# Journal of Technology Education

Volume 15 Number 2 Spring, 2004

**Journal of Technology Education**


ISSN 1045-1064

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# *From the Editor*

## Changing Venues

It has been over fifteen years since the first issue of the *Journal of Technology Education* was published. It has been housed at Virginia Tech from the outset. The founding Editor was Mark Sanders and I served as Associate Editor. Mark and I switched roles about six years ago. Around the first of July of this year, the *Journal of Technology Education* will move from Virginia Tech to Millersville University of Pennsylvania. I will follow it there, having accepted a faculty appointment in the Department of Industry and Technology.

Millersville University is a fitting place for the JTE. The University began as a Normal School in 1855, dedicated exclusively to the preparation of teachers. The technology education program there has a long history of accomplishment. It is among the four largest undergraduate programs in our field in the US and among five undergraduate programs that were designated as Outstanding by the Council on Technology Teacher Education. The faculty serve the technology education community in a variety of scholarly, leadership, and service roles. The Ganser Library holds the official archives of the International Technology Education and its councils, including the Council on Technology Teacher Education. The administration at Millersville has made a commitment to supporting the JTE in its new home.

The venues where work is done in this field are changing as well. In the US, land grant universities (LGUs) have been the principal locus for the conduct of research in this field. But over the past two decades, many LGUs have eliminated their undergraduate technology education programs or closed the doors on technology education all together. There seems to be a continual pattern of reorganization, usually in response to budget crises. One colleague remarked to me that for nearly one-fourth of our careers, the administrative unit in which we worked was undergoing reorganization. Actually, that is an underestimate.

Reductions in resources have forced LGUs to seek alternative sources of revenue, relying less and less on state tax revenues and more and more on benefactors, tuition increases, and especially on externally funded research projects. Though there has been a considerable amount of research dollars available in recent years for the support of education, they pale in comparison to research dollars in the hard sciences, engineering, and especially bio-related areas. At the same time, competition has become severe among LGUs on all fronts, especially to maintain or move up in national rankings for research. Virginia Tech is one example, where the quest is to move into the top thirty research universities within ten years. Several other universities have similar, formally stated goals.

With this as a context, I have several observations and possible implications I wish to share. First, the vast majority of technology education teachers are now prepared in regional colleges and universities, not in LGUs. This is nothing new, but the proportions have been changing. This is a sort of "back to the future" situation since most teachers in the past were prepared at normal schools and many of these schools evolved into regional colleges and universities. Typically, these aspiring teachers take most of their technical course work alongside their peers who are headed for careers in industry. The venue for preparing technology teachers is these regional institutions, even more than it has been in the past.

Second, there are very few doctoral granting institutions remaining that provide a concentrated study in technology education. Yet, it is critical that the professoriate of the future be supplied with adequately prepared members, whether they end up in LGUs or in regional institutions. Though there are huge political problems to surmount, it seems logical that regional colleges and universities will offer doctoral degrees in increasing numbers. In the past, faculty in regional institutions often did not have doctoral degrees and were therefore unqualified to participate in the delivery of doctoral programs. Now, however, the vast majority of faculty have doctoral degrees, regardless of the type of institution in which they are employed. The venue for the granting of doctoral degrees in technology education may be shifting toward regional colleges and universities.

Third, research and development is no longer the primary domain of LGUs. For reasons mentioned above, faculty in regional institutions are, by and large, every bit as qualified to conduct research as their LGU counterparts. Typically, they earned their doctoral degrees at LGUs where the curricular emphasis was on research. Several large-scale, funded research projects have been awarded to regional institutions and the completed projects have been innovative and of high quality. Often these institutions have a much lower indirect cost rate as well, making them a better return on investment than many of the LGUs. Moreover, grants are increasingly being awarded to organizations, right along with higher education institutions. The venue for the conduct of research is clearly expanding.

Fourth, innovative ways in which technology education teachers are prepared will no doubt continue to be developed. Teachers may increasingly receive their undergraduate preparation in classical disciplines, such as engineering, architecture, and product design. Then, they will receive their pedagogical preparation at the graduate level, following the Holmes Group model. My colleague Mark Sanders, in collaboration with faculty in Virginia Tech's College of Engineering, has put together an innovative program along these lines. It was reported in the December 2003 issue of TIES Magazine Online (http://www.tiesmagazine.org/).

Other options may surface as well. It is possible that community colleges will become more responsible for the preparation of teachers. Cooperative regional centers, perhaps sponsored by school districts, are another possibility. Distance education is already playing a significant role at the graduate level and it will no doubt have a more significant role at the pre-service level. If the field continues to become more cognitive, then distance education will become even more pervasive. It is even possible that a significant part of the preparation of teachers could be privatized. This seems particularly plausible in the context of programs that use learning modules developed and marketed by the private sector. The venues in which teachers are prepared will be much broader than has been true in the past.

Finally, a stronger connection between the world of theory and the world of practice must be made. There is a great chasm that is yet to be crossed between institutions of higher education and the practitioners in the public schools, regardless of the idealism one might adopt through reading the literature. The venue for research must go beyond the lip service now typically given to the importance of the context of the public schools.

The articles in this issue of the JTE validate several of the points I have made above. A science development center, a technological literacy center, and a prestigious engineering academy are represented. One public school teacher and one aspiring teacher are represented. No one who is currently employed in a land grant university is included.

It is interesting how certain words suddenly become part of popular jargon. The word “venue” was first popularized by the Atlanta Olympic Games in 1996 and it suddenly became part of our vocabulary. Despite my study of Latin and Greek, I must admit that I had to look up the word in the dictionary during the ‘96 Olympics. This is my first public use of the word.

JEL

# *Articles*

## Factors that Influence Students to Enroll in Technology Education Programs

Michael Gray and Michael Daugherty

### Introduction

Increased primary and secondary student enrollment, recent expansion of secondary technology education programs, teacher attrition, and the decreasing number of universities offering technology education degrees have led to a nationwide shortage of technology teachers (Bell, 2001; Daugherty, 1998; Daugherty & Boser, 1993; Litowitz, 1998; Weston, 1997). This study sought to identify effective recruitment techniques and factors that might influence students to enroll in undergraduate technology education programs. To accomplish the purposes of the study, two sample populations were surveyed: (1) Technology Education Collegiate Association (TECA) undergraduate students who attended the 2001 TECA Midwest Regional Competition in Peoria, Illinois and (2) Technology teacher education faculty members in Midwest institutions as listed in the *Industrial Teacher Education Directory* (Bell, 2001).

### Background to the Study

The shortage of technology teacher education graduates and the increasing numbers of technology teacher retirements continues to be a major problem in the profession. Starkweather (1999) stated that the technology teacher shortage was an immediate problem that needed to be addressed. Daugherty (1998) asserted, "The greatest problem facing the technology education profession in the next decade will be the acute shortage of entering technology education teachers" (p. 24). Studies more than twenty years old show a shortage of technology/industrial arts teachers, so attracting students into the profession has not been a new problem (Edmunds, 1980; Miller, 1978). In a study that consisted of an expert panel of technology teachers, collegiate supervisors,

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administrators, and teacher educators, Wicklein (1993) implied that the most critical issue in the profession was the insufficient quantities of technology education teachers and the elimination of teacher education programs. In the mid-1980s, Wenig (1986) pointed out that "the future of technology education in our public schools is inextricably and critically linked to the future of technology teacher education and, in particular, to critical problems in the supply and preparation of technology teachers" (p. 77). Edmunds (1980) acknowledged that even though many problems exist within the profession, recruiting students into the profession was a major one.

In 1990, over 50% of all technology teachers were over the age of 50 (Dugger, French, Peckham, & Starkweather, 1991). This aging workforce has led to an increased number of retirees. With as many as 76 million baby boomers approaching retirement age, this trend is likely to continue and will impact the classroom (Dohm, 2000).

Even though the total enrollment at higher education institutions has continued to increase over recent years to about 15 million students (Gerald & Hussar, 2001), technology teacher education enrollment has continued to dwindle (Bell, 2001). Many technology teacher education preparatory institutions have closed their programs or significantly reduced the number of graduating technology teachers. For instance, in the 2000-2001 issue of the *Industrial Teacher Education Directory*, nine institutions in the United States and its territories closed their technology teacher education programs. During the same period of time, no institution added new technology teacher programs (Bell, 2000).

Between 1997-2001, Weston (1997) projected there would be 13,089 middle and high school technology teacher vacancies in the United States. More recently, Ndahi (2002) completed similar research and projected there would be 6,655 middle and high school technology teacher vacancies between 2001-2005. To add to this dilemma, many states do not have a single technology teacher education preparation program and depend on other states for all of their technology teachers (Litowitz, 1998). In the mid-1970s, technology/industrial technology teacher education programs were preparing approximately 6,000 students per year (Rogers, 1997). According to the 2000-2001 *Industrial Teacher Education Directory*, U. S. institutions prepared only about 800 technology education students in 2000 (Bell, 2001). Volk (2002) indicated that in the 2001-2002 *Industrial Teacher Education Directory* "less than 625 new technology teachers graduated" (p. 2). If this trend continues, the profession will be substantially short of qualified technology education teachers in the upcoming years (Bell, 2001; Ndahi, 2002; Volk, 2002; Weston, 1997).

While there are undoubtedly numerous factors that influence people to enter the technology education profession, the relationships built during formal and informal recruitment exercises sponsored by the university can affect personal decisions (Daugherty, 1998). If we desire to alleviate this current shortage, the recruitment of technology educators has to become a top priority of the profession (Daugherty, 1998). Secondary teachers, post-secondary teachers, administrators, counselors, and alumni must begin to identify the tools needed to recruit potential teachers and use this knowledge to exert their influence. Members of the technology education profession need to explore all possible avenues toward increasing the quantity of qualified graduates.

## Purpose of the Study and Research Questions

The purpose of this study was to identify effective recruitment techniques and influential factors that attract individuals to the technology education teaching profession. The following research questions guided the study:

1. What are the effective recruitment techniques and influential factors through which current technology education undergraduate students discover, are attracted to, and enter the field of technology education in Midwest institutions?
2. What recruitment techniques, as perceived by technology teacher education faculty members in the Midwest, are effective in recruiting undergraduate students into the field of technology education?

## Methodology

To answer the research questions above, the faculty sample of technology teacher education programs in the Midwest and a sample of Technology Education Collegiate Association (TECA) students who attended the 2001 TECA Midwest Regional Conference in Peoria, Illinois were surveyed. For the TECA group, a convenience sample of the larger population of all TECA students was used. The faculty group was a purposive sample of all technology teacher education faculty members in the Midwest. This sampling technique was used in an effort to survey faculty members from the institutions represented by TECA members attending the TECA Midwest Regional Conference. For this study, Midwest states were identified as Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin (*Encarta Online Encyclopedia*, 2001). Due to the fact that not all faculty members representing Midwest institutions attended the TECA Midwest Regional Conference, the researchers used the *Industrial Teacher Education Directory* (Bell, 2001) to identify the faculty sample for this study. Two questionnaires were generated: One for technology teacher education faculty members in the Midwest and one for TECA undergraduate students in technology teacher education preparatory programs who attended the conference. By reviewing previous studies in the technology education discipline (Craft, 1980; Devier, 1982; Edmunds, 1980; Frisbee, Belcher, & Sanders, 2000; Isbell & Lovedahl, 1989; Izadi & Toosi, 1995; Sanders, 1986; Smith, 1983; Wright & Custer, 1998), recruitment techniques and influential factors were generated. The questionnaires were pilot tested with technology teacher education faculty members ($n$ = 6) and undergraduate students ($n$ = 25) at Illinois State University, Normal, Illinois. A Cronbach Coefficient Alpha test was conducted on the returned pilot-study questions for both questionnaires in order to establish reliability and validity for the instruments. After removing three questions from the TECA survey and two questions from the faculty survey, reliability indexes of .82 and .84 respectively were achieved in follow-up tests. The refined instruments were then used to collect data for the study.

The faculty questionnaire consisted of open-ended free-response, multiple-choice, rank-order, and Likert-type questions designed to elicit recruitment techniques that are believed to be the most effective in attracting potential student candidates to the technology education major. The faculty questionnaire consisted of three sections. Section 1 consisted of questions designed to elicit demographic information about the respondent and general information about perceptions of student recruitment. Section 2 asked faculty participants to rank the three most (and three least) effective recruitment techniques. Section 3 was designed to identify those techniques most often (and least often) used by faculty members.

The TECA student survey also consisted of three sections. Section 1 was designed to gather demographic and general information concerning students' motivation for entering the field of technology education. Section 2 asked students to identify appropriate recruitment techniques and techniques that may have been used to recruit them into the field or how they found out about the career path. Section 3 contained four questions designed to identify individual, personal, and job related characteristics that influence students to enter the field of technology education.

## Data Collection

The TECA student questionnaire was administered in November 2001 at the TECA Midwest Regional Conference in Peoria, Illinois. The protocol for administering the test was read, and then the questionnaires were distributed. Upon completion, the questionnaires were collected for analysis. Thirty-one student questionnaires were administered and returned; all instruments were deemed usable. The faculty questionnaire was mailed to all Midwest technology teacher education faculty members ($n$ = 52) as listed in the *Industrial Teacher Education Directory* (Bell, 2001) in January 2002. After follow-up e-mail messages and phone conversations to non-respondents, an overall return rate of 59.6% was achieved by February 2002. However, only 53.8% ($n$ = 28) were usable.

## Findings

The collected data were analyzed using descriptive statistics to discover the effective recruitment techniques and factors that influence undergraduate students to enroll in Midwest technology teacher education programs. Frequency distribution was utilized to summarize values and to identify the most common responses by the participants.

*Research Question One*

What are the effective recruitment techniques and influential factors through which current technology education undergraduate students discover, are attracted to, and enter the field of technology education in Midwest institutions?

To answer this research question, the undergraduate students were asked 18 questions within three sections (as described earlier). An analysis of the demographic data gathered in Section 1 indicated that the majority of students, 84% ($n$ = 27) ranged from 18 to 22 years. This reflects the typical age range of students in colleges pursuing a bachelor's degree in technology education (Devier, 1982; Sharpe & Householder, 1984; Wright & Custer, 1998). The data also suggest that few non-traditional students participate in the TECA Midwest Regional Conference. The majority of students (80%, $n$ = 25) were male. The data could reveal that males continue to vastly outnumber females in the technology education profession in the Midwest. Previous studies have identified this imbalance and have made recommendations to remedy the situation, though it appears that the methods used have resulted in only slight, if any, progress. When asked about their first exposure to technology education, the majority of students, 74% ($n$ = 23), suggested that they first experienced a technology education class while in middle school. Even though this was the case, over 67% ($n$ = 21) of the participants suggested that they wanted to teach only at the secondary (9-12) level when asked what they plan to do after graduation. The majority of students (90%, $n$ = 28) indicated that they had decided to enter the technology education profession while attending high school rather than after enrolling at the university.

In 2000, the ITEA published the *Standards for Technological Literacy: Content for the Study of Technology*. This publication appears to have made an impact within Midwest technology teacher education programs. TECA student respondents were asked to mark the description that best described the university program in which they were currently enrolled. Over 80% ($n$ = 25) of the participants indicated that the program with which they were affiliated offered a standards-based curriculum and learning experiences that were influenced by the *Standards for Technological Literacy*.

Section 2 asked the student respondents to identify the types of recruitment techniques that their university or department had used (if any were used) to influence or recruit them to enter into the technology education profession. Using the recruitment techniques that they identified (if any were), the respondents were asked to rank the ones that influenced them the most (see Table 1). The left column in the table lists the techniques used to recruit students to technology education. The columns to the right identify the number ($N$) and corresponding percent of participants who ranked the identified recruitment techniques as the first, second, and third most used. In some cases (noted in the table), the respondents indicated that no recruitment technique was used or that only one was used. The response of the majority of participants (68%, $n$ = 21) suggested that the university had done nothing to recruit them.

Eight respondents split the number one recruitment technique equally among the following: (a) university recruiter visiting their high school, (b) brochures, (c) face-to-face interactions with faculty, and (d) contact with alumni. According to the data, few students are being recruited into the field of technology education by university faculty members.

**Table 1**
*University's Recruitment Techniques Used to Influence Students to Enter Technology Education*

| | Student Rank | | | | | |
|---|---|---|---|---|---|---|
| | First | | Second | | Third | |
| **Recruitment Techniques** | ***N*** | **Percent** | ***N*** | **Percent** | ***N*** | **Percent** |
| None | *21 | 67.7 | **29 | 93.5 | **30 | 96.8 |
| Univ. Recruiter to HS | 2 | 6.5 | 1 | 3.2 | 0 | 0.0 |
| Brochures | 2 | 6.5 | 0 | 0.0 | 0 | 0.0 |
| Face-to-Face Interactions | 2 | 6.5 | 0 | 0.0 | 0 | 0.0 |
| Alumni | 2 | 6.5 | 0 | 0.0 | 0 | 0.0 |
| Posters | 1 | 3.2 | 1 | 3.2 | 0 | 0.0 |
| Positive Job Characteristics | 1 | 3.2 | 0 | 0.0 | 0 | 0.0 |
| Current TE Students | 0 | 0.0 | 0 | 0.0 | 1 | 3.2 |
| Total | 31 | 100.0 | 31 | 100.0 | 31 | 100.0 |

* denotes that 21 respondents indicated that they were not recruited in any way
** additional respondents were not exposed to a $2^{nd}$ or $3^{rd}$ recruitment technique

Section 2 also sought to collect data from TECA student respondents regarding recruitment techniques that they would use to attract students into technology education if they were in a position to recruit for a university. Using the recruitment techniques previously identified, the respondents were asked to rank the ones that they believed would be the most effective in attracting students to enter the field (see Table 2). The left column in the table lists the recruitment techniques that the students identified as being effective. The columns to the right identify the number (*N*) and corresponding percent of participants who ranked the identified recruitment techniques as the first, second, third, and fourth most effective. The student respondents suggested that explaining the positive job characteristics, sending a university recruiter to high schools, hosting open houses, and holding contests would be the most effective. From the techniques identified, the respondents suggested that high school counselors were least effective.

