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Making Technology a Major School Curriculum — Part 2

Jerry Streichler

An earlier statement on this topic (Streichler, 2002) took a provocative stance. It remains a matter of critical importance to all technology professionals (including engineers) and their organizations, all professionals in education, persons in business, industry, and government, and other concerned citizens. Since that first statement was published, ideas continued to be generated in support of the rationale and for implementation strategies. It was thought that these would be useful to respond to readers' inquiries or challenges.

Surprisingly, another very meaningful use for these ideas surfaced in the form of an invitation to give the keynote address at the New York State Technology Education Association's 41st Annual Conference this coming spring. The ideas being collected and the material in the first statement are strikingly appropriate to the conference theme: "Technology Education: A Core Subject." Thus far it has been pleasing to consider that the stimulating, challenging, and motivating ideas will be included in a presentation that will attempt to include uplifting and positive notions about the listeners' chosen profession and about themselves.

These ideas are offered as a sort of preview of a provocative and challenging issue. Obviously, they are not in the final presentation format and they provide more information than is likely to be in that presentation. The reader is invited to come along on this "trial run" for the keynote address. While this material can stand alone, some readers may wish to read the 2002 first statement. Also, even for those who have read it, revisiting *Technically Speaking: Why All Americans Need to Know About Technology* (Pearson & Young, 2002) will provide a meaningful context for what follows here.

The Importance of Technology Studies

That technology is an important school subject is partly confirmed by recent activities of engineering educators. Creighton (2002) described a number of "innovative" programs that engineering schools have gotten underway to get kids excited about engineering. This is only part of a much broader involvement in the lower schools by engineers.

The foregoing, an aspect of technology instruction and engineering's interest, represents recognition of the need to include technology experiences in the curriculum. Other components of technology could have been used to make the preceding point, but *engineering* is intentionally used as a device to capture the readers' attention and more will be said in this article about that technique.

Regardless of why the term has been used, it is emphasized that engineering is but one important component of the much broader kindergarten through college technology curriculum.

No Go?

Technology educators may be tempted to bask in the glow of recent impressive accomplishments and accept small successes of programs in some school systems and states while being resigned to the field's current status in many other states and school districts. Such an attitude may ensure that technology will never assume its rightful place in the majority of school offerings. In fact, that attitude may contribute to an unhealthy erosion of the progress the field has made.

In considering a militant and vigorous campaign to achieve the status that technology deserves, some may respond that this is not the time in the current socioeconomic and geopolitical scene in the United States. Ideas, charged words, and slogans may be invoked to justify inaction such as unemployment, outsourcing, dependency on foreign talent, dearth of citizens preparing for the scientific and technology professions, increasing productivity with minimum job creation, a presidential election campaign, national security needs, and the war on terrorism. Some or all could be used to rationalize the status quo for the technology curriculum.

Go!

The position here is much to the contrary. The circumstances that those words and phrases suggest may indeed be the foundation and rationale for:

- a militant, self-confident, dynamic posture for the technology curriculum and those who deliver it;
- assuming leadership in research and curriculum studies that deal with the issue of

inclusion of all subjects at all levels;

- making the case that technology studies makes a vital contribution to meeting human and societal needs and matters of national necessity at least equal to that achieved by the other so-called basic subject fields;
- taking the lead in an effort to revolutionize the entire public school curriculum, the college entrance examinations, and college entrance requirements; and
- asserting the leadership and professional skills that exist in state, regional, and national professional organizations, particularly as these issues are in their self-interest. (The International Technology Education Association has demonstrated considerable effectiveness in dealing with issues as discussed here in the past several years.)

Several steps need to be taken to get the job done, but before these are discussed, it is helpful to consider the forces that have influenced the current position of technology instruction in today's schools.

Changing the Playing Field

It is not an oversimplification that today's school curriculum has not changed much in the past 100 years. If that comment raises eyebrows, what will be the reaction to the notion that the 100-year-old curriculum of the lower schools, particularly of the high schools, echoes curriculum concepts out of the middle ages?

In itself, old is not bad, but this static, slow to change condition has profoundly resulted in stifling, rigid, unresponsive college entrance requirements, which in turn drive the curricula of the lower schools.

In part, that explains the existence of English (or language arts), mathematics, science, and social studies, sometimes referred to as "the Big Four," as the dominating elements of the existing curriculum.

Clearly, there is much to be done to change the situation. But first, it is helpful to consider the forces that have influenced the current position of the technology curriculum in today's schools.

Curriculum kings (barriers to curriculum reform) are persons who currently influence the curriculum and who technology educators must be able to identify. To a degree greater than they deserve, these are persons who have achieved success in one or more elements of the Big Four and believe that everyone ought to be required to experience it in the manner they had and ought to achieve the same level of success. So, when they become leaders in higher education or in school districts, or in other venues in society (such as politics), their values are invoked and are extremely difficult to change.

Influential universities, entrance requirements, and the college boards have positions and values that make them curriculum kings (dictators?) of a sort, but with an interesting twist. These folks fail to recognize that although the lower schools remain wed to the Big Four as a consequence of their dictates, the offerings of the nation's higher education institutions themselves evidence an impressive array of options. Many of these institutions now inventory courses and programs, and use names for colleges and departments that better respond to the changing nature of knowledge, technology, and the needs of society. The irony unfortunately is that a corresponding flexibility has not resulted, except perhaps at the community college level, in college entrance requirements. There seems to be no disposition to diminish the emphasis on the Big Four or to introduce alternatives to them for high school graduation, college entrance requirements, and the content of standardized college entrance examinations.

Can technology educators be their own worst enemies? Consider the effects upon fellow professionals from other disciplines when technology teachers engage in forms of promotion about their students' work and accomplishments. While pride in what they are doing with students is justified, is it possible that the way the promotion is done achieves just the opposite of what is intended? Might not fellow professionals who are comfortable about their subjects and place in the school curriculum wonder why that crowd in technology needs to engage in that sort of promotion? Consider, also, the possible negative effects when:

- the technology literature unintentionally promotes the difference between "academics" and technology subjects. Might persons outside the field then conclude that technology is inferior?
- it is proudly announced that technology helps students to succeed in mathematics and science. Do persons outside the field conclude that technology is only a helping experience and not a subject that should enjoy equal status with mathematics and science?
- technology educators exhibit "supplicant behavior." Throughout the discipline's history, and particularly in the current period of budget cuts and threats of program elimination, a great deal of time, energy, and effort is spent justifying the existence of technology offerings. What impression does that make when contrasted with the behavior of professionals who populate the Big Four whose status and stature precludes such behavior and who have rarely, if ever, needed to plead to have their subject recognized and respected?

A Think Tank (Can a Good Idea Come from USA Political Parties?)

There is a constellation of ongoing good works and efforts to improve and secure the place of technology subjects in the schools. Most are conventional in nature. Here are some thoughts and approaches that may be less conventional, but equally effective, in achieving the important goal.

George Lakoff (as cited in Powell, 2003) tells us that the Republicans have two think tanks and the Democrats have responded with one of their own. In part, they draw upon such disciplines as linguistics, cognitive science, and the neurosciences, in addition to political science.

A think tank for technology ought not be unthinkable. It could draw upon those same disciplines within an overlay of other education disciplines. It goes without saying that it should be supported by the broadest possible consortium of the professional associations devoted to technology education in all its manifestations—general and occupational education, from kindergarten through postdoctoral levels. Its overall purpose would be to establish technology in the schools as envisioned here and could undertake to:

1. Work with university programs to focus at least some of the research of technology PhD programs on:

- instructional techniques and curriculum organization for effective learning in shorter time (results may tell that technology can take an equal place in the curriculum with the other basics included in the Big Four);
- the efficacy, relevancy of the curriculum of the lower and higher schools in today's society (likely to be a lifelong challenge to technology education researchers);
- the efficacy of the existing curriculum array; and
- the effects of "selling" technology experiences as motivators for learning mathematics, science, and other subjects upon the image we wish to project.

No doubt some of these items will require longitudinal studies and, most desirably, research teams should include nationally known curriculum theorists.

2. Identify the most effective language (terms, slogans, concepts) that could be used to gain the acceptance of the public, political, and educational decision makers. For example, Republicans have effectively imprinted the notion of tax "relief" in the minds of most voters. With think tank help, they have concluded that the word *relief* denotes that there is a sort of an ailment that needs to be cured or remedied. Such notions, effectively communicated, become difficult to dislodge from a person's mind, and to do that it would take an equally effective and (emotional) concept. Aha…could that be the reason that *engineering* was used in preceding paragraphs of this statement? And if it worked, what would it take to make the term *technology* as or more attractive? So, the think tank could undertake considerations of the terms and concepts that technology educators would use to communicate the message about the importance oftechnology.

3. Formulate and deliver training. Effective use of language is only one of the possible aids that could come out of the think tank that would also translate its findings into training and strategies that deal with such items as:

- technology education and academics—what's the message when these terms are used?
- providing aid to state, regional, national professional organization leaders in proper and effective:
  - ✦ use language and terms;
  - ✦ ways to deal with bureaucrats and politicians (how to lobby effectively?); and
  - ✦ packaging and use of data and reports.

4. And, finally, the findings coming out of the think tank could well provide the proper and effective language to promote what "Leaders on Leadership," (2003) reports about M. James Bensen's use of the term *myth*. Successful organizations and movements have an underlying myth. This term is not used negatively. It connotes such things about an organization or of a curriculum movement, as in the case of technology, the purpose, the good, the benefits, the glow of the products. A think tank entity could provide advice to all members of the profession, from individual classroom teachers to professional organization leaders, on proper and effective behaviors and techniques:

- to make the case for technology or when technology offerings come under threat of reduction or extinction.

- that avoid the role of supplicant because such a role may confirm for decision makers that technology is inferior to the basic courses with which technology strives for equal status?
- to communicate that technology instruction:
  - ✦ manifests one of the most effective learning environments in the schools;
  - ✦ includes subject matter that responds to the nation's and individual needs;
  - ✦ maintains student interest to a high degree;
  - ✦ provides effective exploratory, problem-solving, and creativity experiences;
  - ✦ accentuates activity learning that effectively promotes content mastery;
  - ✦ achieves extraordinarily positive effects on students;
  - ✦ has highly motivating to students;
  - ✦ as one of the historically first to adapt and apply activity, continues to accentuate activity in an affective manner while encouraging creativity, problem solving and mastery of content knowledge and technological capabilities and skills;
  - ✦ is by its very nature a totally relevant subject (several ways to look at that); and
  - ✦ uses methods, historically original and unique, that other disciplines have adopted and adapted.

5. What are the things that can be embedded in the minds of citizens, politicians, and education bureaucrats and will work toward the establishment of the technology curriculum? Could it be *all* that good stuff enumerated above communicated within a theme with the following "charged" terms or concepts?

- Technology studies responds to a national need.
- Technology studies is equal to the other basics (Big Four?) such as social studies, mathematics, science, and English.
- Technology studies articulates to higher education programs in business, engineering, architecture, design, environmental studies, biotechnology, computer science, and technology in the same way, for example, that social studies articulates with higher education disciplines and majors as political science, sociology, psychology, government, and foreign affairs.
- Technology studies helps meet the United States' need for engineers and scientists and:
  - ✦ reduces need to import talent;
  - ✦ helps the nation to maintain its high rate of productivity in the global competitive market; and
  - ✦ plays a critical role in ensuring that all citizens understand the effects upon them and society of technology and technological change.

Members of the technology profession, particularly those responsible for delivering the program in the lower schools, are inheritors of a good doctrine of which they should be justly proud. With fellow technology professionals from other venues, and hopefully with the aid of the preceding ideas and suggestions, they will gain proper acceptance of their programs. And when that occurs, the citizens and the nation will benefit greatly and the school day will be much enriched for all.

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Supervisor's Perceptions of the Work Attitudes of Two Groups of Employees

Paul E. Brauchle and Md. Shafiqul Azam

The concept of *work ethic* relates to the desirable work attitudes, values, and habits expected from employees. Good work attitudes are often mentioned as attributes that employers want their employees to have, but these attributes are often hard to find. Even though various programs have attempted to address the problem, employers still complain that they are unable to find a dependable workforce (Hill & Petty, 1995). Studies conducted by Custer and Claiborne (1992, 1995) found that both vocational educators and employers gave more emphasis to employability skills than technical skills and basic skills. Employability skills or positive affective work attitudes are not job specific, but are skills that cut horizontally across all industries and vertically across all jobs from entry level to chief executive officer (Sherer & Eadie, 1987).

In the last three decades, attempts were made to identify affective work competencies and construct instruments to measure ethic/work attitudes (Kazanas, 1978; Beech, Kazanas, Sapco, Sisson, and List, 1978; Petty, Kazanas, and Eastman, 1981; Brauchle, Petty, & Morgan, 1983). Working on this line of research, Petty (as cited in Hill & Petty, 1995) identified 50 work ethic descriptors that in the end became the Occupational Work Ethic Inventory (OWEI).

Using a precursor to the OWEI, Brauchle (1979) studied the relationship between trainee and supervisor perceptions of trainee work attitudes. The results of this study suggested that self-perceptions of trainees' work attitudes did not match the perceptions of their supervisors. Using the OWEI, Minton (1997) found a significant difference between employers' expectations of work ethic and the self-perceived work ethic of secondary school students. In a recent study, Azam (2002) found significant differences between employees' self-perceived work attitudes and their work attitudes as rated by their supervisors. In the same study, significant differences in work attitudes were obtained between information and noninformation employees. However, there appears to be little or no research that focuses specifically on the differences between supervisors' perceptions of work attitudes of *information* and *noninformation* employees.

Information employees perform in jobs that are characterized by (a) comprehensive, open-ended tasks requiring high responsibility and critical thinking; (b) tasks that need little supervision and require active individual initiative; (c) tasks that require creative solutions to non-routine situations; deviations are handled by the lowest level of specialist; (d) continued improvement of performance is as important as completing tasks; and (e) integrated work processes; increased ownership of product and process by the individual (Law, Knuth, & Bergman, 1992).

Noninformation employees perform in jobs characterized by (a) narrowly defined tasks that require minor responsibility; (b) heavy supervision and passive order taking; (c) specific response to a limited number of possible problems with deviations from the norm handled by specialists; (d) task completion is more important than continued improvement of performance; and (e) specific tasks are independent of the purpose in the organization's overall operation (Law et al., 1992).

Research Design and Method

The purpose of this study was to investigate whether the type of job (i.e., information job versus noninformation job) had an effect on employee work attitudes as rated by their supervisors. In this study, the OWEI, a self-reporting type instrument, was used to record supervisors' responses on the work attitudes of information and noninformation employees. The OWEI is a 50-item instrument developed for measuring affective work attitudes using a 1 to 7 Likert-type scale. It has been found to be a highly reliable instrument that yielded Cronbach's coefficient alpha greater than 0.90 for various populations. In this study, 304 supervisor responses on information employee work attitudes and 277 supervisor responses on noninformation employee work attitudes were used. The number of responses was adequate to conduct a two-group MANOVA according to a prior power analysis (Azam, 2002).

Five test plans were worked out to compare supervisors' perceptions of information and noninformation employee work attitudes. The

MANOVA tested differences using the 50-item OWEI across the four factors (*Ambition, Dependability, Self-Control*, and *Teamwork*). Perceptions of work attitudes between information and noninformation employees were compared when their work attitudes were rated by their supervisors. The factor scores used were based on the above factors and were obtained by factor analyzing the combined responses of information and noninformation employees and their supervisors on the OWEI (Brauchle & Azam, in press). The test plans were designed with different combinations of dependent variables, the presence or absence of univariate outliers, and using transformed or untransformed scores.

The Kolmogorov-Smirnov test with Lillefore's correction was used to test for normality in the distributions. Because effect sizes given by SPSS output on the MANOVAs do not represent multivariate effect sizes, multivariate effect sizes (Mahalonobis Distance) were calculated based on the procedure given by Stevens (2002). Stevens suggested 0.25 as a small, 0.5 as a medium, and greater than 1 as a large effect size. The MANOVA results included commonly used test statistics (i.e., Pillai's trace, Hotelling's trace, Wilk's lambda, and Roy's largest root).

Results

Statistically significant differences were obtained between supervisors' perceptions of information employee and noninformation employee work attitudes in all of the five test plans. Two of the obtained effect sizes (Test Plans 2 & 3) correspond with Stevens' (2002) criteria for small effects. Other effect sizes met the criteria for large effects. The power obtained in each of the five tests was 1.0. The MANOVA results for each test plan yielded the same significance level for each of the four test statistics. In terms of descriptive statistics, the results also show that for 45 of the 50 OWEI items, the means of supervisors' ratings of information employees were higher than those for noninformation employees. In other words, the supervisors rated information employees higher on desirable work attitudes than noninformation employees.

Discussion

This study revealed that supervisors perceive differences in work attitudes between information and noninformation employees and that the supervisors rate information employees higher than noninformation employees on 45 out of 50 OWEI items. This result supports earlier findings by Azam (2002), who obtained differences in self-perceptions of work attitudes between information and noninformation employees. In that study, information employees rated themselves higher on 26 out of 50 OWEI items. Noninformation employees rated themselves higher on 23 OWEI items. For one item, there was a tie between information and noninformation employees and there may be various reasons for this.

One explanation may be that information employees inherently possess better work attitudes than noninformation employees. The results of this study and the previous study by Azam (2002) imply that this may be the answer because not only do information employees think they have better work attitudes than noninformation employees, but their supervisors agree.

Rater bias might also be a reason for higher work attitude scores of information employees. In a sense, supervisors and information employees can be treated as members of the same group. A basic characteristic of information employees is that they need little supervision. In other words, to some extent, they need to have the qualities of a supervisor, with such employee characteristics as high responsibility, critical thinking, and active individual initiative. In addition, supervisors may be more likely to be have been promoted from the information employee ranks than from the noninformation employee group. Thus, supervisors and information employees are more likely to be similar than supervisors and noninformation employees. Several studies (Duck, 1973; Huston, 1974; Kelley, 1979; Werner & Parmelee, 1979) reported positively biased performance ratings of subordinates by their supervisors when there were similarities between supervisors and subordinates (similarity of opinions, attitudes, and values; compatibility of roles; pastimes; motivation and other personality attributes; reciprocity of liking; socioeconomic status and biosocial attributes such as age, sex, ethnicity, and level of education). This similarity factor might be a reason for supervisors' higher rating of information employees on work attitude attributes.

It is possible that the lower supervisor ratings of noninformation employees on work attitude attributes are related to the nature of work that the noninformation employees perform. Narrowly defined jobs and limited responsibility provide little opportunity to display good work habits and attitudes that may draw attention from a supervisor. In other words, the job environment for noninformation employees probably does not provide much opportunity to display good work habits and attitudes, other than refraining from behavior that slows down production or affects quality.

Another reason for the relatively poor showing of noninformation employees may be that they work at jobs where exceptions (poor quality, product defects, accidents, time off task, inattention, etc.) are more readily visible and quicker to affect production than errors made by information employees. Because many supervisors still use the principle of exception (Certo, 2000), deviations from the norm seem more prominent to them in noninformation employees than information employees. Additionally, noninformation jobs are more likely to have a supervisor close at hand and may, therefore, notice any exception to desired performance. However, further investigation is needed to identify precisely why there is a difference in work attitudes between information and noninformation employees and why information employees are more likely to exhibit better work attitudes than noninformation employees.

Whatever the reason, it is clear that a new kind of employee, the information employee, is becoming more prominent in the workforce, and these employees are perceived differently by their supervisors than the more traditional noninformation employees. Because information and noninformation employees are different in so many ways, supervisors of the future may need a new skill set to properly manage both groups of workers. Research is needed to shed light on the reasons that supervisors perceive these two groups of workers differently, to determine whether these perceptions are based on real differences between the two types of workers or just the orientation of the supervisors, and to ascertain which skill sets are best used by supervisors in dealing with both groups of employees.

Dr. Brauchle is a professor of Technology, associate director of the Center of Mathematics, Science and Technology (CeMaST), and director of the Bureau of Training and Development at Illinois State University. He is co-trustee of Gamma Theta Chapter and holds the Epsilon Pi Tau Laureate Citation.

Md. Shafiqul Azam is a web developer for the Illinois Network of Child Care Resource and Referral Agencies.

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Portfolios: Conceptual Foundations and Functional Implications

Andreas Luescher and John W. Sinn

As is true at many institutions of higher learning, Bowling Green State University (BGSU) in Ohio is in the process of testing, rating, and adapting the portfolio as an addition to its arsenal of assessment tools with application to classroom, administrative, and professional development domains. The College of Technology at BGSU, in particular, has been exploring the nuts and bolts of portfolios with a focus on the transition of technical students to technical professionals.

Our thesis is that portfolios represent a heuristic methodology that yields a sensitive and adaptable indicator for the assessment of student development. The importance of marketing to academia cannot be ignored; even though many academics protest the corrupting influence of money on the purity of academic research, marketing is irrefutably as much a part of the academy as it is the world of commerce (Kliment, 1998). Because of the portfolio's dual existence as a marketing tool and as a matrix for intellectual exploration and reflection, it is increasingly relevant to the marketing aspect of academia.

In this article we address several important areas that combine to illuminate the portfolio as performance, index, and design. We provide an in-depth look at the conceptual foundation and selected functional implications of portfolios. Accordingly, the foundations laid here may serve as a basis for further development and application to a comprehensive application of the portfolio methodolgy.

Background and Definition

The portfolio simultaneously adheres to and defies the notion of an assessment tool. As a heuristic methodology, the portfolio offers opportunities for assessment of the work of oneself and of others in a context of professional and intellectual growth. This quality of heurism, or self-instruction, is at the core of the portfolio's uncomfortable residence in the world of assessment. It transcends disciplinary boundaries and developmental hierarchies in application, but it is a notoriously hard format to pin down or quantify. The strength and the weakness of the portfolio format is that it foregrounds qualities of experience. Portfolio methodology showcases mechanical and imaginative skills. By nature this methodology also leads to inquisitiveness about possibilities and tangents; it also brings up questions about chronology and authenticity. Instead of pursuing the psychological or philosophical implications of the portfolio as a performance medium, we concentrate on the portfolio as an ideology that places the value of individual work efforts within the greater context of learning to think, which benefits artists and technicians, undergraduates, and mid-career professionals alike (Seguin, 1991).

The portfolio model stands in opposition to a value system that favors the individual measured against his peers. This is the world of standardized or quantitative experience. Instead, the portfolio represents a value system which emphasizes that which is immeasurable: the qualities of experience. This distinction tempers all implications of the portfolio as an assessment tool. Goffman's *The Presentation of Self in Everyday Life*, originally published in 1959, explores the details of individual identity, group relations, the impact of environment, and the movement and interactive meaning of information. His perspective, though limited in scope, provides significant insight into the nature of social interaction and the psychology of the individual. The actor performs interactively in order to present a compelling front. This process, known as "dramatic realization," is predicated upon the activities of "impression management," the control (or lack of control) and communication of information through the performance.

Equally controversial is the portfolio's dual existence as a matrix for intellectual exploration and reflection and as a marketing tool; portfolios will increasingly be used, particularly due to relevant and purposeful direction, in an academic, professional, or personal career. As previously stated, marketing is as much a necessity in the academy as it is in the market. To the extent that portfolio assembly is concerned with the design and presentation of information, or "*impression management*," it can be seen as a corrupting factor, an insertion, or gloss obstructing the real or "authentic" evidence of knowledge possession (Goffman, 1959/1990). The question "Evidence of what?" comes from those who challenge the indices generated by standardized testing. What exactly is being measured: performance or possession? Does portfolio methodology tip the scales of assessment toward the form of information (interface, packaging, etc.) to the exclusion of its content? How adequately do portfolios straddle the blur between the qualitative and the interpretive?

Broadly represented in this article are several different types of portfolios including (a) a student portfolio: a show of accomplishments for a class; (b) a project portfolio: a documentary of project or independent study; (c) a personal portfolio: a scrapbook or collection of one's interests; (d) a professional portfolio: an organized collection of complex, performance-based evidence that indicates one's growth, goals, and current knowledge and skills needed to be competent in a role or area of expertise; and (e) a teaching portfolio: a selection of artifacts and reflective entries representing a teacher's professional experiences, teaching competencies, and growth over a period of time (Campbell & Brummett, 2002; Syre & Pesa, 2001).

Accordingly, our study supplies the following details as evidence that portfolios are a highly flexible instructional and assessment tool, adaptable to diverse curricula and administrative contexts.

