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Different by design

W. MIKE MARTIN,[1] RENATE FRUCHTER,[2] HUMBERTO CAVALLIN,[3] AND ANN HEYLIGHEN[4]

[1]College of Environmental Design, University of California, Berkeley, Berkeley, California, USA
[2]Project Based Learning Laboratory, Department of Civil and Environmental Engineering, Stanford University, Stanford, California, USA
[3]Escuelade Arquitectura, Recinto Río Piedras de la Universidad de Puerto Rico, San Juan, Puerto Rico
[4]Department of Architecture, Urbanism and Planning, Katholieke Universiteit Leuven, Leuven, The Netherlands

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Abstract

It is generally known that architectural practice relies heavily on the interactions between architects and other professionals. However, during their formal education, most students attending architecture schools, and engineering schools for that matter, get very little (if any) exposure to decision making in conditions that involve expertise and/or worldviews beyond those reflected and valued by their own discipline. In the past 10 years, a project-based learning initiative was developed between the University of California, Berkeley, and Stanford University in an international context involving several other universities around the world. Throughout this experience, we have identified several issues that have shown to be crucial to these interactions. This paper elaborates on three key issues: improvement of communication skills, empowerment through developing strategies of leadership, and recognition of own and others' worldviews. We also make the case to include experiential educational situations that can introduce these aspects into the academic curricula of architecture and engineering schools.

Keywords: Collaboration; Communication; Cooperation; Design Studio; Project-Based Learning

1. INTRODUCTION

Designing in architectural practice is essentially a social endeavor. To design and build an edifice requires communication and collaboration of people coming from different professional backgrounds, and not always sharing similar goals and/or worldviews (Cuff, 1992; Habraken, 2004).

Architectural and engineering education, however, have not consistently addressed this issue. Architects and engineers are usually socialized in academic environments where they grow intellectually isolated into the specific subdisciplinary field of design, without interaction with other bodies of knowledge from disciplines that can complement and impact their world views and build an understanding of the complexities of real-world projects.

In the case of architecture, the design studio culture has traditionally emphasized the value of the building as a final object, a goal for students to achieve, most of the time minimizing and consistently overlooking the role that process and social interaction play in shaping that object. In engineering, the problem-solving approach brought to the profession by the educational methods of technical rationality, make these professionals focus on problems in isolation of the social contexts in which these problems occur in real professional life (Schön, 1983, 1987).

Limited approaches have been implemented to cope with the disciplinary isolation and the need for developing team related skills. One of them has been the so-called dual degrees, in which students get academically exposed to more than one disciplinary field as part of the curriculum they have to follow, that is, as in the case of architecture and civil engineering dual degrees. However, these modalities have provided limited success in bridging the academic divide. Most of the time, the curricula in these programs have courses from both disciplines, that is, architecture and civil engineering. Nevertheless, they are often developed as parallel curricular tracks in which there is no interaction between the two programs and integration or systemic links between the knowledge of the disciplines, leaving the bridging up to the interests of either students or instructors.

In addition, professional associations, for example, licensing boards, have pushed for agendas that require practical training as a part of the educational process professionals have to complete before their registration. An example of

Reprint requests to: W. Mike Martin, College of Environmental Design, University of California, Berkeley, Department of Architecture, 232 Wurster Hall, MC 1800, Berkeley, CA 94720-1800, USA. E-mail: wmmartin@berkeley.edu

these initiatives is the Intern Development Program (IDP) design by the American Institute of Architects (AIA). In this program, participants must record 5600 h of their work and track it among 16 specific training areas. However, it has been accused of being a program disconnected from both academy and practice, and has been also criticized for becoming a lengthy process.

In a study about the demographics of the architectural profession in the United States (AIA, 2005), more than two-thirds of the respondents pointed out that they completed the IDP in 4 years or less. However, 14% of the respondents took 5 years to complete the IDP and 6% took more than 6 years to do so. This statistic can be significantly affected by factors such as gender; nearly twice as many males as females completed the IDP in less than 3 years and slightly more females than males did so in 4–6 years.

The present landscape clearly shows the need for establishing fruitful interactions between education and practice in building design, which have to be addressed creatively to bridge the disciplinary domains of the numerous stakeholders that participate in creating the built environment.