Section 3 of the TECA student questionnaire asked students to list all of the people who influenced them to choose a career in technology education. From that list, the respondents were then asked to rank the people, who influenced them the most to pursue a teaching degree in the field (see Table 3). The left column in the table lists the people who influenced student choices. The columns to the right identify the number (*N*) and corresponding percent of participants who ranked the identified people as the first, second, third, and fourth most influential. High school technology teachers had the largest number of responses at 42% ($n$ = 13). The groups identified as least influential toward encouraging entry into technology education were friends of the family, high school athletic coach, and high school counselor.

**Table 2**
*Recruitment Techniques That Should Be Used to Recruit Students, as Perceived by Student Participants*

| | Student Rank | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | First | | Second | | Third | | Fourth | |
| **Recruitment Techniques** | ***N*** | **Percent** | ***N*** | **Percent** | ***N*** | **Percent** | ***N*** | **Percent** |
| Positive Job Characteristics | 7 | 22.6 | 0 | 0.0 | 1 | 3.2 | 0 | 0.0 |
| Univ. Recruiter to HS | 5 | 16.1 | 6 | 19.4 | 1 | 3.2 | 0 | 0.0 |
| Open House | 5 | 16.1 | 4 | 12.9 | 0 | 0.0 | 0 | 0.0 |
| Contests | 3 | 9.7 | 3 | 9.7 | 1 | 3.2 | 0 | 0.0 |
| Brochures | 2 | 6.5 | 1 | 3.2 | 5 | 16.1 | 0 | 0.0 |
| Media | 2 | 6.5 | 1 | 3.2 | 0 | 0.0 | 0 | 0.0 |
| Career Days | 2 | 6.5 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |
| Video | 1 | 3.2 | 2 | 6.5 | 1 | 3.2 | 0 | 0.0 |
| Variety of Courses | 1 | 3.2 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |
| Scholarships | 1 | 3.2 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |
| Current TE Students | 1 | 3.2 | 0 | 0.0 | 1 | 3.2 | 0 | 0.0 |
| Face-to-Face Interactions | 0 | 0.0 | 1 | 3.2 | 1 | 3.2 | 0 | 0.0 |
| Promote Reputation | 0 | 0.0 | 1 | 3.2 | 0 | 0.0 | 0 | 0.0 |
| TSA or Skills USA Activities | 0 | 0.0 | 1 | 3.2 | 0 | 0.0 | 0 | 0.0 |
| Undeclared Univ. Students | 0 | 0.0 | 0 | 0.0 | 1 | 3.2 | 0 | 0.0 |
| HS Counselors with Info. | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 1 | 3.2 |
| None | 1 | 3.2 | 11 | 35.5 | 19 | 61.3 | 30 | 96.8 |
| Total | 31 | 100.0 | 31 | 100.0 | 31 | 100.0 | 31 | 100.0 |

The final questions on the instrument (Section 3) were designed to identify personal attributes of the respondents. Question 17 asked respondents to identify (from a list) attributes that most attracted them to major in technology education. Over 32% ($n$ = 10) of the TECA students indicated that their personal interests and hobbies attracted them into the profession. The second most frequently rated attribute, enjoy hands-on activities, yielded 29% ($n$ = 9) of the responses. The final question on the instrument asked the student respondents to pick the job-related characteristic that most influenced them to enter the field. Most respondents indicated that they entered technology education because of (a) versatile opportunities with their degree (29%, $n$ = 9) or (b) having freedom and flexibility in the classroom (29%, $n$ = 9).

*Research Question Two*

To answer the second research question, technology teacher education faculty members from the Midwest were asked questions regarding demographic information, disposition toward recruitment, recruitment technique used, and recruiting in general. The instrument used with the teacher educators was divided into three sections (as described earlier).

**Table 3**
*Student Participants' People Who Influenced Choice of a Career in Technology Education*

| | Student Rank | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | First | | Second | | Third | | Fourth | |
| **People Who Influenced** | ***N*** | **Percent** | ***N*** | **Percent** | ***N*** | **Percent** | ***N*** | **Percent** |
| HS Technology Teacher | 13 | 41.9 | 2 | 6.5 | 0 | 0.0 | 1 | 3.2 |
| HS Other Teacher | 5 | 16.1 | 3 | 9.7 | 0 | 0.0 | 0 | 0.0 |
| Myself | 3 | 9.7 | 0 | 0.0 | 1 | 3.2 | 0 | 0.0 |
| Parents | 2 | 6.5 | 7 | 22.6 | 0 | 0.0 | 0 | 0.0 |
| University Professor | 2 | 6.5 | 2 | 6.5 | 1 | 3.2 | 0 | 0.0 |
| Co-Worker | 2 | 6.5 | 0 | 0.0 | 0 | 0.0 | 2 | 6.5 |
| CC Counselor | 1 | 3.2 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |
| Friend | 1 | 3.2 | 0 | 0.0 | 2 | 6.5 | 0 | 0.0 |
| Relative | 1 | 3.2 | 1 | 3.2 | 0 | 0.0 | 0 | 0.0 |
| Sibling | 1 | 3.2 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |
| Friend of the Family | 0 | 0.0 | 1 | 3.2 | 0 | 0.0 | 0 | 0.0 |
| HS Athletic Coach | 0 | 0.0 | 1 | 3.2 | 0 | 0.0 | 0 | 0.0 |
| HS Counselor | 0 | 0.0 | 1 | 3.2 | 0 | 0.0 | 0 | 0.0 |
| None | 0 | 0.0 | 13 | 41.9 | 27 | 87.1 | 28 | 90.3 |
| Total | 31 | 100.0 | 31 | 100.0 | 31 | 100.0 | 31 | 100.0 |

In the first section of the faculty survey, the data suggested that the majority of faculty participants (46%, $n = 13$) were between 41 and 50 years of age. Males made up the majority of the participants at 93% ($n = 26$). Only 7% ($n = 2$) of the respondents were female. The responses of the TECA students to a similar question suggest that it may be reasonable to anticipate that this imbalance could continue for years to come. Over 85% ($n = 24$) of the teacher educators indicated that their institution sponsored a TECA chapter.

Faculty members were asked to indicate how effective they believed they were at recruiting. The majority (54%, $n = 15$) of faculty participants indicated that they were somewhat effective at recruiting undergraduate students into technology education. Four (14%) of the respondents identified that they were not effective at recruiting. Almost 68% ($n = 19$) of the faculty respondents indicated that they were either not effective or only somewhat effective at recruiting students into the field. Meanwhile, 25% ($n = 7$) identified themselves as being effective recruiters, and two (7%) faculty members described themselves as very effective at recruiting. Conversely, when asked to determine how critical they thought it was to increase the number of students entering technology teacher education programs, the majority of respondents (71%, *n* = 20) suggested that it was very critical. The number of faculty respondents who indicated that recruitment was critical (71%, *n* = 20) was almost equal to the number of faculty who indicated that they were less than effective in recruiting students (68%, *n* = 19).

To examine another aspect of student recruitment, faculty participants were asked to estimate how much time they spend per semester actively recruiting students. Two participants suggested that they spend no time recruiting. Most faculty participants (74%, *n* = 21) indicated that they spend less than 40 hours per semester on recruitment. The faculty participants were also asked to identify the approximate amount of money their institution spends on recruiting students into the technology education program per semester. Of those who did give estimates (10 did not), eight (30%) implied that their institution did not spend any money on recruitment. For the remaining respondents, money allocated toward recruitment ranged from $200 to $3,000.

In Section 2 of the faculty survey, faculty members were asked to evaluate various recruitment techniques. The first question in this section asked respondents to rate an inclusive list of recruitment techniques on how effective they believed each item was at attracting students into the field. Each technique was rated on a Likert-type scale (1=Not Effective, 2=Slightly Effective, 3=Effective, 4=Quite Effective, 5=Extremely Effective). The mean and standard deviation were calculated to assist in identifying the effectiveness of each recruitment technique.

Over half (52%, *n* = 15) of the faculty participants rated face-to-face interaction as being extremely effective (see Table 4). Calculations revealed that it also had the highest mean at 4.30 and a low standard deviation of 0.82. Conversely, the majority of student respondents indicated that they were not exposed to face-to-face interaction with university faculty (see Table 1). Maintaining a rapport with high school technology education teachers was identified as the second most effective recruitment technique, with a mean of 3.93 and a standard deviation of 1.14. In the influential factors section of the student questionnaire, over 41% (*n* = 13) of the student respondents recognized high school technology teachers (see Table 3) as the most influential person in their career choice. The faculty participants also acknowledged this assertion, with a response of 40.7% (see Table 4), suggesting that maintaining a rapport with high school technology education teachers was extremely effective.

Faculty respondents selected hosting a departmental open house as the least effective technique, with the lowest mean at 2.19 and a standard deviation of 0.88. Ironically, the student respondents rated open houses as one of the top three recruitment techniques (see Table 2) they would use to attract students into technology education if they were in a position to recruit for a university. The faculty members also indicated that providing displays at teacher conferences was an ineffective recruitment method, even though 63% (*n* = 18) of the faculty respondents indicated that they regularly used this technique. Both the TECA students (Table 2) and the faculty members (Table 4) indicated that supplying high school counselors with information was an ineffective recruitment

**Table 4**
*Faculty Participants' Recruitment Techniques Ranked on a Likert Scale for Perceived Effectiveness at Attracting Students into Technology Education*

| Recruitment Technique | Not Effective (value = 1) | | Slightly Effective (value = 2) | | Effective (value = 3) | | Quite Effective (value = 4) | | Extremely Effective (value = 5) | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ***N*** | **%** | ***N*** | **%** | ***N*** | **%** | ***N*** | **%** | ***N*** | **%** | ***N*** | ***M*** | ***SD*** |
| Face-to-Face Interactions | 0 | 0.0 | 0 | 0.0 | 6 | 22.2 | 7 | 25.9 | 14 | 51.9 | 27 | 4.30 | 0.82 |
| Maintaining Rapport with HS TE Teachers | 0 | 0.0 | 5 | 18.5 | 3 | 11.1 | 8 | 29.6 | 11 | 40.7 | 27 | 3.93 | 1.14 |
| Current TE Students to Recruit | 0 | 0.0 | 4 | 14.8 | 8 | 29.6 | 7 | 25.9 | 8 | 29.6 | 27 | 3.70 | 1.07 |
| Alumni to Recruit | 0 | 0.0 | 4 | 14.8 | 6 | 22.2 | 12 | 44.4 | 5 | 18.5 | 27 | 3.67 | 0.96 |
| Modern Lab Facilities | 0 | 0.0 | 5 | 18.5 | 4 | 14.8 | 13 | 48.1 | 5 | 18.5 | 27 | 3.67 | 1.00 |
| Scholarships | 1 | 3.7 | 5 | 18.5 | 9 | 33.3 | 5 | 18.5 | 7 | 25.9 | 27 | 3.44 | 1.19 |
| Promote Reputation of Program/ University | 0 | 0.0 | 3 | 11.1 | 12 | 44.4 | 10 | 37.0 | 2 | 7.4 | 27 | 3.41 | 0.80 |
| Alternative Certification Programs | 2 | 7.4 | 6 | 22.2 | 5 | 18.5 | 11 | 40.7 | 3 | 11.1 | 27 | 3.26 | 1.16 |
| Share Positive Job Related Characteristics | 0 | 0.0 | 7 | 25.9 | 9 | 33.3 | 9 | 33.3 | 2 | 7.4 | 27 | 3.22 | 0.93 |
| Contests for HS | 0 | 0.0 | 9 | 33.3 | 8 | 29.6 | 7 | 25.9 | 3 | 11.1 | 27 | 3.15 | 1.03 |
| Personal Letters to Students | 0 | 0.0 | 10 | 38.5 | 6 | 23.1 | 7 | 26.9 | 3 | 11.5 | 26 | 3.12 | 1.07 |
| Articulating Univ. to Comm. and Tech. Coll. | 0 | 0.0 | 11 | 42.3 | 3 | 11.5 | 10 | 38.5 | 2 | 7.7 | 26 | 3.12 | 1.07 |
| E-mails to Students | 0 | 0.0 | 11 | 42.3 | 5 | 19.2 | 8 | 30.8 | 2 | 7.7 | 26 | 3.04 | 1.04 |
| Talk at TSA or Skills USA-Type Activities | 0 | 0.0 | 9 | 33.3 | 11 | 40.7 | 5 | 18.5 | 2 | 7.4 | 27 | 3.00 | 0.92 |

**Table 4** (continued)

| Recruitment Technique | Not Effective (value = 1) | | Slightly Effective (value = 2) | | Effective (value = 3) | | Quite Effective (value = 4) | | Extremely Effective (value = 5) | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *N* | % | *N* | % | *N* | % | *N* | % | *N* | % | *N* | *M* | *SD* |
| Contact Undeclared Univ. Students | 3 | 11.5 | 8 | 30.8 | 8 | 30.8 | 2 | 7.7 | 5 | 19.2 | 26 | 2.92 | 1.29 |
| Info on Departmental Website | 0 | 0.0 | 12 | 44.4 | 9 | 33.3 | 3 | 11.1 | 3 | 11.1 | 27 | 2.89 | 1.01 |
| Talk in Univ. GE Courses | 1 | 3.8 | 8 | 30.8 | 13 | 50.0 | 3 | 11.5 | 1 | 3.8 | 26 | 2.81 | 0.85 |
| HS Counselors with Info | 1 | 3.7 | 13 | 48.1 | 7 | 25.9 | 5 | 18.5 | 1 | 3.7 | 27 | 2.70 | 0.95 |
| Printed Brochures | 2 | 7.4 | 11 | 40.7 | 8 | 29.6 | 5 | 18.5 | 1 | 3.7 | 27 | 2.70 | 0.99 |
| Talk During Student Teacher Supervisions | 1 | 3.7 | 12 | 44.4 | 10 | 37.0 | 2 | 7.4 | 2 | 7.4 | 27 | 2.70 | 0.95 |
| Advertise through Media | 4 | 15.4 | 9 | 34.6 | 8 | 30.8 | 3 | 11.5 | 2 | 7.7 | 26 | 2.62 | 1.13 |
| Wide Variety of Courses in Department | 3 | 11.1 | 12 | 44.4 | 7 | 25.9 | 3 | 11.1 | 2 | 7.4 | 27 | 2.59 | 1.08 |
| Recruitment Video | 4 | 15.4 | 8 | 30.8 | 9 | 34.6 | 5 | 19.2 | | 0.0 | 26 | 2.58 | 0.99 |
| Univ. Recruiter to Comm. and Junior Coll. | 4 | 14.8 | 11 | 40.7 | 6 | 22.2 | 5 | 18.5 | 1 | 3.7 | 27 | 2.56 | 1.09 |
| University Recruiter to High Schools | 4 | 14.8 | 13 | 48.1 | 5 | 18.5 | 1 | 3.7 | 4 | 14.8 | 27 | 2.56 | 1.25 |
| Recruitment Posters | 2 | 7.7 | 14 | 53.8 | 6 | 23.1 | 2 | 7.7 | 2 | 7.7 | 26 | 2.54 | 1.03 |
| Recruiters to HS Career Days | 4 | 14.8 | 13 | 48.1 | 5 | 18.5 | 4 | 14.8 | 1 | 3.7 | 27 | 2.44 | 1.05 |
| Bulletin Board Display | 4 | 14.8 | 13 | 48.1 | 7 | 25.9 | 3 | 11.1 | 0 | 0.0 | 27 | 2.33 | 0.88 |
| Displays at Teacher Conferences | 4 | 14.8 | 11 | 40.7 | 11 | 40.7 | 1 | 3.7 | 0 | 0.0 | 27 | 2.33 | 0.78 |
| Departmental Open Houses | 6 | 22.2 | 12 | 44.4 | 7 | 25.9 | 2 | 7.4 | 0 | 0.0 | 27 | 2.19 | 0.88 |

technique. The TECA respondents also indicated that high school counselors were not influential in their career choice of technology education. This may reveal that both faculty and student respondents believe that high school counselors may not fully understand technology education and may not be directing students into the field.

In the final question of Section 2, faculty participants were asked to mark all recruitment techniques they have used in the last year from the same inclusive list used for previous questions. Every recruitment technique was identified as being used by at least five of the respondents. None of the respondents identified using every recruitment technique. All but one of the respondents indicated that they used face-to-face interactions, and this technique was rated as the most effective recruitment technique. Maintaining rapport with high school technology education teachers was identified as being the second most widely used, with 88% (n = 25) of the responses. Student respondents seemed to agree with the perceived influence of high school technology education teachers (see Table 2).