Student Portfolio: Classroom and Administrative Uses

Questions surrounding portfolio implementation in the classroom since its introduction to the normative retinue in the 1980s are those of process and strategy. Ideally, the portfolio crosses diverse curricular settings. Students are challenged to take charge of their personal collection of work, reflect on what makes some work better, and use this information to make improvements in future work. The portfolio is a way for teachers to structure student involvement in developing and understanding criteria for good efforts, in coming to see the criteria as their own, and in applying the criteria to their own and other students' work (Campbell et al., 2000).

A decade of portfolio-specific research has shown that students benefit from an awareness of the processes and strategies involved in writing, solving a problem, researching a topic, analyzing information, or describing their own observations (Gardner, 1993). In building a portfolio of selected pieces and explaining the basis for their choices, students generate criteria for good work, with teacher and peer input.

Central to the importance of portfolio methodology is the idea of sensuality. It is the sensual appeal to the process of storing and retrieving information that distinguishes the portfolio as a didactic method. The portfolio is nothing so much as a mirror of the individual psyche. This leads to the central conflict surrounding the portfolio as an assessment methodology. Who "owns" the criteria? Who quantifies the assessment? Is it the individual performer or the audience?

Critics point to portfolio methodology as a symptom of *anomie* or loss of standards. Proponents of portfolio methodology point to a compromise between individual and societal requirements. In practical terms, "packaging" the component of portfolio, which asserts itself in ways that are uncomfortable to the notion of academic purity, questions whether the design of information supercedes and/or corrupts the authenticity of the information represented.

Our thesis is that the design and presentation of information—in other words, the emphasis on form—does not diminish the role of substance, skill, emotional content, worldview, or appropriateness. The principles of form are universal and immutable. They include compression, grasp of the essential, balance, and ideality. Form provides the spark without which content languishes. The portfolio as a methodology features the criteria of quality performance. The hope is that by engaging students in performance and critique they can apply these criteria to their own work and monitor their own progress, chronicling work and opening new channels for substantive communication.

Perhaps the key to the importance of portfolio methodology is the kinetic and haptic dimensions the process adds to understanding and self-awareness. Portfolios provide a vehicle for instruction focused on the processes and strategies underlying effective performance. They allow accomplishments and growth to be identified and assessed in a context well beyond traditional classrooms. In essence, portfolios are defined as selected performance. Beyond that, definitions vary widely in relation to content, purpose, and structural elements (Campbell et al., 2000).

Both inside and outside of schools, observers are uneasy about what role portfolios, commercial tests, and other assessment tools should play in administrative activities. Questions have centered on the technical adequacy of portfolios for administrative decision making and reporting. Are they comprehensive enough? Are they reliable enough? Are assessments generalizable within a specific curriculum area? Inasmuch as portfolios allow identification of areas of weakness, academic institutions can employ portfolios as a means of assessing their success at meeting institutional goals. Indeed, student portfolios are being used for institutional accountability reporting, program evaluation, and a variety of administrative decisions affecting the future of individual students. Are portfolio systems sufficiently informative and technically strong enough for these added functions? Also, what is involved in making them adequate to the structural and content requirements of accountability, evaluation, and student-level administrative decisions?

Again, the crucial questions center on "authenticity." Are portfolios merely evidence revamped to satisfy technical requirements? Or can they still play a constructive role in teaching for understanding? Can portfolios answer to all calls and still motivate students to be active learners? Can the portfolio format be standardized without losing its classroom application, which foregrounds the expansion of the individual students' setting of self vis-à-vis society?

The shift to administrative evaluation and to the education system, in other words, away from individual students, teachers, and classrooms, introduces a broader and less well-defined audience. While administrative uses of the portfolio require increasing standardization (and at least a partial shift in ownership), a student's sense of ownership of his or her portfolio is linked with interest, motivation, and actual engagement. Some compromise between centralized structure and local, classroom-level discretion may work just as well (Costantino & De Lorenzo, 2002).

Should there be unique courses to cover the redundancy at the heart of portfolio/self-reflective activities, and should this system exposure and control be integrated institutionally? The answer is yes. Furthermore, while a single course can—and should—be dedicated to the process of developing a portfolio, it is essential that subsequent courses reinforce the importance of adding to and refining one's portfolio materials. The portfolio model is a testament to the value of redundancy.

The Case for Portfolios, Added Definition, and Functional Approaches

The portfolio answers the requirements of an increasingly visual world as a visual document, but resumes and curriculum vitae have been the standard experimental summary in business and academia since the 1960s. Resumes and curriculum vitae were created at a time when informal networking and insider connections were suddenly inadequate as a delivery system for the numbers of new positions and applicants created by the postwar economic boom. Developed to efficiently compress pertinent information in a very particular way, resumes and curriculum vitae remain an essential career tool (Berryman, 1991, 1994; Porter, 2000). But the portfolio can be much more than a resume or collection of work.

Like professionals in any discipline, records of our activities accumulate in brief cases, file drawers, and Zip drives. It is from these various forms of documentation that we can extract a focused and coherent representation of our history. When applying for admission to graduate school, for tenure at a university, or when looking for a new position or freelance work, an applicant generally selects the finest examples to make the strongest case for his or her abilities and experience. Composed of good samples of past work presented in a clear, unambiguous, and accessible form, that document was a portfolio (Linton, 1996). The use of a portfolio goes beyond the mere collection of information as a cosmetic arrangement of loose pieces of work in a folder. The assembly of a portfolio is not merely about "looking good" (Scher, 1992); it is an essential documentary tool for anyone who does creative work in any field.

Building the portfolio falls into *source* and *mini* or *disposable* approaches. Source portfolios contain original (non-reproduced) work whose security should be protected; pieces might be selected from source portfolios to take to interviews. By contrast, mini or disposable portfolios made up of reproductions of original work represent the difference between *ephemera* and *accretion*. The mini or disposable portfolio is a mass-produced version. An abbreviated introduction to one's work, the mini or disposable portfolio is generally made up of examples that are easy and affordable to reproduce.

In the same way that the student portfolios are adapted from older forms of presentation, professional portfolios are similar to the traditional resume and curriculum vitae. As job titles continue to become obsolete and as hiring practices shift from permanent and full-time workers to independent contractors, temps, consultants, and freelancers, traditional formats may offer an insufficient summary of one's experience (Kimeldorf, 1997). A portfolio offers hard evidence of problem solving by graphically revealing both the direction and depth of one's experience. It answers the "show-me" demands of employers and is, therefore, an important technique of self-presentation. Unlike the resume or the curriculum vitae, the portfolio emphasizes the qualities of experience rather than the objects or names of experience. The portfolio goes beyond merely talking about a topic or entry to actually demonstrating the issue or item under discussion.

Creative professionals are likely to assemble several portfolios in the span of a career. A personal portfolio is required to enter graduate programs in many disciplines while a project portfolio can measure the quality and dimension of one's undergraduate study. As a career develops, a professional portfolio includes updated samples and projects in progress. A personal portfolio functions purely as a method of self-reflection, often evolving into a source of propulsion toward new endeavors that, given time, eventually evolve or overlap in professional activities.

Making the Portfolio Happen: Student-Based Concerns

Familiarizing students with virtual presentation via electronic portfolios will help them to better understand the phenomenon of synchronic practice over a distance as well as communication and display protocols unique to remote collaborations. But how should this be done? Should there be unique courses to cover such activities, or should the act of developing a portfolio be integrated into all that is done for professional preparation? The answer is simple—both. Although a course can, and should, be dedicated to the process of developing a portfolio, it is essential that subsequent courses reinforce the importance of adding to and refining one's portfolio materials.

Students must transpose original portfolio items into electronic files. Like the traditional portfolio, the electronic portfolio is a performance. Both types of portfolio establish a narrative that is concerned with the linear piecing together of continuous or disconnected images and events. In addition, both types require decisions about how much space and emphasis to give to each successive visual event in the presentation. But the electronic portfolio is a performance with different dimensions, quite literally, from the traditional portfolio. It must be carefully managed if the "message" of the medium (i.e., the linkages) is to enhance rather than diminish the original material, primarily due to issues raised earlier.

Because of the freer and more varied technologies of image manipulation that are available, designing electronic portfolios differs from designing the traditional portfolio. The addition of movement and sound can enhance the presentation, but it also means that more must be managed and understood in construction. Questions to be addressed instructionally include awareness of solutions for structuring contents and navigation in a screen and time-based medium. Development of guidelines and criteria for the efficient streamlining of the process, including assessing work electronically, will be required (Cambridge, Kahn, Tompkins, & Yancey, 2001).

Development of electronic or multimedia portfolio instruction is imperative for teaching and for encouraging portfolio use among students. The complexities and sophistication of electronic programs make them difficult for one to utilize without some type of intentional instruction. Portfolio and presentation instruction is meant to provide a bridge between the student and professional worlds by offering students the chance to see their work and themselves in the broader context of the marketplace. The goal is to link technical education and careers by working in the context of the way things are produced in the business world via practical skills (specifically, knowledge of strategies for collection, organization, design, and evaluation of an evolutionary document—the professional portfolio) for accomplishing personal marketing and presentation tasks (Marquand, 1985).

Electronic Opportunities and Challenges

If portfolio assembly is merely a matter of student transposition of original material to electronic files, the electronic portfolio is—like the traditional portfolio—a performance. Both portfolios establish a narrative that is concerned with the linear piecing together of continuous or disconnected images and events. Both portfolios also require decisions about how much space and emphasis to give to each successive visual event in the presentation. Similar to a paper portfolio, the electronic portfolio offers options and encourages evaluators to spend more time in the portfolio. Like paper portfolios, the electronic portfolio offers options for both linear and nonlinear navigation. It takes the form of a guided tour, helping to point evaluators toward particularly relevant pieces, just as it takes the form of random access, inviting intuitive investigation. The portfolio method can be navigated either way, allowing evaluators to decide which pathway (linear or nonlinear) is most appropriate at the time they review the portfolio. A consistent navigational scheme allows evaluators to find any particular piece with a minimum of effort and searching (Sanders, 2000).

While concerns about electronically supported portfolio practices exceeding physical boundaries are common, virtual conference and collaboration is more convenient and less expensive. Telegraphy follows on the heels of telephony. Familiarizing students with virtual presentation via electronic portfolios, especially in the realm of technology education, clearly provides an essential exercise in synchronic practice over a distance, particularly communication and display protocols unique to remote collaborations.

A central question remains: What is the bottom line applicability of the portfolio method? Is it simply a demonstration of software knowledge? In some ways, it is. Development and refinement of digital media coupled with the explosion of Internet usage during the last five years has expanded a world culture increasingly mediated by electronic technology for visual presentation. An effective electronic presentation can demonstrate conceptual skills not evident in a traditional physical-static format. It involves skills in scripting, image sequence, and viewer navigation, and as such, it showcases one's ability to organize according to hierarchies, matrices, series, overlays, spatial issues, and parallel texts. Like theatrical, cinematic, or musical events, the electronic portfolio must be timed and paced to address the flow of information in a multidimensional, multisensual environment.

The drawbacks of electronic portfolios include the fact that they are implicitly measured against the mass media. Electronic portfolios must fit the playback hardware of the user or reader assessing the information. While technical advances may eventually overcome incompatibility issues, a major issue inherent in the electronic portfolio is the absence of the actual human presence. The spontaneous response and the physical interaction are removed in the traditional sense when moved from a physical document or presentation to an electronic portfolio. Questions about electronic portfolio security are also of concern, as is the ability to know who actually completed the work being viewed electronically. Ironically, portability (i.e., system compatibility) between sender and receiver is a source of awkward and clumsy communication transmission.

Functional Implications

The model in Figure 1 is a conceptual layout of a portfolio system-process for undergraduate studies in the professional curriculum. This model shows portfolio checkpoints, or stepped phases, for assuring that students are successful from start to finish. Checkpoints also provide potential involvement by students in student organizations and other broad-based university-wide experiences.

The checkpoints include several key steps, phasing the portfolio assessment over the entire degree process:

- Checkpoint I: Initial phase—collecting and organizing all work.
    1. Fundamental skills
    2. Technical skills
    3. Practical skills
    4. Ethical skills

The second checkpoint engages students in determining when and how to integrate important activities such as co-ops into their experience.

- Checkpoint II: Portfolio assessment – planning and evaluation.
    1. Find strength and weakness
    2. Evaluate university/college/departmental/program performance
    3. Develop goals for future growth
    4. Review accreditation standards (i.e., NAIT)

The third checkpoint broadens the student perspective to include a phase with participation with professional senior members through conferences and advisory committees as part of the broader assessment system based on refinement, further design, and actual production.

- Checkpoint III: Portfolio refinement—design and production.
    1. Employ written and graphic modes of communication
    2. Apply a concept of self-reflection
    3. Make sound judgment concerning career
    4. Communicate a vision

The final checkpoint is the phase of assessment, which requires actual presentation, electronically and physically, of the total portfolio product: graduation. It is suggested that graduation occur only after successful completion of the portfolio.

- Checkpoint IV: Graduation—presentation of the professional portfolio.
    1. Evidence of university/college/departmental/program outcomes
    2. Evidence of leadership in the field
    3. Evidence of professional experience
    4. Evidence of preparation for the job market

At BGSU, several portfolio initiatives to integrate portfolio methodology are underway including the offering of a professional portfolio course, the establishment of an Electronic Portfolio Information Center at the university level (*http://folios.bgsu.edu/epic)*, program-specific and online portfolios, and teacher training in portfolio methodology.

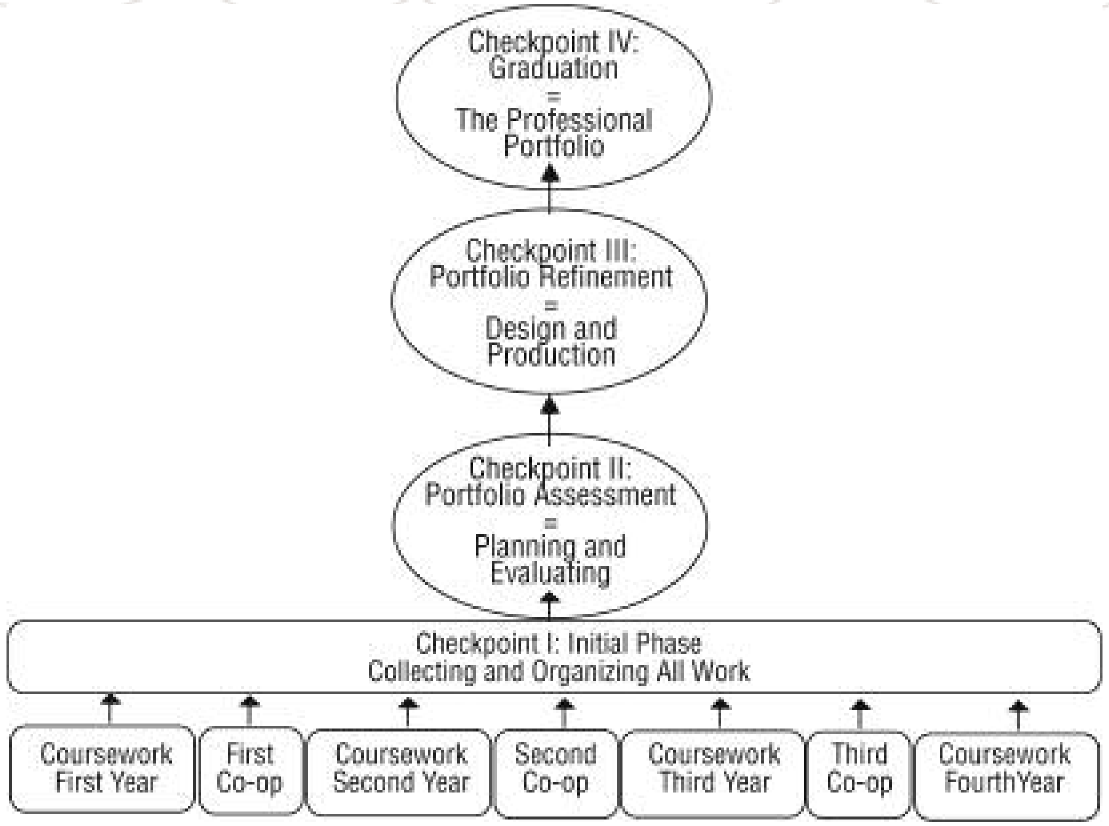

Figure 1. Conceptual layout of a portfolio system-process for undergraduate students.

In practical terms, one example is a professional portfolio course currently offered at BGSU. *Professional Portfolio*, initiated in 2000, lends credibility to proponents of core courses in professional curricula. This course is designed around the premise of a coalescence of experiences and coursework. Portfolios developed by students working independently and in teams reflect the interdisciplinary assessment function in robust and obvious ways related to the curriculum and professional preparation.

Not only can a portfolio course be used as an introductory vehicle for structuring various experiences, but various courses in the curriculum can also be used to integrate and build the portfolio along the way. In other words, the portfolio as a methodology is a means by which institutions or individual instructors measure their success at attaining the goals set forth for their students in the classroom. A key component of course design in this case is the identification of core values as reflected in learning outcomes. Five learning outcomes constitute broad BGSU core values: analysis, integration, communication, interaction, and disciplinary knowledge. Each graduate will also have multiple professional imprints unique to the College of Technology that include technological problem solving, pragmatic field insight, application capability in research and development, cultural global perspective, and skill in the communication of concepts and ideas.

At the university level, portfolio techniques such as assessment, organizing information, and developmental progress are being tested for traditional freshman transition courses as part of the matriculation process. Along with other basic study skills, students learn how to evaluate what they are learning and how they are learning. The university learning outcomes offer the basis for transforming educational practices from teaching-centered coursework to active learning.

Students are taught to identify for themselves examples of various learning outcomes (e.g., critical thinking, writing skills, presentation skills, leadership, and making connections). In addition to examining the process by which they are learning, students also learn to identify examples of their own "best work." Samples that demonstrate both their abilities in the learning process and their abilities in their area of study are added to their portfolio. The process will help students to develop and judge their progress toward their own educational and career goals.

Examples from one such professional curriculum, Quality Systems, can be reviewed at *www.bgsu.edu/colleges/technology/qs*. This site is designed to demonstrate and explore how a faculty Web site portfolio can be integrated into the broader learning community. At the site, go to *Teaching* and then prompt *Student Work Examples* to see various portfolios in process. Prompting *Example Courseware* will also provide insights into one interpretation of how to help guide the portfolio development process electronically.

The five learning outcomes and the college's "imprints" are all reinforced in various ways in the professional curriculum, upheld as adding important value to the total undergraduate experience. The foundational learning outcomes are intentionally reflected as core values in the professional curriculum, noted specifically as elements sought after and reflected via core knowledge. Assessing these outcomes through the portfolio is designed to assure that the learner makes steady progress. Outcomes are assessed through a combination of courses, professional experiences and certification, and incremental preparation of a portfolio which ties it all together.

Teaching portfolios are performance-based assessment tools that promote quality teaching at the college level. When used effectively, teaching portfolios can enhance focus and refinement of classroom teaching. As an example, teaching portfolios could be used to assess the outcome of team-based project planning, analysis, and execution. This outcome is assessed through completion and review of classroom performance requirements and core courses. The end result is a continuously built, cumulative portfolio to reflect projects planned, designed, and executed by the learner, either in a team or individual atmosphere. Periodic reviews of the evolving portfolio in core courses and through a final presentation to faculty and professionals in the field will occur via ongoing electronic postings and traditional presentations, documenting learner growth and professional preparation in various courses and experiences.

Monitoring participation in student organizations assesses the outcome of professional and leadership skills certified. Student membership is suggested, along with successful completion of various professional certification exams. Additional professional portfolio items could include presentation materials or experiences from a professional conference.

Although not new, portfolios have recently enjoyed revitalization due to cultural changes identified in this article. This may be true not only for students in technical areas, but also for students in any discipline. Portfolios, particularly those created electronically, will provide many challenges and opportunities to academia.

Portfolios are equally important as students prepare for various professions, allowing all growth and accomplishments to be identified and assessed in a context well beyond traditional classrooms. Portfolios allow identification of areas of weakness in academic curricula as well as ways for faculty to assess their own effectiveness in the classroom. Institutions are also beginning to use portfolios as a means of assessing their success at meeting institutional goals.

We have just begun to tap the surface of the potential uses of portfolios. The future may see a completely new system of assessment in institutions of higher learning. Students would no longer earn grades in individual courses; rather, a portfolio could be begun as a freshman and modified and refined over time. Upon achievement of a certain level of excellence, the portfolio would be approved and a degree awarded.

Dr. Andreas Luescher is an assistant professor of Architecture/Environmental Design Studies in the College of Technology at Bowling Green State University, Bowling Green, Ohio.

Dr. Sinn is a professor of Technology Systems and director of the Center for Quality, Measurement, and Automation in the College of Technology at Bowling Green State University, Bowling Green, Ohio. He is member of Alpha Gamma Chapter of Epsilon Pi Tau and received his Distinguished Service Citation in 2002.

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Distance Learning: A Comparison of Classroom Students With Off-Campus Television Students

William L. Sharp and Edward P. Cox

The study summarized in this article was undertaken to increase the level of understanding of some of the issues associated with distance learning in higher education. We sought to do that by gathering and comparing direct feedback from both on-campus and off-campus students regarding discussion, attendance, and student assessment procedures. The students participating in the study were taking classes in the Department of Educational Leadership at Ball State University (BSU). The results will be of interest to those already involved in or considering a distance education initiative.

Background

Today's universities no longer expect their undergraduates to be 17 to 21 years old and their graduate students to be a few years older. The student population has changed over the years with many older adults attending universities and urging the universities to provide instruction in ways that would have been unheard of a few years ago. "Working adults want education delivered direct to them, at home or the workplace…. Preparation may be weaker than among conventional students; motivation may be stronger" (Jones & Pritchard, 1999, p. 56). These new methods of delivery include television and the Internet, both of which allow students to access coursework miles from the traditional campus classroom. Thorpe (2000) reported that one course offered over the Internet recruited "over 9,000 students in February and another 4,000 in May" (p. 11). While this may not be typical of the student enrollment in most distance learning courses, it does indicate that instruction will have to change and that assignments will need to be more tailored to a population that is not on campus. The population of the distance learning format means that college instructors will increasingly encounter classes that are much larger than the traditional graduate level class. Not all courses are ideal for distance learning, and decisions regarding which courses are selected for distance education need to be carefully considered. It is one thing to offer a course via distance education because this method of delivery will not harm the content and may, in fact, enhance it. It is quite another to schedule a course for distance education simply because there will be a large market for that particular course. As Lamb and Smith (2000) pointed out, "The distance education environment tends to exaggerate both the positive and the negative aspects of all the elements of instruction" (p. 13). Kelly (1990) mentioned that instructors must develop new skills for distance education teaching in the areas of timing, teaching methods, feedback from students at remote sites, and the evaluation of students. Student assessment, in particular, provides many challenges to those involved in distance education.

Because of the differences between traditional instruction and distance education, it is important, whenever possible, to determine the effectiveness of the new methods of delivery and periodically compare them to traditional campus classroom instruction. Swan and Jackman (2000) discussed Souder's 1993 comparison of distance learners with traditional learners, stating that the distance learning students "performed better than the host-site learners in several areas or fields of study, including exams and homework assignments" (p. 59). Citing the limited number of studies comparing different methods of instruction, Swan and Jackson looked at remote-site and home-site students at the secondary school level. They found no significant differences in student achievement between the two sites when comparing grade point averages.

In keeping with this need to compare students in traditional classrooms and students at remote-site locations, we decided to compare the perceptions of our students in two different traditional classroom courses with students who took the same courses via television.

Methodology

As professors in the Department of Educational Leadership at BSU in Muncie, Indiana, we surveyed graduate students in our School Finance and School Principalship classes. Of these students, 12 in the finance class were in a studio classroom, with 89 taking the course on television at 42 off-campus sites around the state of Indiana. In the principalship course, 25 students were in the studio and 60 were at 22 remote television sites. The purpose of the survey was to see if there were any different points of view regarding the questioning format, attendance, and assessment procedures between the studio groups and the groups at the remote sites. We also wanted to collect data regarding any technological problems and about the students themselves and their backgrounds.

These courses utilized the following format: Finance class—one class for four hours, twice a week, for five weeks, with all students (on-campus and off-campus) taught at the same time; Principalship class—four hours, twice a week, for five weeks for one class and four hours for 10 consecutive weekdays for the other class. All of the on-campus and off-campus students in the principalship class were taught at the same time for each of the two classes.

