Industry Fellows

Bringing Professional Practice into the Classroom
DRAFT SUBMISSION

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ABSTRACT

The *Industry Fellows* project involves a practicing college or university faculty member and practicing industry professional (the *industry fellow*) in the joint curriculum review, planning and delivery of a course related to the professional's domain of expertise. *Working together exploits what each does best.* The faculty member brings a broad, theory-based understanding to the discipline, while the industry fellow brings knowledge gained from professional practice. The faculty member retains full responsibility for all academic aspects of the course: planning and writing the syllabus, developing the assignments and examinations, and assigning grades. The professional joins the faculty member in the classroom on a regular basis as a co-lecturer, interacts directly with the students, and evaluates a sample of the student work on an advisory basis. This model was successfully run in winter 2009, with the project leader collaborating with an interaction designer from Google on teaching a Human Computer Interaction course at the University of Washington, Tacoma (UWT). This paper describes the *Industry Fellows* model, its instantiation at UWT, and an evaluation of this instantiation.

Categories and Subject Descriptors

K.3.2 [**Computer and Information Science Education**]: Computer science education; K.3.2 [**Computer and Information Science Education**]: Information systems education; K.7.0 [**Occupations**]: General

General Terms

Human Factors

Keywords

Professional practice, industry/academic collaboration

1. THE ACADEMIA-INDUSTRY GAP

A recent study on Engineering Education from the Carnegie Foundation for the Advancement of Teaching concludes that "[I]f students are to be prepared to enter new-century engineering, the center of engineering education should be professional practice, integrating technical knowledge and skills of practice" [13]. But because of the fast pace at which technological change occurs and the practice-based nature of the software and information technology professions, teachers in these fields can become remote from the technologies, practices, and pragmatics associated with professional work as it is currently practiced in industry. Faculty may thus be limited to the extent to which they are able to teach their students the practices that students will use as professionals once they have completed their degree studies. Practicing computing professionals, on the other hand, have up-to-date technical knowledge of specific areas of software development, but their time commitments to their employer and lack of knowledge of teaching, classroom management, and curriculum development hinder their ability to be effective as teachers. As the authors of *How People Learn* state "[e]xpertise in a particular domain does not guarantee that one is good at helping others learn it" [1]. These differences in expertise between teachers and practitioners often result in gaps between the academic studies of computing students and the required practices that they will employ in professional settings. As one student remarks "A lot of the time in courses, I find myself asking 'how much of this stuff am I actually going to use[1].'"

2. SHRINKING THE GAP: THE *INDUSTRY FELLOWS MODEL*

The *Industry Fellows* model involves a community college or university faculty member and a practicing industry professional (the *industry fellow*) in the joint curriculum review, planning and delivery of a course related to the professional's

[1]This student quote and the others given in this proposal were obtained from a survey of students as part of the pilot evaluation described later in this paper.

domain of expertise. *Working together exploits what each does best.* The faculty member brings a broad, theory-based understanding to the discipline, while the industry fellow brings knowledge gained from professional practice. The faculty member retains full responsibility for all academic aspects of the course: planning and writing the syllabus, developing the assignments and examinations, and assigning grades. The professional aids the faculty member in reviewing the course curriculum, joins the faculty member in the classroom on a regular basis as a co-lecturer, interacts directly with the students, and evaluates a sample of the student work on an advisory basis. Targeted courses–whether from the community college or university–are those tied closely to professional practice using tangible representations of work, such as prototypes, storyboards, UML diagrams, and flow diagrams. These tangible representations serve both as externalizations of student thinking about the disciplinary knowledge in computing and information technology, and also to mediate the interaction between students, the teacher, and the practicing professional.

The *Industry Fellows* model is designed to satisfy three objectives:

1. Increase student learning of course material, motivation to attend classes, and engagement in the coursework.

2. Increase the knowledge of participating faculty members from community colleges and universities in current practice in disciplinary areas of computing and information technology.

3. Increase the knowledge of teaching-related skills (such as goal setting, managing work groups, and communicating ideas effectively) for participating professionals from the computing and information technology industry.