*Summary of Findings*

Midwest technology teacher education faculty members indicated that they were aware of the concern regarding technology teacher shortages. Over 71% (*n* = 20) of the faculty members suggested that it was very critical to increase the number of students entering technology teacher education programs. However, most faculty respondents (68%, *n* = 19) see themselves as less than effective at recruiting students into the field. Face-to-face interaction was the most widely used technique (96%, *n* = 27) by faculty participants and perceived to be the most effective. Although the vast majority of faculty members indicated that they use a face-to-face recruitment technique and perceived it to be effective, this technique is obviously not reaching the correct audience since the majority of TECA respondents (68%, *n* = 21) indicated that no recruitment techniques were used to recruit them to the university that they were currently attending. However, by examining the *Industrial Teacher Education Directory* (Bell, 2001), one important relationship came to the surface. Of those universities graduating the greatest numbers of technology education teachers in the Midwest, face-to-face interaction was indicated as the predominant recruitment technique used.

Maintaining a rapport with local high school technology education teachers also seemed to garner strong support as a technique that can be used to reduce the critical shortage of new students entering the field. Both faculty and student respondents indicated that high school technology teachers are an important link in the recruitment process. In fact, almost 42% (*n* = 13) of the TECA students identified their high school technology teachers as the most influential factor in their career choice. This may indicate that keeping a good relationship with current high school technology teachers is one very effective way to recruit students.

**Conclusions**

With less than 10% of the student respondents indicating that they were recruited to the institution they attend, it appears that universities are not effectively using the techniques perceived to be effective by students. In addition, techniques that students believe to be effective are not being used or are not valued as effective tools by faculty member respondents. It is clear that what faculty perceives to be effective differs greatly from what TECA students perceive to be effective. It is surprising that over 95% of the faculty respondents indicated that they used face-to-face interaction to recruit, but just over 6% of the student respondents acknowledged that it was used effectively to recruit them. Perhaps these faculty members are talking to the wrong students or the students are changing fields of study after entering the university.

It is clear that high school technology teachers are vastly underutilized as recruiters for technology education, and steps must be taken to include them in future recruitment programs. Using currently enrolled technology teacher education students to recruit can be effective as well. Faculty participants ranked using current majors as the third most effective recruitment technique. Student respondents concurred, indicating that over 74% had tried to recruit other students into the profession of technology education. Clearly, using students to recruit new members to the profession is an underutilized resource for the profession.

It is also clear that depending on high school guidance counselors as a recruitment source is not an effective solution. Both faculty and student respondents suggested that counselors were not a factor in recruitment decisions. Perhaps, high school counselors are not guiding students into technology education because they do not fully understand the profession.

If members of the profession continue to be so ineffective at recruiting students, the future of the profession is in danger. In order to curb the shortage of teachers, all members of the profession must begin to communicate the benefits of technology education and spread the news to those outside the profession. It is those human interactions and communication channels that will make the difference in future recruitment efforts. Our profession has a great deal to offer, but clearly this message is not being delivered to the correct population.

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# Developing Technology Teachers: Questioning the Industrial Tool Use Model

John W. Hansen and Gerald G. Lovedahl

Sanders (2001), in the conclusion of his study on the status of technology education practice in the United States, discussed the apparent "ambivalence regarding the relationship of technology education to vocational and general education" (pp. 52-53). He stated:

> These waters are muddy: the absence of meaningful dialogue within the profession regarding the relationship between technology education and vocational education has led to continuing confusion both within and beyond the field. It is time the profession addressed this issue in an articulate and thoughtful manner.

This article seeks to open this dialogue by questioning the role of technology teacher preparation programs that are based on an "industrial tool use" model to develop technology education teachers. It is the position of the authors that the manner by which technology education teachers are prepared may need revision and that technology teacher educators need to reanalyze the objectives and methods used to develop their protégés. The ideas posited in this article find their locus in the experience of the authors while directing the rewrite of the K-12 Technology Education Standards for the state of Texas.

Technical courses are those that focus on developing the knowledge and skills to use tools, machines, and equipment at a proficient level of capability. Technical courses taken at the high school level are referred to, in this article, as vocational-technical education. The technical courses taken after high school, but at a level less than the baccalaureate are referred to as technical education and are not the subject of this article. The technical courses taken in a baccalaureate program, such as industrial technology or engineering technology, are referred to as the industrial tool use model.

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**Asking the Question**

What is the desired outcome of a technology education program? In posing this question to the technology teachers involved in rewriting the technology education curriculum in Texas (Hansen, 1996), the authors discovered a clear dichotomy of opinion among the teachers about the purpose(s) of technology education. Teachers who described themselves as technology education teachers stated technological literacy, while teachers who called themselves industrial technology/arts teachers (they considered these to be equivalent terms) stated "career preparation." All of these teachers had completed industrial technology/arts teacher preparation programs, and one-half of them were adamant that the focus of industrial arts has always been vocational-technical skills development and that the purpose of the new technology education curriculum they were writing should remain vocational-technical skills development. This experience is confirmed by Sanders' (2001) study, which indicated that almost 40% of his respondents identified their programs with vocational education and that there appeared to be little change since 1979. He suggested that this may be because many technology education programs are still administered and funded under vocational education administrative structures.

Technology teacher educators, to a large extent, can articulate the differences in purpose and outcomes of industrial arts, technology education, and vocational-technical education. But if one observed the teaching of industrial arts and vocational-technical education in actual settings (in the classroom, at the university, or in the high school), could one detect any differences between them? If one analyzed the purpose, content, methodology of instruction, and clientele, could one tell the difference? Sanders' (2001) study indicated that 65.6% of the technology education programs still use either a "unit lab" or "general lab" for the instructional facilities. For the neophyte (parent, student, administrator, and counselor), it is suggested that there would be no perceived difference.

The perceived similarities between the laboratories and course titles of industrial arts and technology education programs should alarm the proponents of technological literacy since many industrial arts programs have "converted" to technology education without a recognizable shift in praxis. Texas, for example, was converted from industrial technology education to technology education at the stroke of an administrative pen. If the instructional methodologies, content, clientele, and purpose are pragmatically the same before and after the name conversion, aren't the new technology education programs really vocational-technical education?

How is it that the technology teachers, who are supposed to have different philosophical foundations, implement programs that look so similar? It is the authors' opinion that part of the confusion exhibited in the high school classroom in regard to the purpose, content, method of instruction, and clientele of the industrial arts and technology education programs has its origin in the technology teacher preparation programs, which are organized around an industrial tool use mental model. If the use of this model to develop technology teachers persists, technology education may follow the same fate as industrial arts, teaching exclusively about tools, machines, and processes, and focusing on equipment and projects. The issue for technology teacher educators becomes one of implementation and practice as well as one of curriculum.

### Owning the Question

The promulgation in practice of the rationale, structure, and standards for technology education described by the International Technology Education Association in its *Standards for Technological Literacy* (2000) is a critical issue for technology teacher educators. Wright (1996) asked technology educators:

> Are you trying to use a vo-tec paradigm for a fundamental area of education, a core subject or are you using an interrelated, general education sci-tech model that prepares all students, regardless of career goals, to make intelligent citizen, consumer, and career decisions? (p. 4)

If high school technology teachers require a paradigm shift, it appears that technology teacher educators might also need to shift their paradigms. Technology teacher educators can hinder change by resisting or neglecting critical revision in their programs and their instructional strategies. The issue at hand is an assessment of the organizational and programmatic structures by which technology education teachers are prepared.

### Constraints on the Technology Teacher Development System

The organizational structures for programs providing technology teacher preparation have dual, if not multiple, missions. Brown (1993) suggested two classifications for technology teacher programs: (1) those housed in departments which support educational programs exclusively, or (2) those housed in departments supporting industry-oriented technical skills acquisition, i.e., industrial technology and engineering technology. Due to enrollment and budgetary constraints, the use of common courses and shared faculty for multiple programs is common (Brown; Israel, 1995; Pucel, 1997; Volk, 1997). Programs that service the largest number of students usually determine the content and methodology of the courses.

There has been an increase in the number of business- and industry-related technology programs, such as human resource development (HRD), developed by technology faculty in an attempt to secure their futures at their respective institutions (Ritz, 1997). In addition to these other options contributing to a decline in the number of students entering technology teacher preparation programs, as described by Daugherty (1997), they also dictate the content of courses in the major. In order to maintain an enrollment, undergraduate technical courses often consist of students in various “options,” with the content of the course tailored to meet the needs of the majority.

The degree of technical expertise required of postsecondary students entering a technology-related profession might be significantly different from that of prospective technology teachers (Brown, 1993). In addition, Smith (1997), in describing his perspectives on how technology teacher programs might change, suggested that the degree of technical proficiency required of future technology teachers is probably less than it was in the past and that a restructuring of the curriculum might be in order. Wright (1997) stated:

> The growth of industrial technology and engineering technology programs has presented a serious dilemma. Those programs generally focus on an in-depth study of fairly narrow areas of technology. They may offer a series of CAD courses or courses in robotics, hydraulics, CNC, and other similar topics. On the other hand, the technology education movement calls for a broadly educated teacher who understands topics such as control (integration of mechanics, electronics, hydraulics, pneumatics, etc.), automation (integration of CAD, CNC, robotics, etc.), and communication (integration of technical graphics, desktop publishing, and electronic media). (p. 32)

To a large extent, technical courses focus on developing the technical proficiencies of students to the exclusion of other knowledge and skills required for a technologically literate student, and it is these courses that often serve multiple clienteles. Israel (1995), in discussing the administration of technology teacher preparation programs, indicated that the "goals and objectives of the different technical programs and courses are usually not appropriate for the technology teacher education program" (p. 33).

If there are differences in the technical proficiencies needed to teach technology education compared to becoming an industrial or engineering technologist, should technology teacher preparation programs continue to organize themselves around an industrial tool use model? Can a "one-size fits all" perspective in developing the technical proficiency of teachers and technologists be justified? Technology teacher educators need to determine if there are differences between what a technologist needs to know and be able to do and what a technology education instructor needs to know and be able to do. Wright (1997) observed that:

> Many programs unrealistically expect the technology teacher education student to take a group of very specific, and often unrelated, courses designed for other majors and somehow develop the large picture without guidance from the technical course instructor. Also, the future teacher is expected to develop teaching skills and integrate the content from isolated technical classes in one or two professional classes. This expectation is unrealistic. (p. 32)

If, in fact, "we teach like we were taught," new technology teachers will tend to organize and teach their courses using models similar to the programs they completed. If their teacher preparation programs utilized an industrial tool use model, their objectives and strategies will reflect that model. A delineation of the knowledge and skills required of technology teachers to develop the technological literacy of students has yet to be determined, and will have critical influence on sustaining the innovation currently underway in implementing technology education in public schools**.**

**A Hypothesis on the Cause**

Educators throughout the years have recognized that education about technology has the unique characteristic of being both content and method. Manual training, manual arts, industrial arts, and technology education have all taught *about* technology (content) and have also taught *with* technology (method). In describing manual arts, Cranshaw (1912) wrote: "History in a multitude of instances bears testimony to the fact that manual training is an essential educational means" (p. 18). Kilpatrick (as cited in Grinstead, 1930) stated, "Purposeful activity, under strong mind set, helps in all kinds of learning-habits, skills, attitudes, and appreciations as well as in things properly to be remembered." Lauda (1988), past president of the Council on Technology Teacher Education, stated, "Technology is the basis of the content in technology education and also the means by which it is taught" (p. 12).

The development of industrial arts education was guided by the underlying concept that "learning by doing" was an effective means of learning (Bennett, 1926; Shemick, 1985). Learning was to occur in a laboratory or workshop with some type of hands-on work incorporated into the activity (Scripture, 1899). Manual training, manual arts, industrial arts, and technology education were founded, to a large extent, on the premise that hands-on activities were an integral, if not required, component of learning about the human-made world. Learning about technology could not be done without experiences with technology and necessitated a new instructional environment: the shop. "The industrial arts shop provided the context in which students could experience the problems of industrial society and actively engage in manipulating its materials, technique, and knowledge" (Herschbach, 1996, p. 31).

Fales (1937), in discussing the relationship of industrial arts and the general education curriculum clearly divided shop-based learning into vocational and non-vocational education, and industrial arts was identified as non-vocational. Industrial arts education became synonymous with hands-on, activity-based education and eventually became synonymous with the location of the activity, the shop. Vocational-technical education, which also utilized hands-on, shop-based activities, has also become identified as shop. To the uninitiated, industrial arts and vocational-technical education looked the same and served the same purposes; they were both shop.

This confusion in program goals and implementation by teachers may have originated in the teacher education programs by the utilization of industrial tool use courses to develop the technical capabilities of industrial arts teachers. Industrial arts teacher preparation programs, located in industrial/engineering technology departments, also tend to focus on technical skills preparation (Wicklein, 1997). Brown (1993) indicated that new industrial arts teachers modeled their teaching and laboratories on the technical competency model used in college. The de facto teaching methodology and content for the preservice industrial arts teacher became the same as that which was used for the technical skills development of industrial and engineering technologists. The shift in emphasis and time allocation from general education objectives to technical knowledge and skills objectives by the industrial arts teachers themselves effectively redefined industrial arts as vocational-technical education.

English (1992), in discussing the issues associated with aligning and auditing curricula, described the *written curriculum* that includes the published curriculum guides, state standards, and textbooks, the *taught curriculum* that includes the instruction, and the *tested curriculum* that includes standardized tests and teacher made tests. English (p. 8) stated, "These three curricula deal with content and express the absolute possibility that there could be in schools three unrelated 'contents floating around, unconnected to one another." Could this be true in industrial arts and technology education classrooms; that the written curriculum is neither taught nor tested? Is the taught curriculum an industrial tool use curriculum and not technological literacy? Is there actually a hidden curriculum focused on skill development (vocational-technical) rather than technological literacy? Obermier (1994) reported that the vast number of technology education programs he surveyed had their content developed by individual teachers acting on their own or with the recommendations of their colleagues. These teachers developed their course content without a proper "philosophical anchor" to guide their instructional design.

Could it be that the industrial arts teachers who resist the change to technology education teach a traditional unit-shop-based program focusing on skills development for specific occupations? Since they quite possibly view themselves as vo-tec educators, they legitimately resist the change because they recognize the pragmatic differences between vocational-technical education and technology education. In their minds, technology education as described by the International Technology Education Association does not adequately develop the technical skills a student needs to enter the world of work. Although they have degrees in industrial arts, and call themselves industrial arts teachers, they are by philosophy and practice vocational-technical educators as a result of their college academic experiences.

As industrial arts matured, it utilized hands-on learning as a basic argument for its continued place in the middle and high school curriculum. If that argument was true, industrial arts teachers operationally defined hands-on learning not as a strategy for instruction and learning, but as an end in itself. Rather than teach technology as a means to solve a problem or extend human capabilities, teachers taught the technical aspects of the technology (Wicklein, 1997). Teachers de-emphasized the general education objectives of industrial arts and emphasized technical skills training. Badger (1937) stated, "Too often, particularly in the field of education, we set up objectives and then forget about them and continue to emphasize subject-matter facts and skills for their own sake" (p. 160). In content and methodology, industrial arts became vocational-technical education. In describing his concern over the technical skill development issue in technology education, Wicklein (1997) editorialized:

> The critical issue is, to what degree should the curriculum be devoted to technical skill training? Historically, educators within technology education have given an exorbitant amount of instructional time to this area while slighting many of the other facets of the curriculum. An appropriate balance of tool skills with other curriculum areas is a key to a healthy curriculum. (p. 75)

**Positing an Undesirable Future**

Industrial arts education enjoys a rich and controversial history. Its visionaries were clear in describing industrial arts education as general education, suitable for all children (Smith, 1936). The discrepancy between the intent of industrial arts and its practice existed not so much between the visionaries of industrial arts and the general education advocates, but between what industrial arts advocates said it could do and what its teachers actually did (Foster, 1994). In the classroom it was difficult to describe exactly what the objectives of industrial arts education were since much of the content and methods were identical to those used in vocational-technical programs.

The theme of hands-on learning pervades the history of industrial arts (Foster, 1994) and became an axiom of technology-based education. Technology education has also claimed this axiom. Technology education advocates should be alarmed at the "blurring" of the distinctions between industrial arts education and vocational-technical education *by the industrial arts educators* themselves. The original objectives of industrial arts are very similar to the objectives of technology education (Foster). Simply stating that technology education is not vocational-technical education is not a sufficient safeguard against this shift in purpose and the eventual de-emphasizing of general education objectives.

Teacher preparation programs, adopting the technology education paradigm, while simultaneously utilizing an industrial tools model, may be producing pseudo-vocational-technical educators for the technology education classroom. Technology education teachers, who in philosophy and practice are really vocational educators, are likely to ignore or adapt technology education objectives to align with their vocational-technical education orientation. These technology educators will focus on classroom activities and projects and resist teaching technological literacy objectives because they are not occupationally specific. Rather than teach the objectives of technological literacy, they will revert to teaching only the restricted technical aspect of technology. Rather than using technology as a means to an end, they will teach and evaluate technical skills. The promised general education goals will not materialize, and technology education will be forced to justify its inclusion in middle and high school programs just as manual training, manual arts, and industrial arts have had to do. Only this time the failure of technology education may effectively inoculate parents, administrators, and other teachers against technology studies.

