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**Miscellany**

# *From the Editor*

If you haven't read *Project 2061: Science for All Americans* (AAAS, 1989), it's time you did. My guess is it will have more significance for technology education in the 1990s than any other single document published in the '80s or '90s. Subtitled *A Project 2061 Report on Literacy Goals in Science, Mathematics, and Technology*, it is, first and foremost, a call for action.

*Project 2061* is a set of recommendations from the National Council on Science and Technology Education, a group of scientists and educators appointed by the American Association for the Advancement of Science. It serves to draw attention to the critical need for scientific literacy for all Americans, a literacy which the report says "embraces science, math, and technology."

Unlike other national reports that seem to ignore or downplay the role of technology education, this one speaks to our needs and interests throughout. The tone sets the stage for establishing alliances, rather than turf. Through this and a set of accompanying documents, the AAAS seems to be suggesting that this is a time for us to pull together the common interests of science, math, and technology education so that the cumulative whole may exceed the sum of the parts.

In addition to the main report, five companion volumes were produced by the National Council, each directed toward different areas of the curriculum. The one of most interest to technology educators is titled *Technology: Report of the Project 2061 Phase I Technology Panel* (Johnson, 1989). This report should make your decade. The panel, which former 3M Company executive scientist James Johnson chaired, sought to answer the question: "What is the technology component of scientific literacy?" (p. viii). They deliberated for two years before issuing their answer in the form of this report. Among the ground rules provided the panel by Project 2061 was a directive to "Propose a common core of learning in technology that can serve as part of the educational foundation of all students, regardless of sex, race, academic talent, or life goals." (p. ix).

The report acknowledges the contributions industrial arts programs have made over the years: "The Technology Panel continually emphasized the importance of this experiential learning process, and nearly every consultant advocated the need for more. A key question is how to expand the technique to serve a much broader pedagogical role." (p. 5). Johnson suggests the answer lies in providing more science and math in technology courses, and more technology in science courses: “They [mathematics and the biological, physical, and social sciences] should be a part of technology education curricula, just as technology should serve to bring additional meaning to the curricula of the sciences.” (p. 7).

The discussion of technology that fills this document is one with which technology educators should be familiar. Section III provides brief essays on “selected technology fields,” including Materials, Energy, Manufacturing, Agriculture and Food, Biotechnology and Medical Technology, Environment, Communications, Electronics, Computer, Transportation, and Space. Not many surprises for our field in this list; we've been working on it for four decades.

I think it is immensely significant that technology education and science and math education are being mentioned in the same breath, particularly when the voice is that of the science establishment. The symbiotic relationship suggested by these reports has obvious implications for all parties involved.

Talk is cheap, you say? Where's the beef? Well, it is true that change of this magnitude in public education may be unprecedented. Yet, the wheels are beginning to turn even as you read this. A few days before Labor Day, I learned the National Science Foundation is, for the first time, actively seeking proposals relating to materials development and teacher enhancement in technology education... and *that* is unprecedented! If interested, contact Dr. Gerhard Salinger, NSF Program Director for Instructional Materials Development at (202)357-7066.

Perhaps indicators such as these signal a return of technology education to the general education arena it enjoyed as industrial arts education for the first three quarters of the 20th century? I, for one, hope so.

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## *Guest Article*

# Design and Technology in the United Kingdom

Stephanie Atkinson

### Historical Perspective

"Handicraft" was a recognized subject in the national education system of the United Kingdom (UK) almost a century ago. But it is only in the past sixty years that the curriculum area we in the UK now call "Design and Technology" has progressed from single material, craft-skill based courses for the less able to a thinking, feeling, doing activity drawing on and linking with a wide range of subject bases for all pupils of compulsory school age. In comparison to many subjects in the current school curriculum, Design and Technology is still in its infancy.

Unfortunately the English language has no single word like "literacy" or "numeracy" which might denote the activities which go on in Design and Technology. Over the years, this has had unfortunate consequences for those trying to establish and build up this important subject.

The subject which started out as Handicraft has over the years developed and evolved to encompass a growing range of activities. Early Handicraft teachers were usually classroom teachers who became craftsmen, or practicing craftsmen who, by taking a short course, obtained a qualification to teach only that subject. Its very name has altered from "Handicraft," to "Woodwork," "Metalwork," "Manual Training," "Craft," "Technical Subjects," "Design," "Craft, Design and Technology" (CDT), and now "Design and Technology." Its status and its place in the overall school curriculum has also changed as a result of these developments.