There are several experiences that had addressed the issue of learning to practice and/or from the practice. In the architectural design domain, William Mitchell pioneered courses in which architectural students learned about collaborative design by using digital tools. The Building Stories course at the University of California, Berkeley, in which architects, students, and young professionals produce case study research about professional practice in the San Francisco Bay area, is another example in which students are confronted with the practice in an academic environment. Both of these academic experiences, however, mainly involve students of architecture.

One other program worth mentioning is the "Clinic" at the Department of Engineering of Harvey Mudd College in California, which has already been successfully run for decades. This Clinic is a set of three-unit required courses for junior and senior engineering majors, and it is the centerpiece of the design and professional practice component of the engineering curriculum. In it, students work in project teams of four or five juniors and seniors, experiencing professional design and development projects for clients from industry, government, and the community (Clinic Handbook, 2006).

In this paper we introduce and discuss some relevant results regarding practice learning an academic setting, the project-based learning–architecture/engineering/construction (PBL-AEC) experience, in which the interactions between education and practice in building design are simulated by bringing together some of the typical participants found in real building projects.

2. LEARNING HOW TO DESIGN: THE DESIGN STUDIO EXPERIENCE

Design studios are probably the customary modality of education across almost all architecture schools, not only in the United States but also worldwide. This mostly homogeneous studio culture can be traced back to the educational model developed during the second half of the 19th century by the Parisian Ecole des Beaux Arts. Many Americans graduated from the Ecole, returned home, and brought back with them the philosophies of Beaux Arts to the first schools in the United States. Examples of these imports can be found in the original curricula of MIT and Columbia University's architecture programs, in particular, the approach to the teaching of architecture centered on the activities occurring in the design studio (Cuff, 1992; Koch et al., 2003).

In a typical design studio, a group of students are assigned to an instructor who provides mentorship. In most cases, this studio instructor is an architect (practitioner or not). Work in the design studios usually consists of problem solving in design situations, whereby the instructor provides the students with the conditions of the problematic situation and scaffolds their progress toward the resolution.

As the report produced by American Institute of Architecture Students (AIAS) on design culture points out (Koch et al., 2003),

> The design studio lies at the core of architectural education. In architecture schools, studio courses command the most credit hours, the largest workloads, the most intensive time commitment from educators and students, and supreme importance. Studio courses are intended as the point of integration for all other coursework and educational experiences.

However, this aspect of "integration" rarely takes place in the studio's dynamic. Cuff (1992) points out that architecture schools are places in which future architects learn not only to solve design challenges, but also what design challenges are about and what are reasonable resolutions to them. Through their learning processes, students in architecture schools learn that the object, that is, the product to be designed, is of capital value and the design process is mainly an individual operation in which clearly bounded design challenges have to be resolved in original/unique ways.

Cuff compares the emphasis architectural practice, education, and professional societies allocate regarding the nature of the problems they deal with, as shown in Table 1. Notice that the values pertaining to each dimension for any given domain can vary significantly.

According to Akin (2002), there are three types of weaknesses in design instruction regarding how design operates in the real world: motivational difficulties, insufficient instruction of the design process, and inefficiencies in learning. Because of the traditional focus on the product-based precedent in the design studio, Akin explains, students are often provided with little or no instruction on the process of design. For example, he points out that when analyzing design precedents in studio projects (Akin, 2002),

> [students] start by understanding its physical characteristics and from there they move on to abstracting the conceptual aspects of the design. Nowhere in this picture is there

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Table 1. *Comparative emphasis in design problems*

Dimension	Architecture Office	Academy	Professional Society
Design	In the balance	Master value	Balanced practice
Participants	Countless voices	Solo and duet	Architect at the helm
Dynamics	Uncertainty	Clarity	Manageable complexity
Product	Predictable building	Unpredictable design	Predictable services
Process	Open ended, circular	Open ended, circular	Linear sequence
Stakes	Significant to many	Significant to one	Significant to many

Adapted from Cuff (1992, p. 107).

> any room for analysis of the process. Unless for some unusual reason the process is manifested in the overt physical characteristics of the final design, such as in building failure cases, students are generally uninformed about the process of design . . . In the situational model of instruction, where the relevance of general design principles, or specific design solutions for that matter, hinge upon circumstance and chance, students are generally on their own to devise the means to get to the desirable end.