Or perhaps parents, administrators, and legislators will conclude that technology educators cannot provide technological literacy, delegating this important responsibility to those who they perceive as technology teachers, i.e., science and computer teachers or anybody who can manage a modular technology laboratory. The problem of who should teach technology education appears to be an issue that is not yet entirely resolved (Kanigel, 1986) and may eventually be resolved by those outside the field. Technology education is finding its subject matter being taught by unqualified teachers without the proper philosophical foundation (Sanders, 1997) or the appropriate technical training. As a result of the lack of adequate teacher preparation, the field will revert to playing technology games (bridge destruction contests and $CO_2$ drag racers) and doing technology busywork rather than developing technologically literate students.

Johnson, Evans, and Stem (1996), in discussing the National Association of Industrial and Technical Teacher Educators (NAITTE), stated:

> The assumption that underlies the structure and mission of NAITTE is that the programs of technology education, T & I, technical education, and industrial and military training are fundamentally similar across a wide range of characteristics. Of course these programs are not identical. Clearly, each program is based on a distinct philosophy, purpose, methodology, content area, and clientele. (p. 53)

Are the purposes, methodologies, content, and clientele distinctly different as these programs are implemented in the field, or do the differences exist only in the minds of the academicians? Teacher educators need to determine if the programs are different enough to merit separate preparation programs and if separate programs are not possible, how can they be organized to serve multiple objectives and still maintain their philosophical integrity?

**A Plan of Action**

Recognizing how our practices of preparing technology teachers may have exacerbated an already confused philosophy of technological literacy, it is critical that we unite and utilize our knowledge and skills as higher education faculty to create a new future for preparing teachers. Improving technology teacher education programs requires several coordinated efforts that leverage our collective experience and wisdom over the next five years. These efforts direct our focus on how we will respond on a national, university, programmatic, and individual level to the transition. A recommended plan of action for improving technology teacher preparation at a national level should include the following points:

1. All technology teacher education programs should be engaged in this process. This is not a problem limited to ITEA, NCATE, or CTTE membership. It is recommended that four national symposiums be organized over the next five years to provide the framework, planning, guidance, and evaluation of future activities. Programs in the various stages of transition must have a venue for managing and sharing their wisdom and "lessons learned." This hard-earned knowledge can assist others with the practices that helped and hindered the organization and faculty. The results

of these efforts should be promulgated as "best practices" in preparing technology teachers for technological literacy.

2. Technology teacher preparation programs need to perform curriculum audits to identify if they are providing the enabling knowledge and skills technology teachers require. English (1988) suggested that a curriculum audit may be necessary under the following conditions: (1) the stakes are high, (2) the status quo is not acceptable, (3) objectivity is necessary, (4) the past and present are not well understood, (5) public confidence and trust must be re-established or retained, (6) results count, and (7) cost is important. An affirmative answer to any *one* of these questions should trigger a curriculum audit in secondary and postsecondary technology education programs. We should be alarmed that we can affirm virtually all of the statements and may still be adhering to an inappropriate model for developing technology teachers.
3. It is the role of university and college faculty to define and research the questions related to a philosophy of technological literacy. It is university faculty who must lead the efforts to expand and extend our understanding of the critical importance of developing a technologically literate population.
4. Technology teacher educators must also identify and develop the content of technology teacher preparation programs that surpass the *Standards for Technological Literacy: Content for the Study of Technology* (2000). The proposed *ITEA/CTTE/NCATE Curriculum Standards: Initial Programs for Technology Teacher Preparation* (2003) are critical for establishing baseline outcomes for technology teacher preparation programs. We should commit to, if this is the best model for technology teacher preparation programs, adhering to these standards, regardless of our NCATE affiliations. The standards by themselves, though, cannot perpetuate the continuous improvement that must occur in the academic institutions. It is our intellectual responsibility not to teach to the standards.
5. Technology teacher preparation programs should be evaluated at several levels to truly determine their efficacy in promoting technological literacy. Kirkpatrick's (1975) four levels of evaluation attempt to answer the following questions: (1) were the participants pleased with the program? (2) what did the participants learn in the program? (3) did the participants change their behavior based on what was learned? and (4) did the change in behavior positively affect the organization? In colleges and universities, end-of-course teacher evaluations and teacher-made tests address levels one and two, respectively. Rarely, though, are levels three and four evaluated. A fifth level of evaluation has recently been added to Kirkpatrick's model, determining the Return on Investment to the organization. Do we really know what is going on in the high school technology classroom? Are technology teachers really striving to teach the goals of technological literacy? Or, are we relying on anecdotal evidence to support our favorite

programs and curriculum? Is there any evidence of the benefits, economic or otherwise, that technological literacy is providing?

6. We need to give serious consideration to what we will have to "let go of" to improve the probability that the planned changes will succeed. Technology focuses on innovation to solve problems. Innovation is stifled when one becomes fixated on the traditional solutions to problems. Traditions help us transfer our experiences and wisdom from one generation to the next, and they help us to resist fads. But, adherence to tradition often leads to traditionalism, which seeks to perpetuate tradition at the expense of 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. Keynes (as cited in Peters, 1997) states, "The greatest difficulty in the world is not for people to accept new ideas, but to make them forget about old ideas" (p. 78).
7. We need to recognize that this is not a "one shot" cure-all. It will be difficult to let go of the past and move toward a new beginning. Many innovations will not work well, ideas will appear ambiguous, and it will take repeated efforts to refine our programs and faculty. Thus, a national change management task force should be established to assist programs and faculty during this process.
8. We must redefine the role of the faculty in technology teacher education. It is not enough that we teach a workshop on grant writing or curriculum assessment or how to run this or that piece of equipment or software. It is not enough that we teach the technical content of our favorite areas (e.g., digital electronics, design processes, printing, digital image manipulation, materials, and processes). Our role as scholars in the academy demands that we discover new knowledge in technological literacy, that we subject this knowledge and the processes by which it was discovered to external peer review, and that we disseminate this new knowledge. It demands that we: (1) place the issues of technological literacy in larger societal contexts, (2) educate the non-technologists about technological literacy, (3) bring new insights to bear on the issues of technological literacy, (4) determine how technological literacy can help solve consequential problems. In addition, it demands that we understand that teaching is not simply about the transfer of technical knowledge and skills. Scholarly teaching requires transforming and extending our understanding of the learning process and how it relates to the development of technological literacy and technological thinking (Boyer, 1990).
9. It is imperative that models for the evaluation of technological literacy be developed and validated. Otherwise, we will not be able to determine if technology education has truly made a difference. These models must go beyond the assessment of knowledge and skills. They should include an analysis of the social, psychological, and economic returns of technological literacy.

10. Leadership training for program coordinators, department chairs, school directors, and college deans should be offered to help in understanding and supporting the physical and pedagogical changes and mental transitions that their faculty and students will undergo. They must be able to explain, encourage, and reward success as their programs change. Academic leaders must understand the nature of the changes before them and be prepared to guide their institutions and colleagues through the transitions.

**Conclusion**

Are we attempting to prepare pre-service teachers to teach for technological literacy (rationale, structure, and standards) with teacher preparation programs based on the traditional industrial tool use model? Without the support and cooperation of teacher preparation institutions to prepare teachers qualified to teach for technological literacy, the focus of secondary technology education programs will continue to be based on technical (tool use) competencies, and the goals of technological literacy will never be realized. Do we have the courage, wisdom, and fortitude to examine our traditional approaches to pre-service teacher preparation and to agree that it might be time for change?

The issue may be one of new wine and old wineskins. Ancient wisdom suggests that placing new wine into old wineskins is problematic. As new wine reaches maturity, it stretches old wineskins to the point of rupture. The wine and the wineskins are lost. Are technology teacher preparation programs putting the new wine of technological literacy into the old wineskins of industrial tool use programs? Do we have the courage, wisdom, and foresight to examine our well-worn wineskins and then to decide that it might be time for new ones?

We as technology teacher educators must ensure that we understand the differences between the various programs and that we build programs and build our professional activities around scholarship that allows teachers to function effectively and unambiguously in their classrooms and laboratories. If we cannot or will not do this, we have compromised our responsibilities as academicians and have violated the trust that the nation has placed in us.

No attempt to improve the teaching of technological literacy on a large public scale can succeed without careful attention to the training of teachers. Any effort to change what happens in the classroom will not be effective if it acts independently of the competence of the critical variable, the teacher. Our challenge is to figure out how best to implement and follow through on how teachers can best be prepared to teach toward technological literacy.

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# The Status of Design in Technology Teacher Education in the United States

Scott A. Warner and Laura L. Morford

## Introduction

Design is fundamental to the study of technology. McCracken (2000) goes so far as to refer to design as "the creative soul of technology" (p.87). McCracken elaborated on this profound concept by stating:

> As a human soul is to the body, design is to technology. It is important to understand the interdependence and complimentary nature of technology and design. Like the inseparable relationship between body and soul, technology is incomplete without design. Design cannot be fully appreciated without an understanding of technology. If technology is to be fully understood, then the concepts of design need to be understood. (p. 87)

The *Standards for Technological Literacy: Content for the Study of Technology* (*Standards*) (ITEA, 2000) identified the importance of such a holistic grasp of design when developing technological literacy by stating, "To become literate in the design process requires acquiring the cognitive and procedural knowledge needed to create a design, in addition to familiarity with the processes by which a design will be carried out to make a product or system" (p.90). Using design as the fundamental tool to examine and create technology involves the development of the intellectual infrastructure for such an approach. A major part of that infrastructure is formed through the learning experienced by pre-service technology teachers during their undergraduate studies.

Wulf (ITEA, 2000), commenting in the Forward of the *Standards,* emphasized the importance to the profession of the ideals put forth in that document by stating, "It is not enough that the standards are published. To have an impact, they must influence what happens in every K-12 classroom in America" (p.vi). However, this impact cannot happen only in the K-12 classrooms. The system that prepares technology educators in college and university undergraduate programs plays a significant role in both choosing how

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technological literacy will be interpreted through technology education, and in preparing future teachers who will then apply those interpretations in the K-12 classrooms. If the *Standards* are to serve as a common framework for the development of technological literacy, it would then follow that a broad understanding of the influence of design in the study of technology ought to be a matter of importance to the profession.

In the *Standards*, design is a theme that is woven throughout the many benchmarks and is identified specifically as 4 of the 20 overall standards The emphasis on design in the *Standards* begs the need for a definition and description of design. The document describes the characteristics and general processes of technological design by stating:

> Technological design is a distinctive process with a number of defining characteristics: it is purposeful; it is based on certain requirements; it is systematic, it is iterative; it is creative; and there are many possible solutions. These fundamental attributes are central to the design and development of any product or system, from primitive flint knives to sophisticated computer chips. (p.91)

This description of technological design is far more enlightening to the reader than many of the historical definitions that have preceded it in the realm of technical education. Steinen (1977) simply stated, "Design could be defined as a plan" (p.3). Lindbeck (1963) asserted that, "By definition, designing is creative planning to meet a specific need" (p.16). Micheels and Sommers (1963) described the introduction of students "to the broad concepts of design . . . [through] initial experiences in problem solving by the use of tools and materials" (p. 156).

Other professions that deal with technical design, such as architecture and industrial design, provide descriptions and definitions of design from which technology education can benefit. Lawson (1997) used comparisons to sport and music when describing design as a skill:

> Design is a highly complex and sophisticated skill. It is not a mystical ability given only to those with recondite powers but a skill which, for many, must be learnt and practiced, rather like the playing of a sport or a musical instrument. (p.11)

Lawson later makes the point that design, like all skills, requires practice and repeated use for it to become a completely intuitive act. According to Lawson:

> It is in the very nature of highly developed skills that we can perform them unconsciously. So it is with design. We probably work best when we think least about our technique. Beginners however must first analyze and practice all the elements of their skill and we should remember that even the most talented of professional golfers or musicians still benefit from lessons all the way through their careers. (pp. 11-12)

Schön (1983) perhaps best summarizes all of the various attempts to describe and define the process of technical design by stating:

> A designer makes things. Sometimes he makes the final product; more often, he makes a representation – a plan, program, or image – of an artifact to be constructed by others. He works in particular situations, uses particular materials, and employs a distinctive medium and language. Typically, his making process is complex. There are more variables – kinds of possible moves, norms, and interrelationships of these – than can be represented in a finite model. (pp. 78-79)

All of these descriptions of design seem to contain commonalities in their basic conceptual framework. However, the very nature of design leaves plenty of room for unique interpretations of both how the process of design is done and how it can be taught.

**Purpose and Need for the Research**

With design taking such a prominent role in the *Standards*, a measure of the current status of such courses in technology teacher education provides a quantitative foundation for further investigation into the nature and role of design toward achieving technological literacy. This research was designed to be the first in a series of studies to determine the nature and scope of the study of design in the undergraduate experience of technology educators. Essentially, this study and its follow-ups are intended to provide reference marks about how the ideals of the practice of design, put forth in the *Standards,* are played out in the preparation of undergraduate students in technology education. The intent of this specific research effort was to take a measure of the status of the study of design as a part of those undergraduate experiences.

Reed (2002), Lewis (1999), Foster (1996), and Foster (1992) found declining numbers of research efforts being conducted in technology education. Furthermore, Lewis also identified a number of areas in need of research. Examples of those areas that directly apply to the need for this study include (a) "Questions pertaining to technological literacy" (p.43), (b) "Questions pertaining to technology and creativity" (p.46), (c) "Questions pertaining to curriculum change" (p.48) and, (d) "Questions that focus on teachers" (p. 50). In a preliminary review of the literature, Warner (2003) found that there was no specific analysis of the status of the study of design in undergraduate technology teacher programs. The increasing importance of the role of design toward the quest for developing technological literacy in students made this finding a key point in recognizing the need for this study. As a result, the identified lack of literature and data for analysis provided the impetus to perform a more detailed investigation.

## Method

*Limitations*

The researchers chose only to examine and then quantify the status of design related courses. Crowl (1993), Tuckman (1988), and Gersten (n.d.) described the nature of such descriptive research as simply observing and describing the variables, as they exist across a given population. Gersten further observed that descriptive research could provide quantitative data, which can then be used to ". . . help us understand common implementation problems and other pressing problems in current practice. However, despite the rich insights they [descriptive studies] often provide, they can not serve as evidence of effectiveness" (p. 2). The researchers felt that a descriptive study of this issue would be a necessary first step toward developing a database for later research on the effectiveness and influence of the different approaches to the study of design in technology teacher education.

*Definition of Terms*

Two basic descriptors for the study of design courses were agreed upon: technique-based or synergistic. Buchanan (1998), Lawson (1997), and Narvaez (2000) addressed the idea that most design programs in subject areas such as architecture, engineering design, and industrial design organize their programs of study in such a fashion. Specifically, technique-based courses are focused on the technical aspects of design. Buchanan (1998) calls these technical aspects the "basic skills suited to the needs of the trade, but little else" (p. 64). For example, these types of courses might focus on techniques such as technical drawing, mechanical drafting, computer-aided drafting, and model making. Synergistic-based courses combine the technical skills with the overall thinking processes of design. Narvaez (2000) refers to these types of courses as "the meta-structure of design" (p.38) in that they look at and use the design process and all of its constituent techniques in a broad context. Buchanan (1998) argued that the synthesis of the skills of technique with the design thinking process in the synergistic courses "add[s] to these skills other elements of learning that contribute to the formation of a liberally educated professional" (p. 64). Lawson (1997) further expanded on the characteristics of a synergistic approach to technical design by making the connection to the arts through the following statement:

> For many of the kinds of design we are considering, [architecture, interior design, graphic product design, product and industrial design and, urban and landscape design] it is important not just to be technically competent but also to have a well-developed aesthetic appreciation. Space, form, and line as well as color and texture are the very tools of the trade for the environmental, product or graphic designer. The end product of such design will always be visible to the user who may also move inside or pick up the designer's artifact. The designer must understand our aesthetic experience, particularly of the visual world, and in this sense designers share territory with artists. (pp. 10-11)

Generally, synergistic courses were called things such as industrial design, product design, or design processes (Warner, 2003).

*Assumptions*

It is important to note that from the beginning of the research, the assumption was made that most, if not all, technology teacher education courses used or contained some component of design. However, for the purposes of this research, it was decided to investigate only courses that were explicitly focused on design techniques or the overall design process. It was further assumed that many technique-based courses would include synergistic segments and that synergistic courses might also include aspects of teaching specific design-related skills. Therefore, the researchers sorted the courses based on the primary focus of the content, as determined from the various forms of course descriptions.

The raw data were collected between the months of May and November 2002. It was assumed that the data reflected the most recent structure and content of the undergraduate courses in technology teacher education offered at the universities and colleges included in the final pool. It was further assumed that the review of the list of design-focused courses, completed by the representative from each technology teacher education program, was complete and accurate and reflected only the design-focused courses offered through the program.

*Research Questions*

The researchers first organized their approach to the study by creating a series of questions and developing a strategy for collecting the raw data. The fundamental questions were:

1. What was the number of undergraduate technology teacher education programs nationwide?
2. What was the number of design-focused courses offered at those programs?
3. What were the titles of those courses?
4. How many design-focused courses were primarily structured to teach the techniques of design and how many were primarily synergistic in their content structure?
5. How many design-focused courses were electives and how many were program requirements?
6. Was there any pattern to the geographic distribution of the technique-based and synergistic design courses?