To many, the pace of development has appeared to be slow. For the first fifty years, courses in manual training were provided in certain schools for less academically able boys, while girls were allowed to study Domestic Science and Sewing, with little or no alteration as to how or what was delivered.

The changes that took place in the UK economy after World War II required a substantial increase in the skilled labor force. This, in turn, led to an

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increase in the craft and technical training that was provided for the less academic in secondary schools, albeit essentially for male pupils.

The lack of curriculum development in school based Craft Education was recognized in 1959 by C.P. Snow, who argued that the traditional values of literary culture were dominating education at the expense of science and technology. He argued that the UK would decline as a world power if the balance was not redressed (Snow, 1964; Weiner, 1986; McCulloch, Jenkins, & Layton, 1986).

It was not until the 1970s that changes in society became so marked that they brought inescapable pressure upon those responsible for the pattern of education in the UK to develop a new philosophy with regard to the education of future generations. One of the main thrusts of those taking an interest in education at this time was towards the need for pupils to possess a greater understanding and awareness of technology, its future implications, its potential, and its exploitation. Therefore, it is not surprising that the technical subjects were among the curriculum areas to be scrutinized nationally by government.

It became increasingly understood by Her Majesty's Inspectorate (HMI), industrialists, the Design Council, educationists and forward thinking teachers that a change in what was provided in technical subjects was essential (Aylward, 1973; Design Council, 1980; Arnold, 1975). There was also considerable agreement among them that this aspect of education should be accessible for all pupils.

It was at this time that changes to this area of the curriculum at last became apparent (Hargreaves, 1984). The name of the subject changed. Instead of being called Woodwork, Metalwork, Engineering Practice, etc., there was a merger of the more resistant materials (wood, metal and plastics) into Craft, Design and Technology (Breckon & Prest, 1983). The content of courses changed too (Kimbell, 1986; Department of Education & Science, 1980; Inspectorate of Schools, Craft, Design & Technology, 1983). No longer were pupils taught only craft skills; they were also encouraged to design whatever they made (Harahan, 1978). At the same time, access to the subject in lower secondary schools (ages11-14) was improved. Pupils of all ability were scheduled to participate in the new courses (Kimbell, 1982; Royal College of Art, Department of Design Research, 1976). In many instances these courses were organized into modules which pupils took on a rotational basis. These courses were nicknamed “roundabouts” or “circuses.” As well as allowing each pupil to experience as wide a variety of materials and skills as the school could provide, these courses forced girls to have access to ‘boys’ subjects and boys to have access to ‘girls’ subjects. It was hoped that this would have the effect of encouraging more girls to study technological subjects at the option stage when pupils were allowed to choose between subjects.

The pity was that two different “camps” formed among educationists (Baynes, 1976; Cross, Naughton, & Walker, 1986; Cross, 1986). Those who saw creative designing as the necessary route forward, and those who believed in a need for hard technology and a sound knowledge base. The two polarized factions were not ready to cope with the concept of these two important facets of the curriculum being amalgamated into one. Nor could they easily accept that what went on in the Home Economics and Dressmaking areas of the curriculum might also have a part to play in Design and Technology education. As CDT was not representing "the whole" of design in this sense, it failed to present the united front necessary to persuade academics, educationists, or industrialists that it was essential to have this area of the curriculum as a core subject for all pupils.

During the 1970s and early part of the 1980s, this lack of clarity of message by HMI and prominent educationists continued to prevent CDT from securing a major role in the academic core of the school curriculum. This was further accentuated at a grass roots level by the teaching staff of CDT, Technology, Art, and Design attempting to protect what they perceived to be their individual subject boundaries. Conflicting pictures of the rank importance of CDT, hard technology, craft skills, design skills, the place of scientific knowledge, etc., prevented development of the subject (Cross & McCormick, 1986).

There continued to be educational opposition from senior members of staff in schools towards CDT, as it was still equated with vocational training for the academically less able. The Senior Management Teams within the schools, who were mainly made up of academics, with beliefs based on their own school experience, still saw intellectual work as of high status and manual work as of low status. Science Departments were also concerned with CDT's expectation of equal status. At this time, activities in many CDT departments were rightfully seen as secondary to, and dependant upon, basic science (Woolnough, 1986).