This lack of attention to the process while designing in the studio setting, exacerbated by the exaltation of individuals' creative work with little or no concern for the role other professionals or even peers play in actual design projects, ends by distorting the view students have of what building design takes in everyday practice (Thomas Fisher in Koch et al., 2003):

> Most of us were taught in school to think of ourselves as individualists and even encouraged to be iconoclasts. One result of that individualism is that it has accustomed us to think of ourselves as competitors, something more characteristic of a trade than a profession.

In those rare cases where collaboration between students is stimulated, it is usually constrained to the data collection that precedes the design phase, in which collaboration with other students is usually seen as something that hampers individuals' best ideas (Koch et al., 2003).

Because of these insufficiencies of design studio instruction, many educators in architecture question this modality as the unique way for learning what is required to become a designer. As Habraken (2004) poses it,

> In studio it is impossible to exercise distribution of design responsibility, or to deal with the sharing of values and qualities among designers, or to handle issues of change. Studio can no longer be the only format for teaching design. Other ways must be invented.

3. THE PBL EXPERIENCE

Considering the particular characteristics of a building project and the complexities involved in both the technical and the creative fields, the endeavor of designing a building requires the engagement of professionals coming from various knowledge areas and expertise levels in different stages of the project. As Cuff (1992) points out, these projects emerge from a collective action, a fundamental aspect of designing the built environment.

This aspect is seldom brought into the design studio education. Students rarely experience that the development of a building's design necessarily implies collaboration among the different stakeholders, and not only the work of an individual mastermind. As Rittel (1965) points out, the different actions, observations, and communications associated with the design work cost money, and people's net gain for cooperation is the difference between the value of the achieved solution and the cost of the design activity. This net gain has to be maximized by an adequate organization structure, and by suitable rules for choosing the actions of the participants.

To challenge both the disciplinary isolation approach and product-oriented education, in the context of technological innovation, the PBL Lab at the Civil and Environmental Engineering Department of Stanford University and the Department of Architecture at the University of California, Berkeley, have taken the initiative to team up architecture, structural engineering, and construction management students in a PBL environment (Fruchter, 2004). Through this PBL students participate in a learning experience that confronts them with cross-disciplinary interactions designed to emulate those taking place in the professional world.

The PBL experience is coordinated by Stanford University, and involves undergraduate and graduate students from Stanford, University of California, Berkeley, Georgia Institute of Technology, University of Wisconsin, California Polytechnic, San Luis Obispo, and University of Kansas in the United States; Manchester University and Strathclyde University in the United Kingdom; University of Ljibljana in Ljibljana, Slovenia; Bauhaus University in Germany; ETH Zürich and FHA Aargau in Switzerland; TU Delft in The Netherlands; KTH Stockholm and Chalmers University in Sweden; and Aoyama Gakuin University in Tokyo and Stanford Japan Center in Kyoto, Japan.

Teams of AEC management students work on a building project using Internet-based communication technologies to connect, collaborate, and interact in geographically distributed shared environments. Each AEC team has an owner representative whose responsibility is to set the budget, program, and context limitations as well as approve changes to the project. In addition, each team has an existing site and a user program for the building of approximately 30,000 ft^2. The building type has been in all cases an educational facility for a university campus. Faculty and practitioners supporting this effort act as mentors, each of them representing one of the three professional areas of expertise.

Students are organized in AEC teams, whose members interact remotely from their home universities in their countries of origin, say the architect at Berkeley, the structural engineer at Stanford, the construction manager at the TU Delft, and the apprentice at the Stanford Japan Center in Tokyo. Typically, students use wireless tablets or desktop computers. For three-dimensional computer-aided design (3-D CAD) designing tasks students use commercial applications such as CAD tools (e.g., AutoCAD, 3D Studio Max, Form Z), simulation tools (e.g., SAP2000, RISA), and costing and scheduling tools (e.g., 4DCAD, MS Project), as well as custom-designed collaboration technologies developed by the PBL Lab research team (Fruchter, 2003; Fruchter et al., 2003). Students perform the noncollocated communication tasks by using Instant Messaging, NetMeeting exchanging voice, video, and application sharing, in addition to sharing design, scheduling, and project cost applications using Web project group workspaces, and Web discussion forums.

4. WHAT IS LEARNED IN PBL?

Close to 100 team projects have been developed (at the time this paper is published) in this context by AEC student teams since the PBL-AEC course was established in 1993. The research component of this course has tracked the interactions produced by these teams, and produced several research projects ranging from the nature of the communicational issues to the development of technology to facilitate collaborative work (http://pbl.stanford.edu).

