Moving From Chaos to Socially Aware Technology Design: Reflections on the Courtship of Theory and Praxis[1]

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> *For feminists, the practical problems we face in our lives become the basis for our study, and consequently our theories. We use theory to make the problems we experience in our lives coherent.*
>
> (Hartsock 1975, in Balka 1991: 283)

Abstract

In this paper I describe a course designed to teach students about bringing social values to bear on the design and implementation of technology. The course attempts to bring a 'science, technology and society' (STS) perspective to those interested in the development and implementation of technology. Here I outline the course content, pedagogical methods employed in course delivery, and discuss the challenges inherent to supporting interdisciplinary learning through a problem-based curriculum.

Introduction

In this paper I describe a course developed to teach undergraduate students about incorporating social values into the process of designing technology. A brief description of the context that gave rise to the development of the course is followed by an overview of the content of the course and the pedagogical methods used in the course's delivery. Strengths and weaknesses of the course are discussed through an examination of student comments from course evaluations, and through personal reflections. I argue that bridging theory and praxis in a cross-disciplinary university setting is a challenging undertaking that often leaves students ill at ease, but ultimately contributes to the development of skills that will foster socially aware technology design.

Overview of the course

Background

As has been true for many scholars whose interests lie within science, technology and society studies (STS), a consistent interest in technology and society (in my case, with a focus on women) found me traversing multiple disciplines at a relatively early stage in my career. My exploration of STS issues through the completion of my MA had focused on identifying the effects of technological change on women, and the development of educational strategies aimed at ameliorating adverse effects of technological change experienced by women. As a doctoral student my research focused on documenting how social biases were reflected in technology design, and how these biases influenced women's on-line communication (Balka 1992, 1993, 1997). My subsequent work was increasingly anchored in ideas about the social bias of machine design and the mechanisms through which technology is socially shaped.

The course discussed here emerged from a major research project concerned with end user engagement in technology design.[2] As my work progressed on that project I increasingly engaged in professional debates with colleagues whose work bridged social sciences (anthropology and sociology) and computing sciences (computer supported cooperative work, human computer interaction), and whose work rested (either implicitly or explicitly) on theoretical debates concerned with science, technology and society studies (actor network theory, labour process theory, political economy, etc.).

Having begun my career as a women's studies professor, opportunities to teach courses concerned with technology and social change had been rare. With a move to Simon Fraser University's School of Communication I was keen to teach about technology and social change, and, as a new faculty member, I had an opportunity to develop new courses. As I increasingly spent time in multidisciplinary professional contexts, my interest in bringing a critical perspective about technology design to computer scientists and engineers grew at the same time that I increasingly became aware of the contributions that those trained in critical communication studies could make to technology design.[3] Although Simon Fraser

University's School of Communication sits, at best, uneasily in the Faculty of Applied Sciences,[4] for me this administrative association with the Schools of Engineering, Computer Science and Kiniesiology presented a unique opportunity to bring a more critical perspective about technology design to those who ultimately would be responsible for it.

Rationale for the course

The course I developed, called *Communication and Social Issues in Design* takes as its starting point the idea that social bias is incorporated in machine design—an idea often linked to the work of Noble (1979, 1984), which in turn builds on Braverman's now classic notion: 'technology, instead of simply producing social relations, is produced by the social relations represented by capital' (Braverman 1974: 20). In describing the development of technology Noble points out that there is always a range of possibilities or alternatives that are delimited over time. Some are selected while others are not, based on social choices of those with the power to choose. These choices reflect the 'intentions, ideology, social position, and relations with other people in society [...] technology bears the social 'imprint' of its authors' (Noble 1979: 19).

The idea that technology bears the social 'imprint' of its authors also served as a starting point for the research project that I was undertaking at the time, which sought to investigate the extent to which practitioners working within two technology design paradigms (participatory design and participatory ergonomics) took gender into account (or failed to take gender into account). Through both the theoretical investigations and field work I undertook as part of that project I became increasingly aware of how assumptions about the world shape design practice, and I sought a way to convey this awareness to students—I was no longer content to point out that social values influenced the design of technology as I had for many years, during which time much of my teaching and research had been concerned with documenting the impacts of technological change on women. Instead, I sought to create a course that would support the development of skills that would allow students to consciously engage in the social shaping of technology.[5]

Communication and Social Issues in Design was developed to meet four goals: (1) I wanted to help students develop an appreciation for how social values become embedded in technological systems; (2) I wanted to provide students with exposure to a variety of social issues related to the design and use of new information technologies (ranging from health and safety issues to the use of new information technologies by differently abled people); (3) I wanted to assist students in developing the skills to consciously address social issues in designing new technologies, and (4) I wanted to assist students in developing the skills to work with practitioners from other disciplines. Towards this end, the course was reviewed by undergraduate curriculum committees in the schools of Computer Science, Engineering Science and Kinesiology, and has been approved for credit in degree programs in each of these schools. It is recommended for communications students interested in technology and society; Kinesiology students in the human factors/ergonomics stream, and computer science and Engineering students interested in usability and the social implications of their work.