This paper is organized as follows. The next section provides an example of how the *Industry Fellows* model is enacted by describing a pilot running of it undertaken by the author in winter, 2009, includng an evaluation of its impact on students. A brief summary of the theoretical underpinnings of this project is presented, grounded in research on how people learn. The paper concludes with a summary of the model.

3. THE PILOT INSTANTIATION

The *Industry Fellows* model as just described was run as a pilot during the 10-week winter term, 2009[2]. The author, a professor at the University of Washington, Tacoma (UWT) paired with an Interaction Designer at Google to teach the Human-Computer Interaction course at UWT. The course involved a design project carried out by student teams using a human-centered design process. Students were engaged directly in user inquiry, ideation, brainstorming, sketching, prototyping, interface design, and user evaluation. Students delivered three project milestones, with the final milestone-a prototype, "envisionment video" demonstrating their prototype in use, and the results of usability tests-presented to an external panel of industry practitioners from Microsoft and Google.

[2]See `http://faculty.washington.edu/jtenenbg/courses/452/w09/` for course materials

The faculty/industry fellow pair met for three 3-hour planning sessions during summer 2008 and delivered the course January-March 2009. The faculty member handled generation of all of the documents and course materials, including writing the syllabus, assignments, project outline, and project documentation requirements. The course met twice weekly in sessions of two hours each, with the industry fellow attending one class session weekly. Approximately half of each class session attended by the industry fellow focused on critiques of student work for their term-length group projects, with the other half of each session devoted to presentations by the industry fellow and discussion with students of case studies and artifacts derived from his past professional work. The industry fellow also arranged the external industry panel for the final presentations through his professional network. On the class sessions when the industry fellow did not attend class, the sessions were devoted to discussions of the course readings, monitoring groupwork, and practicing the methods that would be used on the project, such as contextual inquiry, observations, prototyping, and design brainstorming.

As an example, week 6 of the course was centered on design representations such as wireframes and storyboards, and the basics of interface design. During the first class session of the week (without the industry fellow), students carried out a heuristic analysis of student-chosen websites in small groups, based on the interface design principles discussed in their associated readings. There was also discussion on the requirements for the second project milestone (due in one week), and how design is fundamentally concerned with wicked problems [10]. In the second session of the week two days later, the industry fellow discussed example wireframes and storyboards that he had used in previous projects. In addition, students demonstrated current versions of their prototypes to get early feedback from one another, the instructor, and the industry fellow.

3.1 Evaluation of the Pilot

The industry fellow reported two distinct benefits of participation. The first was in the realization of his goal for participating in the partnership: to directly influence the education of future software developers, to "make it better" in his words. In addition, he commented on his deeper appreciation of the complexity and demands of being a teacher in the university setting, particularly the number of interlocking decisions that need to be made about task setting, the management of student groups, and instructional design. As a result of working with the industry fellow, the participating faculty member reported significant learning gains in the subject area. In addition, by attending to the kinds of comments that the industry fellow made in critiquing student work, the faculty member also learned more about how to apprentice students into the key practices associated with HCI. Additional discussion from the faculty member's perspective can be found in [15].

The author also undertook an evaluation of the impact of the industry fellow on the student experience in the HCI course using a survey with both constrained-choice and short answer questions. The survey was administered electronically and was completed the last day of the academic term. Ten of the twelve enrolled students in the course completed the survey. On a 5-level Likert scale (strongly positive, positive, neutral, negative, strongly negative), students were asked to indicate how the participation of the industry fellow impacted several aspects of the course. No students indicated negative impact on any items. 9 of 10 indicated positive or strongly positive impact on *motivation to do coursework*, 8 of 10 indicated positive or strongly positive impact on *motivation to attend class session*, 7 of 10 indicated positive or strongly positive impact on *engagement in the course activities*, and all 10 students indicated a positive or strongly positive impact on *learning the course material*.

Two short-response questions were also asked: "Compared to other courses in the Institute of Technology at UW Tacoma, what difference did it make having the industry fellow as part of the teaching team?" and "How has interaction with the industry fellow affected the design and execution of your final project?" All ten students made some response to each of these questions. A few themes predominated: *legitimization of the course material*, *connecting the classroom to the "real world"*, *a higher standard of performance was required as well as enabled*, and *students value both academic knowledge and practical knowledge*. Each is described in turn.

