [15]. One common example of open innovation is open source software (OSS) such as Linux, Apache, and MySQL. The ability of a firm to leverage 'crowds', or the general public, and customers through the web has not only been adopted in software development [12], this phenomenon is also exemplified in the emergence of affordable do-it-yourself (DIY) prototyping and manufacturing [1]. This is a rising phenomenon involving virtual teams that develop open source plans for objects such as circuit boards, custom tools, furniture, and even cars, which are them outsourced to a small batch manufacturer who produces a prototype and offers to set up production for a set price [4, 32]. As modularized projects under the guidance of expert developers have a higher likelihood of reaching advanced stages of development [32], communities have to attract expert participants by making diverse opportunities available, allowing for self-selection of tasks to match their interests and expertise. Nevertheless, these small, extremely flexible, and surprisingly profitable companies represent a new form of organizing better suited for dealing with an era where the cost to interaction has become almost non-existent due to our digitally interconnected society [28]. These fundamental shifts in the world of work have created the need for innovative education [16], particularly for design thinking [17], and their close examination also provides guidance on how these changes can be applied in the realm of education. More fundamentally, a close observation of these organizations displays the intertwining of learning, working, and innovating [7].

## 3. From open organizing to open learning

The idea that organizations have much to gain from interaction with elements in their external environment is well established in organization theory. Organizational researchers who have studied different forms of organization term this aspect 'open systems' and define them as systems that are, 'capable of self-maintenance on the basis of throughput of resources from the environment [36].' Furthermore, researchers argue that exposing organizational systems to environmental complexity 'preserves the differential structure of an open system [36]'. Organizations are required to build the mechanism of self-maintenance by training their employees and encouraging a culture of learning. The open system view of organizational structure focuses on the complex organizational processes and changeability of individual entities such as individuals and subsystems. Open systems enable organizations to self-maintain a differential system based on a throughput of resources from the surrounding environment and place sufficient attention to activities that span boundaries while enabling linkages across internal sub-systems [35].

At the individual level, an open perspective is well reflected in the everyday actions of individuals who are enclosed within the boundaries of any one organization but constantly engage in boundary crossing. For instance, an employee of a software firm who participates in open source online communities and is able to contribute and absorb technical knowledge through her interactions is one instance of boundary spanning. Williams [43] conducted empirical research designed to identify and categorize the different competencies of 'boundary spanners' and reveals four major competencies: building sustainable interpersonal relationships; managing through influencing and negotiation; managing complexity and interdependencies; and managing roles, accountabilities, and motivations. Although open innovation, manifested as external linkages, has been a part of organizational ecosystems for a while, recent shifts due to information technology have sharply changed the nature of these linkages, and facilitated

the exchange of distributed sources of information [14]. As Friedman [21] presents the argument in *The World is Flat* (2005), individuals can now draw on the power of their network to innovate and interact with prospective customers around the world.

The argument for open innovation when extended to education and learning suggests that similar transformations are not only possible but necessary for innovative and innovation-developing educational institutions and learning practices [2, 5]. Open educational resources offer teaching, learning and research resources to the public domain with the main goal of nurturing a culture of sharing within major higher education institutions and amongst individuals [2]. Establishing an open participatory learning cyber infrastructure enables a learning ecosystem that prepares individuals to meet challenges in a knowledge-based world, where creativity, innovation and entrepreneurialism are in demand. With a similar tone, researchers suggest that in order to tackle the global demand for higher education, students can exploit user-centric information infrastructure made possible by Web 2.0 technology and participate in innovative exploration, experimentations and purposeful activities [5]. Empowered by the Internet and Web 2.0 technologies, virtual communities form distributed intelligence around various topics by swarming together to form extensive interconnections. These 'smart mobs' exploit collective knowledge bases, benefit from the unbridled sharing of knowledge and subsequently coalescing activities to form rich virtual social environments [33]. It is not hard to see how, given the reach of the Internet and the capability to engage external members into design ideas, the adoption of open innovation strategies can be helpful in many ways for design learning.

Learning theories, particularly those ascribing to the situative perspective such as distributed cognition [46] and activity theory [47], have for decades argued that learning is meaningful participation in communities of practices including identity development [24]. Activities and interaction facilitate learning, and individuals participate by doing and being within a social and material context. Meaningful peripheral participation within communities of practice helps to underscores the highly contextual nature of human learning. Situative learning theories adhere closely to the use of representations, alignment with professional practices, and the emphasis on design in engineering education and may therefore deepen our understanding of engineering learning [24]. Even from a cognitive perspective, the importance of open-ended and ill-structured tasks in shaping meaningful learning and cognitive flexibility is well established in the literature [22]. As open-ended learning focuses on self-inquiry, divergent thinking and heuristics-based learning in ill-defined, ill-structured domains, educators can therefore help scaffold learner's cognitive processes by providing tools and resources to guide learning efforts and facilitate productive student interaction [22].