Content

Communication and Social Issues in Design explores social issues and values in designing technology through a focus on both the objects and processes of design. The course emphasises the identification of social issues and values that influence design, and communication between participants in the design process. Topics addressed in the course include:

- theoretical perspectives that inform the approach to design presented in the course;
- design as interdisciplinary communication and the design process as a social and communicative process;
- communicating across disciplinary boundaries;
- the use of representations in the design process;
- design, users and use;

- user involvement in the design process;
- situated work, skill and design;
- social responsibility, ethics and design;
- bias in design;
- the meaning of products;
- design and culture and cultural factors in design;
- design, sex and gender;
- ergonomic design;
- universal design (design to accommodate a broad range of users, especially the differently abled);
- environmental considerations in design and green design.

Course content is particularly concerned with understanding how people interact with technology (broadly defined) in a range of contexts, and how to anticipate the range of issues that arise when people and machines interact. The course strives to expand students' knowledge of human factors issues by exposing them to material about culture and technology, gender and technology, universal design (designing for people with disabilities) and other related topics. The course does not train someone to become an ergonomist, though it gives students exposure to ergonomics and will provide them with a problem-based arena in which to further develop those (and other) skills. The course weaves together theory and practice by introducing students to theory pertaining to several areas of technology design, and requiring students to apply theoretical concepts as they modify or design a technology. In all but the first year the course was offered, students have worked on a variety of real problems, experienced by community groups and small businesses.[6]

The following student comments about the course indicates how, for one student, the course fit into broader inquiries about technology and society.

> *Communications and Social Issues in Design is an amazing class that has provided me with the foundation for much of my interest in technology and*

> *technology studies. Unlike many classes available to communications students, this course provided me with practical knowledge about technology, which I was then able to use to understand much of the technologically mitigated world around me.*
>
> *By focusing on the design of technology specifically, {this course} effectively blew open the black box that shrouded much of my understanding around computers as well as other technologies, allowing me to see and understand technology in a new light.*

Format and delivery

As Graaff and Cowdroy (n.d.) point out, the specific format for problem-based learning classes varies considerably from one setting to the next. Typically, these courses involve small group learning. In some cases lectures are completely eliminated, while in other cases lectures occur in addition to problems. This is the format that has been adapted in *Communication and Social Issues in Design*, which follows a lecture and lab format. Students attend a two hour weekly lecture-discussion in a large group (35–40 students). In addition, smaller groups of students (typically 12–15 students) meet for two hours each week with a teaching assistant, in a lab setting. The course is built around the logic that lectures will give students exposure to theoretical issues while labs will lead them through the processes of applying theoretical issues introduced in lectures to technology design processes. This latter goal is accomplished through a series of lab exercises.

At the beginning of the course, students receive an outline that lists weekly readings and provides an overview of assignments, and a lab manual. In weekly lectures, students are introduced to theoretical material related to both social issues in design (e.g., bias and social responsibility in design; sex, gender and design; ergonomic and health and safety issues in design), and methodological and epistemological issues in the design process (e.g., the methodological implications of viewing technology use as situated). Throughout the course emphasis is placed on communication issues that arise in the design process (e.g., the use of different vocabularies by designers and users), their relationship to social issues (e.g., the gendered

nature of expertise), and methods that can be used to support the inclusion of groups typically excluded from design processes (e.g., participatory design).

As the student comment below indicates, the inclusion of lectures in conjunction with problem-based lab activities appeared to fill an important role:

> *As a course that centres on human-technology interaction, I enjoyed most the fact that the course took into account popular thoughts about technology from a range of disciplines aside from communications, including engineering, geography, industrial design and computer science. As a result, I felt that after {this course} I had the ability to view technology in a balanced light, learn about technology and technology issues on my own and perhaps most importantly, felt as though I had the confidence to engage in technical conversations about technology with people from a range of disciplines and backgrounds.*

The lab manual includes a series of exercises designed to introduce students to issues that arise in the design process (e.g., that designers often use their own experiences as a model for designing technologies), and to give students exposure to processes that they can utilise in consciously bringing social values to the design of technology. Students work in small groups of three or four in the lab setting. The labs provide students with an opportunity to engage in hands-on exercises related to their final project, as well as discuss assigned readings and lab exercises in greater detail than lectures permit. This format is intended to give students exposure to theoretical perspectives that will allow them to recognise the essentially social nature of design processes, as well as hands-on experience integrating theoretical material into design practice.

Lab exercises have two purposes: to lead students through steps that will assist them in developing a design, and to assist them in making decisions that occur during the design process (and especially the value basis of those decisions) explicit. Lab exercises largely build on one another, in the sense that students are expected to have completed one step prior to going on to the next. Many of the lab assignments refer back to processes completed in previous weeks. Lab exercises assist students in recognising

how their perceptions shape their designs; defining design problems and investigating user needs; establishing performance criteria for the emergent technology design; developing design briefs; building prototypes of designs; revising designs; evaluating and testing designs; and communicating proposed designs to interested parties.