*Data Collection*

The strategy for collecting the data involved first identifying the undergraduate programs in technology teacher education and then accessing the specific information about course offerings and course content. The initial selection of programs to be examined came from the list of institutional members of the International Technology Education Association (ITEA) posted on the ITEA web site (http://www.iteawww.org/J4.html) as of May 2002. At that time there were 64 institutional members listed. After filtering for appropriateness for inclusion, the total number of undergraduate technology teacher education programs examined was reduced to 60. Programs were excluded from this study for one or more of the following reasons:

1. The university or college did not have an undergraduate program in technology teacher education.
2. The university or college did not have a technology teacher education program.
3. The university or college was located outside of the United States.

Three additional technology teacher education programs were eliminated because they were in the process of closing, resulting in 57 programs being used for this research.

The primary source for the data collected was the information provided by the university or college on its Web page. Some programs provided the course listings and individual course descriptions on their departmental Web pages. Other departments provided only general program descriptions. In these latter situations, the researchers accessed the university or college undergraduate catalog through the Internet. For the vast majority of programs, the Internet proved to be productive in locating both the program curriculum and the individual course descriptions. For a small number of programs, it was necessary to make personal contact with either the department chairperson or with the admissions director of the university or college to request that a copy of the university catalogue be sent through the regular mail. For a few courses, it was also necessary to contact a representative from the program and ask for additional information concerning course content and/or request a copy of the class syllabus.

The raw data were collected for each school and a list of courses that fit the description of being design oriented were then presented to the respective department chairperson or the identified departmental representative for technology teacher education. The contact with the representative was initially made through an e-mail message. Subsequent contacts were made, as needed, through additional e-mail messages, facsimiles, and direct telephone calls. The departmental representative was asked to confirm the list of identified design-oriented courses or to make changes accordingly. The messages included a brief description of the research, brief definitions of synergistic and technique-based design courses, a list of the identified courses from that college or university, and an indication of the status of the class as being either a requirement for the program of study or an elective. Responses from the program representative were included to help provide direct input into the study from each of the schools. Once the list of courses was confirmed or adjusted by the school's representative, it was then reviewed by the researchers, who then organized them by the published course description and categorized them as being either technique-based or synergistic in approach. The data were tabulated, first for each school, and then as part of a collective database of the status of the study of design across the United States. The results were then used to address the questions set forth by the researchers.

## Results

The researchers were persistent in acquiring the data from each of the identified schools ($N = 57$). This persistence paid off in that all responses were received from all of the schools.

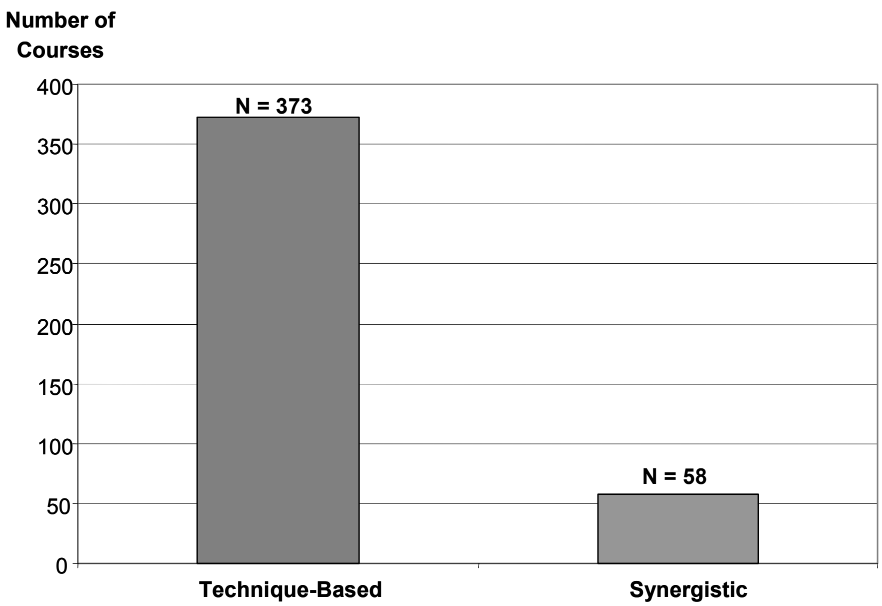


*Figure 1.* Comparison of technique-based to synergistic design courses.

The research determined that there were 431 courses focused on the study of design at the 57 programs examined. The breakdown of the courses into their respective categories was 373 technique-based courses and 58 synergistic courses (see Figure 1). The average was 7.6 courses per program that focused on the study of design. The statistical outliers of this particular measure had one school with 21 design courses and two programs with just one such class (see Figure 2). The required courses numbered 140 technique-based and 35 synergistic-oriented (see Figure 3). Only 38% of all technique-based courses were identified as required toward graduation, whereas 60% of the synergistic courses were identified as required for the completion of the degree (see Figure 4). The nationwide ratio of technique-based courses to synergistic courses was a little more than six to one. However, some programs were notable in the extremes of their class ratio. One extreme had several schools with a large number of technique-based courses and few or no synergistic courses. A specific example had 15 technique-based courses and no synergistic courses. Several other schools had similar ratios. At the other extreme, a few schools had a large number of synergistic courses. The most notable example had six synergistic courses and no specific technique-based courses.

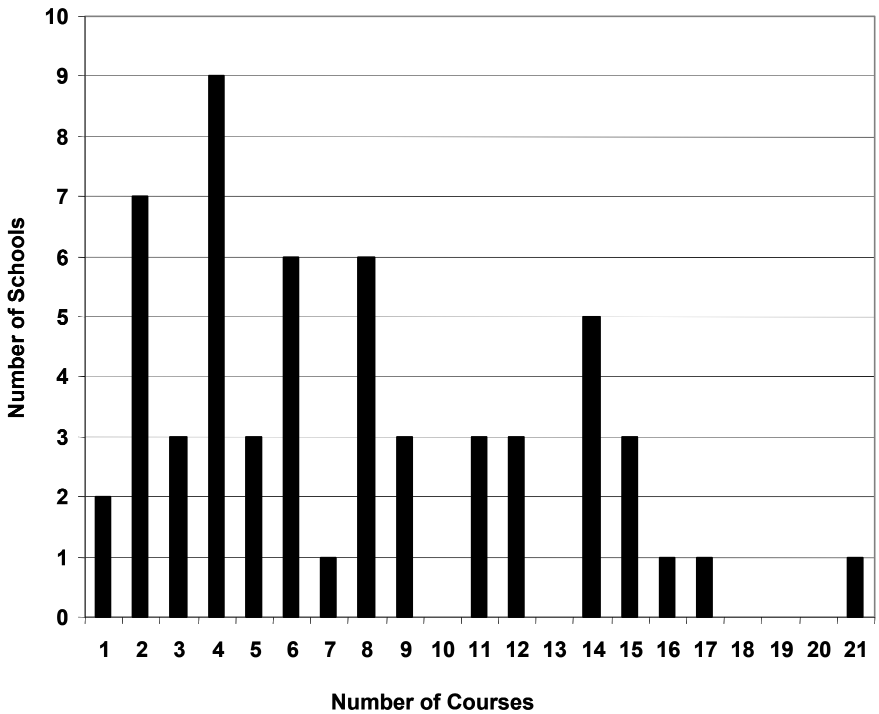


*Figure 2.* Distribution of design courses among the programs studied (*N* = 57).

The titles of the more popular courses in each of the two categories are reported in Table 1. Not surprisingly, the most popular technique-based course title, with 79 courses, was Computer Aided Drafting (CAD), or some variation associated with the use of computers in drafting and design. Other popular titles for technique-based courses focused on Architectural Drafting and Design, Engineering Graphics, variations on Graphic Communication, and Technical Drafting. As might be expected, the titles of the synergistic courses were more reflective of a broader approach to the study of design. Courses with the title of Industrial Design were by far the most common. There were ten such courses with that title. Other popular class titles included things such as Product Design, Research and Experimentation, and Design and Technology.

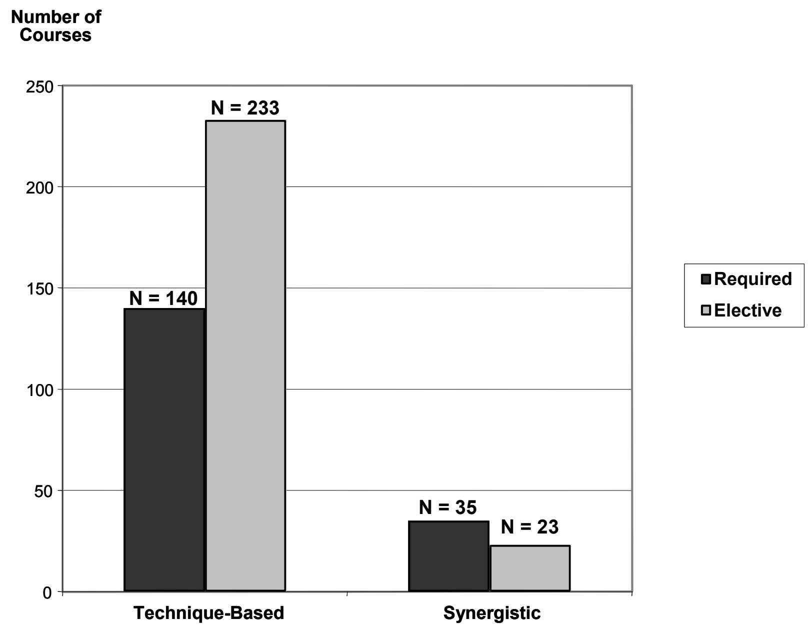


*Figure 3.* Comparison of required versus elective design courses by course type.

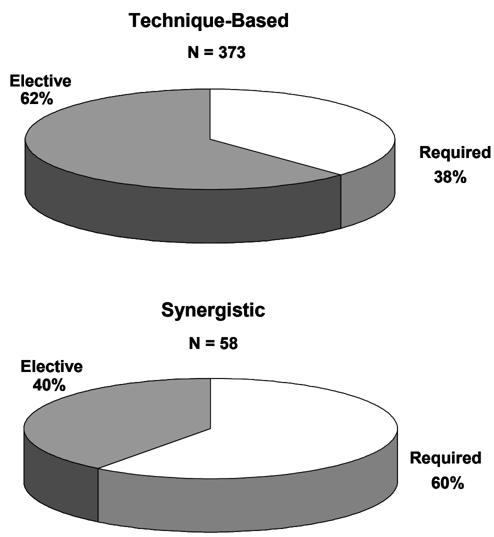


*Figure 4.* Percentage comparison of required versus elective design courses by course type.

Though several schools specifically required or recommended that certain courses be taken in a study of design course sequence, the researchers were not able to ascertain a consistent nationwide pattern on this matter. A possible reason for this might include how schools administratively organize their curriculum (i.e., processes, systems, clusters, etc.). Another explanation may have been that materials that express such a course sequence were available to academic advisors and students at the colleges and universities, but were not readily available through other public forums.

**Table 1**
*The Most Popular Course Titles for the Study of design*

| Technique-based | | Synergistic | |
|---|---|---|---|
| **Course Title** | ***n*** | **Course Title** | ***n*** |
| Computer Aided Drafting | 79 | Industrial Design | 10 |
| Technical Drafting/ Drawing | 34 | Design and Technology | 9 |
| Architectural Drafting and Design | 29 | Product Design | 8 |
| Engineering Graphics | 14 | Research and Experimentation | 7 |
| Graphic Communications | 8 | Design Problems/Problem Solving | 7 |

The material examined for this research provided no indication as to whether any of the courses were specifically organized to address the design components of the *Standards*. A possible explanation for the lack of evidence on this matter is that the *Standards* were less than three years old when the data were collected, and thus, such changes were only just beginning to be made. Also, specific references to the *Standards* as an organizing force for a class may have been imbedded in the less public course material, such as the course syllabus and activities list.

An examination of the geographic distribution of technique-based and synergistic courses simply reflected the distribution of technology teacher education programs (see Figure 5). The researchers thought that there might be a geographic pattern to the way that design-related courses were distributed, perhaps reflecting regional differences in the interpretation of design as a component of technology teacher education or influences by government agencies, school programs, and groups or individuals toward that interpretation. However, the distribution of the two types of courses appears to be entirely random.

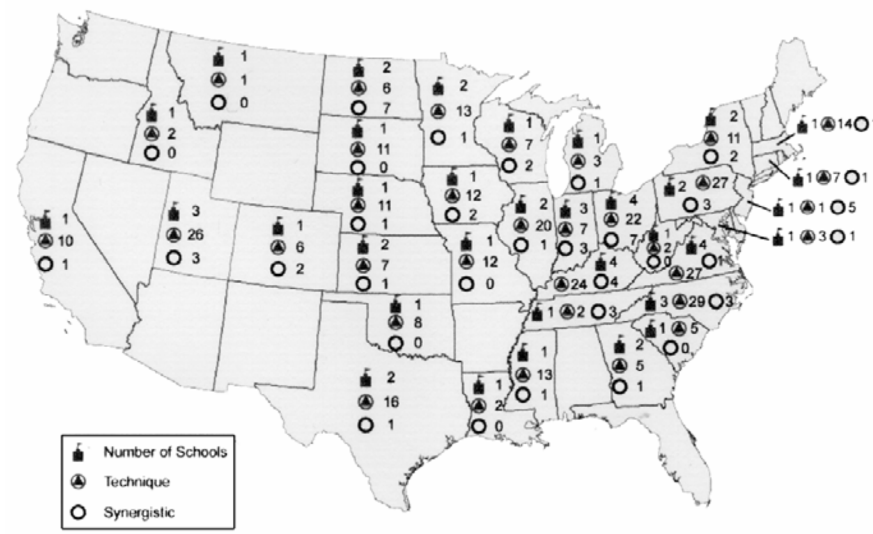


*Figure 5.* Geographic distribution, by state, of design courses among teacher education programs.

**Conclusions**

Since this was only an observational study, there was no determination of the benefits or the drawbacks of either type of class, and there was no determination of an ideal ratio between the two types of courses. However, the current status of the study of design in the curriculum content experienced by pre-service technology teachers during their undergraduate studies indicates a profession that is deeply rooted in the technical aspects of the design process. With the release and the subsequent acceptance of the *Standards* as a professional yardstick by which technological literacy can be measured, it could be expected that the content and organization of the courses for the study of design during the undergraduate experience will evolve to reflect a broader understanding of the influence of design toward the study of technology.

## Recommendations

The lack of similar data in the literature prevented a comparison between the past and the present. However, future research could be done to measure the type and amount of change that has occurred since these data were collected. This information will be helpful in tracking the changes made by the undergraduate technology teacher education programs as they make adjustments in their curricula to reflect the technological literacy goals and objectives of the *Standards*. In-depth research could also be done on the specific content of both types of courses to determine how they relate to the goals and objectives of the *Standards.* Finally, research could also be done to identify an ideal ratio of technique-based and synergistic courses in an undergraduate curriculum. As stated previously, this study was intended to be the first in a series of investigations into the nature and status of the study of design in technology teacher education. During the next several years, the researchers will be initiating studies into these and other questions on this subject using this study as a foundation upon which to build.

University administrators and faculty have a responsibility to provide their students with an educational experience that prepares them for long and successful careers as technology educators. The findings of this research should serve as one piece of the puzzle in determining how they can meet that responsibility.

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# Creating Change? A Review of the Impact of Design and Technology in Schools in England

Valerie Wilson and Marlene Harris

## Introduction and Background

The role of Design and Technology in schools in England is changing. These changes were heralded by the Government Green Paper *14–19: Extending Opportunities, Raising Standards* (Department for Education and Skills [DfES], 2002), which proposed that education and training of 14–19-year-olds should be delivered by a more flexible curriculum with a broad range of options. Beginning in September 2002, Design and Technology (D&T) is no longer a compulsory school subject from age 14: the age which marks the end of Key Stage 3 in the broadly-based National Curriculum in England. Students will have a statutory entitlement to opt to study D&T subjects, but also more freedom within what was recognized as a very crowded curriculum to select other subjects of their choice. It is anticipated that these changes will impact considerably on D&T provision in schools. But what exactly is D&T? How has it been taught in elementary and secondary schools to date and what impact has it had on pupils? These are some of the questions that researchers from the Scottish Council for Research in Education (SCRE Centre) addressed in a literature review commissioned by the Department for Education and Skills (DfES) in England. This article is based upon that review (Harris & Wilson, 2003). In the following sections, we present the research evidence mainly from the UK regarding the origins of the concept of D&T, its unique educational components, and the impact it has had on the curriculum in England. These findings are summarized at the end of each section.

The main aim of the review was to search for evidence of the impact of Design and Technology (D&T) on schools in England. Literature was identified that highlighted issues relating to:

- The concept of D&T
- The effect of including D&T as part of the National Curriculum in English schools
- Gaps in the research evidence.

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Key words applicable to this review process were used to search literature from four educational databases: the British Educational Research Index (BEI) for research published in British educational journals; Educational Resources Information Center (ERIC) encompasses international literature, as does PsychInfo, which concentrates on articles published in psychology journals; and Current Educational Research in the UK (CERUK) for recent studies in the UK. The number of references found is displayed in Table 1.