Other factors which affected this area of the curriculum were costs for necessary hardware, materials, and the staff and pupil related scheduling costs. These continue to be significant issues today as Local Financial Management of schools comes into effect.[1] Difficulties with assessment, low accreditation value, shortage of well trained teachers, and the fact that this area of the curriculum was offered under more labels at examination level than any other subject in the curriculum were additional aspects that caused concern. And yet it was against this backcloth that a positive change in attitude towards Design and Technology education started to emerge (Assessment of Performance Unit, 1981).

A debate regarding education in general was beginning to come to the front; up to this moment in time, education within schools had not been related to the outside world (Department of Education and Science, 1980; TRIST, 1987a; TRIST, 1987b). In fact, despite attempts, it appeared that there had been

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[1] Local Financial Management is part of Local Management Structure (LMS). It is being implemented in all state schools in the UK. At school level, it marks a change from local administration management to local management delegation by Local Education Authorities.

a failure to recognize the necessity to do so. Many believe that the UK lives by trade therefore they must succeed by trade. The continuing economic decline of the UK added strength to the educational movement, which supported curriculum development. Additional impetus came from industrialists with influence and/or the ability to inject money into the system. The Technical and Vocational Educational Initiative (TVEI), new examination systems, the National Curriculum, Local Financial Management (Department of Education and Science, 1988) and Equal Opportunities are just a few of the recent initiatives that have proved that, although *ad hoc* subject-based curriculum models developed by grass root teachers are an important process, large scale national intervention can cause mountains to be moved quickly. Almost too quickly for some!

## National Interventions

*Technical and Vocational Educational Initiative (TVEI)*

TVEI influenced the whole curriculum of many secondary schools. It was set up as a pilot scheme in 1983 with 14 Local Education Authorities (LEA's) taking part. Its purpose was to help prepare pupils aged 14-18 for the demands of working life. In 1986, the government, supported by industry, announced its intention to offer funds to all LEA's to take part in the Initiative. The exact nature and content of plans were determined by LEA's and took into account their own needs and circumstances. The National Aims of TVEI sought to encourage close collaboration between LEA's and industry/commerce/public services etc., so that the school curriculum gained the confidence of industrialists (TVEI, 1987; Leicestershire County Council, 1987).

TVEI still in effect supports the aim that pupils in school need to:

- gain the qualifications which will be of direct value to them at work;
- become better equipped to enter the world of employment;
- acquire an appreciation of the practical application of the qualifications for which they are working;
- become accustomed to using their skills and knowledge to solve real-world problems; and
- develop initiative, motivation and enterprise.

*The Effect of TVEI upon Design and Technology.* One effect of TVEI upon Design and Technology education has been the injection of money from industry enabling change to take place. This has provided much needed hardware, often in the form of computers, at limited cost to schools. TVEI has also promoted a holistic approach to the design process carried out by pupils, encouraging business awareness and industrial links. This, in turn, has brought its rewards to the schools concerned, often in the form of expertise and equipment.

*The New Examinations at the end of Compulsory Education*

*General Certificate of Secondary Education (GCSE).* Until 1987, pupils in the UK were examined in two separate systems at the age of sixteen: the General Certificate of Education (GCE) and the Certificate of Secondary Education (CSE) examinations. GCE was for the top 20% of pupils while CSE was designed to cater to the next 60% of pupils. In fact CSE was usually attempted by the majority of the pupils who did not take examinations at GCE level. (SCUE, SCDC, SEC & CNA, 1987; Department of Education and Science, 1985)

After 1987, these two examination systems were replaced by GCSE, operated as a single system and open to all. It was introduced after many trials of new approaches to tackle weaknesses in the GCE/CSE two-tiered system.

In addition to this form of academic discrimination, there had been many inadequacies in the old two-tier examination system, other than this including:

- the difficulty in changing from one system to another
- the fact that two years work was assessed in one or two examination papers which gave a bias towards teaching that could be examined in timed written papers; and
- syllabi called for learning facts at the expense of understanding or using information.