Pedagogical approach

Course development was informed by my belief in the iterative relationship between theory and praxis, which emerged from my background in feminist theory, qualitative research, and from previous exposure to theorists such as Freire (1972) and Johnston (1979). Through the process of working on this paper, it became clear that the approach I adopted in the delivery of *Communication and Social Issues in Design* also has much in common with constructivist learning, and incorporates many aspects of problem-based learning. Each of these areas is addressed briefly below.

Links to feminist theory and popular education

The idea that theory and practice should be inextricably linked is central to feminism (Balka 1991). Since the emphasis in the early stages of the contemporary women's movement was on the personal, theory also grew out of personal experiences. Hartsock (1975) asserts that for feminists, theory is an articulation of what our practical activities have already shown us in reality. For feminists, the practical problems we face in our lives become the basis for our study, and consequently our theories. We use theory to make the problems we experience in our lives coherent. Political theory and political action do not occur in separate realms, but rather the concepts we employ in understanding the social world emerge from and are defined by our activities. Thus our practices as feminists derive from our theories, and our theories are derived from our experiences in the world. In structuring the lab component of the course I hoped to give students access to practical activities that could become a basis for critical reflection, and serve as a link for reflection about activities in

students' everyday lives (such as their own interactions with technologies at home and at work).

The iterative relationship of theory to praxis is also stressed within the qualitative research paradigm. For example, Marshall and Rossman (1989) have argued that the research cycle follows a circular path from theory to the construction of models, concepts and hypotheses that are tested in particular settings. Tools are developed, observations are made, data are collected and analysed, results are described and generalised into explanations, that form the basis for predictions, policies and practices (Marshall and Rossman 1989). Research both derives from existing theories and may, depending on the results, challenge existing theories.

Many (e.g. Hubbard 1979) have argued that the separation of theory from practice in the sciences has contributed to the now widely challenged notion that the production of scientific knowledge is value free, and completely independent of the end uses of research. One of my goals in teaching *Communication and Social Issues in Design* was to lead students through processes that would show them that the production of technology is not a value free process. Integrating theory and praxis was central to this goal. Reflecting these insights, a series of questions designed to encourage critical reflection about lab activities has been built into each of the lab exercises. In addition, throughout the semester as work progresses on student projects, students must re-visit the assumptions they had made at earlier stages in the design process, to evaluate whether or not their theoretical understandings have remained salient in the face of new data and fresh insights about their design problem.

Building on insights from popular education practices advocated by Friere (1972), Gelpi (1979) and feminist advocates of popular education (e.g. Griffin 1983; Thompson 1983), I hoped that the lab component of *Communication and Social Issues in Design* would assist students in developing 'really useful knowledge' (Johnson 1979)—real knowledge that served practical ends (Thompson 1983). For Johnson, really useful knowledge consisted of acquiring ideas concerning the conditions of life (Balka 1987). For Johnson, this would inform workers about how to get out of their present troubles. In the context of the course, I hoped to give students

skills that would allow them to exercise agency in relation to technological change, in their futures.

For Johnson (1979), a monopoly of either capital or knowledge was seen as an impediment to the process of developing really useful knowledge. The notion of challenging knowledge monopolies, which is central to Johnson's notion of really useful knowledge, implies a demystification of technology in settings where design of technology occurs. Thus, towards this end, the lab component of the course focuses on making the knowledge necessary to modify the design of technology accessible to a broad cross-section of learner-designer/end-users.

Like Friere's (1972) problem-posing education,[7] which is based on an analysis of banking education (which confines the student's scope of action to one of receiving, filing and storing educational deposits), and which advocates dialogue with students as a means of creating an environment that accommodates the discovery of true knowledge, Johnson's concept of really useful knowledge is anchored in the articulation and discussion of challenging and contradictory everyday experiences, by those who experience them. These ideas are also similar to the well known feminist insight that 'the personal is political', which legitimated the notion that one's personal experiences were an appropriate starting point for the analysis of larger political problems. Discussions during both the lecture and lab components of the course provide opportunities for discussion of everyday experiences, which, to my surprise, was met with mixed responses from students.

Links to constructivist approaches to education, problem-based learning approaches to education and reflective practice

Although I was not aware of it at the time that I initially developed the course, the approach taken in the course reflects the ideals of constructivist approaches to education, as well as problem-based learning. I discuss each of these approaches below, as theory and practical experience gleaned from problem-based learning, in particular, provides insights into some of the more challenging aspects of *Communication and Social Issues in Design*.