As in previous SCRE reviews (e.g., Harlen & Malcolm, 1999), we utilized the concept of "best evidence synthesis," which Slavin (1990) applied to reviewing educational research. It requires the reviewer to identify criteria for determining good quality research and to place more emphasis on those studies that match the criteria than those which have identifiable shortcomings. Four criteria for inclusion of studies in our review were established:

- Papers published during the past twelve years.
- Studies relating to primary and secondary mainstream schooling.
- Papers published in peer-reviewed journals and government policy documents. Where these were not sufficient, relevant conference papers may have been included.
- Studies of well-designed experimental interventions in D&T education.

The first three criteria were used in this study. However, unfortunately it proved impossible to adhere strictly to the fourth because of the dearth of published evaluations of well-designed experimental interventions in D&T.

## Origin and Concept of Design and Technology

"Design and technology" was introduced into the National Curriculum in England and Wales as a distinct academic subject in 1990 (under the *Technology in the National Curriculum* Statutory Order, DES and We1sh Office, 1990). Some suggest that this was a response to government recognition of the importance of technology to the British economy (Layton, 1995). However, most agree that little research evidence existed before the introduction of D&T into the curriculum on which to base decisions (Department of Education and Science/Welsh Office [DES/WO],1988, Section 1.15; Kimbell, Stables, & Green, 1996; Penfold, 1988; Shield, 1996). Nevertheless, its associated distinctive model of teaching and learning had been evolving over a few decades (Kimbell et al.; Kimbell & Perry, 2001; Penfold). It is claimed that England and Wales were the first countries in the world to make technology education compulsory for all children between the ages of 5 and 16 (Education Act, DES/WO, 1988; Kimbell & Perry). This has been described as a pivotal moment in history. However, since its introduction, it is clear that a range of meanings and usages of the term D&T have developed. In her letter to the Secretary of State accompanying the Interim Report, the chairman of the National Curriculum D&T Working Group (DES/W/O, 1988), Lady Parkes, explained that:

> Our *[the Working Group's]* aim has been to develop an approach to design and technology which will enable pupils to achieve competence by engaging in a broad range of activities which are currently undertaken in a number of different school subjects. (Letter accompanying Working Group)

It is, therefore, not surprising that D&T has come to be acknowledged as a multidisciplinary subject with potential for cross-curricular activity. The Programmes of Study (PoS), which describe what will be taught in each curricular subject, stated that pupils in D&T should be given opportunities to: "apply skills, knowledge and understanding from the Programmes of Study of other subjects, where appropriate, including art, mathematics and science" (DfE/WO, 1995, p. 6). But this assumes that conceptual knowledge learned in one area of curriculum can be applied to another area, and that it is the same knowledge. Yet in 1995, as Levinson, Murphy, and McCormick (1997) note, there were no cross-references with the science curriculum. However, more recent PoS, including the current National Curriculum, link D&T with a range of other subjects including science, mathematics, art & design, and ICT. Others (Kimbell & Perry, 2001) suggest that D&T is deliberately interdisciplinary: "It is a creative, restive, itinerant, non-discipline" (p.19). The Working Group (DES/WO, 1988) also stressed that the new subject should encompass more than just technology:

> Our use of design and technology as a unitary concept … is intended to emphasize the intimate connection between the two activities as well as to imply a concept which is broader than either design or technology individually and the whole of which we believe is educationally important. (DES/WO 1988, para. 1.6)

From the documentation it is clear that one of the central features of D&T is its focus on designing and making activities, and developing technological capability for all pupils. Curriculum guidelines stress that:

- Pupils are able to use existing artefacts and systems effectively.
- Pupils are able to make critical appraisals of the personal, social, economic, and environmental implications of artefacts and systems.
- Pupils are able to improve and extend the uses of existing artefacts and systems.
- Pupils are able to design, make, and appraise new artefacts and systems.
- Pupils are able to diagnose and rectify faults in artefacts and systems. (DES/WO, 1988, paras. 1.42-1.43)

**Table 1**
*Search Strategy*

| | | No. of References Identified | | | |
|---|---|---|---|---|---|
| **No.** | **Searched Phrase or Term** | **British Educ Index** | **ERIC** | ***Psych-Info*** | **CERUK** |
| 1 | "technology education" | 909 | 1092 | 22 | 8 |
| 2 | Design (and OR &) technology | 388 | 3 | 13 | 6 |
| 3 | 1 OR 2 | 654 | 1094 | 34 | 12 |
| 4 | 3 AND (age* OR stage*) | 32 | 84 | 6 | <12 |
| 5 | 3 AND ("national curriculum") | 139 | 26 | 2 | <12 |
| 6 | 3 AND (gender OR sex) | 24 | 61 | 10 | <12 |
| 7 | 3 AND (disab* OR (special WITH needs)) | 12 | 29 | 3 | <12 |
| 8 | 3 AND (ethnic* OR race OR racial) | 2 | 13 | 0 | <12 |
| 9 | 3 AND ((social (inclusion OR exclusion)) OR (economic* disadvantage*) OR poverty) | 0 | 5 | 0 | <12 |
| 10 | 3 AND (attainment OR achievement OR outcome* OR result* OR examination*) | 31 | 194 | 16 | <12 |
| 11 | 3 AND (literacy OR numeracy OR ((key OR core) skills) OR "cognitive development") | 19 | 166 | 2 | <12 |
| 12 | 3 AND (truan* OR attend* OR motivat*) | 4 | 52 | 8 | <12 |
| 13 | 3 AND ((cross OR across) WITH curricul*) | 11 | 8 | 0 | <12 |
| 14 | 3 AND (employ* OR work OR business OR industry* OR vocation* OR profession*) | 92 | 376 | 12 | <12 |
| 15 | 3 AND ((out WITH of WITH school) OR (extra WITH curricular)) | 1 | 9 | 0 | <12 |
| 16 | 3 AND ((teach* (method* OR approach*)) OR (curriculum WITH delivery) OR pedagog*) | 25 | 121 | 8 | <12 |
| 17 | 3 AND ("continuing professional development" OR "CPD" | 13 | 35 | 0 | <12 |

**Table 1** (continued)

| | | | | | |
|---|---|---|---|---|---|
| 18 | 3 AND ((new WITH technolog*) OR "CAD" OR "CAM" OR "ICT" OR electronics) | 32 | 117 | 0 | <12 |
| 19 | 3 AND (resource* OR fund* OR financ* OR econom*) | 20 | 241 | 7 | <12 |
| 20 | 3 AND (able OR gifted) | 2 | 7 | 0 | <12 |

Note: CAD = Computer-aided Design
CAM = Computer-aided modeling
ICT = Information and Communications Technology

Doherty, Huxtable, and Murray (1991) identified three main concepts at the heart of D&T:

- What resources are required for the activity (i.e., human, physical, financial. or technical)?
- How is a D&T activity handled (e.g., processes, techniques and methods employed)?
- How/why are people linked to processes/resources?

They concluded that "capability" can only be achieved when an inter-relationship occurs between these three concepts and that this delineates ability from capability: "If the separate elements are fostered, ability is developed, however where the concepts are developed in an inter-relational way, then capability is achieved" (Doherty et al., 1991, p.72).

More recent descriptions of capability have embellished and reiterated sentiments set down in the Working Group's original report. For instance, Kimbell (1997) described capability as "that combination of skills, knowledge and motivation that transcends understanding and enables pupils creatively to intervene in the world and 'improve' it" (p. 12). He says that capability provides pupils with a bridge between what is and what might be. Thus pupils are expected to develop the capacity to identify things which need improving or creating in the world, and in response, design and make something that will bring about the desired improvement (Kimbell, 1997; Kimbell et al., 1996). Moreover, the capacity for design should involve the use of cognitive modeling (Layton, 1995; Roberts, 1994). This inter-relationship between modeling ideas in the mind and modeling ideas in reality, described as "thought in action" (Kimbell, Stables, Wheeler, Wosniak, & Kelly, 1991) is seen as fundamental to capability in D&T.

In addition, advocates describe a societal dimension to D&T, one that "entails critical reflection upon and appraisal of the social and economic results of design and technological activities beyond the school" (DES/WO, 1988, para. 1.14). D&T is thought to require a breadth of understanding and social concern and a depth of knowledge and skill, together with a capability to identify shortcomings and take creative action to improve the made world (Kimbell & Perry, 2001).

Kimbell and Perry (2001) note that D&T is about “creating change in the made world; about understanding the processes of change and becoming capable in the exercise of change-making” (p. 3). An explanatory leaflet issued by The Design and Technology Association (DATA) stated that learning in D&T:

> . . . helps to prepare young people for living and working in a technological world. Children learn the technical understanding, design methods and making skills needed to produce practical solutions to real problems. (DATA & DfEE, 1996; see Barlex and Pitt, 2000)

Others (Barlex & Pitt, 2000) argue that “the art of designing” is intrinsic to the concept of technological activity. The Working Group (DES/WO, 1988) cautioned against using the term “design process” (para. 1.27), and cited warnings outlined in an earlier report from the Assessment of Performance Unit/Department for Education and Science against any linear, rule-bound view of what the activity of designing entails.

Finally, although other subjects could be said to involve “process,” uniquely within technology education the process is said to define the discipline (DES/WO, 1988; Kimbell, 1997). The contexts in which the “process” is associated are “our made world; our clothes, our food, our means of travel, our shelters, our communication systems” (Kimbell & Perry, 2001, p. 3).

*Summary*

In sum, D&T:

- Is a deliberately interdisciplinary subject.
- Combines both “design” and “technology” but is broader than both.
- Encourages pupils to develop the capacity and value judgments to operate effectively and creatively in the made world.
- Focuses on designing and making activities, and developing technological capability for all pupils.
- Involves the use of cognitive modeling.
- Combines knowledge and motivation to enable pupils to intervene creatively in the world to improve it.

**What are the Unique Educational Components of D&T?**

Unsurprisingly, some of the factors which researchers claim make D&T unique are the same as those which relate to the different meanings and usages of the concept of D&T. Paechter (1993) points out that the sudden elevation of what had been a practical subject area for less academic pupils to the core curriculum was unique, especially for secondary schools. In addition, Hendley and Lyle (1995) identified the process-based nature of D&T’s curriculum as its most unusual feature. Kimbell (1997) has described this change in pupils’ learning as: ". . . a move from receiving 'hand-me-down' outcomes and truths to one in which we generate our own truths. The pupil is transformed from passive recipient into active participant. Not so much studying technology as *being* a technologist" (p. 47).

One of the questions addressed by the Working Group in 1988 was: What is it that pupils can learn from D&T activities which can be learned in no other way? Their reply was:

> . . . in its most general form, the answer to this question is in terms of capability to operate effectively and creatively in the made world. The goal is increased 'competence in the indeterminate zones of practice.' (Interim Report, D&T Working Group, DES/WO, 1988, p. 3)

This unique purpose of D&T remains a distinctive feature after a decade of teaching the subject in English schools (Barlex & Pitt, 2000). In addition, part of the original intention was that D&T education would be less about "knowing that" than about "knowing how;" less "propositional knowledge" but rather "action knowledge;" not so much "man the understander" (*homo sapiens*) but rather "man the maker" (*homo faber*) (DFE/WO, 1988).

Davies (2000) suggested that what first distinguished D&T from other subjects was its framework of assessment (Attainment Targets) which were "process" rather than "content" based. Although the development of this proactive, process-centered view of D&T has been seen in other areas of the curriculum (e.g., process science and process mathematics), uniquely in D&T the process defines the discipline (Kimbell et al., 1996). D&T is about creating change in the made world, about understanding these processes and developing a capacity for bringing about changes; uniquely, D&T empowers us to change the made world (Kimbell & Perry, 2001).

The model devised by the Working Group was significantly different from what had previously been taught in schools in England and Wales, incorporating aspects from craft, design, and technology, home economics, business studies, art, and information technology into a design-focused, student-centered subject (Paechter, 1993). The Working Group distinguished D&T from other subjects such as science, stressing that the special qualities about D&T are that it is:

> . . . always purposeful, i.e. developed in response to perceived needs or opportunities, as opposed to being undertaken for its own sake), takes place within a context of specific constraints (e.g., deadlines, cash limits, ergonomic and environmental requirements as opposed to unconstrained, blue-sky research) and depends upon value judgments at almost every stage. (Interim Report, D&T Working Group, DES/WO, 1988, p. 4)

Similarly, what makes the educational experience of D&T different from science is the type of cognitive processes involved. The Working Group (DES/WO, 1988) emphasized that D&T is more about "what might be" than "what is," i.e., the conception and realization of the form of things unknown. They characterized this as a visionary activity. Drawings, diagrams, plans, models, prototypes, and computer representations are all employed in developing the imagined artefact, system or environment. It is this special type of creative thinking that is associated with designers and technologists and is different from and complementary to verbal modes of thinking (DFE/WO, 1988). In sum, the particular creative aspects unique to design activity in a technological context are that the person has to imagine a concrete object which does not yet exist, and has to determine spatial and temporal details which cannot yet be observed, but will have to be created by the designing and manufacturing process (Ropohl, 1997).

Kimbell et al. (1996) argued that the unique concrete language employed in D&T, such as graphics and models, strengthens its importance educationally as it facilitates pupils' cognitive development. Through this language pupils are empowered to identify failings in the "made world" and to do something to improve things. They suggest that such a capability encourages independence and resourcefulness; it also combines practical, intellectual, and emotional challenge in a way that is quite unique within the curriculum (Kimbell, 1997; Kimbell et al., 1996). However, others believe that insufficient attention was given to the potential for overlap between subjects, and thinking in the late 1990s was that the National Curriculum should be efficient, with little duplication between subjects (Barlex 2002; Barlex & Pitt, 2000).

Kimbell and Perry (2001) have gone on to argue that D&T has a distinctive pedagogy: its model of teaching and learning not only draws upon different learning styles than other National Curriculum subjects, but also employs a richer range of learning styles. D&T aims to develop capability in which the pupil is an active participant. The distinctive model of teaching and learning:

- is project based
- takes a task from inception to completion within the constraints of time, cost, and resources.

Students have to learn how to:

- deconstruct the complexity of tasks and the values inherent in the concept of improvement
- be creative, conceiving ideas and planning that which does not yet exist
- model their concepts of the future
- make informed judgments
- manage both complexity and uncertainty in their projects
- deal with multi-dimensional and value-laden tasks.

This inter-relationship between conceptual knowledge and procedural knowledge was highlighted by others (McCormick, Murphy, & Hennessy, 1994; SEAC, 1991). Levinson et al. (1997) charted the changes from the early 1990s when there was a greater emphasis on (conceptual) knowledge in D&T. Smithers and Robinson (1992) argued that suggestions by the UK Engineering Council that design and technology students should adopt a mix of problem solving and knowledge and skills had been influential. They also pointed out that the Council believed that electronic solutions could not be applied until students had learned about electronics. Prior to the Revised Order of 1995, the preferred method within D&T was to pass on appropriate knowledge as and when needed (McCormick & Murphy, 1994). The emphasis now is on knowledge likely to be useful to developing particular solutions (through focused practical tasks and investigation, disassembly, and evaluation activities) before pupils tackle a designing and making assignment (Barlex, personal communication, 2003). Although others (e.g., Kimbell & Perry, 2001) point out that the issue now has shifted from "passing on knowledge" to pupils "learning how to learn."

Many point to the importance of co-operative learning. Some (Hendley & Lyle, 1995; Hennessy & Murphy, 1999) identified D&T as a rich environment for cooperative learning in which a range of designing skills can be developed (Koutsides, 2001). And Hennessy and Murphy argue that D&T is a unique subject for involving procedural problem solving activity where cooperative learning between peers relates to physical manipulation and feedback, and in which concrete models and graphical representations play an important mediating role.

*Summary*

Advocates suggest that Design and Technology is:

- a process-based subject
- based upon "knowing how" rather than "knowing that"
- empowering
- a visionary activity
- purposeful.

In addition, Design and Technology:

- Draws on a richer range of learning styles than other curriculum subjects, mainly through project-based learning.
- Requires students to be creative but reflective problem solvers, either individually or in teams.

**What Has Been the Impact of Design and Technology?**

Despite this innovative vision for D &T, disappointingly, in many cases it has not been possible to identify the effects of introducing the subject into the school curriculum, either because research has not been undertaken or relevant data (e.g., statistics) are not available. School inspections (OfSTED) of D&T record less satisfaction with teaching at Key Stage 3 (age 14 years) during the early years of its introduction (DES, 1992, pp. 18-19). Partly this was due to the fact that at secondary school level (ages 11-18 years) the new D&T subject grew out of an amalgam of five separate disciplines:

- art and design

- business studies
- craft, design, and technology
- home economics
- information technology

Kimbell (1996) described three ways in which schools began to implement this change: one, a "status quo—single-subject approach" where delivery continued much as before, with each individual discipline making its contribution; two, "a federated approach," which necessitated active planning, liaison, and discussion between departments; and three, "an integrated approach," which accepted D&T as a new construct where the emphasis was more on a whole new technology team. However, over the past decade, revisions of D&T curriculum have resulted in more understanding of what can be achieved (Kimbell, 1999) and contributed to other areas (Davies, 2000). Advocates of D&T suggest that it impacts pupils in a number of ways:

*Key Skills Development*

Some suggest that key skills occur naturally in group-based working within D&T (Summer, 1998, in Barlex, 1998; Davies, L., 2000). D&T has added to the development of Key Skills (Davies). Key Skills provide a foundation for common areas of learning through the six areas of competence. Davies has outlined how D&T specifically contributes to these. With specific reference to Key Stage 3, she argues that D&T aids communication, and improves numeracy, information technology, working with others, improving performance, problem solving, and creativity. Furthermore, Davies stresses that if pupils are aware of the key skills they are learning in D&T, they will understand the wider contribution this subject is making to their education.