Legitimization of the course material

The presence of the industry fellow conveyed the sense to students that what they were working on was not simply an academic exercise. "[The industry fellow's] presence helped us to think of our project as serious work rather than a practice exercise that simply simulated the real work. I think this encouraged us to think more deeply about the problems we faced rather than simply grasping at 'good enough' answers." "The biggest thing he did for the course was to validate how important HCI is for the technology community." "Having an industry fellow in the classroom provided validation that what was being taught could actually be used in the industry that we plan to (or already) work in. In turn, I think this increased the level of attention in class to everything that was being discussed."

Connecting the classroom to the "real world"

Students indicated that they often fail to see the connection between what they study in the classroom and how to apply it in practice, or even if they will ever user it in a professional setting. Students also commented on the increased sense of authenticity of the work that they were carrying out. "A lot of the time in courses, I find myself asking 'how much of this stuff am I actually going to use,' and come with an answer myself. Having and [sic] industry fellow present to clear up any ambiguity to this question helps a lot." "The industry fellow gave the design and execution of our project a real 'professional' feeling. It made the project feel like a REAL project, instead of just another assignment. It helped tie in some of the key concepts that we would need to learn and be conscious of for work outside of an academic setting."

A higher standard of performance was required as well as enabled

Students perceived that having a practicing professional in the room increased the level of scrutiny of their work as well as the level of performance expected, which increased their motivation to meet these expectations. But they also felt that his feedback and instruction increased the quality of what they were producing. "The feedback he was able to give us on our milestones was well-grounded, and the fact that he didn't hold his punches made us more determined to work hard." "He also pointed out some key design choices that we never would have thought about. If anything, [the industry fellow] was like a model of doing things right. Although we would probably never really meet his high expectations at this point, I know that our group was better off having seen a pro in action!" "I think that the input received from the industry fellow improved the quality of our final project." "I feel that since we were going to be presenting our project to an industry professional, we wanted to increase the quality of the project." "The industry fellow really added to the standards of the class. I personally had the feeling that without him it would have just been another difficult class. But because this person had a large amount of experience and offered up his knowledge, I felt that the demands and expectations for the class was much higher. I personally felt that knowing that he was going to work hard for us made me work harder for him and the class."

Students value both academic knowledge and practical knowledge

Students commented that the course combined types of knowledge, symbolized by having both a professor and an practitioner in the classroom. Having the industry perspective did not negate the academic knowledge, but helped contextualize and integrate it within a body of practical knowledge. "Having a representative from the industry provides a much needed alternate perspective. We have been able to get both the research and experimentation view alongside the practical hands on perspective." "There's an academic side to things and a practical, product-driven side. Normally, a professor is either an academic who has written many research papers or, and more rarely, and [sic] industry professional. In this class we got both. It really helped to have both broad readings and instruction as well as real-life examples." "Having [the industry fellow] around . . . provided an alternate perspective on a lot of issues, including some unexpected areas like the ethics [of] Interaction Design work."

In university-administered end of course evaluations, students in aggregate ranked the course in the 90-100th percentile ("among the best") of all courses that they have taken both in the department and at the university. They frequently mentioned the industry fellow in associated comments.

These results provide evidence that there is considerable value in the *Industry Fellows* program, but dissemination of this model will benefit from running it again and having additional expertise and externality on its evaluation. In addition, the replication of this model needs to be undertaken in different institutional contexts, in different subject matter, with different participants, in order to understand those factors which influence the success or failure of this intervention.

4. RESEARCH GROUNDING

The design of this model is informed by research on how people learn, particularly in technical disciplines. This research is clustered in the following three areas: learning as participation in communities of practice, the nature of expertise, and the transfer of professional practice into the classroom. Each is discussed in turn, along with implications for the project design.