Constructivist learning suggests that learning is an active process in which learners construct new ideas or concepts based on their current or past knowledge. Often linked to both Piaget and Vygotsky, constructivism suggests that 'meaning is not given to us in our encounters, but it is given by us, constructed by us, each in our own way, according to how our understanding is currently organized' (Duckworth 1987: 112). Constructivism rejects decontextualised knowledge in favour of learning that occurs in whole experiences. Similar to Freire's (1972) pedagogical approach which advocates dialogue with students as a means of creating an environment that accommodates the discovery of true knowledge, constructivists advocate encouraging students to discover principles by themselves, which can occur, in part, through engagement in an active dialogue between instructor and student (Socratic learning).[8]

Constructivist notions of education are one of the building blocks of problem-based education (PBL), in which small groups of students work with the assistance of a faculty tutor to solve problems. The popularisation of problem-based learning is frequently traced to its use in the curriculum of Canada's McMaster University Medical School, in the 1960s (Neufeld and Barrows 1974; Barrows 2000). Responding to faculty observations that medical students seemed bored and dissatisfied with their educational experiences, basic science courses were seen as difficult and irrelevant hurdles to be overcome, and that there was too much emphasis on memorisation of quickly forgotten facts, resulted in the development of PBL.

Problem-based education is built on the notion that we build understanding largely through what we experience. Students learn by being presented with a problem they must solve. Typically, problems have no single, correct answer, which requires students to interpret the question, gather additional information, create possible solutions, evaluate options and present solutions. PBL reflects the notion that our greatest challenges often become our greatest learning experiences, and learning occurs in trying to solve the problem (Delisle 1997). A collaborative undertaking, PBL is characterised by peer-based social interaction that 'establishes the context in which shared cognition can occur' (Banta *et al.* 2000: 6). Such collaboration can help to ground knowledge in a 'community of practice'

(Lave and Wenger, 1991), and provides opportunities for modelling professional expertise associated with teamwork (Banta *et al.* 2000). Faidley *et al.* (2000) have suggested that through such interaction, a new level of self consciousness can occur, in which learners reflect on individual and collective activities during and after the construction of knowledge. This is similar to what Schon (1983) has called 'reflection in action'. Schon suggested that it is important to reflect on what you are doing as part of the learning process, as the capacity to reflect both on one's action and 'in action' (while doing something) results in a process of continuous learning, characteristic of professional practice.

Problem-based learning also finds support in insights outlined in Lave and Wenger's (1991) notion of situated learning. Lave and Wenger have argued that learning is normally a function of the activity, context and culture in which it occurs. Social interaction allows learners to become involved in a community of practice, through which beliefs and behaviours become embodied and are acquired. Lave and Wenger's insights suggest that knowledge must be presented in an authentic context, and that learning requires social interaction and collaboration.

Development of lab problems and structure of lab groups

Among the attributes of problems suited for a problem-based learning experience identified by Gallagher *et al.* (1992) are that the student assume the role of investigator; resolution of the problem requires the generation of additional questions by the student; the problem builds on or drives the student to a solid knowledge base; it has the potential to generate a variety of reasonable answers, rather than a single 'right answer'; the problem should be intriguing and socially relevant to the student; and the problem should become interdisciplinary when thoroughly pursued. Indeed, the nature of problems suited to problem-based learning closely parallels Buchanan's 'wicked problem' (Buchanan 1995), a concept that is introduced in an early assigned reading in the course.

In developing *Communication and Social Issues in Design*, my hope was that anchoring the class in real world problems and giving students a range of theoretical tools that offered social—rather than strictly

technical—explanations for those problems would provide students with the resources for developing an alternative explanation of some of the challenges in their lives, related to technology. Each time the course has been offered, students have been required to either re-design or invent technologies to address real world design problems. The lab section of the course provides students with a problem-based learning environment, while the weekly lectures give students exposure to theoretical material they are expected to utilise in solving their design problems.

In the first offering of the course, students were required to come up with their own technology design problem, and they were given the option of working either alone or in self-formed groups. This however proved problematic for many students, who were unaccustomed to thinking that technology could be designed differently than its current form. In addition, difficulties defining suitable design problems led to enormous flux in group composition in the first offering of the course. To address these problems, and as a means of incorporating a suggestion made by one of the departments that approved the course for credit within their curriculum, in subsequent offerings of the course students were placed in interdisciplinary groups of three or four after the first meeting of the course.[9] In both the second and third offerings of the course, students were presented with an array of real world problems they could choose amongst, as the focal point of their term work. Early in the term, students engaged in a lottery to determine which groups would work on which projects. Typically, the number of projects available to students exceeded the number of groups in the class. Project ideas emerged as a result of canvassing campus and community groups (e.g., the Aboriginal Student Society required a web page; the local FreeNet computer networking utility required a prototype for a computer terminal that could be used in low-security public places) prior to the start of the term.

Responses to the course

Here I discuss student responses to *Communication and Social Issues in Design*, which I then consider in relation to theory about problem-based

learning. I end the paper with a discussion about how the course might be altered in the future, in light of theoretical insights gained from a reading of the problem-based learning literature.

Student responses to Communication and Social Issues in Design

> *I am feeling a little uneasy about being in this course. I have talked to a few other people who feel the same way. I think I feel this way because I do not have any previous experience in design, but I am definitely interested in learning about it. Was this course designed with the assumption that the students taking it would have some design experience or knowledge?*
> E-mail message from student, early in the first offering of the course.