*Cognitive Development*

There is clear evidence that the different teaching methods and the range of pupil activities within D&T assignments provide opportunities for cognitive development. From a study, which included classroom observation, Twyford and Jarvinen (2000) concluded that much of pupils' knowledge of D&T was learned through social interactions. Pupils' capabilities were enhanced through their direct active socio-cultural interactions within a range of classroom settings involving different teaching methods. However, McCormick and Davidson (1996) have indicated that concentration on product outcomes may undermine the design process and problem-solving activity that teachers wish to foster. In this study, it was found that the desire to ensure successful product outcomes prevented students from failing to produce outcomes, reduced the risk involved in the process, and thus prevented students learning from failure.

Various researchers have claimed that D&T has the potential to be a rich environment for co-operative learning (Hendley & Lyle, 1995; Hennessy & Murphy, 1999). In addition, D&T is believed to be a unique subject for involving procedural problem solving activities where co-operative learning and talk between peers "relates to physical manipulation and feedback," and where "concrete models and graphical representations play an important mediating role" (Hennessy & Murphy). However, they go on to point out the crucial role played by the teacher in fostering this collaboration—a role which has been underplayed in research literature on collaboration. Positive collaborative experiences mentioned include, for instance, that (intellectually) matched pairs of pupils learn better than asymmetrical pairs.

Linton and Rutland (1998) found improvements among less able children. Not only did their behavior improve during D&T activities, but they seemed to excel in practical problem-solving tasks, while practicing and developing more academic skills, such as measurement, speaking, listening, etc.

In contrast to these positive examples, Elmer (2002) laments the peripheral status of meta-cognition in the D&T literature (e.g., Eggleston, 2000, but with notable exceptions, e.g., Lawler, 1997; Kimbell & Perry, 2001; and to some extent, Hennessy & McCormick, 1994). And Atkinson (2000) discovered that high order thinking, such as creativity, problem solving and analytical thinking, impact upon pupils' General Certificate of Secondary Education (GCSE) D&T performance. Results of a relatively small study of 27 pupils taking GCSE suggest that D&T is not capitalizing on its potential for pupil learning because of the need for high levels of performance at public examinations which fail to reward creativity (Atkinson, 1994). Atkinson (2000) found surprising evidence that such capabilities are not necessarily required and that being highly creative could be a hindrance in terms of examination grades.

Nevertheless, the D&T curriculum does actually provide *opportunities* for pupils to develop their high order thinking skills (e.g., creative thinking, critical thinking, analytical thinking) and problem-solving skills which they will need to participate in our technological society (Lewis, 1999; Atkinson, 2000).

**Raising Standards of Achievement in Literacy and Numeracy**

Some advocates of D&T believe that it has an impact on literacy and numeracy. However, OfSTED (2001a) reported that the teaching of literacy and numeracy through D&T is weaker than in most other subjects in primary schools. Nonetheless, there are some positive examples. The use of language across the curriculum is a requirement of the National Curriculum 2000, and D&T contributes to this aim by developing the ability of pupils to:

- use technical terms
- clarify specifications and plan manufacture
- evaluate both the product and process (Davies, L., 2000).

Moreover, the use of technical terms and concepts in D&T is essential for effective participation in the subject. These include:

- expression of ideas
- terms relating to materials and making processes
- descriptions
- the language of evaluation.

Nevertheless, there is some suggestion (Parkinson, 1999) based on classroom observations of 49 children aged 3–6 years and 28 teachers, that the use of technical vocabulary from an early age can be undesirable, and specialized terminology should be delayed until secondary school, where more technically able staff can use appropriate terms consistently within relevant contexts. Also Stables and Rogers (2001) found that boys' thinking and reflective skills can be enhanced by literacy interventions in D&T.

Direct research relating to the effects of D&T on numeracy was not evident. However, D&T has an obvious link with mathematics (Davies, L., 2000). For instance, during the planning, realization, and evaluation of processes and products in D&T, opportunities arise for the collection, sorting, representation, and analysis of data in lists, diagrams and graphs, estimation, measurement of lengths and angles, and for calculation for drawing to scale or for the effects of loads.

*Key Stage Tests*

There was some evidence showing how pupils perform in D&T on national tests. For instance, OfSTED Primary Subject Reports (2002a) show that although pupils' achievement in D&T generally is at least satisfactory in the great majority of schools and is rated "good" in one school out of four, it is unsatisfactory in one school out of six at Key Stage 2 (age 11). Similarly, pupils' achievement in Key Stages 1 (age 7) and 2 (age 11) continues to be better in "making" than in "designing," but their knowledge and understanding of the materials, components, and processes that they use continue to improve steadily.

*General Certificate of Secondary Education (GCSE) (Age 16)*

We found no research literature to show the impact of D&T on GCSE results in other subjects. However, greater numbers of pupils have been entered for D&T GCSE examinations over the past decade, with annual improvements in the proportions of pupils attaining grades A* (a starred A being the highest grade awarded) through C, and D&T is the fifth most common subject to be taken at GCSE. In common with other subjects, girls outperform boys in GCSE D&T examinations at grades A*–C. However, there was some criticism in the literature. For example, Atkinson (2000) found that examples of highly structured, inflexible models provided by teachers (in 8 schools studied) while enabling pupils to achieve success in examinations, limited the development of high order thinking skills.

*General Certificate in Education Advanced Level (Age 18)*

Again, we found no research literature on the effect of D&T on performance generally, but achievement in D&T is rising at a rate well above the average of all subjects (OfSTED, 2002b). Changes in post-16 participation levels and the broadening range of subjects both increase the number and range of students involved in D&T manufacturing courses (Perry, Davies, Booth, & Sage, 1998). Broadening the range of students has resulted in those who are more academically successful joining D&T manufacturing courses, thus adding to the demands on teachers versatility (Perry et al.).

*Enhancing Attendance Patterns*

There appeared to be no published research on the impact of D&T on truancy or attendance in the UK. Although official publications (e.g., DfES) compared unauthorized truancy rates to authorized ones by school characteristics, there were no tables showing unauthorized absences by subject. Similarly, there were no research papers directly exploring the possible effects of D&T on improving attendance rates. Two papers relating to D&T and motivation (Denton, 1993; Hine, 1997) suggest that group work within D&T may make a positive contribution to pupils' attitudes. Kimbell and Perry (2001) mentioned low truancy rates in D&T reported by OfSTED. However, OfSTED (2001b, para. 127) warned that a "vocationally-oriented curriculum was not a panacea" for coping with disaffected young people.

*Cross-curricular Learning*

There is sufficient evidence to confirm that cross-curricular learning is recognized as fundamental to D&T activity, especially in primary schools (Makiya & Rogers, 1992; Cross, 1998). However, the effects of cross-curricular learning are less clear. Current National Curriculum Requirements (Department for Education and Skills [DfEE/QCA], 1999) indicate areas of language which are to be used in all subject teaching. However, the national strategies for literacy and numeracy appear to have had mixed effects in primary schools as they have impinged on the time available for D&T activities. Nevertheless, despite the frequent mention of art work in D&T activities, Howe (1999) believes that the fundamental connection between "art and design" and "D&T" has not been fully recognized or exploited in primary schools.

Over the past decade, especially during the earlier stages of D&T inception, some thought that (design and) technology and science were almost indistinguishable (Gardner, 1994), especially at the primary level (Davies, D., 1997). Yet others consider science to be a resource for technology (Kimbell et al., 1996). Many science teachers have been opposed to the separate teaching of what they considered to be the "applied science" of D&T (Layton, 1993; Gardner, 1994; De Vries, 1996). The limited research relating to cross-curricular links between science and D&T has been somewhat equivocal. Levinson et al. (1997) pointed out that the National Curriculum for D&T assumed that technological conceptual knowledge and knowledge learned in subjects such as science could be used in D&T tasks. Yet, their pilot study of Key Stage 3 showed that pupils were not drawing on prior scientific knowledge for design purposes, and therefore, science knowledge developed in science lessons could not readily be used in technology lessons. This cast doubt on children's ability to transfer knowledge learned in one context to another. On the other hand, this may not be such a problem, as the more usual approach in D&T is to introduce knowledge as and when needed (McCormick & Murphy, 1994).

## Summary

Despite the lack of studies charting the impact of D&T in the National Curriculum, some effects were identified. Researchers argue that D&T:

- demonstrates the potential to develop key skills
- provides opportunities for pupils to develop high order thinking and problem-solving skills
- improves pupils' technical vocabulary
- links with mathematics
- is associated with a rising rate of achievement well above the average of all school subjects
- may have a positive effect on truancy
- develops cross-curricular learning in primary schools.

## Discussion

*Key Findings*

During the course of this review, we found:

- many published papers referring to the teaching of D&T in schools in England
- a consensus about the concept and aims of D&T
- few well-designed evaluations of the effects or impact of teaching D&T
- gaps in the research evidence regarding the most effective ways of teaching and learning D&T in schools, in particular the use of ICT, methods of assessment, individual and collaborative learning, and ways of strengthening designing.

Over a decade ago, D&T was introduced as a new subject in all primary and secondary schools in England. At that time, it was clearly thought to be an innovative concept that combined separate school subjects into a unified approach to teaching design and technology. Though the concept is now widely accepted, identifying the impact of D&T on pupils is difficult to determine. As reviewers we were impressed, and somewhat overwhelmed, by the number of references to D&T in the literature in the English language. However, many references were produced by the community of practice, and few were research-based or peer-reviewed. Our criteria for inclusion excluded much action research and also curriculum development undertaken by the "user" community. Therefore, the fact that we found little peer-reviewed research in D&T is no reflection on the activities being undertaken by practitioners in schools and colleges. It is more likely related to the amount of research commissioned and/or the interest of professional researchers in this topic area.

Gaps in existing research emerged. Some have argued (Kimbell, 1996; Atkinson, 2000) that the inflexible assessment methods used to judge pupils' D&T project work have dictated the processes used by those pupils. Atkinson would like to see teachers offered more encouragement in the documentation which accompanies the National Curriculum to adopt strategies which are less formulaic and ones in which the thinking associated with design is not outweighed by the stages in the design process. More research into the area of effective learning and teaching of D&T is clearly required.

In addition, more research is required on the role of ICT. Weaknesses in designing activity led OfSTED (2002b) to suggest that more work needs to be done to discover the most effective ways of teaching pupils to use computer software to help them in solving design tasks. Suitable curriculum materials need to be developed that foster creative responses from pupils using these new designing and manufacturing resources. These findings highlight the need for further research into the impact of assessment on design and the use of ICT. In addition, research is needed to explore how design might more effectively be encouraged within D&T.

The UK Design and Technology Association (DATA) is aware of the inadequate advice and resources available for teaching CAD/CAM in schools and has introduced a design awareness competition that it hopes will help to stimulate debate. Similarly, DATA is currently conducting research on the influence of CAD/CAM on teaching and learning. Further research in this area is needed, especially as there are considerable economic issues involved in the effective use of ICT.

Hennessy and Murphy (1999) have been critical of D&T research and call for more classroom-based research to explore the role of collaboration in facilitating technological problem solving rather than the teacher-led problem solving which they claim is typical. The finding that intellectually matched pairs of pupils learn better than asymmetrically matched pairs (Hennessy & Murphy) needs further exploration as this has important implications for group work in mixed ability classes. Observations that some children are inhibited from showing what they know or from developing their skills when in the presence of more able children, yet are more encouraged by working with children whom they can help, point to the need for further investigation (Burgess, 1998).

Denton (1994) has also criticised D&T research, and has called for appropriate methodologies that recognize the difficulties in separating out the variables in live learning situations—a problem shared with other curricular subjects.

Anning (1994) has demonstrated that D&T in the elementary school provides a learning environment which highlights children's previously un-noted capabilities and deficiencies in areas such as graphicacy, evaluation processes, and the manipulation of tools. However, much more research is needed in order to substantiate these claims.

Shield (1996) considers that many of the problems associated with D&T were related to the fact that a complex curriculum was introduced via a top-down strategy, i.e., from the Department of Education to schools, and he believes that a deeper understanding of the professional issues is required. Essentially, he argues that having been told what the concept of D&T means by those introducing this new subject into the curriculum, teachers endeavored to make this a reality. In 1996 Shield was pressing for researchers to test the validity of claims that D&T in schools could enhance problem solving, craft skills, knowledge, aesthetic awareness, graphical and broader communication skills, social awareness and teamwork, scientific and technical literacy, industrial and economic understanding, environmental activism, and life skills and vocational training. Our overall conclusion is that despite the number of references to D&T in the published literature, the impact of Design and Technology has not been proven. This remains a challenge for the research community.

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# *Editorial*

## Collaboration Conundrum

**Greg Pearson**

There may be few other issues more important to technology education at this moment than the nature of the profession's relationship to engineering. Technology education has undergone a significant reshaping since the mid-1980s, particularly when the International Technology Education Association (ITEA) launched the field on a standards-based reform path in the early 1990s. The standards' vision for what students ought to know and be able to do in technology reflects a strong engineering influence. This is not surprising given that ITEA sought input from the National Academy of Engineering (NAE) on the standards and, later, submitted the standards to an intensive quality-review process at the National Research Council (NRC).

This editorial examines how engineering and technology education view one another, and how these perceptions shape prospects for collaboration between the two camps. These are important issues, though one could reasonably question my qualifications for addressing them. I am neither a technology educator nor an engineer. However, my work at the NAE has brought me in contact with many individuals from both groups. My lack of pedigree has allowed me to observe each at a certain distance. What follows is very much a personal take on the psychology and politics of the relationship between engineering and technology education.

### No Respect

Rodney Dangerfield must have been an engineer before he went into comedy. No, wait. Maybe he was in technology education![1]

It is striking, and an interesting point of departure for this editorial, that both engineering and technology education believe themselves to be undervalued. Although these feelings find expression in different ways, they provide a common basis for strengthening ties between the two groups.

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It may come as a surprise to many technology educators that engineering has for years—decades, in fact—been engaged in a campaign for public recognition. Engineers in industry, academia, and public service, along with the professional societies that represent them, have met countless times and funded hundreds of public outreach efforts, all with the goal of improving the public image of engineering. The NAE and many professional engineering societies have programs dedicated to boosting public understanding of engineering (PUE). Results of a survey recently commissioned by the NAE indicate PUE efforts consume some $400 million per year in the United States (Davis & Gibbin, 2002). Despite this investment, most engineering groups believe the public neither understands nor appreciates sufficiently the role of engineering in society.

As one measure of standing, Harris Interactive tracks the prestige of various professional fields. In these polls, engineering consistently places in the top half of the 17 professions assessed. In the latest survey, only 5 other professions (policeman, minister, teacher, scientist, doctor) had a higher ranking of "very great" prestige than did engineering (Harris Interactive, 1998). Despite results that could be interpreted as quite encouraging, many in the engineering community perceive these findings as evidence of a failure to communicate its mission and accomplishments to the public. The fact that the public bestows scientists with almost twice the amount of prestige as engineers is particularly rankling. Engineers, it seems, just don't get no respect.

Engineers also believe that the public does not understand much about the role of engineering in society or what the practice of engineering involves. Some support for this view comes from a 1998 Louis Harris & Associates poll, commissioned by the American Association of Engineering Societies (AAES), that asked people to associate certain characteristics with either scientists or engineers. An overwhelming majority correctly associated scientists with "discovering the natural world" and engineers with "creating economic growth." However, compared with scientists, engineers were one-fourth as likely to be associated with "improving the quality of life" and only one-tenth as likely to be associated with "saving lives."[2] Harris Interactive (2004) recently released results from a follow-on survey, also sponsored by AAES. For the most part, engineering compared quite favorably to science; for example, both were seen as equally attractive potential careers for young people. So, while the public perception of engineering is not as informed as many within the profession would like, neither is it wholly negative or inaccurate.

Engineers are also frequently the focus of blame when technologies fail to perform as we expect. Engineering was very visible during the aftermath of 9-11, with the bulk of media coverage portraying the profession in a favorable light. Far more often when engineering is in the spotlight, however, engineers are portrayed as contributors to, if not the direct cause of, disaster (e.g., separation of Firestone tire treads, loss of Space Shuttles Challenger and Columbia, collapse of Hyatt Regency walkway). Adding insult to injury, credit for accomplishments such as the development and launch of the Hubble Space

Telescope that are mostly the result of engineering, frequently is assigned to science. This phenomenon reflects public confusion about how technology is developed as well as society's lack of appreciation for the inherent risk of technological development. It reinforces the engineering profession's "Dangerfield complex."

There are many explanations for why engineering is not well understood, but one of them certainly has to be the discipline's near absence in U.S. elementary and secondary classrooms. With a few notable exceptions like February's National Engineers Week (www.eweek.org), engineers rarely interact directly with K-12 teachers or students. Further, engineering concepts and design principles for the most part are not part of the regular school curriculum. The history and nature of "pre-engineering" in American K-12 schools have been examined by others (Lewis, 2002).