4.1 Communities of Practice

Recent work in educational psychology and anthropology has shed light on the importance of cultural participation in human development and learning. Rogoff [11] summarizes this view by stating "people develop as participants in cultural communities. Their development can be understood only in light of the cultural practices and circumstances of their communities." Lave and Wenger [7] provide an elaboration of these concepts by arguing that much of learning occurs when people participate in communities of practitioners in specific settings. Newcomers to these communities start at the periphery, observing and making low-risk contributions, with expertise increasing with further participation and engagement. Hutchins [5] provides a similar account of the development of expertise onboard Navy ships, detailing the way in which novice shipmen are slowly incorporated into increasingly complex tasks and responsibilities through participation in coordinated activities with those more experienced. As he states "human cognition differs from the cognition of all other animals primarily because it is intrinsically a cultural phenomenon."

The implications of this perspective for the *Industry Fellows* project are twofold. First, it is important to recognize that computing faculty participate primarily in communities of practitioners in which the key practices relate to teaching and, at the university level, to undertaking research within an area of disciplinary specialization. Given the commitment of time and energy required to become proficient within these communities, college and university faculty are not (with the rare exception) also participants in a community of professional software developers and information technologists. This is not to denigrate the expertise that faculty develop, only to underscore that college and university faculty may be limited to the extent to which they are able to teach and socialize their students into the practices that students will use as professionals once they have completed their degree studies. But this is exactly the kind of teaching and socialization that the industry fellow can provide, since he or she will be a member of one or more professional communities in the computing and information technology fields.

4.2 The Nature of Expertise

There has been considerable research over the last two decades in cognitive science, education, and the sociology of science into the nature of expertise that provides insight into the different kinds of knowledge that faculty members and industry practitioners might have. In an important volume on expert reasoning [2], the authors provide evidence that experts in a variety of domains are able to build complex cognitive structures in which to encode knowledge about their domain so that it is accessible for skilled action. Experts also have *adaptive expertise*, the ability to be flexible and adaptive in new situations [1]. And, when "[c]onfronted with complex problems, experts can assess the complexity in ways that enable them to bring their knowledge and experience to bear quickly and efficiently" [13].

Schön's [12] studies of professional practitioners in the design professions indicates that much of this expert knowledge is tacit. That is, expert skill is often embodied in practice within specific settings, yet the practitioner may have little explicit access to their expertise in a form that is amenable to linguistic analysis or transfer. Schön calls this *knowing-in-action*: "I shall use knowing-in-action to refer to the sorts of know-how we reveal in our intelligent action . . . We reveal it by our spontaneous, skillful execution of the performance; and we are characteristically unable to make it verbally explicit." Collins [3] also emphasizes that a considerable amount of technical knowledge and skill is tacit, and can only be learned through direct face-to-face contact. The *Industry Fellows* model ensures this face-to-face contact between students and the industry fellow directly in the classroom. The industry professional's tacit knowledge is made visible through presentation and discussion of representations drawn from their own professional practice. And this tacit knowledge is learned by students through the industry fellow's critique of student-generated representations of domain knowledge, a hallmark of studio-based learning models [9, 6]. This mode of interaction is supported by research on learning. As Sheppard et al. [13] state "[t]he best learning happens as experts model performance in such a way that learners can imitate the performance. And this process is greatly facilitated if the experts provide feedback to learners about their performance."

The kinds of knowledge that comprise teaching expertise have received study during the last decades. Shulman [14] discusses content knowledge about the domain as being a key component of expertise, which is increasingly recognized as a necessary aspect to teaching within a domain [1]. And this is the area of teaching to which industry fellows will significantly contribute, since their content knowledge is quite deep. But teachers also possess considerable *pedagogical content knowledge* about the courses that they teach, which Shulman describes as "the most useful forms of representation of those ideas, the most powerful analogies, illustrations, examples, explanations, and demonstrations-in a word, the ways of representing and formulating the subject that make it comprehensible to others." And finally, teachers develop considerable "local" knowledge [4] about the context in which they teach, about such things as the resources available within their universities and classrooms, the frequency and duration of class sessions, the topics that must be covered in particular courses, the level preparation of the students, the availability of labs, tutors, and peer mentors for the students, to name just a few. So although industry practitioners have considerable content knowledge, often far exceeding that of their faculty counterparts, they lack the pedagogical content knowledge and the local knowledge to ensure success were they to teach alone in the classroom.