> *Hi Ellen,*
> *Just a note to say how much I've been enjoying the class. You have really reduced my anxiety over dealing with technology. Thank you!*
> E-mail message from student above, at the end of the first offering of the course.

Student responses to the course have generally been positive, and have consistently improved with each offering of the course. However, as an instructor, I remain dissatisfied with results from end of term student evaluations of the course.[10] The percentage of students giving the course an overall grade of an A or B has increased from half to two-thirds with subsequent offerings of the course. In addition, with each offering of the course, the percentage of students who rated the course content very valuable[11] has increased, to a high of 82% in the most recent offering of the course. Over time, student evaluation of several other factors has also improved. These have included fairness of assignments and the marking scheme, the degree to which the lectures and seminars were informative (74% in the most recent offering of the course), and the instructor's ability to communicate information. However, in spite of these improvements, student frustration with the course remains higher than I would like.

Although student evaluation of the course improved overall between the initial offering of the course and the most recent offering of the course, student views concerning the course also became more polarised. This is

consistent with course evaluation results reported by Liebelt,[12] who also found that students' comments about a problem-based course were quite polarised. Although many students appreciated the independent learning experience and creativity required by the course format, others felt the instructor had abdicated responsibility for teaching. Among those aspects of *Communication and Social Issues in Design* that have garnered polarised responses from students have been the reliance on personal experiences to illustrate theoretical points, and the degree to which continuity exists between lectures, labs and assignments. Each of these issues is discussed below in greater detail.

The use of personal experiences to illustrate theoretical points

The use of personal experiences to illustrate concepts in the lectures was, surprisingly, quite controversial. Several students clearly found my reliance on personal experiences helpful, as the following comments—collected in response to evaluation questions about the strengths and weaknesses of the course and professor—indicate:

> *Most helpful in understanding the issues discussed in the class was Ellen Balka's ability to drive home personal experiences in and around the design of technology. She highlighted many of the themes by discussing her experiences with technology, and by encouraging students to participate with their own understanding of technology and the way it affects their life and the society around them.*
> *Strengths: ability to find real life examples; talks about relevant issues/ applicable to real life. Very good at citing examples that go along with theory. One of the most useful classes I've taken. Ellen used real life examples to explain course theories.*
> *I really liked the open lecture style. All Ellen's personal anecdotes were very applicable to the course materials and helped me understand the material within the context of everyday life. Discussions in class were really cool because they involved the life of the class as well.*

Interestingly, one student suggested that personal experiences had been brought into the class far too much, but also identified relevant life stories as a strength of the instructor:

> *Brought own experiences into class FAR too much. Strong: passion for the subject material; relevant life stories.*

For some students, my explicit concern with social justice issues in general, and improvement of women's lives in particular, proved problematic, as the following comment suggests:

> *Gave time to marginalized perspectives at the expense of mainstream perspectives.*

Continuity of lectures, labs and assignments

Polarised student views concerning the use of personal experiences to illustrate theoretical concepts introduced in the course were also echoed in comments about the degree to which the course successfully integrated theory and practice. One student, responding to an end of term evaluation of the course described the course as:

> *A course that appears at first to be less than genuinely academic. I will probably take more into the real world from this course, than any other undergraduate course.*

Some students clearly felt the course successfully brought theory and practice together, as the comments below suggest:

> *Interesting material—I liked the blend between theory and practice.*
> *Strong: degree of hands on work. Strongest: learning steps in designing during labs.*
> *Related theories to practical solutions.*

As the following comment suggests however, the relation between the theoretical concepts introduced in lectures and the practical exercises introduced in labs was, for some, not clear until quite late in the term:

> *Lab assignments started to tie to lecture/project near the end, but in the beginning they seemed to be more of an 'aside' {...} fun things in design {...}.*

It appears that for some students, particularly during the first half of the course, lectures did not seem related to lab activities and assignments. For other students, the class seemed to lack cohesion, as the following student comments suggest:

> *Class could have been more cohesive and more focused on design, practical aspects and theory.*
> *Readings, lectures and labs did not have continuity.*
> *The course failed to complete the gap between the practical and theoretical areas.*
> *Should be more integration of theory into practical lab work.*
> *The course tries to do too much. There was too much theoretical material to cover, which we were expected to integrate into all our assignments, but we were not given enough time.*

For many students, two assignments, both due in the middle of the term, served as catalysts for the synthesis of course materials. A mid-term exam essay question that presents students with a scenario they must respond to encourages students to synthesise and apply concepts introduced in the first half of the course.[13] As Banta *et al.* (2000) suggest, such essay questions, though not without problems, are a frequently used means of assessment in PBL.