Students at BSU complete course evaluations at the end of each course. The survey for this research study was added to that evaluation form so that all students would complete the survey. In accordance with the policy on evaluations, the studio groups were given the forms by another student, with the professor outside the classroom, and the evaluation/survey forms were returned to the department office by the student, where the forms were scored by a secretary. The results were not given to us until after final grades were submitted. Proctors at the remote sites distributed surveys to the students to complete and mailed them back to the office for scoring. Thus, every student in atten-

Table 1. Prior Experience With Television Classes

No. of Previous Classes	Studio Students	Off-Campus Students
0	30.6%	42.6%
1	22.2%	23.3%
2	19.4%	14.7%
3	16.7%	6.2%
4 or more	11.1%	13.2%

dance completed a survey.

The results of the surveys for this study were then entered into a computer at BSU, and SPSS 10.0.2 was used to obtain a frequency analysis of the data from the surveys.

Results and Discussion

One thing that we wanted to learn was the extent to which these students had experience with television classes. For example, the attitude of the on-campus students towards the off-campus arrangements (taking time for attendance, discussing technological problems, etc.) could be affected if they had also utilized these off-campus classes in the past. We also wanted to know the total amount of experience that the students had had with television classes to see how popular this format was for these students (see Table 1).

The majority of students in both groups had prior experience with television classes, and some students had extensive experience. The students in the studio classroom had more experience than those taking the courses at the off-campus television sites. This may help explain why the majority of on-campus students were generally understanding regarding interruptions from off-campus sites.

The technology enabled students at the remote sites to push a button to "dial in" to talk to the professor during class. When someone "dialed in," a beep would sound in the studio classroom indicating that someone was calling. In discussing live television classes with other instructors, we were told that one common problem was that the students would call in without warning (unlike students raising their hands in class) and interrupt the flow of the class for all the other students and the instructor. Since we wanted to avoid this problem and still give students the opportunity to ask appropriate questions during class, both of us told students that they could only call in to ask questions during designated question and answer times. In the finance class, the on-campus students were asked to follow the same rule (though some forgot from time to time), whereas the professor for the principalship class allowed on-campus students to ask questions without waiting for a prompt from him. Since this "waiting for permission to ask questions" was so different from the usual graduate classroom routine, we wondered how the students would accept this new procedure. In our classes, the students cooperated and were very good about not calling into the studio until we asked for questions or called on students to call in to answer questions that we had posed. In the survey, we asked the students for their opinion on this "no call-in" rule. The results indicated that 82.1% of the studio students said that this rule was reasonable due to the class size, and 83.5% of the remote site students agreed. This was gratifying to us because we felt that the rule worked very well but were concerned that the students would find it objectionable.

Since these phone calls from the remote sites, when they did occur, would make a buzzing noise followed by a "voice from the sky," the studio students were asked if they were bothered by these call-ins. Findings indicated that 66.7% of the campus students said that it was never true that it bothered them, and 30.6% said that it was sometimes true. So, even though calls were restricted, some of the studio class students (30.6%) were bothered by calls from the off-campus sites.

As in most classes, attendance was taken. However, the size of the classes meant that attendance took longer to take. This process was sometimes done early or at break time or during questions and answers. The students were asked whether it was still appropriate to take attendance in these large classes. In the studio class, 76.7% said that attendance should be taken, whereas 56.0% of the remote-site students felt that taking attendance was appropriate. Some off-campus students may have noted the possibility of being absent without being noticed or they may simply have been less patient with the lengthy attendance-taking process.

Another change from the traditional classroom was the way in which students were tested. While some previous television class students had been required to come to campus for mid-terms and final examinations, we felt that this defeated the purpose of having students take the course at various sites throughout the state. As a result, there were two other options: We could use the usual pencil and paper examination and mail them to the remote sites where a proctor would supervise the exams and return them by mail, or we could put the exams on the Internet and students could take them by computer. The first had the advantage of security/supervision but entailed the mailing of exams to the proctors and then back to the campus where the exams had to be graded by hand. The computer method of examination provided an electronic time limit after which the student could no longer answer any questions. Also, the computer exam would immediately be graded electronically so that the instructor and student would have immediate feedback. One of the drawbacks was that there was no supervision of the student who could take the exam at home or at any Internet site during the specified time.

Both methods were used in this study. The students in the School Finance class were sent written examinations for both mid-term and final exams, whereas the students in the School Principalship classes were given computer exams. When the students were asked whether they preferred the way they were examined or whether they would prefer the alternate method, students in both classes preferred the way they were tested, even though they were tested in different ways. For the studio class taking a paper test (finance class), 100% said that they would prefer a paper test; for the off-campus students taking a paper test, 79.5% said that they liked that method. For the studio classes that took their exams on computer (principalship class), 68.2% said that they would prefer the computer for taking exams; for the off-campus students taking the computer test, 91.9% said that they would prefer that method. This seems to suggest that either way is acceptable to students. Since access to computers was the same for all students and since paper tests could have been used for all students, it seems that students simply preferred what was familiar to them.

Since there is always the possibility of technological problems when broadcasting a class to many students at numerous sites around the state and using computers and the Internet for the courses, we surveyed the students about these problems. Students attending class in the studio were not required to use technology to ask questions or talk with the us before or after class, and they did not lose picture or sound when weather conditions worsened. If any studio students had been adverse to technology, it would not have affected these aspects of their class. For off-campus students, however, the same limitations mentioned could cause problems for them.

Each of us established a Web page where students could obtain course information: the syllabus, handouts, additional Web sites, and their grades on exams (whether or not they took paper or computer exams). Students utilized a code and password to navigate some menus to reach this information. When asked if they "got the page," 71.4% of the studio students said that they had no trouble in getting it, while 79.8% of the off-campus students responded in the same way. Only 11.4% of the studio and 0.8% of the remote students never tried to locate the Web page. This indicates that while most students tried to locate the Web page, the instructors may have to spend more time in future classes to demonstrate how this is done since over 20% did have trouble locating the Web page (28.6% of studio; 20.2% of off-campus students).

The television system sends out video and audio signals via satellite to schools or other facilities equipped to receive them. Besides the possibility of mechanical breakdown, stormy weather can also cause problems in the transmission, and these courses were given in the summer when such storms could be anticipated. When asked about problems with the audio and/or video, 58.9% of the off-site students said that the system worked all the time, 32.6% said that it sometimes did not work but was not a problem, and 8.5% said that it did not work a lot of the time and was a problem for them. Students were provided a phone number to call for help when there were serious problems. It was reassuring to know that over 90% felt that they did not have a real problem with the television technology.

As mentioned earlier, students at the remote sites could call in for attendance or questions/answers on a phone system by pushing a button on a special phone at their site. This phone system worked all the time for 65.6% of the students, sometimes did not work but was not a problem for 29.7%, and did not work a lot of the time and was a problem for 4.7% of the students. For example, one student mentioned that there was roof work being done on the school where he was attending class and that the phone system never worked during the course. As noted earlier, students were given a regular phone number to call into the television studio director's office and report problems with their special phones or problems with the television system. The director then notified us during the class and noted whether this was an isolated case or whether there were other sites that were having problems. Although 60.9% of the students did call into the studio to report technical problems, previously mentioned findings indicate that their outages were not considered a problem for most of them (58.9% had no problem; 32.6% did not consider the glitches a problem, as stated earlier).

In the event that the television signal was lost, students could request videotapes of the sessions that they missed. There was no cost for this service if technical problems caused them to miss all or part of a class. These off-campus students were asked if they ever had to order tapes of the presentations because of technical problems. The responses indicated that 10.2% ordered one tape, 1.6% ordered more than one tape, and 88.3% did not have to order any tapes. So, again, it appears that technical problems, though present at times, were not a major problem for the vast majority of the students, and there were provisions made for those who did have problems.

We wanted to know about the gender of the students and their background. Previous researchers have sometimes stated that females had more problems with technology than males, and we wanted to see if females tended to take the on-campus class or the off-campus class or whether there was any difference in their choices. Also, we wanted to know what percentage of the class was classroom teachers and how many students taking these administrative courses were already school administrators. Finally, since recruitment of students is important to a department's survival, we wanted to know if we had students in our classes who were actually in programs at other universities and took our course out of convenience. So, questions were asked to gather information about the students themselves: gender, whether they had been BSU students in the past, why they took the course, and how they found out about the course. Regarding gender, the studio students were 67.6% female, whereas 45.7% of the off-campus were female. In the studio class, 61.8% of the students were classroom teachers and 29.4% were school administrators. At the remote sites, 68.2% were teachers, with 23.3% administrators. While the statistics on gender do not indicate why the students chose on-campus or off-campus classes, it is worthy to note that females did select the on-campus class more than the off-campus sites. This is an area for further research.

When the students were asked about their degree programs, 89.2% of the studio students stated that they had been admitted to a BSU degree program. Off campus, 70.5% were BSU students, with an additional 21.7% taking the course for certification only and not part of any BSU degree program. As expected, the course was being taken to meet a degree requirement, an administrative certification, or both. When asked about the reason for taking the course, 100% of the studio students and 97.7% of the remote students stated that it was a required course for a degree and/or certification. When asked if they already had a degree from BSU, 80.6% of the studio students had at least one degree from BSU, whereas only 35.2% of the off-campus students had a degree from BSU. This was important to us because it demonstrated that the television courses attracted more than just BSU students. These students may have been taking the course because it was not available from another Indiana university, or they may have just needed the course for administrative (principal) certification from the state. This expanded student market, made available by distance learning, impacts professional staffing level requirements and provides valuable exposure for the university to potential new students.

Other questions were asked to determine the reasons they chose this particular method of course delivery. The studio students were asked if they would have preferred to have taken the course off campus instead of coming to the studio. Although 30.6% said that this was sometimes true, 69.4% stated that it was never true. The students who took the course off campus did not have to pay student fees (recreation, library use, sports and musical tickets, etc.) and only paid tuition for the three-hour graduate course. Students on campus had to pay the full tuition and fees amount. When we asked the off-campus students the advantage of taking a course on television, 100% said that it was for convenience. No one chose the option stating that it was cheaper than on campus. In fact, 53.9% said that they did not even know that it was cheaper than taking it as a campus class. An important question for the off-campus students was the following: "Considering the advantages and the disadvantages of a television course, would you take another one if it was something that you needed and it was at a convenient site?" Responses indicated that 96.1% would take another course. Clearly, the advantages outweighed the disadvantages for these students.

We had been told by other professors with television teaching experience that we would receive lower student evaluations from the off-campus students as compared to the evaluations from studio classes. When asked if we did a good job of explaining the course concepts and problems, 80% of the studio students said that we did, whereas 81.3% of the off-campus students felt this way. However, when the evaluations were completed, both of us were rated slightly higher overall by the studio students than we were by the remote site students.

Finally, although it is difficult to define or judge "success" or "achievement" in a course, we did compare the final grades of the campus classes with the remote site students in the finance class. Since the two subjects (finance and principalship) were very different, the examination methods were different, and classes were taught by two different professors, we did not attempt to combine or compare grades in the two subjects. In looking at the finance class, we found that students off campus achieved higher final grades. For example, the 12 students in the classroom had an average final grade of 3.25 (on a 4-point scale), whereas the 89 remote site students averaged 3.63 for their final grades. This should be interpreted carefully since there were only 12 students in the campus classroom, and the students at the remote sites may have been "better students" academically. It seems fair to say that the off-campus students did not suffer academically for having taken the course by television.

Conclusion

The study found that our students had prior experience with television classes, with some students having had extensive experience. The "no-call-in" rule was considered reasonable by the students, and most of the on-campus students were not bothered by the phones ringing from the off-campus sites. Taking attendance took quite a bit of class time, but students, especially those on campus, felt that this process was appropriate. When asked about testing, students preferred whatever method they had been given, whether it was a paper test or a computer test. From time to time, there were problems with the technology, but these problems were not major for most students. Students other than BSU students took the television courses, pointing out potential recruitment benefits of this method of instruction. And, when asked the reason that off-campus students took the course by television, the overwhelming reason was convenience, driving to a nearby site instead of going to campus. Overall, the results seemed positive for our off-campus students: They received the same instruction as campus students for a lower cost (as compared to campus tuition), with no major technological problems, and at a convenient location. And, the on-campus students seemed to accept well the various technological requirements necessary for our off-campus students.

William L. Sharp is a professor in the Department of Educational Leadership at Ball State University, Muncie, Indiana and also serves as the director of Graduate Programs for the department.

Edward P. Cox is an assistant professor in the Department of Educational Leadership and Policies at the University of South Carolina at Columbia.

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Flexible Learning Via Web-Based Virtual Teaching and Virtual Laboratory Systems

K. C. Chu and Dennis Leung

Virtual Teaching System

In the current economic situation, most academic institutions would like to plan new courses to increase enrollment. Often, these changes do not follow with a proportional increase in cost or staff numbers to the institution. For cost-efficiency reasons, a reduction in student contact hours is most desirable, providing that this can maintain the quality of the learning experience. Web-based teaching is a possible and economical solution to this problem (Lee, 1999).

To implement Web-based teaching, the Department of Engineering of Hong Kong Institute of Vocational Education (Tsing Yi) set up an interactive virtual teaching system for the subject Logic System for students studying sub-degree engineering courses. Students are able to obtain updated teaching notes, tutorials, and digital video instructions through the Internet and displayed on a Web browser. Those Web-based programs will automatically correct students' answers for quizzes, and lecturers can obtain and monitor the students' feedback directly without any delay. The aim of the current design is to provide a more attractive and interactive environment for students to learn. The content of this virtual teaching package includes the following parts:

- Background information—Students can learn or review the fundamental concepts in this background section. The Web site also provides related materials such as aim and objectives, the syllabus, and booklists.
- Multimedia lecture on the Web (see Figure 1)—This section provide a place for downloading conventional lecture notes (in both Acrobat and PowerPoint formats) or viewing short video clips for better understanding of each topic. This multimedia approach attracts attention, generates interest to learn, and facilitates students' understanding. Students will be able to apply the theory learned to finish the assigned tutorials. To evaluate what the students have learned from the content, this section includes automatically marked short quizzes. Students must answer correctly a certain percentage of questions at the end of a chapter before moving on to the next chapter.
- Online discussion and related links—In order to simulate the classroom environment, this section provides an online chat room to allow discussion through the Web. Other functions in this section include Web linkage to IC manufacturers, downloading useful data sheets, links to other online lecture or tutorial sites, a search engine, and a glossary for detailed explanation for a particular term. These functions help students to obtain more theoretical and practical knowledge.
- Comment and guest book—Students can submit questions and suggestions to the Web-master through the easy e-mail system. They can leave or view comments on the guest book provided in this section. Such feedback can provide for further improvement for this Web-based teaching system.

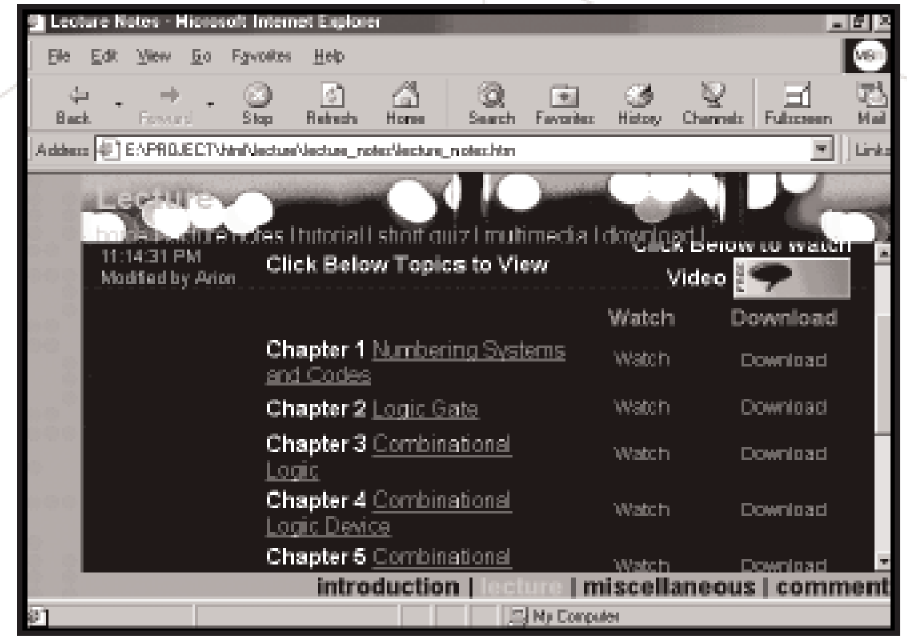


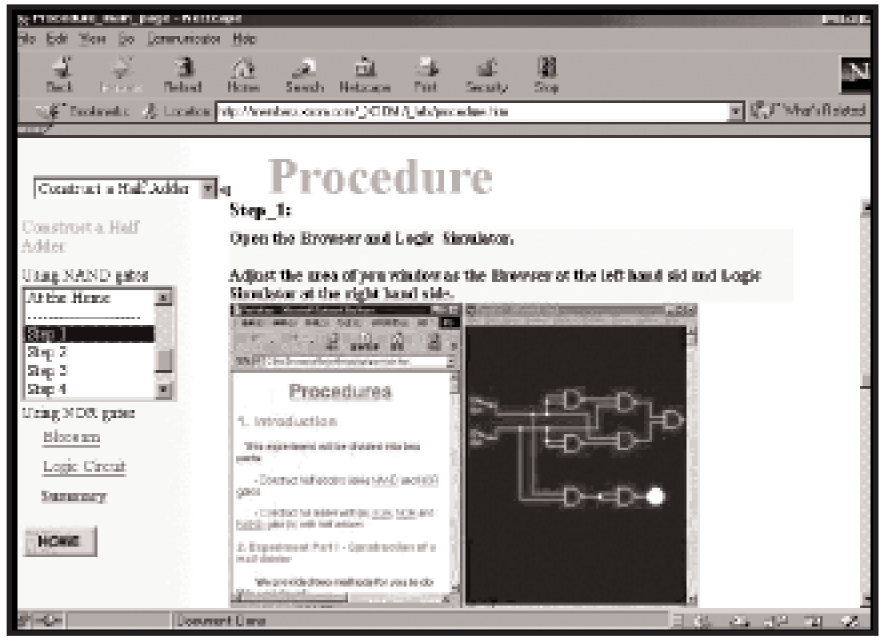
Figure 1. Multimedia lecture notes and explanation.

Virtual Laboratory System

The laboratory is a very important part in engineering education. In fact, heavy weighting in practical training dominates technical education (Leung, 1999). On the other hand, students must also understand a variety of rules, theorems, and devices that involve primarily knowledge-based learning. It is then the educator's job to let students learn to practically apply that knowledge through problem solving and design exercise (Ericksen & Kim, 1998). The virtual laboratory is particularly useful when an experiment involves equipment that may be harmful to human beings. The laser virtual laboratory developed by the Physics Department of Dalhousie University (Paton, 1999) shows how to operate a real time dangerous laser laboratory with the help of commanding equipment through the Internet.

The Department of Engineering of Hong Kong Institute of Vocational Education set up another virtual laboratory system for the same subject, Logic System, for the same group of students. The design of this virtual laboratory involves simultaneous use of the Web browser and any application package. Students are no longer limited to information provided by the prepared laboratory manual. Students can either conduct simple electronic experiments in the computer center on campus or stay at home to do experiments through their computers via the Internet. Students submit answers and comments for the laboratory through the Web. Lecturers can monitor the results of each student and immediately help students with problems.

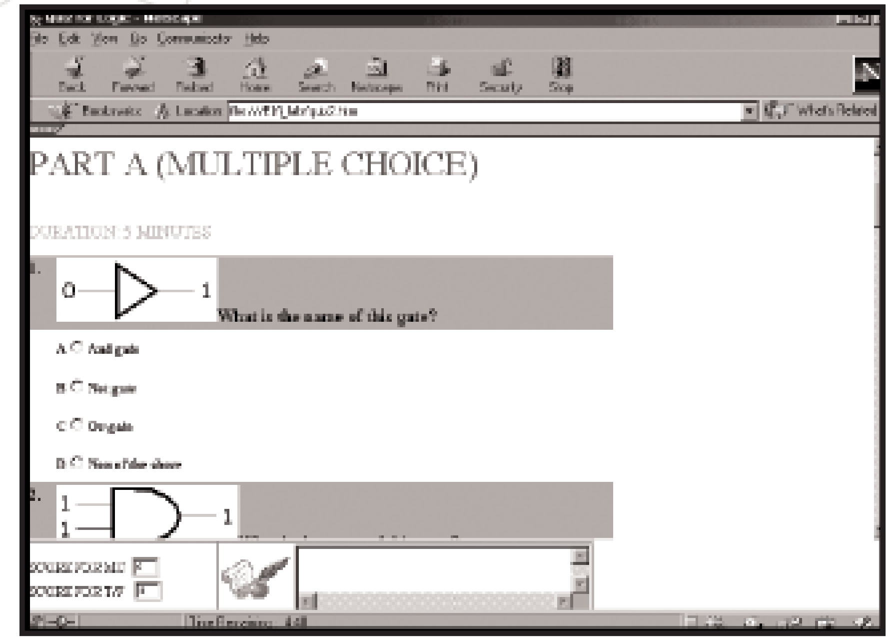
Fig 2. Procedure for the virtual laboratory.



The current content of the virtual laboratory includes the following parts:

- Background information—This section contains all necessary basic concepts and theorems to perform experiments in the virtual laboratory. Students can save a lot of time finding necessary background information (e.g., theories of logic operation and simplification) to support them their use of the virtual laboratory in different locations. They can easily review the basic knowledge learned in the class before going to the procedure section of the virtual laboratory or they can refer back to this section if they find something that is not clear.
- Multimedia explanation and demonstration—This section helps students understand the basic concept of the virtual laboratory by providing different video and audio aids that demonstrate the construction and running steps in the simulation environment.
- Download section for lab sheet, data sheet, and shareware simulator—Students can download lab sheets in this section and then follow the procedures in the lab sheets to perform the virtual experiment. The download area also provides students a location to obtain necessary utility programs (e.g., Adobe Acrobat) and simulation software (e.g., EasySim, MMlogic). All of these software programs are freeware or shareware.
- Step-by-step laboratory procedures—This section includes several experiments for students to perform via the Internet. Step-by-step descriptions, screen captures of simulation software (see Figure 2), and multimedia demonstrations provided in the multimedia section help students with less hands-on experience.
- Summary report and interactive quiz—This section consists of two parts. The first part is a lab report where students answer some questions related to the virtual lab, which provides a chance for them to write a summary report. Lecturers receive the summary report via e-mail. This arrangement provides immediate feedback to lecturers and a means to assess the performance of students participating in the virtual laboratory. The second part includes a quiz section with multiple choice (see Figure 3) and true or false type questions. These two quizzes allow students to review what they have learned in the laboratory. After completing the two quizzes, the screen displays the analysis of the quiz results. This analysis provides feedback to both students and lecturers.
- Online comment and feedback statistic—Students can offer their opinion for improving the virtual laboratory by selecting corresponding items (from excellent to bad) in the questionnaire. They can also leave messages on the guest book. Students and lecturers can easily check the questionnaire results (shown in bar chart) or take a look at the comments on the guest book.

Fig 3 Quiz section



Students' Reaction

Eighty first-year engineering students at the Hong Kong Institute of Vocational Education tried the Web-based teaching and laboratory systems separately in a computer laboratory. In order to assess students' views of this Web-based approach, students completed a set of questionnaires immediately after their first experience of these systems in the computer laboratory. In addition, students freely wrote down their feedback to this study at the end of the questionnaire. The questionnaire's main purpose was to obtain students' views in regard to existing functions of the system, learning to use the virtual systems, quiz arrangements, and user interface, and to investigate the needs of students in the virtual environment. Finally, in order to find out how this virtual system approach might affect student learning and to obtain their views towards this new teaching approach, the lecturer randomly selected 8 students from this group of 80 students and interviewed them using open-ended questions.

According to the results of the questionnaire, most students showed a positive attitude towards the virtual systems and found that such systems encouraged and motivated them to learn better. Most students found it interesting to learn through virtual teaching (VT; 89%) and performing experiments through virtual laboratory (VL; 88%). Some students related their interest in using VT or VL to their previous knowledge of Web browsing.

> "I do not feel so interested as I am not familiar with browsing through the Web."

> "I am not so familiar with the computer. So, I prefer to do experiments in a normal laboratory class."

On the other hand, other students who had suffered from previous hardware building experience found that VL was very useful for them to learn through this Web-based experiment.