Because of skilled yet tacit performance by both teachers and industry fellows, it is crucial that they both be in the classroom together, interacting directly with students and the artifacts that students create. Both will contribute content knowledge, with specialized knowledge coming from the industry fellow. But the pedagogical content knowledge and local knowledge of the faculty member will be critical to ensure that the industry fellow's content knowledge can be leveraged. By working face-to-face, each will learn some of the deep tacit knowledge possessed by the other, exactly as was observed between the faculty member and the industry fellow in the pilot instantiation of this project.

4.3 Professional Practice in the Classroom

It has become clear to policy setting and advisory bodies that faculty and professional practitioners need to cooperate more closely in educating the next generation. Both the National Research Council, in their report *How People Learn* and the Carnegie Foundation's *Preparation for the Professions Program* "stress the need for ... teachers to work with practicing professionals as they create robust strategies for teaching and learning in the various professional disciplines" [8], with similar sentiments echoed by the National Academy of Engineering [8].

A recent large scale study of 11 mechanical and electrical engineering programs at 6 engineering schools was undertaken under the sponsorship of the Carnegie Foundation for the Advancement of Teaching [13]. Their key result is that in order to educate the engineer of the 21st century, *education must be centered on professional practice*. As such "faculty need to make clear what expert practice looks like, modeling or otherwise making visible both thinking and doing." One important avenue for doing so is for "engineering educators [to] engage practitioners from business, industry, and government. Practitioners can . . . also work with faculty to help bring approximations of professional practice into the classroom." With its direct interaction between students and practicing professionals, the *Industry Fellows* begins to realize these research-based recommendations.

The *Industry Fellows* model is novel, drawing inspiration from but also distinct from past attempts to link practitioners and academics. Industry advisory boards can provide important input into curricula, yet are divorced from the classroom, most commonly operating at a programmatic level. Guest speakers from industry provide students a window into the world of work; yet speakers have no opportunity to provide feedback to students on their work, and they rarely understand the context of specific academic settings. Industry professionals moonlighting as part-time teachers can be an important addition to an academic department. They have deep content knowledge and a keen awareness of one or more specific work settings. Yet, as discussed above, they do not have the pedagogical content knowledge that only comes from experience in teaching. Without significant contact with skilled teaching faculty, part-time teachers will improve as teachers only very slowly through their own trial and error. The *Industry Fellows* program thus complements all of these efforts to bring the classroom and professional practice into closer alignment, while at the same time having the potential to be extended to other STEM disciplines and diverse settings.

5. CONCLUSION

The *Industry Fellows* model is a novel approach to bridging the gap between academic coursework and professional practice. It is different from but complementary to guest speakers, industry advisory boards, and part-time teaching by industry professionals. Its power arises from leveraging the separate and overlapping expertise of professional teachers and computing professionals by placing them together in the classroom. Having a clear division of responsibilities exploits what each does best. The project is grounded in research on how people learn, and implements recent proposals to connect professional practitioners with educators in the engineering professions. It is directed toward changing students' conceptions and perceptions of the value of coursework and its link to professional practice, faculty learning disciplinary practices and skills from industry professionals, and the learning of transferable skills in teaching by industry professionals that they can apply to training and mentoring in the workplace. The model has been instantiated in an HCI course at UW Tacoma with an industry fellow from Google. An evaluation of this course indicates a positive impact of the industry fellow's participation on student learning and motivation.

This model begins to fulfill one of the key aspirations stated by the National Academy of Engineering in their recent report *The Engineer of 2020: Visions of Engineering in the New Century* [8]: "It is our aspiration that engineering educators and practicing engineers together undertake a proactive effort to prepare engineering education to address the technology and societal challenges and opportunities of the future."

6. ACKNOWLEDGMENTS

I am grateful to Beth Simon for a critical reading of an earlier draft of this paper. Jessica Yellin also provided a critical reading, along with several important references to the literature, for which I am grateful. Thanks as well to Yi Chen for help with the evaluation. Thanks to Adam Barker of Google for his participation as the first industry fellow. And many thanks to the students in the HCI course at the Institute of Technology for their engagement during the quarter in which Adam and I worked together on this course.

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