Obviously the main issue addressed by the PBL experience relates to collaboration. However, it is relevant to state a division between collaboration and other terms frequently used in describing practice of architecture. Doctors (2004) provides an important distinction:

> Collaboration is a cultural practice of two or more individuals working together on a task or project and is intrinsically a framework for the production, sharing, and contestation of knowledge . . . In architecture, the term is increasingly employed in practice and literature—the spirited discourse on networks and globalized practice of recent years has done much to popularize the term—though often used interchangeably and misleadingly with related terms such as coordination (a process of organizing sets of information into a cohesive whole), cooperation (an attitude about relationships), and communication (a mechanism for the exchange of knowledge or information). The use of the term in architecture tends to evidence little substantive consideration of its variable signification in the history of the profession, from the utopian Ruskinian interpretation of medieval-era trade guilds to its polemical challenge of the architect-hero paradigm.

There are many relevant aspects mentioned by the participants in the course regarding the several levels of learning they achieve through the PBL class, such as the awareness and appreciation of others' goals. However, and certainly connected to the type of challenges students must face in the class, a relevant amount of all aspects mentioned by them directly relates to the role of communication issues in their interaction.

5. REPORTING THE EXPERIENCE

The interactions studied for this paper have been part of the PBL Lab at Stanford, an initiative and vision launched in response to the need for imp roving and broadening engineering and architecture students' competence toward the new work settings in the professional practice of both architecture and engineering (Fruchter, 1999).

At the end of each PBL generation, students are asked as part of their final presentations to reflect on the evolution of their team process and report on what they considered their most important learning experiences in the context of the course. This study examines 54 of these self-reports, focusing on the communicational and interdisciplinary aspects pointed out by the students as relevant to the experience had through PBL. These self-reports were included in the final sets of MS PowerPoint slides for each team.

Based on the texts, we categorized the different reports and we selected those aspects that were more frequently mentioned. These most mentioned aspects pointed to three key issues faced during their interactions: group dynamics, communication, and disciplinary divisions.

5.1. Group dynamics

Within an organization—a collection of people collaborating in a division of labor to achieve a common purpose—individual members have to work as social instruments through which combined efforts enable to accomplish more than any one person could do alone (Shermerhorn et al., 1995). The organization's behavior and its success as a group are intimately intertwined with the way in which they choose or are imposed by someone to operate. As one PBL team poses it, in a building project "changes should occur collaboratively."

However, the structure of an organization can be shaped in several different ways. As Rittel (1965) points out, there are multiple alternatives, and it is also possible for one organization to be arranged in several ways at the same time, say hierarchically with respect to one aspect and teamlike regarding another.

In architectural design, the role of leadership practiced by the creator or master designer has been historically important. As Cuff (1992) points out, buildings that are recognized as excellent projects are designed by a few leaders and, sometimes, because of the collaborations of those leaders. When architects mention buildings that are important for their culture, the persona attached to them is an important part of the reference.

Design studios often emphasize the culture of the individual. Most of the time, students work on projects that do not involve any communication beyond the one required with their studio instructors. PBL courses show that learning to design in this manner is not incompatible with learning about the collaborative nature of architectural practice. Product-oriented architecture students consider that anything is worth sacrificing to achieve the object they want. This conviction has been consistently reinforced by the culture of the lone creator, the mythical Howard Roarke, fighting against an opposing world order to achieve his idealistic dreams.

The development of leadership in design teams can take several modalities. Several styles of leadership exist, ranging from authoritarian to participatory. It is hard to attach a single style of leadership to the success of organizations. In some successful groups, that is, those that Bennis (1997) calls Great Groups (i.e., Manhattan Project, Disney Studios, and Bauhaus), members tend to be organized in a collegial and nonhierarchical way. However, Bennis points out that all those groups also have in common the presence of a strong and visionary leader.

Holt (in Wagenknecht-Harte, 1989) introduces the term *cooperative process* to denote one type of organization in which all members cooperate to achieve the goal of a vision or leader. She exemplifies this type of organization by referring to people involved in landscape designing, an activity that requires the concert of various disciplines in which a team works altogether to achieve the vision of one of its members. The artist has a conceptual idea for placing a sculpture in a park, whereas the landscape architect and the engineer make it work.