> "I feel that it is more convenient in performing the lab in this way. I do not need to find real electronic components in order to do the lab. I need not worry about loose connections of wires."

> "It does not require me to set up equipment. I can know the results by pressing a button on the screen. I also know whether my design is working or not without constructing the circuit by real components."

Nowadays, a common phenomenon is that students have difficulty in learning and spend less time in studying. However, 60% and 67%

Table 1. Feedback From Students Using Virtual Teaching and Virtual Laboratory

Feedback	Virtual Teaching	Virtual Laboratory
Encouraged to participate	78%	82%
Motivated to learn	74%	92%
Software interacted well	83%	78%

of the students felt that it was easier to learn difficult concepts through VT and VL, respectively. The reason was that students found most information in the Web-based system or easily searched in the browser environment.

> "It is easier to learn as these systems can contain hyperlinks to connect to a site so that we can get information that we need. We can also search information using the Web browser in the same environment. We can learn faster in this way."

Students were more active in learning in a Web-based environment than in a conventional laboratory class. These Web-based systems encouraged most students (see Table 1) to participate during the process of using VT or VL and students claimed that they were motivated to learn the subject. Actually, students found that the software interacted well with them during the learning process. Moreover, students could review the VT or conduct the experiment again at any time by means of VL.

In the assessment part of these Web-based systems, 80% and 73% of students agreed that the quiz in VT and VL, respectively, could test how much they gained in the experiment. Also, 70% and 77% of students found that the quiz in VT and VL, respectively, could improve their understanding of the topic. Some students found that it was interesting to do the quiz.

> "The quiz is interesting and provides us another channel to understand the content more."

In the response to other questions for investigating the needs of students in the environment of Web-based systems, most students (90% for VT and 82% for VL) liked immediate feedback after finishing the quiz. This finding helped the developer of these Web-based systems to prioritize marking and giving feedback.

Also, students (>90%) reported the content should be more interactive. Video-conferencing, e-mail, and discussion groups can fulfill this requirement. Otherwise, students would find it boring if they just read materials provided in these Web-based systems.

> "I find that it is more attractive, interesting, and easier to understand by using multimedia."

> "I like the video or movie more. I like to group information and select to read by pressing a button on the screen rather asking me to read many texts. Texts are boring."

However, only a small percentage of students agreed that VT (35%) or VL (52%) could replace the normal class or practical laboratory.

Reflections on the Systems

The developer built these interactive virtual teaching and laboratory systems, and the subdegree engineering students who used the systems provided valuable feedback. Actually, these nonstop systems can provide a multimedia learning environment to motivate students, promote a more active form of learning, offer more individualized and independent learning, and provide simulations of complex scientific processes that are less likely to be demonstrated in a normal class or laboratory.

The feedback from students confirms that they like this innovative learning and working environment and feel encouraged to learn better in this way. The fact that students do not have real face-to-face learning and hands-on experience with the senses are the drawbacks of these Web-based teaching systems. Actually, VT or VL is not going to replace normal teaching or workshops. They can provide a complement to traditional

classroom and laboratory resources (Chin, 1999; Chu, 1999; Lee, 1999). Through longer exposure, different assessment tasks, evaluation, and modification, the developer can improve the materials of VT and VL through these nonstop cycles of design, trial run, feedback, and modification.

The Future

There is the trend for tertiary institutes to increase student enrollment but without adding any staff. In order to overcome this increasing student-staff ratio and maintain the teaching and learning quality, universities or colleges could implement Web-based teaching and laboratory systems to reduce the workload of teaching staff and improve the learning outcome of the students. Future developments of these systems include:

- Integrating the virtual teaching and virtual laboratory (Waite & Simpson, 1996) to benefit students by presenting the same material in different ways and to exercise different learning styles. Our department is planning to build a scenario-based learning package (Chu & Leung, 2000) that will simulate a scenario similar to the students' future working environment. Students can virtually walk around and realize how the actual working environment should be. They can also take this opportunity to study how to operate and interconnect different equipment. Students can use this virtual environment to better understand the operation and the theory behind the operation. Using hierarchical explanations can also suit the learning progress of students with different backgrounds. This scenario-based learning package will enable students to virtually immerse themselves in a scenario to enhance their learning and practical knowledge.
- Improving visual impact and reality of the existing VL system by real time captures the image and controls the instrument in the laboratory. Using virtual instrument control software such as LabVIEW (Ko et al., 2000), it is very easy to implement a real time remote laboratory system. In such a design, a more realistic feeling of controlling the remote instruments is accomplished by using a mouse to press control buttons or to turn knobs displayed on the screen. Users can observe any change of output from the real-time image sent from the remote site through the Internet.

K. C. Chu is a lecturer in the Department of Engineering at the Hong Kong Institute of Vocational Education, Tsing Yi.

Dennis Leung is head of the Department of Engineering at the Hong Kong Institute of Vocational Education, Tsing Yi.

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A Curricular and Instructional Challenge: Teaching and Learning for Technological Literacy/Capability

James S. Levande

The role of technology education in the development of technological literacy and capability maintains a constant presence in, and at certain times and places, a point of debate within the field. This debate permeates all levels of the profession—from teachers selecting laboratory/classroom curricula and instructional strategies to institutions of higher education determining how to prepare technicians, technologists, and educators for K-12 and university programs to researchers seeking to establish sound theory and practice for the field. In these situations, as well as many others, views and perceptions are advanced to make a case for a particular focus on what constitutes literacy and capability. Usually this advocacy centers on meeting the needs of the immediate mission—teaching students at the K-12 level; or preparing teachers, technicians, or technologists; or developing the skills and abilities of postgraduate students to serve the diverse demands of research and continued development of the field. How is it then that an agreement can be reached about the similarities and differences between literate and capable when confronted with the scope of teaching and learning about technology across the places and times that students are engaged with technological studies?

The approach to consensus and agreement requires an understanding of the nature of technological literacy and capability, the establishment of a framework that will be inclusive of the many views and perceptions that are held within the many segments and focus areas of the field, and an application of the framework to meet the challenges of developing literacy and capability.

In understanding the continuing theme of developing technological literacy one only needs to go to the continuing discussion and development of the concept within the field of technology education. The fundamental point, that a person must know about technology and be able to do things technologically, is a continuing theme throughout the literature. This literature (Custer & Weins, 1996; Dyrenfurth, 1991; Todd, 1991; Weins, 1988) notes that there are diverse definitions of technological literacy and that these definitions frequently reflect the field or discipline of the definer. However, one key element can be found in this diversity: It is the concept that a person must know about technology and be able to do things technologically.

The literature makes a series of key statements related to the relationships that exist between literacy and capability by:

- Linking literacy and capability. Capability is application, the use of technological knowledge (literacy) to solve practical problems through doing within the full curricular scope of the teaching and learning environment.
- Including curriculum integration by bringing together mathematics, English language arts, science, and social studies with the study and application of technology.
- Providing meaningful, personal realism where the impacts and consequences of technology can be confronted.
- Placing the learner in an active role at the center of achieving literacy and capability for whatever the purpose or mission at hand is.
- Placing achieving literacy and capability on a scale that delineates the increasing complexities demanded by the roles a person takes on in knowing about and using technology—scientist, technology teacher, technician, etc.

Compounding the literacy/capability issue is the specter of technological illiteracy. What are the consequences of not being literate and/or capable?

Here again the literature (Custer & Weins, 1996; Devore, 1991; Dyrenfurth & Kozak, 1991) within the field addresses the consequences of not developing technological literacy. Reasons included are democratic needs, the nature of life in society, dehumanization-humanization, and the nature of jobs-competitiveness-workforce literacy and where the impacts will be if literacy is not achieved. This illiteracy is described as impacting the quality of life and the natural environment in four ways: (a) the inability of citizens to function and contribute in society, (b) the loss of competitive economic potential in business and industry, (c) reduced national security, and (d) economic and political disfranchisement of citizens. All of these points relate to the need for and the significance of technological literacy within society.

The Challenges

A major assumption of this article is that the field of technological studies is committed to the development of technological literacy and capability as described in the literature. And, that the need for technological literacy and capability is essential to avoid a breakdown in the quality of contemporary life. A major problem exists in how this is to be accomplished. The problem's solution requires answers to the questions of: To what extent or degree should it be achieved at any given time and place? Where should it be achieved? and Who is responsible in achieving literacy and capability?

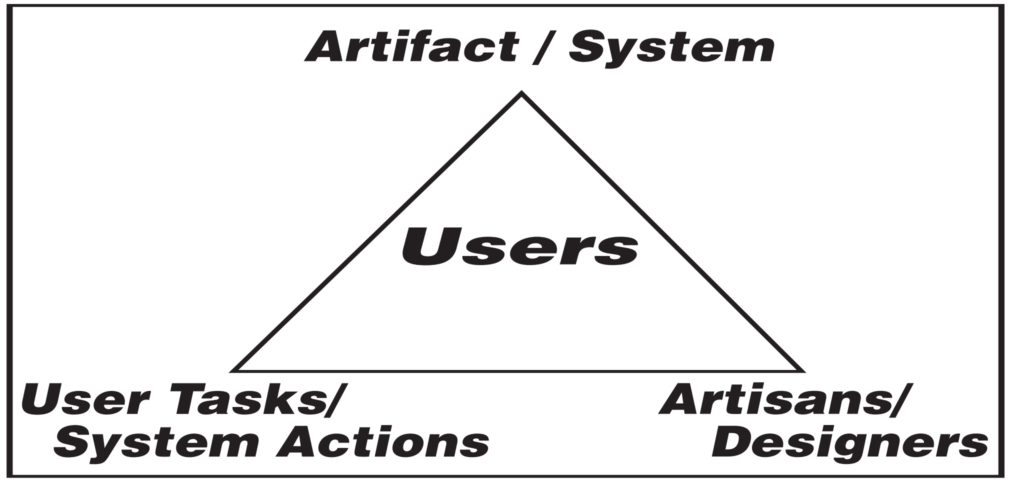
Streichler (2000) encapsulated the issues that revolve around the above questions by asking the field to establish a framework and formalize a continuum that addresses *technology* and the *learner*. The challenges that must be met in achieving the "continuum" include: changes in professional behavior; bringing segments of the field together; giving up past concepts and processes; and the quality, direction, and quantity of research in the field. The last challenge was further emphasized by the Technology Education Research Conference (Project 2061/American Association for the Advancement of Science [AAAS], 2000), the purpose of which was to think about a common strategy that would best support literacy goals, where it was pointed out that there is fragmentation in approaching the field's research agenda that is driven by discrete contributions without really impacting the educational system as a whole.

It is also important to note that the contributors to Technology Education for the 21st Century (Martin, 2000) touched on the theme of literacy, capability, and achieving a teaching and learning environment centered on the learner and learning. The essayists in this work, each in their own way, all touched on placing the learner at the heart of developing technological literacy and capability by describing exemplary practices that achieve it and in outlining an agenda for taking further action. This desire to center on the learner is not new as is evidenced in the theme of the 1965 American Industrial Arts Association's (AIAA) national convention—"Developing Human Potential Through Industrial Arts" (AIAA, 1965).

With the existence of a segmented, multifocused agenda, the field will continue to define the notion of literate-illiterate to meet the diverse definitions and requirements of the specific contexts of each segment. A way to overcome the problems of segmentation and multiple focuses is to include all the viewpoints in one flexible, operable framework. The elements for this type of inclusive model are available within the discourse, research, and literature of the field. Agreement could be achieved on the basis of these elements and allow each of the segments or focuses in the field to deal with reaching the level of literacy and capability it believes is necessary to meet the needs of its constituency and society in general. This calls for a comprehensive, flexible perspective that gives everyone involved a common foundation, framework, and reference point. If the field cannot define and present this perspective on what technological literacy-illiteracy is, then it faces the danger of being unable to convince society of the need for technology education and technological studies.

Through its current discourse on technological literacy-illiteracy, the field has identified many required key components upon which to build the continuum and framework and meet the challenges identified by Streichler (2000). Basic standards are in place and a framework for achieving them is under development through the Technology for All Americans Project (1996). Higher level standards of technological literacy for trades people, technicians, technologists, engineers, and scientists are available through such sources as the National Skill Standards Board (NSSB) and the Accreditation Board for Engineering and Technology (ABET). Higher levels of technological literacy standards for teachers of technology, as set down by the Council on Technology Teacher Education and the National Association of Industrial and Technical Teacher Educators, are also available. There is recognition of the practical implications for the study of technology (Savage & Sterry, 1990) which include: balancing the "doing" and the cognitive dimensions; integrating knowledge with laboratory activities; including technologi-

Figure 1. User-centered triangle.



cal objects, artifacts, and systems within environmental contexts; distinguishing between technology and science; and defining the role of the human will within the technological problem-solving process. Placing the learner at the center of the process of technology education, and teaching and learning in general, is evidenced by the contributions in Martin (2000) as well as in the research and publications on the brain and learning, intelligence, designing learning experiences, and teaching that are available through the Association for Supervision and Curriculum Development (ASCD) and other professional organizations.

The elements serve as a basis for building a continuum. They address the range of diversity in opinions and beliefs held within the field about what constitutes literacy and capability. And, they comprise a set of essential working functions for a comprehensive, flexible continuum. These functions include:

- Adhering to a standards-based approach.
- Meeting the challenges of: changes in professional behavior; bringing segments of the field together; giving up past concepts and processes; and the quality, direction, and quantity of research in the field.
- Addressing the entire complexity of understanding and using technology in the complete spectrum of its application.
- Teaching and learning for literacy and capability that meet the required range of levels from that of a citizen in general to those of technologist, engineer, or scientist.
- Centering on learning and using technology in a "doing" setting.
- Placing the learner at the center of focus and application.
- Meeting the demands of preparing people for the complex roles required in the development and use of technology.

These workings comprise the framework to link segments together. Without the link the discussion and debate will continue to contribute to highlighting differences instead of emphasizing commonly held fundamentals.

Standards for Technological Literacy: A Starting Point and Foundation

The Standards for Technological Literacy: Content for the Study of Technology (International Technology Education Association [ITEA], 2000) states what all people should know and be able to do with respect to being technologically literate in our global society. This should be the accepted starting point for all approaches to increasing literacy and capability. The standards identify the five key areas of technology—(a) the nature of technology, (b) technology and society, (c) design, (d) abilities for a technological world, and (e) the designed world—and set benchmarks within these areas as performance indicators.

Specifically, the standards state what a student should know and be able to do. The standards also provide for knowing and doing or process by describing the basic knowledge required for literacy and the abilities needed to act technologically. The associated benchmarks offer criteria to assess progress toward both cognition and process. The first three key areas—dealing with the nature of technology, society, and design—involve knowing. The remaining two key areas—abilities and the designed world—primarily address doing within contexts.

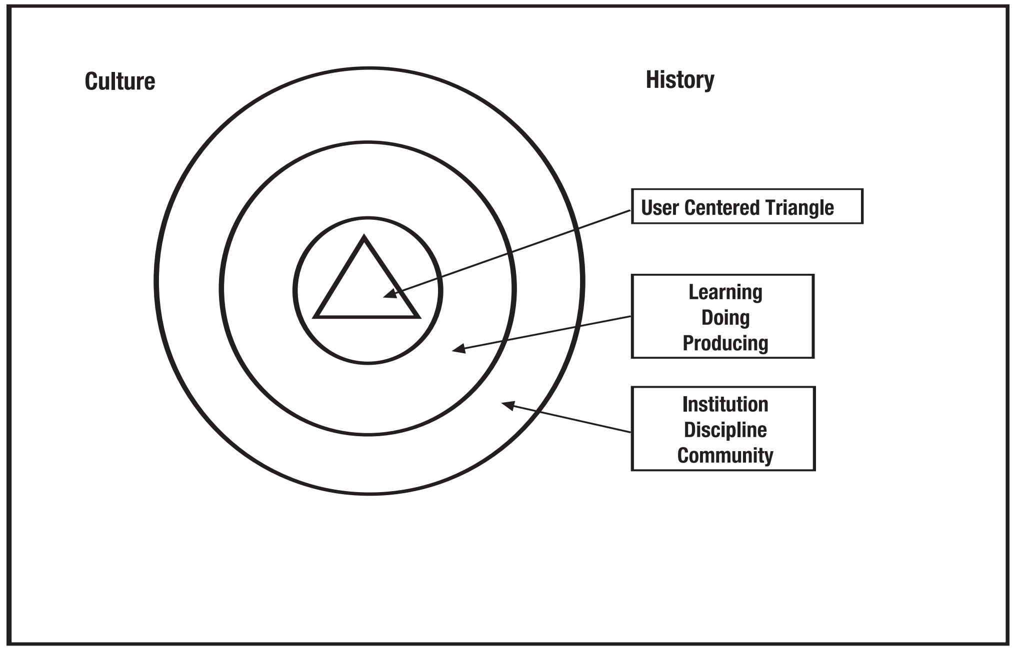
This article operates on the assumption that the *Standards for Technological Literacy: Content for the Study of Technology* (ITEA, 2000) sets a foundation and provides a platform to build increased levels of literacy and capability. And, it is recognized that standards for more advanced forms of technological literacy, such as those under the auspices of the NSSB and accreditation bodies for programs offering associate, baccalaureate, and/or advanced degrees in teaching technology, technical, engineering, and related fields, exist and constitute a more complex set of requirements for specific, in-depth forms of technological literacy that are built upon the basic standards. Without this agreed-upon starting point, the segmented, intrafield focuses on what constitutes literacy-illiteracy will have us running multiple races to reach disparate finish lines.

A User/Learner-Centered Approach to Meet the Challenges for a Continuum

Where can a flexible, operable model that brings all the elements together be drawn from to provide the framework and continuum? Streichler (2000) suggested that the field turn to the formulations offered within the literature to achieve the "continuum" goal. In taking up this course of action, and to include the professed values of technology education, the field may have to step "out of the box" to reach a consensus. The rationale behind this approach is based on giving equal consideration to all the viewpoints and avoids the appearance of giving precedence to any one segment.

Many other fields of study and practice face similar challenges in dealing with the complexities of technology. Turning to the points of view of these other fields permits a perspective or "out of the box" view of technology education's situation. One such view comes from the field of communications. Here the communicator, usually a writer, is faced with the job of interpreting the use and application of a tool, artifact, and/or system for the purposes of enabling the user to accomplish a technological task or function. The writer relies on the discipline of rhetoric. This is not the rhetoric commonly associated with the use of language as a means to deceive that comes to us from Socrates' descriptions in the *Gorgias* or *Phaedrus*. Nor is it the use of exaggeration or display in language often associated with political campaigns. It is a collection of techniques that makes the production and dissemination of language a strategy by which the writer achieves the purpose of turning the reader into a func-

Figure 2. User-centered complex of technology.



tional user of the tool, artifact, and/or system. This latter definition as strategy is a process as much as the process of house building. The end of house building is not the house itself or the builder's use of the completed structure, but rather the use made of the house by those for whom it was constructed.

Johnson (1998) took the above notion of rhetoric as a strategy and applied it to achieving a user-centered approach to technology where humans who interact with various technologies (systems, simple hand tools, appliances, complex electronic networks, etc.) are the primary focus. He pointed out that technology has too often been focused on either (a) the interest of the developers who hope to gain from it, (b) the interest of the disseminators who hope to reap the fruits of its success, or (c) those who develop and release a technology into the public sphere with little or no concern for its intended or unintended consequences.

Johnson (1998) argued that it is the demands of the technological artifacts and systems that drive design and innovation. Human factors are too often left out of consideration in the design and use of technology. His basic premise was that because humans use and apply technology it is necessary to place them at the center of all interactions that involve technology. To remedy the oversight of human factors, he offered the "user-centered complex of technology." This view offers the field of technology education an operable model capable of meeting the requirements of a continuum that prepares people for understanding and using technology in the complete spectrum of its application.

The user-centered complex describes the relationships between users of technology and the designed/created world. The complex is made up of the following elements: (a) artisans and designers, (b) artifacts and systems, (c) user tasks and system actions, and (d) the user. The first three elements are dimensional in form. They can be seen as scaling from one end to the other (i.e., artisans/designers; artifact/system; user tasks/systems actions). These elements are configured in a triangular structure with the first three dimensional elements at the vertices while the fourth element, the user, and for the ends of technology education the learner as well, is placed at the center of all interactions (see Figure 1). For the purposes of this article, user and learner can be considered to be synonymous and interchangeable. All future references to the user will be referred to as user/learner.

The employment of a triangle as a taxonomic device ensures that any one element is always in a direct link with any of the other elements. These links are considered to be dynamic. The sides of the triangle indicate the process of exchange that occurs among the elements. Finally, this triangular, dynamic user-centered complex is set within the shells of learning, doing, and producing; community, discipline, and institution; and culture and history (see Figure 2).

The dimensional elements (artisans/designers, artifact/system, user tasks/system actions) are characterized in the following manner.

Artisans/designers are viewed as "creators" of technology. *Artisan* represents the maker of tools, artifacts, and some forms of technologies while *designer* defines the engineer and in some cases the scientist (in the sense of scientist as a participant in the construction of technologies). Teachers of technology, technicians, and technologists can be considered to stand somewhere in between the two ends of this dimension. It is important to note that all the roles in this artisan/designer element often switch places and that the artisan takes on the functions of the engineer and vice versa.

Artifact/system defines the "constructs" of technology. *Artifacts* are simple technologies—tools, products, prototypes—created and used independently of other tools, products, and prototypes (at least in any direct physical way). *Systems*, or complex technologies, are usually artifacts physically connected either mechanically, electronically, or in some other direct, interactional manner. Systems can also be viewed as "nonartifactual" technologies such as organizations or networks.

User tasks/system actions are the "contextual subject matter" of technology. User tasks represent technology's actions as perceived by the user/learner. System actions are technology's actions as perceived by the artisan/designer.

The key completing element in the complex is the *user/learner* of technology, who is placed at the center of the other elements, at the heart of the dynamic, collaborative interactions of the other elements.

No technology is developed, disseminated, or used in a vacuum. The user-centered complex operates within the shells of learning, doing, and producing; community, discipline, and institution; and culture and history as depicted in Figure 2. These shells provide the situations and constraints that form the user/learner as well as the artifact/system, user tasks/system actions, and artisans/designers.

Learning and doing, as part the first shell or layer, is where the user/learner is engaged in the design, dissemination, or end use of technological systems or artifacts. Producing, the third component of this shell, engages the user/learner in applying knowledge and skills as a practitioner and producer. This is not just a tool-use model describing user knowledge and ability from a tool-centered, artifact-centered, or systems-centered perspective, because the knowledge and skills of technology are assumed to be in the technology, not in the user/learner. If one accedes to the definition of learning, doing, and producing of a tool-centered model, then one accepts that the knowledge and ability of technology is put there by designers or inventors, not by users/learners. Placing the user/learner in the role of producer entails accepting the user/learner as capable of being an artisan/designer of technology. This also recognizes that users/learners bring the human factor into technological decision making.

The next outward shell constitutes the human networks that constrain technology. These networks—*disciplines, institutions,* and *communities*—probably do not make up a complete list, but do cover much of the territory at this level. These networks easily overlap and create complexes within and among themselves. One example is our own field of technology education or technological studies. Within this discipline there are overlapping communities that are working to achieve numerous missions—general technological literacy for all people, entry-level and continuing career preparation, pre and in-service professional development of teachers, etc.

The outermost shell comprises the factors of *culture* and *history*. These two factors are often invisible but they should not be ignored. Cultural forces define nearly every human action, and in a world more dependent than ever on international communication and technology transfer, the factor of culture becomes essential when defining the use of technology. History, integrally related to culture, refers to the reflective aspect of understanding human action, particularly in terms of responsible, ethical behavior. History informs the understanding of technology in unique and fundamental ways.

Johnson (1998) offered that this "complex" serves the purposes of analyzing technological artifacts and processes; exploring the people who use, make, and/or even destroy technology; helping to examine those who are enamored and/or bored with technology; and studying the user/learner actions within the complex.

Application of the User/Learner-Centered Approach to the Challenges

How does this user/learner-centered approach apply to the mission of developing technological literacy and capability? The application is based on Johnson's (1998) purposes, primarily studying the user/learner's actions within the complex, but also including the examination of artifacts, systems, design, and human behavior and conditions surrounding using, making, and even destroying technology. In this sense the entire complex serves as a framework or structure for the continuum called for by Streichler (2000). It addresses the challenges by (a) providing for all forms of behavior—including that of users, learners, and professionals—within the field, (b) providing settings where all segments of the field can function in association and collaboration, (c) considering past (historical and cultural) concepts and processes, and (d) providing a research frame of reference with which to gauge a point of interest, debate, concept, and/or process with any other point within the continuum. Most of all it provides a place where the essential working functions described earlier in this article can be included and addressed.