Therefore, learning communities can be created through an open innovation model thereby providing authentic learning environments that combine working on relevant and useful projects where innovation and cognition go hand in hand. An authentic environment is crucial for skill development that transfers easily across contexts, particularly for learning design. Authentic learners typically focus on real-world complex problems with real circumstances and devising solutions using role-playing activities, problem-based exercises, case studies and participation in communities of practice [41]. Examples of related innovation already exist, such as virtual science communities that connect newcomers with experts in authentic environments [23].

In addition to supporting the idea of 'communities of practice,' open innovation trends also shed new light on the balance between face-to-face and digitally mediated interaction. For instance, the cost of physical infrastructure and class based face-to-face interaction has impressed upon all the need to use face-to-face interaction innovatively; rather than using it for transfer through rote learning, dialogic learning may be a better option. As classroom dialogues or argument are classified as a resource or conduit for learning students may benefit vastly from collective knowledge building and co-constructed activity realized through talk or arguments in the classroom [31]. These ideas are not new but adoption of technology changes the way in which they are applied in the construction of learning environments.

## 4. Lessons learnt from empirical research

In addition to the field study of 'Digitech', our research group has conducted a series of field studies and compiled rich sources of data from various organizations in relevant industries, and analyzed them so as to better understand how open learning can be designed and sustained [25–27]. In this section, we lay out various lessons in order to highlight procedural and educational dimensions while retaining the rich context to assist learners to identify new aspects and phenomenon [19, 44], we employ the use of case studies of a various engineering firms. This will assist us in shaping the thought experiments in the next section.

### 4.1 Collective intelligence

Our first example comes from the study of a firm, RAPID, which is a completely virtual firm of 60 employees that develop an open source blogging software and also provide paid services to support enterprise versions of the software. RAPID designed organizational practices are designed to support collective intelligence practices and this is made possible by the engineers who foster relationships with external communities using blogs, online forums and by active participation in community-organized conferences. Field studies show that engineers 'make do' with existing resources and exploit multiple media usage as well as personalize technological tools for new purposes. Overall, these studies highlight the importance of connecting individuals through technology and allowing relevant practices to develop over time. The communities thus fostered provide an excellent opportunity for the development of collective intelligence—applicable and contextual knowledge that can be leveraged by any community member. The open source communities thus provide an excellent opportunity to gain applicable and contextual knowledge that can be leveraged by any community member as a culture of collective intelligence assures support for newcomer socialization. A culture of collective intelligence therefore assures support for newcomer socialization.

### 4.2 Task centrality and division of labor

Findings from our study of open source development alerted us to the central role of tasks in organizing the division of labor and power structure within the community and its importance for learning. In open source software projects power relationships emerge through expertise of team members and not their seniority in terms of tenure. In a typical classroom, a teacher is the central character and holds both power and expertise and the responsibility for knowledge sharing and learning. Invariably, the teacher is also older than the students. We observed in the open source projects that often teenagers were the leaders of modules and other contributors were senior in terms of age but not in terms of experience and expertise. Moreover, power relationships were determined through the display of expertise, primarily through contributions, rather than tenure of age, which changed the quality of interaction among the community members making it more equitable and on task. Overall, the contributions determined the social nature of the entire enterprise. This observation lends credence to the conception of 'new schools' by John Dewey as early as early 20th century. Dewey argued that,

> *The conclusion is that in what are called the new schools, the primary source of social control resides in the very nature of the work done as a social enterprise in which all individuals have an opportunity to contribute and to which all feel a responsibility [13, p. 56].*

### 4.3 Newcomer support and mentorship

In another series of studies of newcomer participation in open source communities, we found that even a few experts can help a large number of newcomers when the interaction is managed well [45]. Our studies of online forums of these communities show that, first, there are different kinds of newcomers based on their intentions and expertise; and, second, that often newcomers also help others while asking their own questions. This behavior helps the community as experts are not over-leveraged but also helps move newcomers to full participation. In addition, the use of online forums, division of forums around topics, and guidelines on how to participate, in particular how to ask questions, made newcomer socialization a lot more efficient and also enhanced the scalability of the entire enterprise. At any given time the number of newcomers far exceeds the experts and such mechanisms are essential to support the community. Whereas earlier cognitive apprenticeship studies focus more on physically enclosed spaces, these observations lend support of the idea of virtual mentoring where mentoring is not just availability of one mentor or expert but it is the opportunity to leverage the knowledge of an entire community.

## 5. Lessons for structuring open design courses

In this section we reflect on the literature, findings from our study and lessons derived from case studies to outline some 'thought experiments' related to the structuring of design courses to make them more innovative. At this stage these are initial forays and we plan to revisit and revise these ideas to make them more concrete and applicable and then test them out by creating learning environments and courses around them. Some of the ideas seem more far-fetched than the others but there is enough evidence to suggest that they are all applicable in terms of technology needs, the primary bottleneck are institutional issues and resistance to change.