Workload and course difficulty

Students were most positive about the overall level of difficulty of the course the first year the course was offered. Interestingly, the quantity of readings and assignments was not increased after the first offering of the course—the most significant change between the first and second offering of the course was the requirement of group work. The workload was generally considered to be excessive, although, as the comment below indicates, this did not pose an insurmountable obstacle for all students:

> *This class was one of the few that held my interest right to the end. I really enjoyed it even with the heavy workload!*

> *The amount of readings was enough to be really challenging, but that is a good thing in my book. The structure of the class rewarded those who diligently read, which I like. The topics were really cool, and I wouldn't change a thing.*

In the second and third offering of the course (in which group work was required), student evaluation was based on a mix of individual assignments (such as an in-class mid-term) and group work (e.g., the final paper and design prototype). Although the mix of individual and group evaluation used in the course is consistent with evaluation strategies reported elsewhere (e.g. Liebelt), some have suggested that traditional exams should not be used to evaluate outcomes in PBL. However, it is generally recognised that individual exams allow one to identify what Liebelt (n.d.) has called 'passengers in project groups'. As the following comment suggests, students seemed to like this mix of individual and group evaluation:

> *I like the 50%/50% individual/group marking scheme. This way, individual effort is reflected in the mark as well as the efforts of the collective. There are too many classes that do not place so much weight on individual projects, and it is a sad thing that many people get away with letting other group members do all the work. I found the 354 marking scheme to be more fair.*

In spite of frustrations, for some the course was clearly a high point:

> *I learned so much in this class. Despite the difficulties, I can say that it was the best class I had ever taken, simply because I was so engaged in the material.*

Professorial reflections on Communication and Social Issues in Design

Efforts to understand the polarised nature of student evaluations of *Communications and Social Issues in Design* led me to literature about student reactions to problem-based learning. Student turmoil in PBL classes is a prominent enough feature to have gained mention in PBL literature. For example, Harris, Simons and Edwards (1998) reported that in a workplace setting that relied on PBL, learners reported '*being overwhelmed* at the enormity of the job and the amount of learning they felt they needed to

do' (p. 5, emphasis in original). Although Banta *et al.* (2000) suggest that PBL seems to increase class attendance and decrease student distress, my experience has been that stress seems to run high in delivery of a PBL class. Banta *et al.* also suggest that 'in the beginning, the learning curve for students schooled in traditional, positivist approaches is steep' (p. 6). Those students most adept at lecture-discussion and testing that requires primarily recall have the most difficult time adapting to a PBL course (Banta *et al.*).

Student responses to problem-based learning depends upon several factors, including the amount of prior experience students have had with PBL. As has been the case with *Communication and Social Issues in Design*, PBL is often tried in a piecemeal approach, where it is tried in some courses but not across an entire curriculum. Banta *et al.* (2000) suggest that in such settings, PBL does not receive a fair hearing. Initial exposure to PBL often produces enthusiasm. However, after a few weeks, students often 'become aware of their own deficiencies in thinking, problem-solving, teamwork skills, and self-directed learning skills',[14] and experience confusion and uncertainty, and often anger.[15] Bridges and Hallinger (1996) have suggested that instructors need to 'preserve the perspective that for students, being lost at sea is part of the journey; not far off, near the horizon, are calmer waters that lead towards the desired destination' (p. 58–59, cited in Banta *et al. 2000*). It has also been suggested that students require an ability to cope with ambiguity that arises from a lack of pre-determined objectives in problem-based learning.[16]

Savin-Baden (1998) has suggested that students in PBL settings pass through a number of stances or domains, which she described in relation to the 'Dimensions of Learner Experience' model.[17] She suggests that learners move through three different stances that operate simultaneously, and contain a number of discrete, but inter-related domains. As students move from one domain to another, they no longer see the previous domain in the same way. Progression through the domains requires learners to make sense of their current domain by reflecting upon the past domain and giving meaning to the learning that has taken place. This model sees learning as transitional, and is characterised by movement away from a learner's current way of understanding. Such transitional

learning occurs 'as a result of critical reflection upon shifts (transitions) that have taken place for the students personally (including viscerally) pedagogically and/or internationally' (Savin-Baden 1998a: 4).

Savin-Baden goes on to suggest that such transitional learning is often prompted by disjunction—a sense of fragmentation of part, or all of the self, characterised 'by frustration and confusion, and a loss of sense of self, which often results in anger and the need for right answers' (Savin-Baden 1998b, cited in Savin-Baden 1998a: 4). She (1998a) suggests that in problem-based learning, disjunction may occur because students may experience challenges to their life-world that are at odds with their current meaning systems, and which ultimately prompt transitions in their lives. Savin-Baden argues that the potential for disabling disjunction to occur is greater where PBL did not fit in with traditional institutions, where lecture-based learning is the dominant mode of instruction. Disabling disjunction appeared greatest when students were undertaking PBL as a component of a traditional academic program, as has been the case with *Communications and Social Issues in Design*.

Savin-Baden (1998a) outlines five aspects of a learner's personal stance, which are similar to Belenky *et al*. (1986) 'women's ways of knowing'.[18] PBL may lead to fragmentation, where a learner's sense of self and way of seeing and acting in the world are challenged. Savin-Baden (1998a) suggests that this can occur because learners are encouraged to assemble their own body of knowledge, and, in doing so, core aspects of their values and beliefs may be threatened through uncertainty. She suggests that students who come to know the world differently as a result of problem-based learning may emerge with an increased sense that it is possible to act upon, rather than be subject to, events in the world. In short, Savin-Baden suggests that successful PBL can lead students to believe they can effect social change.