Let us take these four challenges and apply the user-centered complex to them one by one.

Behavior

At any one time a person can take on a multiplicity of roles within technology and technology education. The complex provides for these roles and permits moving freely between and within them. These roles take place in one or more of the shells or layers of the user-centered complex. As a user/learner, designer, and/or artisan one is primarily involved with learning about and using, doing, and producing with technology. As a teacher and educator one is engaged in conveying the needs, wants, desires, and values of the community, discipline, and institution as they relate to technology's use, production, and application. As a researcher one is exploring, documenting, and formulating the relationships that exist between and among all aspects of the complex from the cultural and historical right down to the more detailed aspects of learning, using, doing, and producing.

Moving from the center of the complex to its outer shell requires one to engage in a number of behaviors. First, acceptance of the concept that technology and technology education exist in an inclusive, universal system imbedded in and encompassed by all of the shells of the complex. Second, through reflection and study, identifying where one stands within the complex with respect to personally held beliefs about each and every element—systems, artifacts, learning, doing, producing, tasks, actions, etc. Third, employing behaviors that embrace a greater and greater amount of willingness to respectfully consider other beliefs and viewpoints, relate one's view to those held by others, and to collaborate in, and establishing where mutual benefits can be achieved for the common good of technology education. And, fourth, promoting and advocating for one's personally held beliefs by placing them within the shells and relating them to all elements of the complex through sound research constructs, methodologies, and documentation.

Various perspectives on what constitutes the types of appropriate professional behavior presented above are found in Gilberti and Rouch (1999). A majority of the contributions to this work, all of which advance various aspects of a framework of professional behavior, are devoted to defining professionalism, identifying opportunities for improvement, and describing model professionalism at various educational levels. It is in the final chapter of Gilberti and Rouch's book that Devier (1999) provides a vision of a desirable professional culture. A vision that recognizes the necessity of individuals possessing a general systematic knowledge of the profession of technology education. This systemic knowledge of the profession furnishes a basis for aligning with the systemic nature of the user-centered complex. This culture of technology education professionalism can be found embedded in the general culture as well as in the networks of the disciplines, segments, and focuses of the field that surround the actions and elements grouped in the center of the complex.

The challenge of changed behavior should be considered as a primary and foundational action for use of the user-centered complex. Meeting the other challenges relies on the appropriate behavior.

Setting

The complex, through its elements, provides locations where individuals as teachers and teacher educators can "hang their hats." Teachers can choose to emphasize and promote designing and producing artifacts and/or systems or place stress on user/learner tasks as opposed to system actions within the contexts of the curriculum and programs for which they are responsible. Using the elements to provide a holistic view of the complex of technology, teacher educators can then proceed to stress those things that are necessary to prepare students to meet the standards of certification for specific areas—K-12 general education, high school career and technical preparation, postsecondary technologist training, or higher education at the baccalaureate and graduate levels. The basic requirement is that they, and this goes back to behavior, recognize and accept that the emphasis, promotion, and stress take place within the complex. Rejection will, at the least, create a self-imposed isolation within the complex and at its extremes result in a disruption of the continuum leading to segmentation and disunity.

Past Concepts and Processes

The field cannot escape the fact that current and future concepts and processes rest on that which has happened in the past. The historical and cultural elements provide a location to address the issues that revolve around the inclusion of past concepts and processes without ignoring or eliminating them. Set within the complex, the concepts and processes of technology can be considered to the degree necessary to achieve the desired educational outcome. At a minimum it may only be necessary to cite the lineage of a contemporary concept/practice to reach a standard or benchmark. In other instances including the past concept/process may be needed to build required contemporary knowledge and ability. And finally, emphasis and in-depth use of a key past concept/process may be the only avenue to achieve a very high degree of knowledge and ability that is essential in a particular technological application. The complex's historical and cultural elements coupled with the elements of institution, discipline, and community provide two mechanisms to deal with the past—"handles" to grasp the placement and significance of the past in relationship to the present practices and "platforms" to launch forecasts and speculation on where any concept/process may lead to.

A Research Frame

The entire complex provides a context that permits a hypothesis to be framed in a manner that can display its linkages to all elements of the technological setting. History and culture; discipline, community, and institution; learning, doing, and producing; artifact/system, user task/system action, and artisan/designer; and, most of all, the learner/user constitute places on the continuum where questions can be focused. Granted that the nature of research requires one to consciously and deliberately structure and focus the process of questioning to achieve specific answers within a range of probability. However, the process of questioning does not obviate the milieu in which the research takes place. Basically, the complex provides parameters that prompt consideration of a question within the milieu.

Meeting the Remaining Essential Working Functions for a Continuum

The user-centered complex, because of its inclusive nature, can accommodate the other remaining functions for the establishment of a continuum. Let us examine each in relation to its place in the complex.

Understanding and Using Technology in a Spectrum of Application

Addressing the entire complexity of understanding and using technology in the complete spectrum of its applications can take place by focusing on the elements of the model. The elements provide specific places and contexts for the application of technological understanding and ability. The elements of the shells and the triangle can be associated with activities ranging from the general to the specific, from basic cognition to in-depth understanding, and from a use of modest technical abilities to that of very highly refined levels of ability. The user tasks, system actions, designing and/or producing, as well as working within the networks of discipline, community, and institution, all come into play.

Teaching and Learning for a Range of Literacy Levels

The networked elements within the complex of community, institution, and discipline provide settings for accomplishing teaching and learning for literacy and capability that meet the required range of levels from that of a citizen in general to those of teacher of technology, technologist, engineer, or scientist. A citizen, in general, may never be required to go beyond the need to know about those things technological that are necessary to preserve our democratic society, while this same citizen, as a productive worker, will be required to know about and be able to do things with particular technologies in order to continue in and perhaps advance him or herself in his or her job or career. Taking this scenario a step farther one can go to those jobs, careers, and professions that are specifically technological in nature. Here in-depth knowledge and abilities ranging from designing and producing a particular artifact right on through to systems design and application are required. All can be taught in appropriate settings and at a designated time provided by the situations and constraints of the complex.

A Setting of "Doing"

Centering on learning and using technology in a "doing" setting is evident in that the complex explicitly includes this essential activity. Learning and producing cannot be achieved in a passive manner. If one were to remove doing from the complex, it would destroy the learning and producing elements of the structure.

Learner Centered

The heart of the complex is the learner at the center of focus and application. Everything depends on the presence of the learner/user. Johnson's (1998) theoretical constructs are based on this most primary concept. The reality of leaving the learner out not only destroys the complex, but it destroys the whole notion of providing any form of education whatsoever.

Preparation for Complex Technological Roles

The rationale for "teaching and learning for a range of literacy levels" also applies to meeting the demands of preparing people for the complex roles required in the development and use of technology. The situations and constraints of the model provide the appropriate settings for achieving the complexities associated with the various roles a person plays in a technological world. The complex answers the demands placed on it by accommodating to meet the level of literacy required to perform a technological role, be it elementary or in-depth.

Who Is Responsible in Achieving Technological Literacy and Capability?

The user-centered complex of technology offers one way of dealing with the questions: To what extent or degree should literacy and capability be achieved at any given time and place? and Where should it be achieved? The answer to these two questions provides an indication of the framework's parameters to be dealt with in a holistic continuum. It does not directly address "who" is responsible.

The "who" responsible is every individual in the field of technology education and technological studies. This means that, by engaging in proactive professional behavior, we all begin to recognize, endorse, and promote the systemic, holistic nature of technology and the development of technological literacy and capability within a framework such as the user-centered complex of technology.

The problem may be that we have been looking at any one individual segment of the field as if this perspective is the only view and then promoting this perspective as a definitive model. In the field of physics this concept is termed a *duality*. A duality exists when models appear to be different but nevertheless can be shown to describe the same thing (Greene, 1999).

Dualities are of two types. The first is when ostensibly different models are actually identical and appear to be different only because of the way they happen to be presented. An example of this would be if someone only fluent in English were to describe the process of turning but would be unable to recognize the description if it were presented in Chinese. A person fluent in both languages could easily perform a translation and establish their equivalence. Then second is when distinct descriptions of the same thing do present different and complementary insights. In this instance, where dual (or multiple) descriptions are provided for a single universe, in our case technological literacy and capability, important insights that follow from using dual descriptions can be achieved. Both types of dualities are resolved through an acceptance of a universal, systemic domain in which translations can be made and dual insights be accepted.

Solving this problem of looking at individual segments of the field as if each perspective is the only definitive model could be addressed through the application of the user-centered complex of technology. The complex provides a way of addressing the field's diverse segments and missions while maintaining a universal, systemic framework for developing technological literacy and capability. In addition, the complex meets Streichler's (2000) call for a continuum in that it describes a framework in which a fundamental common character—technological literacy and capability—is discernable amid a series of variations.

Next Steps

Where does technology education go next in the use of this user-centered complex of technology or any other model similar in nature? If this approach is accepted, then technology education must continue to (a) define, develop, practice, model, and teach the proactive professional behaviors that hold the continuum in place and (b) extend knowledge and practices that clearly define, characterize, and promote all the elements within the complex. The field has numerous forums for achieving both of these initiatives. They include the Mississippi Valley Technology Teacher Education Conference, the International Technology Education Association and its councils, the *Journal of Technology Studies*, and the *Journal of Technology Education*. Through these forums the ideas and concepts can be refined, directed, and applied in a meaningful manner.

Dr. James S. Levande is a technology education consultant with the Office of Career and Technical Preparation, Michigan Department of Career Development. He is a member-at-large of Epsilon Pi Tau.

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A Senior Course in Design for Manufacturability

Bernie Huang and Joseph C. Chen

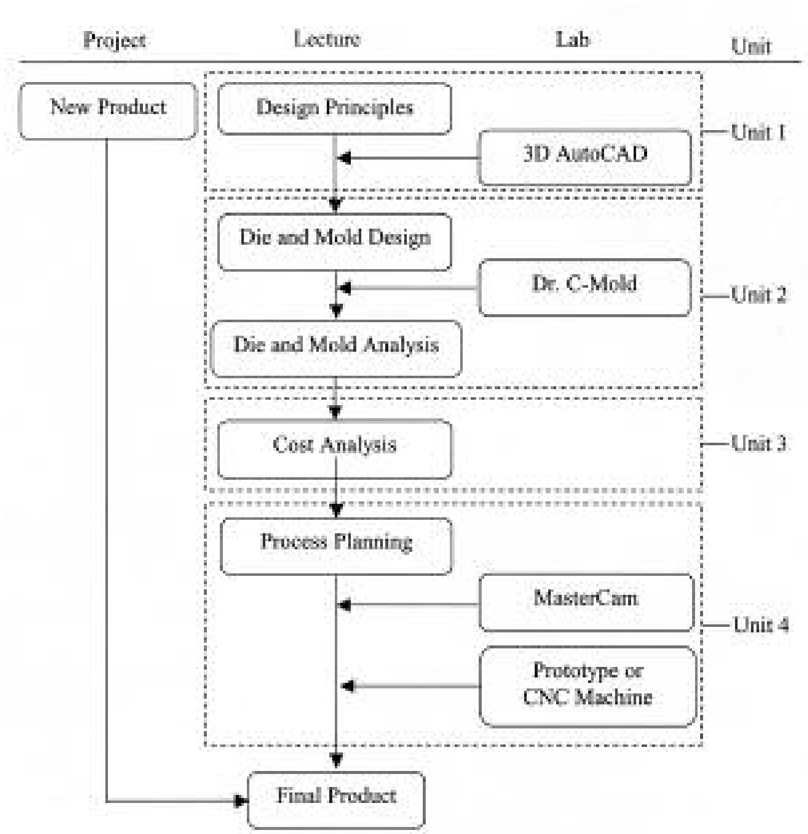
In today's fast-paced world, everyone is looking for the leading edge to become, and stay, competitive in the market. To garner market share, the product must satisfy and delight customers. To achieve this objective, design becomes one of the most important aspects for the product. Design is the first and fundamental step in building and constructing everything. The cost to operate the design department in each company may contain only 5% of a company's budget. However, 70% of the final product costs are influenced by the design (Boothroyd et al., 2002). In today's competitive market, the customer demands a good design with a competitive price. Therefore, in order to compete successfully, the customer has to be satisfied. With a good design, up to half of customer demand has already been fulfilled. Furthermore, a good design can also help enhance quality of the part, increase productivity, and reduce costs in manufacturing and assembly processes.

A manufacturing system is a complex arrangement of physical elements, such as machines, tools, people, and material handling devices, which could be measured by the production rate, inventory level, or percentage of defective rate (Black, 1991). Although the research and design department is not generally within a manufacturing system, the interactions between design and the manufacturing system significantly affect product cost, product quality, and productivity within a company. Therefore, a knowledge of design for manufacturing (DFM) has become a new trend for manufacturers and demands that technology educators include DFM content in their existing design curriculum. According to Boothroyd et al. (2002), DFM is concerned with understanding how product design interacts with the other components of the manufacturing system and in defining product design alternatives that help facilitate global optimization of the manufacturing system as a whole.

In 1995 the American Society of Mechanical Engineers (ASME), with funding from the National Science Foundation, published the results of a study that examined curriculum changes needed to more effectively integrate elements of the product realization process into the education of engineering or technology students (Przirembel, 1995). The premise for this study was the realization that the lack of manufacturing and design capabilities in U.S. industry today is a critical factor in the decline of the nation's international competitiveness. Sixty-six senior managers from 33 companies were asked to rank a list of 56 different "best practices" as to the importance of each topic to both new mechanical engineering graduates and experienced mechanical engineers. In addition, this same list of best practices was sent to all accredited mechanical engineering departments in the United States where academic representatives were also asked to rank these topics in order of importance. Teams/teamwork was selected by over 90% of the industry respondents and the academic respondents. Eighty-eight percent of the industry respondents indicated that DFM was somewhat important or very important.

The team approach allows all employees who are working on a product to act as one team in order to achieve the common goal of manufacturing a quality product in less time and at reduced costs. If a company wants to develop a world-class manufacturing operation, it has no choice but to view design and manufacturing as a single conceptual process, which DFM can do. DFM is a cutting-edge improvement program that can reduce labor, material, and mass requirements without sacrificing the integrity of product or process (Boothroyd & Dewhurst, 1990).

Figure 1. The DFM curriculum module.



In industrial manufacturing, metal casting and plastic injection molding processes are the two most common and most important techniques used to produce parts. Both techniques are used in creating the basic profile of products for advanced manufacturing processes. Before casting and injection molding can be done, a proper mold has to be designed. A good mold design can improve the ease of manufacturing and enhance the quality of a part. Therefore, the conception of designing a good mold becomes very important (Cheremisinoff, 1990).

The purpose of this study was to develop a practical curriculum module to communicate the ideas of DFM. This curriculum is designed for students at the senior level. Since students have a strong background of industrial technology (IT) in the design and manufacturing phases, knowledge of DFM will enhance the students' ability to involve themselves into the strategic planning level in their future employment. For the students of IT, an understanding of DFM becomes very important for them to integrate the knowledge of design principles and manufacturing processes. This curriculum will help students understand how DFM works in the industrial field and how to construct a new product from design through the manufacturing phase.

DFM Curriculum Module

The DFM curriculum module integrates the design principles, the design of injection molding, cost analysis, and the manufacturing processes. Figure 1 shows the architecture of this module. The goal of this curriculum is to assist students in creating a new product. The principles of DFM are applied to generate the idea of the new product.

The curriculum development of DFM can be separated into four units, which contain both lecture and laboratory sessions.

Unit 1—Design principles: The objective of this unit is to illustrate the importance of design and DFM. To this end, 3D AutoCAD drawing technology is applied to assist the product design.

Unit 2—Die and mold design and analysis: The objective of this unit is to focus on the design and analysis of injection molding. The design principles of injection molds are discussed first to generate the ideas of designing an injection mold. The application of C-mold software is the focus of discussion in this unit. C-mold software is a powerful tool used to analyze the mold design for injection processes. It can analyze the pressure, temperature, cooling system, molecular orientation, weld line, and air trap of the injection mold before it is fabricated.

Unit 3—Cost analysis: The objective of this unit is to estimate the cost of fabricating the product. The differences between fixed and variable costs are introduced for the preparation of total cost estimation. The principles of engineering economy are applied to estimate the total and unit costs, identify the break-even point, and decide the proper price for selling. In the discussion of engineering economy, a cash flow diagram and interest formulas relating present and future equivalents and also annuity to its present and future equivalents are focused on to understand the method of cost estimation.

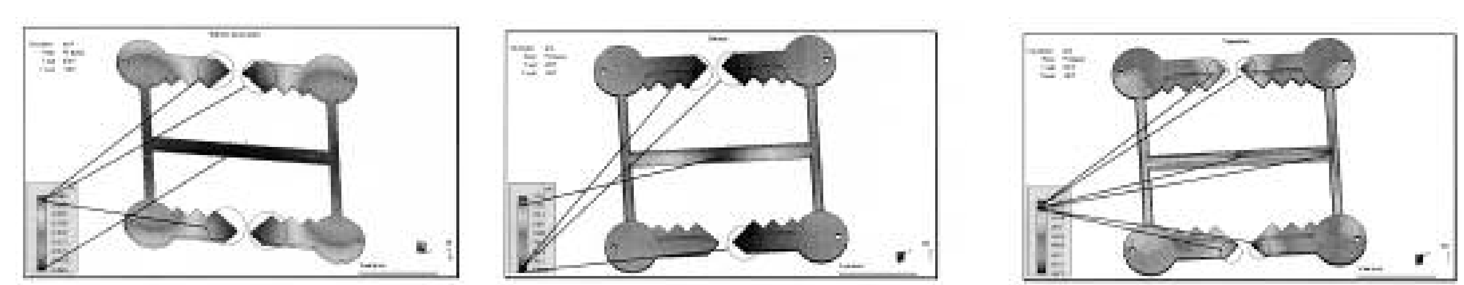
Unit 4—Process planning: The objective of this unit is to discuss the proper machining processes for manufacturing the die and mold. How to optimize the machining parameters for milling operations, such as spindle speed, feed rate, and depth of cut, are discussed. The MasterCam software is applied to create the tool path of a 3D model and then generate the NC program. Finally, the NC program is installed in a CNC machine to cut the mold.

Case Study

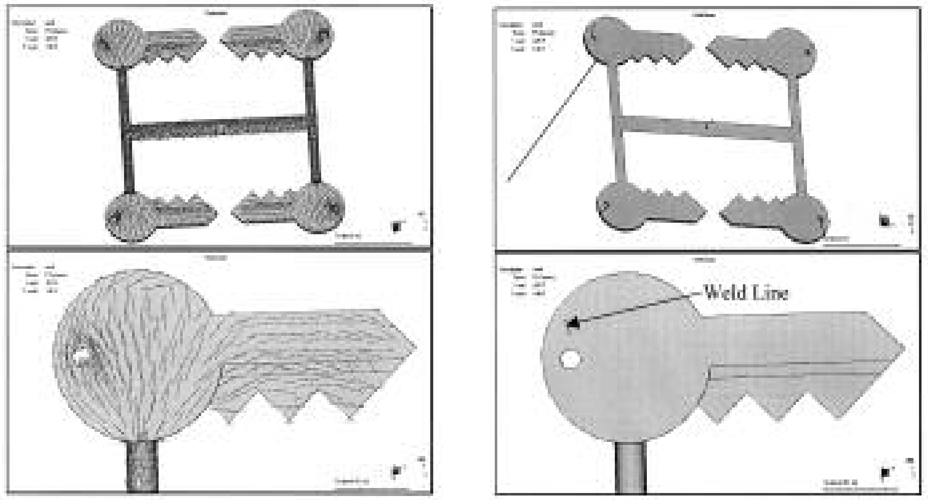
Identify Needs

Several items needed to be considered in designing the product. The first item was to understand the need of the

Figures 2, 3, 4. Results of melt front advance (2), pressure (3), and temperature analysis (4).



Figures 5 & 6. Results of molecular orientation analysis (5) and weld line analysis (6).



customers to decide the design of the injection mold. Basically, the product had to be inexpensive to make, manufactured in large numbers quickly, and something that Iowa State students would like to have. With these considerations in mind, we decided to make small key chains with Iowa State printed on them.

This product fit the criteria we were looking for. Once the product was decided, the design of the injection mold was considered. To quickly produce a lot of key chains, a mold with four keys was designed for this project.

Die/Mold Design

The next decision was to decide what program should be used to translate the free-hand sketch to create the blueprint for further application. AutoCAD software was applied to draw the design. We chose AutoCAD because it has very good drawing capabilities and it is also very easy to export the file created by AutoCAD into MasterCam for future cutting path generation.

Analysis by C-Mold

The next step was to analyze the characters of the mold. C-mold software was applied to analyze the characters of the designed injection mold. The following steps indicate the results of each character of this mold.

Step 1—Analysis of melt front advance: The results of the melt front advance (shown in Figure 2) simply show the flow of the molten polystyrene at the completion of the injection stage. This graphical analysis allows the user to determine if the cavity or cavities have been completely filled or if a short shot has occurred. This also shows the user if any voids have been left in the part. The time required to fill each section of the cavity can also be determined by this analysis. The dashed circles indicate the corresponding time of the scale located inside the lower left corner of the figure.

The analysis of the melt front advancement for our design was ideal. The melt front advancement was equal in all four cavities for all times, indicating that the design was well balanced and that there should be no problems filling or over packing the mold. Also, the time required to fill the mold was relatively short, leading to a low cycle time.

Step 2—Analysis of pressure: The pressure analysis (shown in Figure 3) indicates the amount of pressure at specific parts of the molded part at the end of the injection cycle. It is ideal to have a gradual increase in pressure at the injection point as the part begins to fill.

The analysis of our design was acceptable. We had a maximum pressure reading of 2018 psi at the injection point. The other parts of the design had a gradual reduction in pressure as the flow length increased. This was not a problem because there was not a large amount of variation in the pressure readings of each cavity (approximately 500 psi).

Step 3—Analysis of temperature: The temperature analysis (shown in Figure 4) points out the spatial temperature variation throughout the part at the end of the injection stage. Generally, the greater the variation the greater the amount of warpage that can be expected.

The analysis of our design showed an overall temperature difference of 2.5 ºF. With such a small change in temperature distribution, we expected to have a part with little or no warp.

Figure 7. Result of air trap analysis.

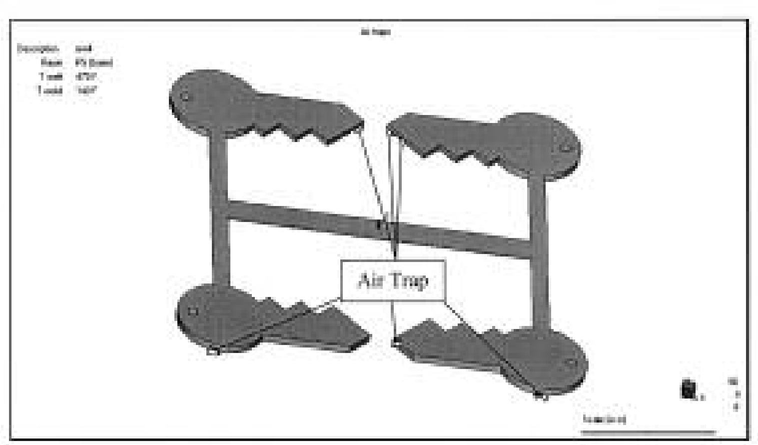


Table 1. Summary of Cost Estimation

Cost Item	Total Cost	Annual Cost	Frequency per Piece	Unit Cost
1. Machine	$45,000	$14,376*	50,000	$0.2875
2. Die and mold	$4,500	$1,440*	50,000	$0.0288
3. Design & analysis	$480	$160*	50,000	$0.0032
4. Maintenance		$1,000	50,000	$0.0200
5. Setup		$60	50,000	$0.0012
6. Machining	$20/hr	$2650	50,000	$0.0530
7. Material	$0.7/lb		0.2 oz	$0.0200
Total unit cost				**$0.3937**

* The interest formulas relating present and future to its annuity equivalent values are applied to calculate the annual cost (Paul Degarmo et al., 1997). The effective interest rate per interest period is set at 20% and the service life of this product is 5 years.