Cuff's (1992) research on architectural practice validates this point. She positions herself as an advocate of collaborative work in an ideal sense. However, her research on successful (excellent) cases in architectural design revealed that, although collaboration was important for some of these projects, and even a teamlike sensibility bonded the central players who struggled together to create the excellent outcome, these individuals did not necessarily participate equally or collaboratively. Instead, important individuals played essential roles, and their talent and authority was reported to be crucial to the building's success.

All this relates to another important issue not only mentioned by the students but also consistently observed by the researchers involved in PBL: leadership. Leaders can offer incentives, persuade and reward members of the organization, using their power and/or charisma. Barnard (quoted in Ahrne, 1994) points out that sometimes there is a difference between what affiliates want to do and what they should do as part of an organization. Therefore, unless the individuals can be induced by someone to cooperate, collaboration will not take place. This is an important reason why leadership inside a group is important.

Our experience with PBL has shown that, in many cases, there is a typical way in which the relationship between architects and other professionals works. Architects produce the conceptual ideas of a building, whereas engineers and other professionals make them feasible. They work together with the architect to transform the vision into an exciting built environment that represents the integration of building systems and constructability aspects.

Leadership in PBL is therefore neither unique nor static. For successful teams, leadership is mostly plastic, dynamic, always changing throughout the project by shifting from one team member to another according to the challenges and needs for expertise in each different stage of the building's development.

5.2. Disciplinary divides

Additionally, the increasing division of work and knowledge that has taken place in the building industry and professional communities, for example, architectural practice, has also created the development of different value structures around each of the different participants in the project's creation. These different value structures represent what Cuff (1992) calls "stereovision."

About 45% percent of all facts mentioned by the PBL students pointed to this disciplinary and cross-disciplinary divide. Some of the aspects mentioned include the value of cross-disciplinary interaction early in the project, to optimize the decision making and the quality of the final solution, and the importance of recognizing each other's expertise and world views, to enhance the communication, develop trust, and better understand the cross-disciplinary goals.

These are some quotes from the students' self-reports:

> "At the core of our process there was the complementing of our skills, sharing points of view, and the development for a mutual concern for cross disciplinary problems."
> "It is needed a greater understanding of other disciplines."
> "No one is ever 'always right.' Ideas often come from outside your discipline."

The understanding of the other did not mean in any case the subrogation of the disciplinary expertise. On the contrary, this understanding enabled each team member to empower his or her position in front of the other disciplines. In most cases, this empowerment was expressed by the others' recognition of the importance of the particular discipline to achieve the common goal of producing the final project.

Professional practice as experienced by the PBL students requires negotiation and argumentation because of the different opinions, constraints, and criteria of those involved in the design process. In this way, students get acquainted to what Rittel (1972) calls symmetry of ignorance, that is, an understanding that no one member knows better than any other by virtue of experience or degree, and that all ideas and judgments are biased.

5.3. Communication

Analysis of the self-reports shows that 80% of the teams reported that the course was useful because it made them aware

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of those aspects connected to communicational or disciplinary issues associated with teamwork. Following are some quotes that reflect this aspect:

> "Having an open and continuous line of communication is imperative."
> "Changing the way you work and communicate with the architect and construction manager can yield huge advantages."
> "When you make a change make sure everyone knows *all* of its implications."
> "Making progress means: communication, communication, communication."

Fifty percent of the students' comments at the ending of the class directly addressed the acquisition of communication skills not only within their discipline, but also across disciplines. As a major element in their learning processes, students mention issues such as the need for assertiveness and agreement regarding communication protocols. Students emphasized that by the end of the course they gain awareness of their and the others' processes, and in many cases an appreciation of the role, goals, and constraints of the other disciplines that they were not aware of initially.

Important issues mentioned by the students concerned jargon specific to each profession, as well as the frequent misunderstanding when interacting across disciplines because of different meanings and world views of specific situations. It is known that several communication issues are present in the relationship between members of building design teams. Mainly, these issues have to do with the special jargon that architects use to refer to the characteristics of space (Schön, 1987; Cuff, 1992; Habraken, 2004). Designers may use a very particular language, in which meanings are fuzzily defined and learned both in academia (Wilson, 1996) and in professional practice. Usually, this poses difficulties when other team members, who have not been socialized as architectural designers, try to understand architects' arguments. Words and structures of values bias the communication among the members of the organization.