Conclusion: Future directions

> *Communications and Social Issues in Design was an incredibly useful course to me. Though demanding and a lot of hard work, the course provided me*

> *with the foundation that I needed to be successful in a technology related industry, as well as in my general life. Ulti-mately the class gave me the foundation and confidence to work with a range of technologies and has provided me with essential skills that have allowed me to excel in my professional life.*
>
> *The course's practical element, the design of a solution to a technology related issue provided me with real-world experience in designing technology and forced me to think in new ways, for example accounting for differently-abled individuals. As a result, many of the techniques and considerations I was able to incorporate into the class, I still use today in my professional life as a software Product Manager.*
>
> Student comment, two years after completing *Communications and Social Issues in Design.*

The comments above suggest that *Communications and Social Issues in Design* has at least been a partial success in giving students an understanding of how social values become embedded in technological systems, and exposure to a variety of social issues related to the design and use of new information technologies. Students appear to be able to take the skills they develop in the course into industry, where those skills can be applied to technology design problems. The course appears to have been particularly successful in giving students the confidence to embark on technology design work with practitioners from other disciplines, though the majority of students who have thus far taken the course have not been educated as computer scientists or engineers.

Although I am generally pleased with the content of this course, as some comments on course evaluations suggest, the course can still be improved. Clearly workload has been a problem, as well as the pacing of assignments. Through continuing attention to student feedback, I am hopeful that this course will garner stronger student evaluations in the future. However, given the nature of the course (one student commented that 'it is impossible to just glide through this course'), it will likely continue to draw somewhat polarised responses from students.

Banta *et al.* (2000) point out that students may need assistance developing skills required for problem-based learning. Such skills

might include problem-solving skills, interpersonal skills, group process and self-assessment skills. Future offerings of the course could include a workshop at the onset of the course, intended to give students exposure to the skills that a problem-based course requires. In addition, provision of assigned readings outlining the goals and objectives of problem-based learning may serve to reduce discomfort associated with the course.

Banta *et al.* (2000) have suggested that because PBL represents diverse ways of knowing and learning, diverse methods of assessment should be utilised in assessing outcomes of PBL. The course would likely benefit from additional means of evaluation in the future, as the standard course evaluation instruments used to collect feedback about the course were not developed to assess courses that follow the model described here. As the comments from the student who reflected on the course two years after completing it suggests, additional insights about the value of the course might be gained by querying course graduates about the value of the course once they have had an opportunity to apply insights gained during the course, in their professional work.

Notes

1 This paper was written during my tenure as a fellow at the Institute for Advanced Studies on Science, Technology and Society, and presented at the Joint Workshop, sponsored by the Institute for Advanced Studies on Science, Technology and Society, Graz, Austria, the Inter-University Research Centre for Technology, Work and Culture (IFZ), Graz, Austria, and Virginia Polytechnical Institute and State University, Blacksburg, Virginia, USA. I am grateful for the intellectual and financial support provided by the Institute for Advanced Studies on Science, Technology and Society, that provided both the encouragement and financial support for the development of this paper.

2 The project, funded by Canada's Social Sciences and Humanities Research Council of Canada (grant # 410-95-0791), was titled 'Skill, Gender, and User Involvement in the Design Process: A Comparative Study of Participatory Design and Ergonomics'.

3 Communication as an area of study has been slow to fill what some have identified as a gap in scholarship related to the computerisation of work. See for example, Balka (2000) for a discussion of the historic ambivalence about technology in

Canadian communication studies, and Taylor, Groleau, Heaton and Van Every (2001) for an in-depth discussion of the contributions a communication perspective can make to studies of the computerisation of work.

4 Simon Fraser University's School of Communication has a significant orientation to the humanities (e.g. history of communication, communication and culture). The department also has strong roots in critical/left communication studies, particularly political economy. Salter (1988) has argued that although communication was concerned in the1980s with 'the historical development of technology, with how different technologies 'biased' not only information but also economic and social relations within any society' (Salter 1988: 26), and that there was an increased emphasis on technology in Canadian communication studies in 1987, (partly related to the movement of Simon Fraser University's communication department into the Faculty of Applied Sciences, and partly related to an emphasis on Habermas' work on technology), she also suggests that the emphasis on technology was not usually concerned with the technology itself. Instead, Canadian communication research tended to be concerned with regulatory and political aspects of technology as well as technology policy. Salter concluded that although the interest in technology within Canadian communication studies remained strong between 1980 and 1987, that the earlier emphasis on the role of technology in the production and distribution of information had been overshadowed by other areas of concern, and that technology was increasingly used as a synonym for the post-industrial era, or for the social and material configuration within society. See also Balka (2000) and Taylor *et al*. (2001).