Table 2. Matching Parameters and Sequences

Sequence	Description	Spindle Speed	Feed Rate	Depth of Cut
1	Rough cut the whole mold (1/4" end mill tool)	2290 RPM	15 in./min	0.050 in.
2	Finish cut the key part (1/8" end mill tool)	4580 RPM	5 in./min	0.010 in.
3	Finish cut the running system (1/8" ball mill tool)	4580 RPM	5 in./min	0.010 in.
4	Finish cut the letters (V-mill tool)	8000 RPM	5 in./min	0.005 in.

Step 4—Analysis of cooling: The cooling analysis provides information about the time required for a material to reach its heat deflection temperature based on the design. This is important because cooling time is the most time-consuming stage of the injection process. The ability to optimize the cooling time by changing the mold design can be achieved through this analysis.

The analysis of our design revealed virtually no difference in the cooling time for any part of our design. We achieved this by keeping a uniform thickness throughout the part whenever possible.

Step 5—Analysis of molecular orientation: The molecular orientation analysis (shown in Figure 5) shows the orientation of the polymer molecules on the surface of the part at the end of the filling stage. Essentially, extreme differential of orientation will cause a differential in shrinkage, thus causing the part to warp.

The analysis of our design showed a gradual change in the direction of orientation in our parts. This was a critical issue along the flow path of the key, where the part would be likely to warp. However, the molecules orientated along the flow path of the key were almost parallel to each other.

Step 6—Analysis of weld line: The weld line analysis (shown in Figure 6) provides the formation of weld lines during the simulation. This information can be used to relocate weld lines and to eliminate them. Malloy (1994) defined weld lines as follows: “Weld lines (or weld planes) are formed during the mold filling process when the melt flow front separates, and recombines at some downstream location” (p. 47). Weld lines look like cracks on the surface of the molded part and generally are the weakest areas having potentials of failure.

The analysis of our design showed four weld lines for our design. The weld lines were caused by the hole in the end of the key. This was of some concern to us because a key ring was to be put through the hole, applying force that would cause stress on the weld line. To handle this slight problem, we had two options. First, for the small price that the part would sell for, long-term reliability was not an issue. Second, we could have found a low-cost semi-crystalline material that was not as sensitive to the structural inferiority at weld lines associated with amorphous materials.

Step 7—Analysis of air trap: The air trap plot (shown in Figure 7) shows the areas of the design that may require venting. The plot shows the areas where air is likely to be trapped inside the mold. If the air is not vented the possible defects are short shots, or burn marks, on parts.

The analysis of our design showed that we needed to vent our mold at two areas on each cavity. This was not a problem or of any concern, as all molds have to be vented to allow air to escape.

Analysis by Cost

As the design and analysis of the injection mold was finished, the next step was to estimate the cost of production and make an evaluation of the sale price of each product. For design and manufacturing engineers, the analysis of alternative production methods of a part, or a product, is faced with cost variables related to materials, direct labor, indirect labor, tooling, and invested capital (Bralla, 1999). Table 1 shows the summary of the cost estimation.

The direct unit cost of the key chain was about $0.39/unit. However, the indirect cost, such as management, transportation, and advertisement, also needed to be considered (DeGarmo, Sullivan, Bontadelli, & Wicks, 1997). We supposed that we would get a 5-year contract, which needed to produce 50,000 key chains per year. The indirect cost was set at 20% of the direct cost. Therefore, the total cost (TC) of the product now equaled:

TC = ($0.39*50,000)1.2 = $23,400.

We wanted to achieve a 30% benefit from the total cost. The total price (TP) of each year could be expressed as:

TP = $23,400*1.3 = $30,420.

The price of each key chain (UP) would be:

UP = $30420/50,000 = $0.61/unit.

Process Planning

The final procedure of the DFM project was to plan the machining processes to fabricate the mold. To optimize the machining processes, the proper machining parameters had to be decided first. A carbide tool was used to cut the mold. Table 2 shows the information of machining parameters and machining sequences.

MasterCam software was applied to create the cutting path and NC program for a CNC milling machine after all parameters were decided. The CAD drawing was directly imported into MasterCam to generate the cutting path. The machining parameters shown in Table 2 were used for each operation. The verification function helped us to evaluate whether the cutting path generated was proper or not. After the cutting path was decided, the NC program was obtained and then used in the CNC machine to cut the injection mold. Thus, the project was prototyped and evaluated throughout this process.

Conclusions

Although design and manufacturing generally are two different departments, the development of a DFM curriculum provides the opportunity to integrate design and manufacturing. This module was created to help students to learn how to design a product from its concept to a realization of the actual part, what to look for in the design, what type of material to use, how to estimate the overall cost of the final part, and how to produce it. For students who graduate from an IT department, it is very important for them to understand how to integrate the courses they have completed. The DFM curriculum provides the students the knowledge necessary to communicate valuable ideas to the design engineer. It also provides an opportunity for them to understand how to apply their knowledge in the future in both the design and manufacturing areas.

Bernie Huang is an assistant professor in the School of Technology at Georgia Southern University, Statesboro.

Joseph Chen is a professor in the Department of Industrial Education and Technology at Iowa State University, Ames, and is a member of Alpha Xi Chapter of Epsilon Pi Tau.

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Developing a Technology Management Curriculum from the Perspective of Strategic Intent

Al Bellamy, Pamela Becker, and Paul Kuwik

Universities throughout the country have become increasingly aware of the competitive environment in which they exist. The emergence of such functional units as extended degree learning programs, satellite extensions, online courses, and corporate education programs and a substantial increase in marketing and advertising campaigns attest to this age of competitive enlightenment. Recent and emerging demographic changes in birth rates and age distribution along with the emergence of colleges that utilize nontraditional delivery methods of educational services are capturing the attention of an increasingly limited pool of students, presenting a real threat to institutional homeostasis. Accordingly, institutions of higher education, similar to their private enterprise counterparts, find themselves with the unfamiliar task of *strategically* competing for students. It is imperative that universities understand the authenticity of this competitive environment and the entropic forces that it produces. Similar to the private sector, universities must realize the importance of developing programs and services that will not only sustain institutional integrity but also lead to competitive advantage. As Levine (2000) stated:

> The survival of some institutions… will be increasingly threatened by both domestic and foreign for-profit institutions, as well as nonprofit competitors like libraries and museums that also have entered the educational marketplace. Moreover, technologies are encouraging the rise of global universities, which transcend national boundaries. The most successful institutions will be those that can respond quickest and offer a high quality education to an international student body. (p. 14)

Many different types of organizations are seeking ways in which to strategically utilize technology as a way to enhance their operational effectiveness and efficiency and to gain competitive advantage. However, there is a paucity of technology management programs within universities and colleges that offer comprehensive instruction on this topic. The absence of such programs represents an opportunity for academic institutions to respond to a significant environmental need through the development of a technology management program.

This article has two primary objectives. The first objective is to provide a basic definition for technology management. There is a lack of common understanding and definition of technology management within the academic community. Technology management is more than just a conglomeration of courses. It has an identified body of knowledge that can be taxonomized and operationally defined. Technology management reflects the need to identify and comprehend radical changes that are occurring at historical, technological, and institutional levels of analyses that few perceive with clarity. We contend that it is precisely the ambiguity inherent within the current informational technology revolution that has created a critical need for programs that clarify, illuminate, and serve as a heuristic guideline for practitioners attempting to navigate their organizations through relatively unknown contours of the information age.

The second objective is to discuss how a viable technology management program can be used as a strategy for responding to student-client demands for management programs relevant to technology. We will attempt to describe the need to develop programs within the framework of *strategic intent*, a concept developed by Hamel and Prahalad (1993), which emphasizes the importance of systematically integrating strategy and implementation processes to effectively accomplish organizational objectives directed towards obtaining strategic advantage.

Technology Management Defined

Even though there is empirical evidence that most private and public organizations perceive technology management as something that could help to improve their operations, there is no common or comprehensive interpretation of its meaning found among practitioners and academics (Steele, 1989). Technology management "links engineering, science, and management disciplines to address the planning, development, and implementation of technological capabilities to shape and accomplish the strategic and operational objectives of an organization" (Manufacturing Studies Board, 1986, p. 1). An axial idea inherent within this definition is that technology management is an interdisciplinary field of study. A point to be made here is that the interdisciplinary nature of technology management is more than an academic construct or another cross-functional team approach within management. Rather it is a radically different conceptual and methodological management framework that addresses the critical need to understand the convergence between the idiosyncrasies of an information society and new modes of organization. The industrial era featured vertical and horizontal fragmentation of tasks and coordination as the primary means of organization. This mode of production represents not only the structure of management practice but consists of the superstructure that permeates institutional, cognitive, and individual action. In short, it became the *industrial paradigm*. This deeply ingrained mindset is a major factor contributing to the inability of individuals to perceive and understand the new integrative principles that are inherent within the information history. This in turn has promoted a fragmented and myopic viewpoint of technology and how it is managed. Steele (1989) stated that there is a

> definite need for an integrated view of technology, which in turn treats it as a closely linked system. This system spans the spectrum from creating new knowledge to servicing a product after it is sold. It includes the work to invent and develop products, the processes needed for their manufacture or delivery to customers, and the information processing inherent not only in all of these activities but also in the functioning of an entire business. Technology pervades all aspects of an enterprise, and effective management must recognize its pervasiveness and its crucial role in establishing competitive advantage and even survival. (p. 6)

This new integrative perspective of both technology and management has been extremely difficult to grasp, not only among practitioners, but also within academia, whose educational structures, in fact, also reflect the orientation of the industrial paradigm. More specifically, academic processes are organized according to highly fragmented fields of study or disciplines. What emerges from this fragmented context is an academic orthodoxy that implicitly describes an approach for creating courses that appear to be addressing environmental directions and needs. The outcome, however, is normally a disjointed and fragmented course program that does not comprehensively satisfy environmental concerns. This is due in large part to the lack of development of an identified body of knowledge. Universities recognizing the need to incorporate some aspect of technology management into their curriculum, particularly for their technical programs, have traditionally added one or two courses within already existing programs of study. For example, Stanford University added management training to engineering, Massachusetts Institute of Technology has chosen to integrate management and engineering, and Harvard University has chosen to incorporate technical awareness into its management programs (Bahouth, 1994). However, technology management and the knowledge objectives that it addresses are far too complex for this fragmented approach. It is not one or two courses that can be integrated into existing curricula. Rather, technology management is a discipline in and of itself (Ulhoi, 1996) that contains an interdisciplinary body of knowledge, and when considered as a whole, is far greater than the sum of its disciplinary parts.

Technical Management vs. Technology Management

It is commonplace for technical departments within colleges or schools of technology to define technology management as technical management. However, there is a distinct difference between technology management and technical management. Technology management seeks to:

- Integrate the knowledge of relevant disciplines into one interdisciplinary approach, thus imparting a more comprehensive understanding of the management of technology.
- Develop a macro perspective of the interface between technology, organization, and management.
- Create a broader perspective of technology that goes beyond the boundaries of one's technical orientation.
- Develop technology management skills that are applicable to nonindustrial settings as well as industrial settings.

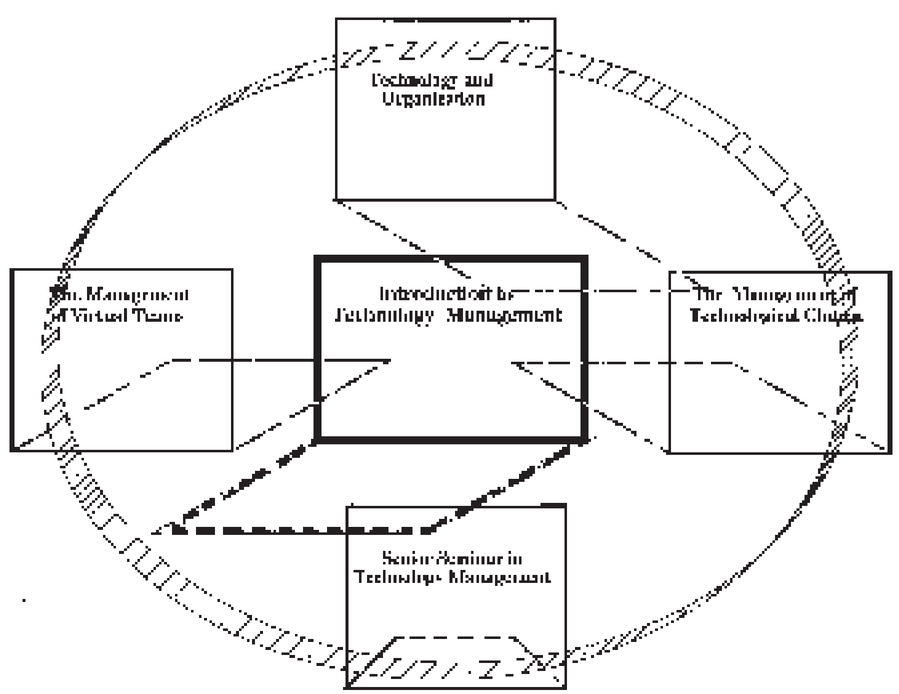
Technical management, in contrast, is much more narrowly focused within its knowledge base. Its objective is to create an *understanding* of management principles *within* a certain technical area such as engineering or industrial technology. Management topics such as project management would receive considerable attention within technical management. While *technical skills* such as project management would be incorporated within a technology management curriculum, they would be subordinate to its objective of developing cognitive abilities for understanding the new management genome of the information age. This cognitive framework is expressed in Figure 1. This figure describes the need for students to possess an *integrative* understanding of technology and management. More specifically, the wheel circle connects each of the courses and indicates that each of the courses is not an isolated topic of knowledge. Rather, the information that is presented within each course is systematically integrated to the core themes of technology management. This integrative understanding is imperative for managing the paradoxes that exist within the information society. These paradoxes consist of the simultaneous coordination of:

- Organizational stability and change.
- Quality and work process efficiency.
- Organizational flexibility and standardization of work processes.

These management dichotomies were recognized within the industrial management paradigm as conflicting forces. Within the information age, they are perceived as elements that must be simultaneously integrated in order for an organization to be effective. Indeed, they form the bases for strategic and competitive fecundity (Burgelman, Madique, & Wheelwright, 1995). Technology management concerns itself with the creation of conceptual frameworks that provide instruction on the basic elements of this integrative managerial viewpoint. It further enunciates the ways in which technology can be systematically utilized by organizations as a strategic lever for integrating this dimension into their processes.

Technology management should be approached much more systematically. Systematic program development would include the development of an entire curriculum on this topic and not just a few courses haphazardly scattered throughout the university. Most important, technology management should be thought of as a strategic initiative for the university or schools of technology. We will now direct our attention to this idea.

Figure 1. An integrated technology management curriculum.



Strategic Intent and Technology Management

It is well recognized that technology management is a vital skill set for the modern manager. Universities are supposed to be the training fields where managers are prepared for future battles (Bahouth, 1994). Currently, however, there is a discrepancy between what organizations require of their managers in terms of this skill and what universities actually offer. This void within the environment should be seen as a strategic opportunity for universities. Strategy refers to how an organization manages its relationship with its environment (Robey, 1995). Strategic intent relates to creating strategies with the objective of winning (Hamel & Prahalad, 1993). While universities are familiar with strategy making, the idea of directing this activity towards other educational entities with the "intent" to gain competitive advantage is unfamiliar territory.

The most salient idea underlying strategic intent within the context of this article is that it emphasizes the need for universities to devote more than marginal attention and resources to developing their technology management curriculum.

> The concept also encompasses an active management process that includes: focusing the organization's attention on the essence of winning, motivating people by communicating the value of the target, leaving room for individual and team contributions, sustaining enthusiasm by providing new operational definitions as circumstances change, and using intent consistently to guide resource allocations. (Hamel & Prahalad, 1993, p. 22)

In short, in addition to first recognizing that technology management could be used to ascertain competitive advantage, the key to effective deployment would be to systematically link its strategic intent and its implementation to daily management practices (Mintzberg, 1994; Witcher & Butterworth, 1999).

A General Framework for Establishing Strategic Intent for Technology Management

Modern day organizations face a very dynamic environment for which it is imperative to rethink antiquated strategies that were more aligned to stable conditions. In general terms, this environment requires strategies that will deal with the issues of:

- Flexibility
- Innovation
- Product cycle time
- Quality

Table 1. Proposed Technology Management Curriculum Core of Courses.

Course 1 Introduction to Technology Management	Course 2 The Management of Technological Change	Course 3 Technology and Organization	Course 4 The Management of Virtual Teams	Course 5 Senior Seminar in Technology Management
• Linking the Environment, Technology, & Mgt. • The Interdisciplinary Structure of Tech. Mgt. • The New Management Paradigm • An Overview of New Manufacturing Technology and Management • An Overview of New Information Technology and Management • Theories of Technology Management	• A Socio-Technical System Approach to Techn. & Organizational Change • Strategic Intent and Technological Change • Technology Planning and Implementation • Human Resource Mgt. and Technological Change • Quality Processes	• Technology and Departmentation • Organizing for Flexibility • The Matrix Organization • The Meta-Business • Platform Teams • Information Tech. and New Org. Designs	• Characteristics of Virtual Teams • Computer Mediated Communication • Electronic Coordination Mechanisms • Analyzing Groupware • Managing Telecommuters • New Supervisory Practices	• The Strategic Management Process • Developing Strategic Intent in Tech. Mgt. • Project Mgt. & Information Technology in Strategy Implementation • Senior Project

The authors will attempt to establish a conceptual discussion on technology management relative to strategic intent by utilizing these concepts as guidelines.

Innovation and Quality

Strategically speaking, the innovation of products and services is intended to create global leadership for an organization among its competitors. The authors strongly believe that a technology management program can create this result for a university if packaged correctly. Quality factors dictate the content of the program. Quality would pertain to the need for creating a program that fully addresses the concerns of the external client while simultaneously maintaining a clear sense of academic integrity. Although courses exist within several disciplines that reflect some dimensions of technology management, a core of classes is needed that more fully represents the integrative nature of technology management.

Table 1 illustrates an example of the type of courses that this core could comprise (this core may be utilized at the undergraduate or graduate levels). Taken altogether, these courses emphasize the need to explore technology, management, and organizational change at deeper levels of analyses than traditionally practiced. This is a dimension that is unquestionably missing within many programs, yet is critical for shedding light on the new management paradigms of the information age. The first course within this core, Introduction to Technology Management, sets the conceptual framework for the entire program by attempting to delineate the processes of aligning history, technology, and social organization that is imperative to understanding effective organizational change within the 21st century. It also provides a broad understanding of the impact of new technology on management systems and processes. (For example, what is the impact of new developments in bioengineering on the food industry and what impact does it have on the ability to obtain strategic advantage?) While various courses are offered in other disciplines that relate to these factors, they exist in isolation. This course brings these ideas together in *one* course with the *specific* intention of integrating them into technology management.

Course 2 describes the structure and processes for systematically planning and implementing technological change. This course integrates micro, intermediate, and macro levels of organizational analyses. Course 3 provides an overview of how to strategically align technology and organizational design. It represents the macro approach to technology management.

This core provides more comprehensive coverage on emerging technological topics such as “virtual teams” (Course 4). This topic is so new that it questions the fecundity of traditional management frameworks and principles currently being taught in colleges of business. It certainly deserves more than the peripheral attention commonly given within management courses.

The primary objective of the final course within this sequence of core classes, Seminar in Technology Management, is to give students the opportunity to integrate the knowledge ascertained within the other four courses. This will be accomplished by using experiential group projects that realistically simulate the integrative management perspective of technology management. Creating linkages between corporations and other organizations with this course will greatly facilitate the realism and learning objectives of these projects. The course will give comprehensive instruction on project management. However, project management is deployed within this class as a technological lever for accomplishing the group projects as opposed to a stand-alone course.

The authors feel that this core balances the need for academic integrity and practical relevance. Equally important is its ability to incorporate both manufacturing and service-type organizations. The majority of technology management programs are directed at the manufacturing/engineering market. The service sector accounts for approximately 70% of the gross national product within the United States, and it also utilizes around 80% of all information technology equipment and software produced (Bahouth, 1994). However, the service sector has been relatively unrecognized within technology management. Approaching the service sector definitely has the potential of affecting strategic advantage (Porter, 1994).

Another salient dimension of quality pertains to the importance of actively interfacing with external organizations for determining their technology management needs. This means that universities will have to take their product *to the market*, which challenges traditional expectations that the market will accept whatever universities produce. As stated by Fawcett, Smith, and Cooper (1997),

> firms fail in their quest for competitive success because they too often fail to recognize and understand customers’ real needs—making the identification of appropriate competitive priorities very difficult—and they are unable to focus their efforts and resources on activities that add real and distinctive value. The essence of competitive success can thus be summarized as selecting customer appropriate strategic priorities and then developing the corresponding operational excellence that leads to high levels of customer value. (p. 411)

Although the authors are referencing the private sector, these comments are directly applicable to institutions of higher education. This requires the need to strategically create flexibility within the university’s operating structure and delivery system.

Flexibility and Product Cycle Time

Flexibility refers to an organization’s capability of adapting rapidly to the demands of its environment (Cambell, 1998; Upton, 1995). This encompasses the ability to:

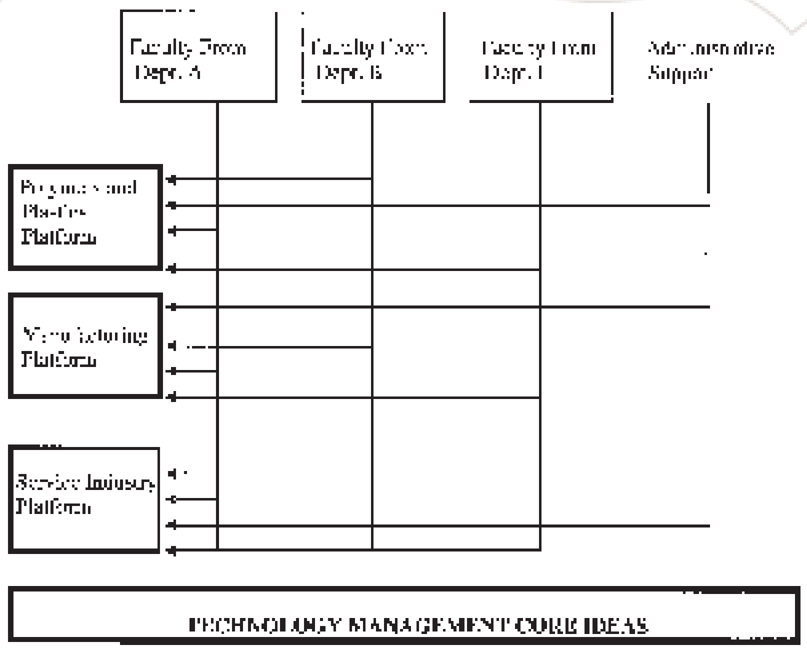
1. Produce different services and products simultaneously.
2. Alter the rate in which services and products are produced.
3. Adapt to varying delivery rates of services and products.

The organization’s structure, processes, and technology primarily affect these dimensions of flexibility. The highly fragmented and specialized structures commonly found within academia are not amenable to establishing the flexibility that is needed to adapt the technology management core (and electives) to the specific demands of varying clientele. Furthermore, it does not facilitate the reduction of cycle time, which is clearly a strategic factor. Product cycle time refers to the time it takes to design a product or service, test it, and deliver it to the market or client. These concepts as they apply to academia relate to developing and delivering new programs. Fragmentation of structure also undermines this capability. The problem is accentuated by course adoption polices, organizational culture, and political battles commonly found among academic disciplines involving the protection of subject domain.

Establishing strategic intent for a technology management program would involve radical changes within academic structures in order to create processes that would lead to flexibility. This would require the development of true interdisciplinary structures that would integrate relevant knowledge and processes and reduce the time for program development and delivery. Using private industry as an example, Chrysler’s platform team structure, which consists of individuals representing all the relevant functions for designing, prototyping, and manufacturing a line of automobiles, has enabled the corporation to secure competitive power though innovative design and the reduction of product design cycles (Kisiel, 1998; Lutz, 1994). Universities can accomplish similar outcomes with a technology management program by developing interdisciplinary platforms consisting of both faculty and support functions from relevant disciplines and administrative groups within the college and/or university aimed specifically towards identified client needs. This would allow the university to take better advantage of its “core competency” (Hamel & Prahalad, 1994) of diversified knowledge which in and of itself can be considered a strategic factor.

Figure 2 presents a hypothetical example of a platform team structure that is based on the objective of developing market-oriented technology management programs within the College of Technology at Eastern Michigan University. Three development platforms are illustrated: polymers and coatings, manufacturing, and service industries.