6. PBL VERSUS THE TRADITIONAL DESIGN STUDIO: LEARNING TO COMMUNICATE, COOPERATE, AND COLLABORATE ACROSS DISCIPLINES

As can be observed from the previously reported findings, the PBL experience empowers students by learning aspects of their and others' disciplines that are not typically learned as part of a traditional design studio curriculum. It presents students with required skills and situations that closely resemble scenarios design professionals face as part of their every day work.

Exposing students to PBL-like studio experiences can help them develop both the understanding and the skills required for a further professional practice. In situations like these, students can learn not only to work collaboratively but also about the values and goals pursued by other professionals involved in the development of building projects.

Real cooperation, however, cannot be nurtured in architectural designers unless their education presents them with the key aspects we have mentioned thus far: improvement of communication skills, empowerment through developing strategies of leadership, and recognition of own and others' world views and their impact on the decision making process in design.

Finally, a major belief that needs to be changed in the minds of both students and design studio instructors is that cooperation does not hinder creativity. In professional practice, in the nonacademic world, it is precisely not knowing how to carry out designers' ideas collaboratively that can really hinder the possibilities to develop truly innovative and successful projects. Issues of cooperation and collaboration are central to the success of excellent practice settings, both in terms of employee satisfaction and the degree of excellence of the resulting design artifacts.

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W. Mike Martin has been at University of California, Berkeley, for the past 14 years in the Architecture Department of the College of Environmental Design. He served as the Undergraduate Dean of the College of Environmental Design for 11 years and has recently completed a 3-year term as Chair of the department. His teaching and research focuses on the study of practice, collaborative design, work studies of practice, and storytelling as a means of knowledge transfer. Digital media is central to his process of representation of knowledge transfer from practice. He is a Fellow of the American Institute of Architects and a recipient of the 2005 AIA College of Fellows Latrobe Fellowship for Research. He served as President Elect of the San Francisco chapter of the AIA, and served as editor of *Architecture California* (AIACC). Dr. Martin received an Honorable Mention in the 2002 NCARB Prize for his work entitled "Building Stories: A Case Study Analysis of Practice." Current writings include "Fundamental Processes in Concurrent Design and Construction," "Progress Through Partnerships: The Changing Profession/Changing the Profession," and a book titled *Building Stories: A Case Study Approach to Practice.*

Renate Fruchter is the Founding Director of the Project Based Learning Laboratory (PBL Lab), Lecturer in the Department of Civil and Environmental Engineering, and Senior Research Engineer thrust leader of Collaboration Technologies at the Center for Integrated Facilities Engineering at Stanford University, which she joined in 1990. She received her Engineering Diploma from the Institute for Civil Engineering in Bucharest, Romania (1981) and MSc (1986) and PhD (1990) from Technion–Israel Institute of Technology. Dr. Fruchter leads a research group that develops collaboration technologies for cross-disciplinary, geographically distributed team work, and e-Learning. Her interests focus on research and development and deployment of collaboration technologies that include team building, synchronous and asynchronous knowledge capture, sharing and reuse, and mobile solutions for global teamwork and e-Learning. In addition, her research group studies the impact of technology on learning, team dynamics, and assessment. She is the leader and developer of the Computer Integrated Architecture/Engineering/Construction Global Teamwork course launched in 1993 at Stanford, which engages universities from Europe, Asia, and the United States.

Humberto Cavallin teaches courses on design and architectural theory in the School of Architecture at the University of Puerto Rico in Rio Piedras. He received his Architecture Diploma from UNET in Venezuela (1990), MSc in social psychology from the Universidad Central de Venezuela (1997), and PhD (2006) from the University of California, Berkeley. He joined the University of Puerto Rico in 2004. Dr. Cavallin's research interests include thinking and problem solving, particularly regarding the use of models for simulation and problem solving in design, as well as the study of the impact of tools, communication, and collaboration in the professional practice of design.

Ann Heylighen received her MSc (1996) and PhD (2000) degrees in architecture/engineering from the Katholieke Universiteit Leuven (Belgium), where she is now a Research Professor in the Architecture Department. She worked as a Postdoctoral Fellow at the Research Foundation–Flanders (FWO–Vlaanderen) at K.U. Leuven and as a Research Fellow in both the Center for Design Informatics at Harvard University and the Architecture Department at the University of California, Berkeley. Dr. Heylighen's main areas of research are design methods, theory and cognition in general, and the role of design experience in particular.

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