### 5.1 Interacting and interfacing with clients

Our thought experiment is informed by the cognitive apprenticeship model [8] and we formulate authentic tasks to expose students to expert design processes and challenge them to engage in well-thought strategies. Drawing from advances in cog-

nitive apprenticeship [8], this model will develop design strategies in a socio-technical environment, encourage students to make independent attempts, and then coach them to apply design strategies to authentic problems. Thus we conjecture that students benefit cognitively from authentic learning experiences and gain competence in developing exploratory design strategies and modeling of expert processes. This model is similar to many client-based design courses currently in place but differs in the way learner-client, learner-mentor, and learner-learner interaction occurs.

To initiate the design process model, undergraduate students form teams and obtain design statements from the select virtual communities before commencing their design project. They collaborate using virtual workspaces such as blogs, Moodle, or wiki, and formal extensions to virtual communities are established. The virtual workspaces act as a channel for authentic interactions and facilitate the building of rich networks, opportunity recognition and intelligence gathering in a socio-technical environment. Upon project closure, students contribute finalized deliverables to the community. This is a key idea of the approach we suggest here. Often in design projects undertaken at educational institutions there is not communal memory and new students work on the same design task as their predecessor every time they take a course. There is limited connection between students in different years of study and peer interactions are limited to students with similar levels of expertise, cognitive development and prior knowledge. Through this model we suggest that there is a strong opportunity to build on Vygotsky's idea of a *zone of proximal development* (ZPD) where students/learners work with knowledge others who can scaffold them through the learning process.

We anticipate that through the entire duration of the project students will interact extensively with external clients and gradually acclimate to routine design methodology, enhancing their ability to detach problems from their original frame of reference to devise innovative design solutions. Yet, their interaction will be strongly supported by community memory that already exists in the virtual environment thereby making the time devoted by clients a lot more efficient. By working on this slightly ill-structured environment, students will learn to make sense of ill-conceived aspects of engineering design, move towards making rational decisions, and learn to handle design ambiguities across multi-disciplinary and multi-cultural contexts. In addition, initial peripheral participation in the virtual community may eventually lead to full participation and an increased willingness to recognize community values and shared norms. The perpetual connections with the virtual communities reinforce the students' abilities to analyze network linkages and synthesize different sources of information, and they gain insights into how open innovation processes enhance network resources and inflow of knowledge into organizations.

While working with clients on client given problems, the social realities of the virtual workplace are replicated and students develop self-organization skills to synthesize knowledge that have been shaped by the presence of complex networks and distributed cognitive artifacts [6, 18]. The exposure to resource-rich virtual communities and expert opinions therefore scaffolds learning and support further cognitive development, allowing students to build on previous content knowledge and further their understanding of the design processes and principles. In line with this perspective, we anticipate that the projects when connected to external clients make available activities or resources to guide learning efforts and facilitate scaffolding of the students' cognitive processes. In this immersive learning environment, we make available expert feedback, rigorous design models and design innovation processes, therefore allowing students to make systematic inquiries, explore successful models and network with expert clients.

## 6. Conclusions

In this paper we review research on open innovation and open organizing [26] to show how working, learning and innovation are intertwined [7] in innovative organizations and how this balance is achieved. In our previous work we had looked at empirical evidence of open organizing [25–27] and here we outline advantages the can accrue from leveraging an open organizing mindset towards learning and suggest a couple of ways in which design education can benefit from this approach. We argue that the threefold link between work, learning and innovation can be actualized in the classroom by adopting an open learning perspective and by exposing students to workplace practices or activity systems of workplaces and encouraging peripheral participation in select community of practice. Learning itself, following this perspective, can be approached as a design challenge with the end goal of developing a socio-technical system that fosters cognitive development [37]. By integrating tailored tools into an information-ecology, interaction may be enhanced through the 'joint optimization' of the existing social and technical systems [35] and individual strengths may be magnified through the powers of the shared work and interests [20].

Informed by empirical findings of various field studies, we then formulate design activities and

foresee that, undergraduate students will immerse in a socio-technical environment and improve their metacognitive competencies through repeated explanation, scrutinizing, debate, and critique of their design. They will also get the opportunity to engage in activities such as planning designs, monitor comprehension, and perform self-evaluation of learning progress, as a group. Throughout this process they will be able to interaction with and learn from experts online and work collaboratively with others on problems. These online group interaction processes and collaborative tasks are strongly linked with enhancement of both knowledge and skills [39], and to student engagement in knowledge construction [38]. We anticipate that collaborative design activities with connections to virtual communities may accelerate sense-making in groups and foster co-construction of knowledge. Although we strongly believe in the open organizing model as a way to improve design education, we in no way disclaim the advantages of physical and embodied interaction in learning. Rather, we point towards a future where the formal/informal distinctions in education will gradually melt away leading to blended experiences that leverage the advantages of curriculum based classroom experiences and online communities. The crucial challenge for course developers is to balance the advantages and disadvantages of both forms of learning.

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