Figure 2. Model of a technology management platform structure.



Each platform would consist of faculty from relevant departments within the College of Technology who would be responsible for:

- Market analyses of the type of technology management programs that organizations within each sector are requesting.
- Utilizing the technology management core of classes as an organizing framework, develop customized technology management programs based upon specified organizational needs.
- Developing the administrative processes necessary to support the developed programs.

We recognize that there are a large number of administrative tasks and obstacles that must be systematically planned for in order to operationalize this type of structure. We don't have the space in this current article to discuss these matters. Our intent is to postulate a possible academic structure that would have the capability of supporting the dynamic processes cited within our framework of strategic intent.

Concluding Remarks

The ideas presented within this article are only intended to alert academic planners of the possible competitive benefits of raising their technology management programs to the strategic level. This will require systematic research on the ways in which other institutions are approaching this subject in order to accurately formulate a technology management strategy and objectives (Hitt, Tyler, Hardee, & Park, 1995). Universities have commonly focused on the advertising dollars spent by other educational institutions and have adjusted their advertising budgets accordingly. However, this is not a complete definition of competition. In other words, competing refers to competing for the future by creating innovative services and products that exceed those of the competitors. Technology management represents such a product.

Dr. Al Bellamy is an associate professor in the Department of Interdisciplinary Technology at Eastern Michigan University, Ypsilanti.

Pamela Becker is a lecturer in the Department of Interdisciplinary Technology at Eastern Michigan University, Ypsilanti.

Dr. Paul Kuwick is a professor in the Department of Interdisciplinary Technology at Eastern Michigan University, Ypsilanti. He is a member of the Delta Alpha Chapter of Epsilon Pi Tau.

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The Challenges in Teaching About Intelligent Building Technology

Joachim Dittrich and Ludger Deitmer

This article is based on a paper entitled "Bridging the Gap—Experiences and a Concept in Technology Education, Networks, and Regional Innovation in the Field of Intelligent Building Technology" presented at the International Conference of Scholars on Technology Education at the Technical University of Braunschweig, Germany, September 24-27, 2000.

Automation Technologies in Buildings—Benefits and Opportunities

The term automation technologies in buildings, or building automation (BA), refers to a continuum of applications involving buildings, information, and automation technologies implemented in buildings. This article starts with commercially used buildings, where the technologies are implemented for the following purposes: to reduce operating costs in terms of resource consumption; to centralize control of lighting, heating, ventilation, air conditioning, and the like; to conform with supplier contracts in terms of peak energy consumption; to ensure reliable operation of the systems; and to meet security needs with respect to operating hazards, break-in, fire, or flooding. It also discusses private homes, where comfort, security issues, probable energy savings, and the integration of alternative energies are matters of concern.

As indicated, modern information and automation technologies can contribute to the reduction of personnel costs to run a building, enhance the operational security of buildings, increase comfort, and ensure that limits on conditions such as temperature, air quality, and peak energy consumption are met. To a certain extent, modern information and automation technologies can also contribute to reducing the consumption of natural resources such as fresh water and energy by switching off lights when no one is in the room, by reducing energy input through solar radiation, and by coordinating heating, ventilation, and air conditioning systems. (In the building we work in, for example, we identified energy savings of around 30% for lighting thanks to automation using brightness sensors and motion detectors.)

Recent developments in the construction sector, namely the statutory restrictions (at least in Germany) of engery consumption for heating, have led to the emergence of so-called low energy buildings. Very little heat is lost through the enclosure, which is beneficial in winter. In summer, however, solar radiation penetrates the building through the windows, heating it up and making it necessary to provide for cooling since there is no heat transfer through the walls at night. Ventilation systems have to be installed because the impervious enclosure does not permit natural air exchange. Renewable energy sources are used to provide the small amount of energy needed for such things as hot water. However, solar energy is also used for heating and cooling (e.g., by means of adsorption machines). All these processes have to be coordinated. Photovoltaic systems produce electrical energy in a decentralized manner on the roofs of buildings, thus helping to avoid the use of nuclear or fossil fuel to operate power stations. They have to be coupled to the power net in terms of frequency and phase, and there must be a data capture system installed. Automation technology is frequently required to perform these functions in addition to the above-mentioned heat management. In these cases, some tasks cannot be performed by people because they would put too heavy a burden on the user; other tasks are carried out through automation for greater overall convenience.

These are the benefits, along with the necessities, of introducing automation technologies in buildings. Now we come to the opportunities. Instead of a lengthy discussion of added value concerning rental or sale, we wish to focus on regional markets, regional development, and employment. In these areas, BA technologies have the potential to supersede traditional electrical installations.The latter are normally supplied by regional small- and medium-sized enterprises (SMEs), at least in small- and medium-scale projects. But BA still is the domain of industrial suppliers, since work tends to be expensive and is therefore often subject to rationalization efforts. As we know from the construction sector as well as from process industries, calls for tender are published nationwide or even throughout Europe, thus removing economic potential from regional markets. If BA competencies existed at the regional level and if there were BA networks providing all the necessary services from planning and installation to operation and maintenance, a large share of the economic activities could be retained in the region. This could stabilize employment in the electrical trades, which nowadays suffer from declining orders as well as from falling prices in the construction sector (Deitmer, 1992).

Additional opportunities include: The competencies needed and acquired in the BA sector, which are of a systemic nature, may help to increase innovation potential in the building trades by demanding systematic and abstract learning processes and also by crossing the boundaries between trades. The competencies acquired and the structures generated in BA can support Agenda 21 processes (United Nations, 1999) because they require the same type of competencies and interactions between the actors to achieve extensive results. In public buildings and residential housing, energy conservation and reduction of CO_2 necessitate both a systemic view along with concerted action in building and housing projects that roughly account for 30% of the energy consumption[1] in Germany.

Obstacles to Technology Implementation

Several facts and attitudes have hindered development in BA applications. Some of them are described here to provide a clearer view of the concept presented in the following sections of this article.

Even managers of major providers of BA systems admit that the development of BA components and systems has not been sufficiently targeted to customer needs (Schneider, 2000). The same often applies to the planning and implementation processes that are insufficiently adapted to end-user requirements (Dittrich & Ritzenhoff, 2000). Further reasons for the stagnation of the market are seen in high prices, few benefits for the customer, an almost exclusively vendor-driven market, few service providers, and, hence, little competition in developing services. Schneider (2000) stated that now the time has come for a rapid development of BA markets: Users are well acquainted with information technologies; producers, vendors, and service providers have discovered the customer; the technologies can now provide surplus value by integrating various technical services; and the opening of the energy market brings in additional players (the energy industry), resulting in augmented competition in the BA service market and thus higher quality and lower prices.

But there is another reason that keeps small enterprises, such as craft trade businesses, away from the BA market. As we learned from several discussions with SMEs, there is a certain disinclination on the part of SMEs towards cooperation with large industrial firms, which still dominate the market of BA applications and installations. Indepe-ndence being one of the key values in the craft trade, small firms are afraid of becoming dependent on the large global players. As a consequence, there is little cooperation between large companies and the craft trades. Small firms are rarely engaged in carrying out large-scale BA projects,[2] a significant number of which are carried out for large commercial facilities, so the small enterprises are unable to gain experience and know-how in this sector. Therefore, it is difficult for them to become familiar with the technologies in order to offer them in smaller scale projects, such as for private homes or small commercial buildings. However, small firms could be competitive because of their proximity to the end user along with the lack of interest of large companies in small orders.

The same pattern applies to architects and technical planners involved in standard, smaller sized buildings. Because of lack of experience with the new technologies, they tend to advise their customers to order the proven, traditional technologies in the knowledge that they are less expensive and because they cannot assess the potential added value provided by modern automation technologies. Insufficient experiences might also cause uncertainty concerning guarantee issues as well as potential future customer satisfaction. In addition, it is still difficult, even for experts in the field, to give advice on a specific system that must also meet future requirements, be it European Installation Bus (EIB), Building Automation Control Network (BACnet), Local Operating Network (LON), European Home System Bus (EHS), or one of the DDC solutions.[3] The "convergence" initiative, which brings EIB, BACnet, and EHS together (Penczynski, 2000), the Process Field Bus (PROFIBUS) standard, which has been adopted by the majority of DDC manufacturers, as well as the new ISO 16484-5 standard (International Organization for Standardization, 2003), will most likely defuse part of this problem. Furthermore, there is little knowledge on the issue of amortization of investment in the new technologies. The key issue, however, is that in the past, planners in the sector comprising small buildings seldom advised their customers to buy and use modern BA technologies;[4] as far as we know, the same conditions exist today.

Another obstacle is the manner in which innovation and learning take place in the craft trades, especially in the construction sector. Here learning is incremental, linear, reactive, and by no means theory driven, as pointed out by Gann (1996) or specifically for the German situation by Brüggemann and Riehle (1996). This topic is discussed in detail in the following section.

Networking and Reflexive Innovation in and for Technology Education in Building Technology

Installation engineering is carried out after the innovation process itself takes place elsewhere. Innovations are implemented by the system developers of the building technology vendors (new supply technologies and new building management system [BMS] and building control system [BCS] products). Innovation is therefore disseminated following a linear model. Small enterprises in the electrical and the heating and plumbing trades have a more or less reactive role in the production chain. They receive much less formal technology training and education than the supplying system industry. They are organized in small workshops with little planning capacity and strong informal learning attitudes. Many new scientific and engineering methods have not yet diffused across the entire sector. Know-how continues to be transmitted through methods of apprenticeship, on-the-job peer group learning, or the study of examples found in existing buildings. Besides formal initial vocational training, the learning opportunities are very limited because of learning through practice. This "learning by doing" can be described as a process of repetition and continuous improvement on the job at the building site. Knowing that construction is a project-based activity, which produces the previously mentioned products—which are individual and hardly standardized, firms build their competencies on the provision of specialized and often quite narrow skills[5] and on resources that rely on expertise accumulated over many years.

Learning at the workplace and in the organization is therefore usually informal with many breaks and little feedback in the highly complex construction business process. Tasks often vary from project to project, and the site environment does not correspond to that in factories; examples include the seasonal nature of the work and building regulations that vary by region. The use of information technology in buildings (intelligent buildings) makes it clear that this systemic technological concept conflicts with professionalization, codes of practice, and the traditional craft trade demarcation lines upheld by trade unions and employees. On the one hand, we have an all-encompassing systemic technology that integrates all craft trades and on the other we have a "locked system" (Nam & Tantum, 1988), which has severe difficulties in coping with radical technical changes in construction. Traditional approaches to the transfer of know-how assume linear continuity of learning with minor changes and adaptations. However, continuity and linear models of technology education in vocational education and training (VET) institutions and in companies are called into question when radical changes occur, as was experienced with the need to install digital microelectronic technologies in buildings during the 1980s (Deitmer, Ritzenhoff, & Sproten, 1998). New competencies are required to exploit such technological opportunities. But construction firms in the craft trades are unable to respond by means of traditional, informal processes of innovation. The companies in the electronics and telecommunications sector have to move into the construction arena to fill the gap and, as argued here, in close cooperation and collaboration with the traditional construction firms. A networked approach is needed to strengthen both informal and formal processes of change and learning. Changes occur very frequently at interfaces between the specific craft trades. Therefore, a narrowing to a particular sector (such as solely for electricians) might be a mistake. Greater fluidity in the transfer of know-how between one business process activity and another is required.

Organizational changes have to be looked at and learned because many of the important innovations developed in the construction sector have taken place in organization rather than in technology (fast-track construction process management techniques, overlapping design and construction phases, and learning for each actor involved in the building construction process). Despite competition, the role and function of cooperation is found in the modern construction industry, especially in building up a learning culture facing new challenges of the market. This necessitates a re-consideration of companies as learning institutions (Lundvall & Borras, 1998). Craft trade institutions have to view themselves as learning organizations characterized by a capability of systemic reflexive learning. This refers to the ability of the company employees to reflect on core values of the organization and operate on the basis of cybernetic thinking and an organizational paradigm changing hierarchy to heterogeneity, which can provide multiple skills and experiences to cope with a problem. Such innovative learning behavior has to be enhanced by an innovative production cluster (Porter, 1990). These clusters encompass building users/investors, architects, technology planners and engineers, and system developers and providers, from software houses to technology component firms, construction companies, craft trade companies and their associated organizations such as chambers and craft trade guilds, regional R&D institutes, higher educational institutions such as polytechnics and universities that educate building engineers, and—last but not least—the vocational education institutions, both in initial and further training. For this reason an analysis of the production chain[6] is important to understand how technology education and training have to be based and initiated.

The structures described above are based on more hierarchical relationships. The point here is to develop heterogeneous structures in which regional networks act as loosely coupled information and dialogue-based networks. The relationships are based on trust, reciprocity, openness to learning, reliability, and a behavior that is inclusive and empowering rather than exclusive and disempowering. Obviously, these networks have to be moderated and somehow initiated by moderators and promoters. In our example, we argue in favor of the VET institutions, formerly known as competence and demonstration centers, as agents for this.

Regional networks are needed to define the training requirements, based on information from their members. Here we advocate a responsive and more interactive innovation model in which the specific conditions of these small enterprises are taken into account. In this respect qualified training and research institutions face the challenge of assuming their role as regional innovation and know-how centers and act as moderators between large building technology vendors (e.g., Landis & Staefa, Johnson Controls, Honeywell) and the many small enterprises in the installation engineering business. Sectoral innovation centers as part of these networks can furnish colleges with analytical background information on new developments and their energy effects on buildings. For more interactive innovation processes, which are very necessary for the successful implementation of BMS, the regional competence centers must create learning networks and innovative structures with their local companies.

In summary, we pointed out that companies still have great difficulties with these technologies because they are used to increment change and have problems coping with radical changes as those introduced with these new building technologies. They lack a comprehensive technical learning concept that helps them to adapt their view of their business. Raising awareness through information and demonstration of possibilities, as well as advice-oriented training models, is missing. Vendors offer scattered courses on specific technical problems or even courses on areas such as marketing, but integrative concepts that lead the firms directly out of their traditional learning situation do not exist. A modular training course concept that encompasses all the stages for full establishment of this technology in business is needed. Companies concentrate on the installation of new systems with little attention paid to the provision of services such as maintenance or to integration between design, system installation, and operation. Viewed from the standpoint of an existing craft trade company, the following requirements should be met:

- Determine potential/advantages/ cost benefits of building management services and facilities.
- Provide technical know-how on the new systems from a comprehensive vendor-independent view and thus the ability to combine and develop new skills among the employees in an installation enterprise.
- Establish competency guidelines for these companies in establishing a new service organization.

A Programmatic Concept for Technology Education and Implementation

Small enterprises, in particular local craft trades, have great difficulties in developing innovation despite the advantages of flat hierarchies and barely formalized communication structures. They suffer from little know-how regarding new building technologies, restrictions in terms of time and finances, and lack of business and market information, which impedes the diversification of products and processes as well as the necessary adaptation of organizational structures. To overcome the above-described deficits within the construction sector, it is necessary to provide specifically designed programs for technical education and develop cooperative approaches. In northern Germany some of the ideas are conceptualized in several competence and demonstration centers.[7] They are aimed at bridging the gap between technology developers/vendors and users from the construction trades. The central focus of these regional initiatives are network-like partnerships between craft trade enterprises and research and vocational institutions (Deitmer et al., 1995; Ritzenhoff & Deitmer, 1999). These regional initiatives use the support provided by regional, national, and European development and demonstration projects. All these projects[8] deal with specific problems concerning effective utilization of new technologies within buildings. The goals pursued by such projects can be summarized as follows:

- To build up new training infrastructures within selected regions in Europe in order to address know-how deficits and to remove innovation barriers erected by technical and social challenges. Product and process innovations in SMEs rely heavily on organizational and technical conditions and on the competence of managers and employees.
- To provide an environmentally sound technology. Minimizing use of energy and water resources in buildings, for example, should help to protect the environment through reduction of CO_2 emissions.
- To provide perspectives for new employment. The introduction of BCS/BMS systems offers a significant new area of work for the craft trades and for SMEs throughout the European Union. These companies are of particular importance for generating new employment opportunities in regional economies. Monitoring of buildings offers new perspectives in addition to classical installation work. BCS/BMS systems can provide data that may be analyzed to allow energy management, and these systems are the basis for technical facility management.
- Additional aims include improvements in several aspects of building security, thus enhancing user comfort.

Overall the activities are targeted at enhancing the skill base of SMEs in the installation and engineering sector in three dimensions.

1. The business dimension addresses the following competencies:

- To design, install, and apply technology for customer benefits.
- To handle quality standards for installation and design work.
- To manage the technology based on contractual cooperation with planners, building construction, and other trades.
- To create efficient management services for public and private buildings.
- To assess the potential of buildings concerning the optimal utilization of technology and actively offer advisory services to potential customers.

2. The technical dimension addresses the functional and practical aspects for competent technology design, implementation, and service. Key subjects include the following:

- Sensors and actuators, function, handling, and integration.
- Signal transmission, bus systems, and related tools.
- Management, control, and analysis software.
- BA system setup and control software.
- Technical equipment of buildings, function, handling, and integration.
- Systemic behavior of buildings, including overall and subsystem dynamics.

3. The work-oriented dimension focuses on work processes going on in craft trade enterprises. The central aim is to enable company personnel to interact with each other, with the customer, and with other trades and also to undertake various work activities to guarantee maximum appropriateness during technology implementation. Learning in the work process is an important issue and should be supported.

The methodological approach to training should be based on the following principles:

- The actual system is always the subject of the learning and innovation process.
- Learning situations are placed at different locations: regional demonstration houses as examples of good practice, regional competence and demonstration centers, and the company itself.
- The learner is instructed in taking planned autonomous action (selecting, applying, and reflecting on information).
- Projects are used to structure learning and teaching processes.
- Cooperative teamwork is supported through supervision and advice.

The tasks of the regional competence and demonstration centers include:

1. The networking of relevant local bodies and SMEs to provide research and development facilities and to encourage cooperative approaches to market development.
2. The provision of business information, cost benefit analyses, case studies on improved environmental benefits, and technical demonstrations.
3. The initiation of further development of technology and systems in direct contact with developers, planners, installers, and end users.
4. The development of new training programs for skilled workers in close cooperation with the regional actors from the BA field.
5. The development of learning material and concepts for different learning locations (center, work, home, Internet).
6. The provision of consulting services for individual small- and medium-sized enterprises and for consortia of companies in order to install adapted work systems that can perform these new tasks.
7. The provision of detailed marketing information material.
8. Promotion and awareness raising of SMEs, local authorities, and customers through planning and execution of promotional activities (e.g., exhibitions, seminars, regional trade fairs, and conferences in the partner regions).
9. Development of transnational networks (including SMEs) in order to stimulate technology transfer, know-how exchange visits, and cross-fertilization of ideas, including the publication, distribution, and dissemination of project results among European countries and regional enterprise networks.

The aim of the centers is to enable the regional craft trades to develop a new service infrastructure in the building management technology field. The project will encompass the whole range of activities related to the innovation process including human resource development, training, marketing, and the development of innovation centers.

Joachim Dittrich is a senior researcher at the Institute Technology and Education (ITB) at the University of Bremen, Germany.

Ludger Deitmer is a senior researcher at the Institute Technology and Education (ITB) at the University of Bremen, Germany.

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Notes

[1]In 1997 German energy consumption of households amounted to 30%; trade, commerce, and service consumed another 15.8% (BMWi, 1999), but not all of it was used for heating, lighting, and ventilation.

[2]Small electrical companies usually perform the cabling and installation of traditional electric devices as subcontractors, but they are rarely involved in planning and programming a BA system.

[3]DDC: Direct Digital Control. These are powerful, freely programmable automation units that are available from various manufacturers. A drawback is that they are largely based on proprietary standards and therefore interoperability with systems of other manufacturers may not be ensured.

[4]The situation is likely to change. Building contractors are beginning to offer pre-planned residential buildings equipped with BA systems and other modern technology, such as solar energy systems.

[5]Skills are specified in occupational profiles that are centrally defined within the dual German VET system and negotiated between the union and employer organizations. Problems in this connection are discussed in Heidegger and Rauner (1997), that is, the borderlines of these profiles that conflict with market flexibilization and dynamism.

[6]Analysis of the production chain includes the relationship between producers and suppliers and between producers and users, the role played by the government in setting standards and regulations and sponsoring R&D, and the way in which know-how is acquired through different learning processes.

[7]Under the auspices of the Institute Technology and Education, University of Bremen, Germany, several centers have been developed. The Center for Building Automation (ZGA), Bremen, based in a VET school, is aimed at supplying the Bremen region with training and advice for regional SMEs to assist them during the introduction of BMS/BCS technologies. They concentrate on initial training in this field. The intention is to provide vendor independent training in a laboratory that provides facilities from different systems providers. The Center for Energy Management in Neumünster shows local enterprises and other institutions how to make use of environmentally sound technologies. Similar processes have taken place in Rostock in the technical training bodies of the Chamber of Craft Trades. All in all a network of different actors from industry (important vendors of this technology), model demonstration houses, craft trades with building management technology experience, and university technical education institutes form a network of different institutions interested in opening up the market through a training, education, and innovation dialogue.

[8]One example of such a national research project is EcoSol: construction and evaluation of a new solar-optimized office and administration building in Bremen. The demonstration building is evaluated and optimized in terms of energy consumption (Ritzenhoff, Bräuer, Limberg, & Niemeyer, 1998). Transfer activities are conducted in connection with the local building trade as well as building investors, architects, and house users/customers. The project is carried out under the BMBF (Federal Ministry for Education and Research) program in solar architecture (see, for example, http://www.solarbau.de).

To Change Perceptions of Technology Programs

John W. Hansen

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Educational Program Quality

The classic definition of quality is "the ability of a product or service to consistently meet or exceed a customer's expectations." An important element of the definition, customer's expectations, requires further defining since customers value certain aspects of a product or service and they therefore associate those aspects with its quality.

Product or service quality has many facets. Quality might include the following elements:

- Performance or the main characteristic of the product or service.
- Aesthetics, which include the "look and feel" of the product or service.
- Special features of the product or service.
- Conformance or how well the product or service aligns with the customer's expectations.
- Safety, which includes the element of risk of injury or harm.
- Reliability or the ability to consistently deliver the intended results.
- Durability or the useful life of the product or service.
- Reputation of the product or service.

Different customers will have different expectations of a product or service based on the relative value they place on these components at a given moment in time. To make a determination of the quality of an educational program, one must identify the customers and their expectations of the program as they relate to the facets they deem most important. This is particularly true when a program, such as technology education, purports a significant change in it focus, content, and importance. In essence, the perceived quality of the new program will be influenced by the reputation of the program it has replaced, its academic home, and the faculty associated with the program.

Perceptions: The Startling Truth (Expressed on a University Campus)

- "I wish you guys would just keep teaching shop" (engineering technology faculty).
- "High schools must have a place to put low performing students" (trade and industry teacher educator).
- "A vital and important part of the university for giving students who don't succeed in business, engineering, and computer science a second chance" (director of university academic services).
- "Vocational education" (engineering department chair).
- "Occupational training program" (engineering faculty).
- "You don't have qualified faculty who can teach the newer technologies" (dean of the business college).
- "You are a blue collar college in a white collar university" (university's alumni organization).
- "The College of Technology is where you go if you don't know what you want to do" (nontechnology student tour guide).
- "Technology teacher preparation programs don't care and are nonproductive" (state administrator).
- "Not doing enough to recruit new teachers" (high school technology teacher).
- "Irrelevant" (dean of the college of education).
- "Teacher training programs are becoming increasingly irrelevant" (school district administrator).
- "Without serious scholarship, the unit does not contribute to the mission of the university, except in student credit hour production" (senior administrator of the university).

As I reflected on the comments, I realized that they all had different expectations of what technology programs should do and that these expectations were based on distorted mental images of technology education. I surmised that if I tried to improve the image of my program based on their responses, I would never win them over. In fact, if these indeed were the perceptions of our programs, we had already lost. In his summary of the events that led to the closing of an important technology teacher preparation program, Erekson (1993) said:

> Trying to speak objectively, it is not difficult to understand why the department was eliminated. The department had several open lines, the curriculum was outdated, and only a few faculty were involved in scholarly activities that were expected of faculty at the "flagship" campus in the state system. This is a chronology of what happened at Maryland and will continue to happen at other places where faculty do not update curriculum, are not involved in scholarship, and are not unified in their direction. (p. 16)

But, what about the facets of a program they do not know about? Aren't questions of quality related to past product perceptions and not to what ought to be? Expectations and statements of quality based on outdated models tend to perpetuate the perceptions and not reality. Is it possible to instill a new image of what technology education is or ought to be?