5 It should be noted here that I have used the term 'social shaping' rather than 'social construction'. This is intended to reflect an important theoretical point that Wacjman (2000) makes about the difference between these two perspectives. She suggests that those whose work is engaged in a social shaping perspective are intentionally more political in their orientation to technology design.

6 In the first offering of the course, students were required to come up with their own technology problem requiring a design intervention, and they were permitted to work either individually or in groups. This proved particularly difficult for students who were unaccustomed to thinking critically about technology design. Many students were unable to settle on the focal point of their projects until quite late in the term, and project groups did not stabiles until late in the term (often as students were unable to realise their initial plans they sought an alliance with an existing project group). Both of these dynamics made project completion difficult. In subsequent offerings of the course, students were placed in interdisciplinary groups in the second week of the term, which partly reflected a request from one of the departments that approved the course for credit within its curriculum. The second year the course was offered, students were required

to work on a community based project. In the third offering of the course, students were given the option of working on a community based project presented to them, or coming up with their own project. The majority of students pursued projects presented to them.

7 Friere's (1972) problem-posing education is based on an analysis of banking education, which confines the student's scope of action to one of receiving, filing and storing educational deposits. While allowing students to become collectors of education, the banking approach to education is alienating because it does not encourage inquiry or reflection on one's conditions. Within the banking concept of education, teachers project an absolute ignorance onto others which Freire suggests is characteristic of the ideology of oppression (Freire 1972).

8 Constructivist theory, http://tip/psychology.org/bruner.html, (viewed June 1, 2001).

9 This was facilitated by a brief questionnaire, which asked students about their disciplinary backgrounds, interests, and about specific skill competencies (e.g. field research method background, programming or web page background, etc.).

10 At Simon Fraser University, all undergraduate courses are evaluated using a standard instrument that is largely quantitative. It addresses items such as student grade point average, the reason students enrolled in the course, how often students attended class, how difficult the course was, and evaluations of course content, the instructor and the course as a whole. In addition, students are given an opportunity to comment on the strengths and weaknesses of the instructor and the course.

11 Here students could rate the course on a five point scale from very valuable to not very valuable. In reporting results here, I have collapsed results into a three point scale, for ease of reporting.

12 Liebelt, n.d., 'Learning through design'. http://web.acue.adelside.edu.au/leap/focus/pbl/Liebelt.html.

13 For example, the following question was used in the first offering of the course: *After an article about your innovative approach to design appeared in the Vancouver Sun you received a call from management of Simon Fraser University, asking you if you would consider preparing a submission to the university about how you would approach the arduous task of redesigning SFU's telephone registration system. You have been told by Simon Fraser University that although they are interested in what you will do and what the design process will look like, that they are particularly interested in the theoretical rationale of your approach. You have been asked to include in your submission*

(1) a brief explanation of your view of the design process;

(2) key issues that your company will highlight in the design process, and a brief explanation of why these issues are important;

(3) a preliminary list of problems in the system, related, where possible to your substantial knowledge of design (course lectures, readings, and lab content).

You should place most of your emphasis on item no. 2, as this was the hook in the Sun article that resulted in your invitation to submit a proposal.

14 But how well do students like it? A case of assessing cognitive complexity. Student responses to problem-based learning at http://grian.com/pblpage/pbl9.html (viewed June 1, 2001).

15 It is suggested that anger results in part from feelings of incompetence related to the new forms of learning PBL requires. It is suggested that to a degree, anger can be alleviated in part by preparing students for it, even though (and this is consistent with my experience in *Communication and Social Issues in Design*), students will not believe you.

16 See 'Skills required for problem-based learning' at http://grian.com/pblpage/pbl6.html (viewed June 1, 2001), which cites handouts developed by D. Wood, presented at a workshop at the Faculty of Pharmacy, University of Toronto.

17 This model is similar in some sense to Belenky, Clinchy, Goldberger and Tarule's (1986) perspectives of knowing, which also suggests that learning is transitional, and can be characterised by movement from one stage to another. Belenky *et al's* model is outlined in *Women's Ways of Knowing*. See also Balka (1998).

18 Savin-Baden suggests there are five aspects of a learner's personal stance. These are fragmentation, discovery of self, definition of future self, placing oneself in relation to a life-world, and re-placing oneself: knowing the world differently. This typology is similar to Belenky *et al's* ways of knowing: silence (a position in which women 'experience themselves as mindless and voiceless and subject to the whims of external authority', p. 15); received knowledge (in which women view themselves as able to receive or even reproduce knowledge delivered to them by all-knowing external authorities, but remain unable to produce knowledge of their own), subjective knowledge (a state where women view truth and knowledge as personal, private and subjectively known or intuited), procedural knowledge, (women are interested in 'learning and applying objective procedures for obtaining and communicating knowledge', p. 15), and constructed knower, (where women view all knowledge as contextual and experience themselves as creators of knowledge). At this stage Belenky *et al.* suggest that women value both subjective and objective strategies of knowing.

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