Technology education suffers its own image and identity problems. In contrast to engineering, technology education is embedded in the K-12 classroom. It is a profession of teaching, albeit comprising an order-of-magnitude smaller workforce than more mainstream subjects such as science and mathematics. In addition to its size disadvantage, the profession has had to struggle with its roots in the manual arts as it attempts a transition to a more academic and intellectually robust self-definition. ITEA's development of content standards and its efforts to align with engineering reflect a conscious striving for legitimacy within the landscape of U.S. education. Science education validates itself through science, and mathematics education through the work of mathematicians. Why not technology education through engineering?

Irrespective of the attempted makeover, most outside the profession, including many engineers, still see technology education through the lens of "shop class," a term almost always used pejoratively. Ironically, one growing concern in engineering education is the entering freshman's lack of hands-on, tool skills. This in part reflects the turning away of engineering schools, beginning at the end of World War II, from practice toward science, theory, and laboratory work (Davis, 1998). The estrangement of today's student engineer from the machine shop and field work has been accelerated by, among other things, the profession's reliance on computer-based design tools and the increasing complexity of many technologies, which has made tinkering seem unnecessary and, more to the point, impractical.

One continuing challenge to technology education's identity is of its own making. The profession's name change in 1985, from the American Industrial Arts Association to the International Technology Education Association, had the unintended effect of making it difficult for the field to differentiate itself from those engaged in the promotion of educational technology. As polling has shown, most Americans have a very narrow conception of technology, as information technology, especially computers (ITEA, 2002). What technology educator has not been confounded by the well-meaning misinterpretation of her occupation: "Oh, you teach computers!?"

I purposefully chose the pronoun "her" above because I knew it would be jarring to most readers in the profession. Women, of course, comprise only a small minority of those in technology education. Slightly fewer than 14 percent of ITEA members, most of whom are teachers, are women, membership data from 2000 indicate (S. Petrina, personal communication, February 27, 2004). Because only about one-sixth of all technology educators belong to ITEA, these numbers may not accurately reflect the diversity of the profession as a whole, but it would be surprising if they were significantly higher. The presence of underrepresented minorities is equally stark. In the early 1990s, about 1 percent of vocational technology teachers were Native American, 0.2 percent Asian, 6.7 percent African American, and 2.2 percent Hispanic (U.S. Department of Education, 1993).

Similarly, engineering remains one of the most disproportionately pale and male career fields. Underrepresented racial and ethnic minorities account for a quarter of the nation's population and roughly a third of the overall U.S. workforce but less than 12 percent of BS, 6 percent of MS, and 4 percent of PhD engineering graduates, and 7 percent of the engineering workforce. Women constitute more than half the nation's population and 60 percent of the workforce but less than 22 percent of engineering BS and MS graduates, 18 percent of engineering PhDs, and only 10 percent of the engineering workforce (Commission on Professionals in Science and Technology, 2002; National Science Board, 2002). (In the interest of full disclosure, women members of the NAE comprise only 3.4 percent of the total membership, a number in part explained by the scarcity of late-career women engineers in the population at large.) The engineering community is well aware of these imbalances in the profession, and there are many initiatives intended to remedy the situation, but progress has been slow.

As I hope this brief review indicates, engineers and technology educators, and their respective professions, share a number of basic characteristics and face a number of similar problems.

- Problem-/project-centered learning
- Buy-in to technological literacy vision
- Concern about the professional "pipeline"
- Desire to influence K-12 education
- Desire to be seen as more relevant
- Misunderstood by the public
- Undergoing change and evolution
- Longstanding diversity problem

These points of commonality may influence in a positive way the two groups' willingness and ability to reach out to each other in collaborative effort.

**Snobs and Dummies**

Let's face it, engineering is filled with elitists and technology education is for blue-collar academic washouts. In my discussions with technology educators and engineers about their colleagues on the other side of the fence, these sentiments surfaced repeatedly. Both points of view, of course, are stereotypes and so by definition are oversimplified and prejudicial. Stereotypes also contain kernels of truth. Some engineers no doubt have an inflated sense of self-importance, and some who pursue technology education do so because of its less "academic," more concrete approach to learning. Stereotypes maintain their currency only as long as they are unaltered by personal experiences and honest self-reflection. If engineers and technology educators are to work together in a meaningful way, they surely will need to spend more time getting to know one another.

Much is made by both engineers and technology educators of the role mathematics and science play as enablers to the study and practice of engineering. Technology educators to whom I spoke returned again and again to this issue, contrasting engineering's focus on scientific theory and mathematical analysis with their field's emphasis on practical problem solving. The U.S. engineering education community traditionally has treated mathematics and science as barriers that only the most qualified students will overcome. It is thus common in many engineering schools for students to have no exposure to hands-on, engineering design problems until their sophomore year.

The academic hazing works. Nationally, over half of all students who start engineering school switch to degree programs outside of science, mathematics, engineering, and technology (Seymour & Hewitt, 1997). Some who leave do so because of poor academic performance, but a significant number, proportionately as many as whom actually graduate, perform as well as, on average, those who stay. It turns out that the most important factor for "switchers" is not inadequate preparation or the appeal of non-engineering fields, but rather poor teaching and advising (Seymour, 2001). A number of leaders in engineering education believe it is the profession's weak pedagogy and failure to present its creative side to prospective engineers that is to blame for the field's relative lack of popularity among young people.

A small number of U.S. engineering programs, including those at Tufts, the University of Maine, and the University of Colorado, are delaying intensive math and science coursework to the second year and are instead exposing freshmen to engaging design activities. At Tufts, this approach has resulted in a net flow of students from other university departments *into* engineering.

Could it be that design and problem-solving activities provide meaningful context for learning in math and science? This is certainly the claim of technology educators, but rarely if ever is the assertion made by engineering. Considerable educational research supports the value of learning experiences that students perceive to be relevant to their own lives. Several small studies of integrated math-science-technology curricula suggest such programs can boost math and science achievement more than when those two subjects are taught independently (Loepp, Meier, & Satchwell, 2000; Todd & Hutchinson, 2000). More research is needed to confirm these preliminary findings and to explore the context-setting influence of engineering and technology education on student learning in math and science.

Several engineers I spoke with, including Bill Wulf, president of the NAE, suggested that much quality engineering can be done with just algebra, and even students without high school calculus, chemistry, and physics can learn the math and science concepts necessary to succeed once they are in engineering school. This raises interesting questions about the iconic role of mathematics and science in engineering education.

Clearly, there are differences between engineering and technology education as well as points of commonality (see Table 1).

**Table 1**
*Points of Difference Between Engineering and Technology Education*

| Engineering | Technology Education |
|---|---|
| High barriers to entry | Low barriers to entry |
| Focus on theory and analysis | Focus on practical/hands-on |
| Large number of practitioners | Small number of practitioners |
| Training for research and practice | Training for teaching |
| Established discipline | Trying to become one |
| Established content | Evolving content |
| See technological literacy as being of minor importance to field | See technological literacy as main justification for the profession |

## Collaboration

Collaboration between engineering and technology education has taken many forms, reflecting the differing motives and cultures of the two groups. The collaboration I know best is that between ITEA and NAE, which began in the mid-1990s with discussions between Bill Wulf and Kendall Starkweather about the nascent ITEA standards. Rodger Bybee, then head of the National Academies science education unit, played a pivotal role in facilitating the dialogue, which moved very quickly to plans for engaging NAE as an informal reviewer of the standards. ITEA took a considerable risk in this venture, exposing itself not only to internal criticism but also to the scrutiny of highly accomplished engineers, most of whom knew nothing about technology education or, for that matter, educational standards.

Why was Bill Wulf willing to entertain the idea of a link to ITEA at all? For the National Academies, such direct work with outside organizations is very rare. Part of the reason was strategic. Wulf wanted to push the NAE to take a more active role in pre-college education issues, as his counterpart at the

National Academy of Science, Bruce Alberts, had done in science. ITEA and its standards presented an opportunity for NAE to connect directly with K-12 schools and to begin to carve out an educational niche—advocating for "technological literacy"—within the broader Academies organization. Wulf also harbored a very personal connection to technology education. He had taken numerous shop courses during high school.

The NAE-ITEA collaboration eventually expanded to include a much more formal review of the standards by the NRC. The review mimicked in almost every way the peer review process used by the Academies to vet its own reports prior to publication. The NRC review group, chaired by Wulf himself, proposed a number of substantive changes to the standards' content and organization, and the ITEA managers of the standards project, Bill Dugger and Pam Newberry, adopted nearly every one. A number of the changes refined and expanded the document's treatment of engineering concepts and the design process. The review process delayed publication of the standards by one year, to 2000. When the review was finally complete, the NAE Council proclaimed its strong support for the standards and urged their implementation (NAE, 2000).

Subsequently, with funding from the National Science Foundation (NSF) and the Battelle Memorial Institute, the NAE and the NRC's Center for Education (CFE) developed a vision for technological literacy in the United States, which was published in 2002 as *Technically Speaking: Why All Americans Need to Know More About Technology* (Pearson & Young). The 20-member committee that oversaw the project included two notables in technology education: Paul DeVore and Rod Custer. The book itself discusses technology education at some length, and a number of citations call out the important work and thinking of those in the field. Despite some critical reviews (Petrina, 2003), the book has generally been perceived as a helpful addition to the literature on technological literacy.

In 2003, NAE and CFE, with funding from NSF, began a follow-on project to *Technically Speaking* focused on the challenge of assessing technological literacy. Rod Custer and Bill Dugger represent technology education on the 16-member study committee for this project. The NAE recently received funding from the Department of Education to spread the word about technological literacy to state education leaders in mathematics, science, assessment, and curriculum. Technology educators will be involved in this effort as well.

Despite this encouraging history, much more needs to be done, even within the National Academies, to bring technology education into the mainstream of education policy discussions. The recently established Teacher Advisory Council, for example, which is supposed to bring a teacher's eye to the work of the Academies, comprises individuals with expertise in math, science, and instructional technology but not in technology education. An effort by the NAE in the late 1990s to involve technology educators in the work of the National Science Resources Center (NSRC), the curriculum-development arm of the

National Academies, fell flat, in part because the NSRC leadership held a negative view of industrial arts.

NSF, through its Bridges for Engineering program, has funded at least two projects—at Virginia Tech and the University of Georgia—that aim to encourage links between engineering and technology education. The Institute for Electrical and Electronics Engineering (IEEE) has launched an initiative to encourage dialogue between schools of education and schools of engineering (Institute for Electrical and Electronics Engineers, 2001, 2003), some of which house programs in technology teacher preparation. The IEEE conferences do not appear to have involved many technology educators.

Over the past year, a group of engineers has begun to explore the possibility of instituting advanced placement (AP) engineering in high schools. The effort is inspired in part by an accelerated technology education program within the Baltimore County Public School (BCPS) system. Students in the program take AP physics, higher-level mathematics, and engineering technology classes in grades 11 and 12. Those who do well in this track can receive college credit in engineering at the University of Maryland, Baltimore County. The program includes an engineering training and certification component for teachers. The NAE is trying to encourage organizers of the AP effort to take a broader view of engineering experiences in high school that is more consistent with technological literacy aims. The current vision seems mostly intended to satisfy the needs of the engineering pipeline.

The Baltimore initiative is unusual if not unique for its engineering-credit-granting feature. However, in the United Kingdom starting in the mid-1980s, engineering schools began to admit applicants who scored well on an exam based on the country's design and technology (D&T) curriculum. Engineering departments were persuaded to do this by the quality of design work done by many of the nation's D&T students (R. Kimbell, personal communication, Oct. 22, 2003). And in England, unlike the United States, a significant proportion of D&T teachers have engineering as their first degree. (Significantly, there are eight engineers teaching technology education courses in Baltimore County [M. Shealey, personal communication, Oct. 22, 2003]).

Massachusetts has received attention for the way it has tried to combine technology and engineering in K-12. In 2001, the state department of education adopted a new curriculum framework that includes specific reference to "engineering" alongside technology. Largely the result of the tenacious lobbying of former Tufts School of Engineering Dean Ioannis Miaoulis, the framework makes explicit the connection between engineering and technology in ways other standards documents fail. For the most part, the curriculum is being delivered by technology teachers.

Though there are certainly bright spots, formal collaboration between technology education and engineering appears limited in scope and to a certain degree lacking in vision. ITEA's linkage with NAE is significant and has potentially far-reaching implications for technology education. But outside that special case, which for the most part has not involved grassroots practitioners in either field, neither profession seems seriously interested in reaching out to the other.

## Recommendations

Despite this somewhat pessimistic ending, I believe there are reasons to be hopeful. Uniting engineering and technology education in common purpose will not be easy, but it is possible. Like everything else in American education, it will require a sustained effort on multiple fronts. Here are some steps that might help get things moving in the right direction.

- Leaders and influential thinkers in both professions have to decide that the benefits of collaboration outweigh the risks. Technology education is in the more vulnerable position, with more to lose and gain, and so needs to be the more proactive partner, at least initially.
- Technological literacy, as expressed in the ITEA standards and *Technically Speaking*, should be exploited as a common theme around which engineering and technology education may build a meaningful relationship.
- The ITEA standards, as helpful as they are, do not provide any guidance for curriculum development. For the standards to be truly useful, technology educators need to think hard about how the content base in engineering—especially related to design—translates into content suitable for the K-12 classroom.
- Dialog that honestly explores each profession’s strengths and weaknesses and respects each profession's history and culture will be needed to develop mutual trust and confidence.
- The role of mathematics and science in the curricula of both fields needs to be reexamined.
- Linkages between engineering and technology education in other countries, such as the United Kingdom, should be studied for lessons that might be applied in the United States.
- Engineering and technology education should work to build greater education research capacity within their ranks, with a goal of understanding better the nature of learning and effective teaching in their fields.

## Acknowledgments

This editorial is based on a talk given November 7, 2003, at the Mississippi Valley Technology Teacher Education Conference in Nashville, Tennessee. The author would like to thank the following individuals for sharing their insights on the subject of this editorial: Gary Benenson, Rod Custer, Karen Falkenberg, Norman Fortenberry, Dennis Herschbach, Richard Kimbell, Ethan Lipton, Pat Mead, Ioannis Miaoulis, Indira Nair, Gerhard Salinger, Tony Schwaller, Harry Shealey, Kendall Starkweather, Maurice Thomas, Ken Welty, John Wright, and William Wulf. The views expressed are entirely those of the author, as are any errors of omission or fact.

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**Endnotes**

[1]Actually, Mr. Dangerfield, whose given name is Jacob Cohen and who originally performed under the stage name Jack Roy, got his start in entertainment as a singing waiter.

[2]The contributions of engineering to quality of life and to safety are, of course, immense. The NAE's recently published book, "A Century of Innovation: The Engineering That Changed Our Lives (Joseph Henry Press, 2003), provides a well-documented and engaging review of the impact of engineering during the 20$^{th}$ century.

# *In Memoriam*

## Michael Leroy Scott
1949-2004

As this issue was in final preparation, a member of our Editorial Board, Michael L. Scott, unexpectedly passed away at the age of 54. Mike provided distinguished and continuous service to the *Journal of Technology Education* from the very first issue published, nearly 16 years ago. In fact, he participated in the annual meeting of the Editorial Board at the International Technology Education Conference in Albuquerque, just a few days before his death.

Mike had an exemplary career of contributions to technology education. His research focus was primarily in the areas of equity and special needs learners. He also was very concerned about the unique challenges of providing quality education to inner-city students, having graduated from an urban high school in Columbus, Ohio himself.

Mike's formal contributions have been recognized over the years in a variety of ways. In 2003, he received the highest award the ITEA offers, induction into the Academy of Fellows. However, his greatest contribution has been in the lives that he has personally touched. He had the ability to make all those with whom he interacted feel better about themselves through his warmth, sincerity, and concern. Countless individuals achieved goals they had never imagined through Mike's encouragement and leadership. He was a champion of diversity and equity, but never carried any banners. Instead, he worked subtly, making his points effectively and, in the process, permanently changed the values and sensitivity of the individuals with whom he worked.

In his role as a member of the Editorial Board, he offered an exceptional level of expertise for both research and conceptual manuscripts. His reviews were always encouraging to the authors. On many occasions I sought Mike's advice on how to deal with difficult situations regarding the review process. In fact, it was through Mike's encouragement that I submitted the requisite proposal to be considered for the editorship of this journal.

At the funeral, I realized that I was not the only one who considered Mike as a best friend. I feel privileged to share his friendship with so many other people. Nearly 30 years have passed since Mike and I began doctoral study at The Ohio State University. He touched my life in so many ways.

It is always difficult for humans to deal with death, especially when the end comes so prematurely. Some level of understanding, however, might be found in the poem below, which was printed in the memoriam distributed at the funeral. Though the poem reflects Mike's religious beliefs, he would not wish for it to be offensive to your beliefs.

God saw you were getting tired,
And a cure was not to be.
So he put His arms around you
And whispered, "Come to me."

With tearful eyes we watched you,
And saw you pass away.
Although we loved you dearly,
We could not make you stay.

A golden heart stopped beating,
Hard working hands at rest.
God broke our hearts to prove to us,
He only takes the best.

JEL

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