Mental Models

Mental models, as described by Senge (1990) in *The Fifth Discipline*, facilitate the organization and integration of complex dynamic events and discrete information into streamlined frameworks. We use mental models to summarize the myriad data and experiences we encounter for retention and rapid access. Limited amounts of information trigger the recognition of a pattern or similarity to other experiences (mental models). Rather than processing and analyzing all of the details of a new event, we make a leap of abstraction that this new event is similar to. We then draw conclusions based on our mental models, and our subsequent actions are based on those conclusions. Mental models are valuable when the assumptions and beliefs they are based on are appropriate and true and detrimental when they are based on false assumptions or the leap of abstraction is incorrect.

The legitimate use of mental models for decision making requires the ability to reflect on our strengths and weaknesses and to know how our experiences have shaped our mental models. This self-understanding is important because our perceptions and eventual actions are based on the mental models we hold. As technology educators, we must always intentionally challenge our mental models and those of our colleagues. Critical reflection and dialogue allow us to expose and correct the assumptions and constraints that our mental models may have assimilated. Critiquing our mental models can lead to decisions that will transform the way we teach, what we teach, and why we teach.

A Vision of Technology Education As It Ought to Be

A vision is an image of life as it ought to be or how we would like it to be. Reality is how life is. The discrepancy between our vision and reality can be reduced in one of three ways. First, we can compromise the vision: "That's just a dream, be realistic." Second, we can distort reality: "It's not that bad; they just don't know. We are the university's best kept secret." Third, we can progress towards the vision. The first two alternatives are unacceptable. To move from reality to the vision requires a clear understanding of the current situation and a clear description of the vision. We must be brutally honest about the present and eternally optimistic about the future.

The International Technology Education Association's (ITEA, 2000) definition of technological literacy is "the ability to use, manage, assess, and understand technology" (p. 9). In an exploration of my mental model of technological literacy (Hansen, 2001), I identified three statements that facilitated the process of defining the personal importance of technological literacy and technology teacher preparation:

- Technology can be a powerful tool for helping individuals achieve personal and shared goals.
- Technology ought to alleviate human suffering and promote social justice: to help people "make a difference" in their worlds.
- People must have the knowledge and skills to evaluate and decide on appropriate courses of action when confronted with problems.

A synthesis of these ideas produces the statement that technological literacy is an individual's ability to adopt, adapt, invent, and evaluate technological solutions to positively affect his or her life, community, and environment.

Technological literacy empowers people to live life well and to positively influence their environment. It enables them to not only do what they might not otherwise be able to do but also to become what they might not otherwise be able to become. It is the concept of empowerment that should guide the development and implementation of technological literacy programs. It is individual empowerment that unites the concepts and focuses my passion. Empowered individuals, as it relates to technological literacy, would exhibit several characteristics that clarify the concept.

I believe people who are technologically literate would:

1. *Perceive themselves as capable* of learning about technology to achieve specific objectives and extend their influence in the world, even when confronted with unknown and ambiguous situations.
2. *Exhibit a willingness* to (a) take control of their decisions, (b) invest time and energy in achieving solutions, and (c) take necessary risks to explore divergent options. In short, they would not, nor would they want to, leave these kinds of decisions to others.
3. *Have an adequate knowledge and skill base* to seek, evaluate, and implement technological solutions. They would be able to determine the discrepancy between what they know and what they need to know to achieve appropriate solutions.
4. *Rely on their abilities and knowledge to use technology* to meet personal and shared goals and to make a positive difference in the world.
5. *Reflect* on (a) how and why they use technology as they do, (b) how they and technology interrelate with their surroundings, and (c) the technological strategies they use to achieve their objectives.

Technological literacy fosters (a) self-efficacy, (b) rational decision making, (c) focused knowledge and skills acquisition, (d) critical application, and (e) reflective practice. This is the model of technological literacy that captures its profound importance. Literacy in technology is much more than the ability to use this or that tool, machine, process, or system. It is the development of human potential and influence through technology. These are the identical characteristics we expect from reading, writing, mathematics, science, and social studies literacy: characteristics that empower success.

So What?

As technology educators, we must consider the legitimate outcomes of our technological programs. We should be concerned with the results of the future technological decisions of our students and their students. Few of us realize the ubiquitous nature of the technology in our lives. We tend to treat technological progress as if it is a natural law that can be neither managed nor influenced. Yet, as we verbalize this thought, we sense that something is wrong. We intuitively understand that technology can improve human life, and we also know that our technologies can distort and destroy human life. It is our place to ask: What does it mean to live, as humans, in a technologically prolific world and how should this affect the implementation of technology education programs? Naisbitt (1999) elegantly stated:

> To love technological progress means that we should cherish it, see its faults and triumphs, heed warning signals, admit mistakes, be open and compassionate, watch, listen, face problems squarely, get philosophical, set standards, question standards, review standards, be informed, and welcome opinions from all professions and denominations. If we love technology we will be careful with it. We won't be reckless. We can enter aware and receptive into a dialogue about technology. We will begin to *nurture* the power of technology instead of rejecting it (as do so-called technophobes) or blindly embracing it (as do technophiles). (p. 4)

The study of how technology is developed and applied to meet human needs and wants and to drive economic prosperity must *not* be constrained to the techniques of designing, using, and producing artifacts and systems but must include the promotion of the rights of all humans: life, liberty, and the pursuit of happiness. The study of technology must encompass an understanding of technology that goes beyond technical skills and techniques. It ought to be a basic and essential element of a person's general education. In addition to literacy in mathematics, science, reading, and writing, we, as well as our students, must become technologically literate.

Technological Literacy: A Solution of Global Proportions

As the proliferation of technology continues at unprecedented rates, individuals and societies will be confronted with critical issues as a result of their inability to appropriately adopt, adapt, invent, and evaluate technological solutions to personal, community, and global problems. We are in the midst of a new revolution, the *genome revolution*, which will dramatically affect humankind in unforeseen ways. We not only have the power through this new technology to determine who and what will exist in the future but we can now control the characteristics of future generations. We, and our students, are ill equipped and unprepared to make the kinds of decisions we must make as the genome revolution progresses. Who will prepare the youth of today for the decisions of tomorrow?

The decisions to effect solutions using this technology will be increasingly left to the science and technology experts, those who advise the politicians, since the average person, the technologically illiterate, will be unable to understand the technology. The responsibility and authority to influence the direction and mechanisms for individual and societal fulfillment will be wielded by an increasingly smaller group of people. Human freedom and action will, as a result, be constrained. The solution to this problem is not the unilateral limitation of technology but the development of a technologically literate citizenry: a citizenry capable of making informed decisions to use technology as a powerful tool for reaching personal and shared goals and for making a positive difference in the world. The success of humanity in the 21st century is contingent on a technologically literate population making sustainable decisions.

One of the functions of a leader is to see what others do not see. Many times we don't know that we should be looking for something. Other times we know we should be looking but don't see what we think we are looking for. Oftentimes we look and see. Other times we look at something so often that we fail to pay attention to it. I suggest that deep within each technology educator is the underlying belief that technological literacy is essential to human development and the pursuit of our most basic and universal human goals and that this belief is the hidden mental model that motivates us. It is this vision that technology education programs must capture and promote. It is this understanding of the importance of technological literacy that ought to guide us in our curriculum development, research, and teaching.

Technology education focuses on innovation. Innovation, though, is often stifled because one becomes fixated on the traditional solutions to problems. Traditions help us transfer our experiences and wisdom from one generation to the next and also help us to not succumb to fads. But, adherence to tradition often leads to traditionalism, which seeks to perpetuate tradition, oftentimes losing the very meaning of the traditions it seeks to protect. We often react to the need for change not by developing new paradigms but by patching up old ones. As much as one desires to be

innovative, the reality is that it is much harder to forget the old ways than it is to create new ways. We must be careful to not let current and past perceptions (mental models) and practices thwart our efforts to develop a technologically literate citizenry.

Now I know why I am in this profession. First, it is because my technology teachers helped me develop some of the characteristics of technological literacy. Second, future civilizations depend on the essential knowledge and skills we take into the future. I now choose to make a difference, in my current world and for the future, by developing these characteristics in others. Whatever I can do to facilitate the development of these characteristics is, indeed, a worthy and noble effort. It is a vocation I can commit to with vision, passion, and focus. It is this vision that will guide the development of my technology teacher program.

John W. Hansen is an associate dean of Research and Graduate Studies in the College of Technology at the University of Houston, Texas. He is a member of the Alpha Lambda Chapter of Epsilon Pi Tau.

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Adaptive Competency Acquisition of Differently Certified Technology Teachers

Patricia G. Coyle-Rogers and George E. Rogers

With the national shortage of technology teachers projected to intensify, the alternative certification of those teachers looms as an increasingly likely option for school administrators (Weston, 1997). Numerous studies have compared the effectiveness of alternative certification programs to traditional certification of teachers. These studies have focused on tangible factors and the background of the participants. But consideration has been limited concerning their readiness to manage the complexities of the technology classroom (Litowitz, 1998).

In an attempt to develop a base of understanding related to alternative certification, Truell (1999) explored levels of concern in career and technical educators. These levels of concern focused on seven categories: human relations, classroom management, instructional activities, personal concerns, work conditions, evaluation, and professional growth. The outcome of his research suggested that concerns by both certification types were task oriented. There was limited discussion related to differences in the essence of teaching, particularly with respect to attributes known as adaptive competencies: intuitive and inductive reasoning, practical skills, and people-oriented tasks.

Various types of alternative certification programs exist. Those noted by Litowitz (1998) include the graduate model, suitable background model, strand licensure model, military career transition model, life experience model, and add-on model. Litowitz also notes that "all of these alternative licensure models can provide the advantage of generating greater numbers of teachers, but some models may have inherent weaknesses in terms of quality teacher preparation" (p. 28). Otuya (1992) indicated that subject matter expertise alone is an inadequate foundation for instruction because teaching requires the transformation of content into situations that enhance a student's learning. Whiting and Klotz (1999) concurred, noting that alternative certification programs that prepare individuals who currently possess the content knowledge but enter the teaching profession without pedagogical skills are ineffective teachers.

Purpose and Framework

The purpose of this project was to determine if there are any differences in the adaptive competency acquisition between technology teachers who have completed a school district add-on alternative certification process and technology teachers who have completed a traditional baccalaureate degree certification program. This comparison should provide school district administrators and teacher educators with additional data regarding the effectiveness of this type of alternative certification process in preparing technology education teachers.

This study examines the adaptive competency acquisition of technology teachers certified through the add-on licensure model. The add-on model is an option for teachers who hold a teaching certificate in a discipline other than technology (Litowitz, 1998), who are then provided training related to the technical content of technology. One advantage of this model is that the individuals already have experience related to pedagogical skills and classroom management. However, it is important to examine whether such academic classroom skills can transfer to a technology laboratory environment.

Kolb's (1976) experiential learning theory was used to form the basic tenet of the conceptual framework for this study. This model was chosen because of its usefulness in determining competency acquisition (Laschinger, 1992). Kolb's view of learning is centered on the assumption that learning does not occur in isolation, but through personal-environmental interactions; these interactions extend beyond formal learning situations into lifelong personal and work experiences (Kolb, 1976; Smith & Kolb, 1986; Ridley, Laschinger, & Goldenberg, 1995). Learning is conceptualized as a cycle that can be summarized through three central concepts: learning styles, adaptive competencies, and environmental press perceptions (Kolb, 1976; Smith & Kolb, 1986). The first area, learning styles, are the means by which an individual processes information. Adaptive competencies, the second area, are the skills required to effectively complete a particular task. The third area, environmental press perceptions, are the learners' views of their competency acquisition. Thus, the acquisition of adaptive competencies served as the conceptual framework of this study.

Adaptive competencies are the skills required to effectively complete a particular task and are the congruencies (balance) between personal skills and task demands (Kolb, 1984; Ridley et al., 1995). These adaptive competencies are accommodative, assimilative, convergent, and divergent.

- *Accommodative adaptive competencies* are the skills required to effectively complete intuitive reasoning tasks, including the following abilities: committing oneself to objectives, influencing and leading others, dealing with people, seeking and exploiting opportunities, and being personally involved.
- *Assimilative adaptive competencies* are the skills required to effectively complete inductive reasoning tasks. They include building conceptual models, designing experiments, organizing information, analyzing quantitative data, and testing theories and ideas.
- *Convergent adaptive competencies* are the skills required to effectively complete problem solving and practical application tasks, and include the following abilities: making decisions, generating alternate ways to do things, experimenting with new ideas and approaches, choosing the best solution, and setting goals.
- *Divergent adaptive competencies* are skills required to effectively complete people-oriented tasks. They include listening with an open mind, being sensitive to values, imaging implications of situations, and being sensitive to people's feelings (Fry, 1981; Kolb, 1976, 1984; Ridley et al., 1995).

This study explored the following research questions:

1. Is there a significant difference between the accommodative adaptive competencies developed by traditionally certified and alternatively certified technology education teachers as measured by the Adaptive Competency Profile (ACP)?
2. Is there a significant difference between the assimilative adaptive competencies developed by traditionally certified and alternatively certified technology education teachers as measured by the ACP?
3. Is there a significant difference between the convergent adaptive competencies developed by traditionally certified and alternatively certified technology education teachers as measured by the ACP?
4. Is there a significant difference between the divergent adaptive competencies developed by traditionally certified and alternatively certified technology education teachers as measured by the ACP?

Laschinger (1992) assessed student achievement related to competency acquisition in the field of nursing education through adaptation of the ACP. The fields of nursing education and technology teacher education share learning components; these shared components are documented in *Elements and Structure for a Model Undergraduate Technology Teacher Education Program* (Henak, 1991) and the *Guide to Undergraduate Education* (National League for Nursing, 1995). Based on a review of these documents, the authors noted similarities between undergraduate nursing and technology education curricula as (a) emphasis on the sciences, (b) interpersonal skills, (c) clinical/field experiences, and (d) preparation for a professional licensure examination.

The ACP is an alternate measure of learning style in which participants rate their achievement level on each of the tool's competency questions, using a 7-point Likert-type scale. The items were generated by Kolb and a panel of experts in the fields of engineering and social work in 1981; they represent specific competencies characteristic of each of the four modes of learning espoused in Kolb's learning theory (Fry, 1981). These items were intended to be generic enough to be useful in describing learning orientations of individuals in a variety of disciplines (Kolb, 1984). In this instance the ACP items were used to calculate a personal profile of adaptive competencies. Mean scores on the four competencies indicate the individual's achievement in that area (Sims, 1983).

To calculate the mean scores for each of the four adaptive competencies, the five ACP items for that competency were tabulated and then this sum was divided by five. This process placed the resulting means back into a Likert-type scale range of 1 to 7, with 1 being unskilled and 7 being highly skilled. Only 20 items of the 34-item ACP assessment tool were calculated; the remaining 14 items serve as distracters. Kolb (1984) reported alpha reliability estimates for the subscales between 0.67 and 0.82.

Based on the common emphasis in the sciences, both nursing education and technology teacher education programs prepare their graduates with the ability to link scientific knowledge and skill with the interpersonal requirements of the profession. This convergence of intuitive and inductive reasoning, problem-solving abilities, and interpersonal skills form the foundations of clinical reasoning for these professions. This research utilized the ACP that was validated previously in nursing education programs by Coyle-Rogers (2001) and Laschinger (1992) to assess the effectiveness of technology teacher education models, both traditional and alternative.

Methods Used

Nonprobability sampling was used for this study. The sample consisted of two groups: 5 teachers who had completed a Midwest school district's add-on alternative certification program for technology education and 10 technology teachers with two years or less of experience, who had graduated from the same Midwest state's land-grant university, The district's add-on model consisted of 80 hours of instruction related to the technical content of the technology education field and was conducted by school district personnel.

The ACP and a demographic assessment constituted the mail survey which was sent to members of both groups. The results provided both individual ACP scores and group ACP means from the Likert-type scale responses. For statistical purposes, the ACP subscale means were compared to determine adaptive competency acquisition. Since this research study involved two samples, the t test for independent samples was utilized for statistical analysis (Polit & Hungler, 1991).

The response rate was 80% (n = 4) for the alternatively certified technology teachers and 60% (n = 6) for the traditionally certified teachers. The alternatively certified technology education teachers averaged 50 years of age and were initially certified to teach special education, foreign language, and health science. The traditionally prepared technology teachers averaged 24 years of age with two years of teaching experience. Seventy-five percent (n = 3) of the alternatively certified teachers and 33% (n = 2) of the traditionally certified technology teachers were female.

What We Learned

Overall, the adaptive competency acquisition of the alternatively certified technology teachers was higher than the adaptive competency acquisition of the traditionally certified technology teachers. The acquisition of accommodative adaptive competencies was 6.2 for the alternatively certified teachers and 5.3 for the traditionally prepared teachers. This difference was significantly greater for the alternatively certified teachers when compared to the traditionally prepared technology teachers (t = 2.582). Assimilative adaptive competency acquisition was only slightly higher for alternatively certified teachers (M = 5.2) than their traditionally prepared counterparts (M = 5.1). Both the convergent and divergent adaptive competencies were higher for the alternatively certified sample (M = 6.0; M = 5.7) than the technology teachers who had completed a university-based traditional program (M = 5.4; M = 5.5).

Significantly higher accommodative adaptive competency acquisition scores would indicate that these alternatively certified technology teachers can perform intuitive reasoning tasks more effectively than the traditionally prepared teachers. Higher scores by the alternatively certified teachers in relationship to the acquisition of convergent and divergent skills indicated that these teachers effectively developed problem-solving and practical application tasks as well as people-oriented skills. Similar assimilative adaptive competency acquisition scoring between the two technology teacher groups indicated that inductive reasoning tasks were acquired regardless of the certification program structure.

The result indicating a significantly higher accommodative ACP by the alternatively certified teachers was similar to the finding by Shoho and Martin (1999) who reported significantly lower levels of isolation by alternatively certified teachers. Higher acquisition scores in convergent and divergent tasks support the work of Truell (1999) who also noted that alternatively certified teachers indicated lower levels of human relations concerns than traditionally prepared teachers.

What It Means

The difference between the two groups was significant in the accommodative adaptive competency (t = 2.582). These findings suggest that these alternatively prepared teachers were able to adapt and successfully manage the environment of the technology education laboratory. However, this difference may be explained by the distinct difference in age and classroom experience between the two samples.

While this study focused on the adaptive competency acquisition, this is only one facet of comparison between the two types of certification of technology education teachers. This study did not examine the technical competency of the alternatively certified technology education teachers. A follow-up study should be conducted to assess whether or not the alternatively certified teachers possess the technical competency to be effective technology education teachers.

Dr. Patricia G. Coyle-Rogers is an assistant professor and director of Life Long Learning in the School of Nursing at Purdue University, West Lafayette, IN.

Dr. George E. Rogers is an associate professor and coordinator of Technology Teacher Education in the School of Technology at Purdue University, West Lafayette, IN. He is trustee of Gamma Rho Chapter of Epsilon Pi Tau.

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The 2002 Paul T. Hiser Exemplary Publication Award Recipient

James G. Edwards

"Samson's Hair: Denuding the Technology Curriculum"

The Board of Editors of *The Journal of Technology Studies* and the Board of Directors are pleased to announce the recipient of the Paul T. Hiser Exemplary Publication Award for Volume XXVIII, 2002.

The Board of Directors established this award for deserving scholars. In recognition for his exemplary service to the profession and to the honorary as a Trustee and Director, the award bears Dr. Hiser's name. It is given to the author or authors of articles judged to be the best of those published each year in this journal.

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A majority vote of the editors is required for the award to be made. The honorary's Board of Directors renders final approval of the process and the award.

Criteria

1. The subject matter of the manuscript must be clearly in the domain of one or more of the professions in technology.

2. The article should be exemplary in one or more of the following ways:
   - Ground-breaking philosophical thought.
   - Historical consequence in that it contains significant lessons for the present and the future.
   - Innovative research methodology and design.
   - Trends or issues that currently influence the field or are likely to affect it.
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GUIDELINES FOR

The Journal of Technology Studies

A refereed publication of Epsilon Pi Tau The International Honor Society for Professions in Technology.

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SUBJECT FOCUS

JOTS welcomes *original* manuscripts from scholars worldwide focused on the depth and breadth of technology as practiced and understood past, present, and future. Epsilon Pi Tau, as perhaps the most comprehensive honor society among technology professions, seeks to provide up-to-date and insightful information to its increasingly diverse membership as well as the broader public. Authors need not be members of the society in order to submit manuscripts for consideration. Contributions from academe, government, and the private sector are equally welcome.

An overview of the breadth of topics of potential interest to our readers can be gained from the 17 subclasses within the "Technology" category in the Library of Congress classification scheme (<lcweb.loc.gov.catdir/cpso/lcco/lcco_t.pdf>). Authors are strongly urged to peruse this list as they consider developing articles for journal consideration. In addition, JOTS is interested in manuscripts that provide:

- brief biographical portraits of leaders in technology that highlight the individuals made in distinct fields of technology or its wider appreciation within society,
- thoughtful reflections about technology practice,
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- technology within society and its relationship to other disciplines,
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- comparative studies of technology development, implementation, and/or education,
- industrial research and development, or
- new and emerging technologies and technology's role in shaping the future.

The immense diversity of technology, along with its applications and import, requires that authors communicate clearly, concisely, and only semi-technically to readers from a diverse set of backgrounds. Authors may assume some technical background on the part of the reader but not in-depth knowledge of the particular technology that is the focus of the article. Highly technical articles on any field of technology are not within the purview of the journal. Articles whose focus has been extensively explored in *prior* issues of the journal are only of potential interest if they (a) open up entirely new vistas on the topic, (b) provide significant new information or data that overturn or modify prior conceptions, or (c) engage substantially one or more previously published articles in a debate that is likely to interest and inform readers. Syntheses of developments within a given field of technology are welcome as are metanalyses of research regarding a particular technology, its applications, or the process of technical education and/or skill acquisition. Research studies should employ methodological procedures appropriate to the problem being addressed and must evince suitable design, execution, analysis, and conclusions. Surveys, for example, that exhibit any or all of the following characteristics are of no interest to the journal: (a) insufficient awareness of prior research on this topic, (b) insufficient sample size, (c) improper survey design, (d) inappropriate survey administration, (e) high mortality, (f) inadequate statistical analysis, and/or (g) conclusions not supported by either the data or the research design employed. The JOTS is neutral in regards to qualitative, quantitative, or mixed method approaches to research but insists on research quality.

Promoting Excellence in Preparation and Excellence in Practice

GUIDELINES FOR The Journal of Technology Studies (Continued)

GUIDELINES FOR SUBMISSION

Articles must conform to the current edition of the *Publication Manual of the American Psychological Association.* All articles must be original, represent work of the named authors, not be under consideration elsewhere, and not be published elsewhere in English or any other language. Electronic submissions in either rich-text format or Microsoft Word formats are strongly encouraged, although submission of three printed copies and a diskette containing the article are also permissible. E-mail submissions should be sent to the editor, Dr. Dennis Cheek, at jots@bgnet.bgsu.edu. Paper submissions should be mailed to:

Editor, Journal of Technology Studies
Epsilon Pi Tau, Technology Building
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Manuscripts should be no more that 25 pages, double-spaced, including references. Typescript should be *Times New Roman* or a close approximation of font and 12 point. Only manuscripts in English that conform to American usage will be accepted. Figures, tables, photographs, and artwork must be of good quality and conform to APA form and style.

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Articles deemed worthy by the editor for consideration by JOTS are subject to external, anonymous peer review. Authors who submit an article that does not merit review by the editorial board are informed within approximately two weeks of receipt of the article so that they may explore other publishing venues. A rejection may be based solely on the content focus of the article and not its intrinsic merit, particularly where the topic has been extensively explored in prior JOTS articles. Articles that exhibit extensive problems in expression, grammar, and spelling are summarily rejected. Authors of articles that have been peer-reviewed are informed within about three months from the date of submission of the article. Anonymous comments of reviewers are provided to authors who are invited to submit a revised article for either publication or a second round of review. The editor does not automatically provide reviewer comments to authors whose articles have been rejected via the peer review process. However, such feedback may be provided if the editor determines that the feedback might prove helpful to authors as they pursue other publishing opportunities.

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Bowling Green State University
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