These latter two points were felt to be particularly important by teachers who wrote examinations for Design and Technology because of the very nature of the activities involved. In addition, employers of those leaving school and those pupils who changed schools during courses found that examinations with the same title did not necessarily include the same content, levels of achievement, or expectations of the pupils.

There was also a serious mismatch between employers and teachers in terms of acceptability. Employers, the majority of whom had left school long before CSE examinations had been established, never accepted top CSE qualifications as equal to GCE. However, many teachers preferred CSE as they were professionally involved in the development of these examinations, and consequently were able to tailor them to their requirements.

The introduction of the new single examination system, however, caused many problems. The new system had to be ‘marketed’ to staff, pupils, parents and future employers who all remembered the difficulties with the acceptance of CSE. The new philosophy of GCSE and the new approaches to assessment required a great deal of in-service training for teachers in order to manage a curriculum to support a single subject examination system.

In preparation for GCSE, National Criteria were established for all subjects to give a uniform framework for examinations and syllabi. This was a major step forward in the UK examination system. The published list of National Criteria aims and objectives explained what students studying courses in all curriculum areas should seek to achieve.

One important and very positive aspect of GCSE was to establish the philosophy that all syllabi must help pupils in schools to understand a subject's relationship to other areas of the curriculum and its relevance to their own lives and responsibilities. Also, in GCSE, assessment was no longer to be by examination alone. At least 20% of candidates' marks were to come from coursework, either in the form of project work or by continuous assessment of pupils' regular classroom activities. In the past, examinations had tended to record what candidates could not do rather than what they could do. GCSE aimed to assess positive achievement.

*The Effect of GCSE on Design and Technology.* GCSE allowed the development of examination courses that were far more suitable for assessing Design and Technology capability than the traditional mode of examination could ever hope to achieve. Some examinations [eg. Midlands Examining Group (MEG) Design][2] were purely an assessment of coursework. Others had a balance between coursework and written examinations. GCSE allowed schools to continue, during the examination years, with the type of work done in the lower secondary (age 11-14) Design and Technology curriculum. This is also similar to the philosophy advocated in the new National Curriculum.

*The National Curriculum (NC)*

One of the most important changes in education brought about by the Government's Education Reform Act of1988 was the introduction of a National Curriculum for children aged 5-16 in all state schools in England and Wales (National Curriculum Council, 1989; Department of Education and Science, 1985, 1987a, 1987b). The purpose of the National Curriculum is to ensure that all children study essential subjects, thus providing a better all around education. It is designed to ensure that children cannot opt out of subjects too early, and thereby close doors to future job opportunities and personal development. Progression from the Primary phase to Secondary should offer much more continuity for pupils in terms of style, structure and content of education. It should also make it easier for children to move from one school to another.

The National Curriculum consists of 10 subjects which all children must study at school: English, Mathematics, Science, Technology,[3] History, Geography, Music, Art, Physical Education, and a modern language from ages 11-16. For each subject there are objectives or goals outlining what children should know and be able to do at each stage of their schooling. These objec-

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[2] England, Wales, and Northern Ireland are divided into 6 regional examination groups. These groups are responsible to the Secondary Examination Advisory Council (SEAC) for the organization and assessment of GCSE Examinations (Scotland has its own educational and examination system).

[3] Technology in the National Curriculum is composed of two areas of study, Design and Technology and Information Technology.

tives are called "attainment targets." For each subject there are also descriptors and programs of study detailing what children should be taught in order to help them achieve the attainment targets set. At ages 7, 11, 14, and 16 students are assessed with regard to the attainment targets. Their performance is measured on a ten point scale.

There are 4 stages for different educational age groups, known as "key stages." These should help pupils, parents, and staff to know what each child should learn at various ages. The key stages are:

- Key Stage 1 - from age 5 to 7
- Key Stage 2 - from age 7 to 11
- Key Stage 3 - from age 11 to 14
- Key Stage 4 - from age 14 to 16

The National curriculum is not the total curriculum for the child, but rather a fundamental framework. It is for each school to decide mechanisms for delivery and additional subjects they wish to provide. By law each school in the public sector must provide the National Curriculum.

*The Effect of the National Curriculum on Design and Technology.* The government's Statutory Orders concerning Design and Technology, were published in April 1990. They must by law be taught from September 1990 starting with Key Stage 1.

Design and Technology has been made one of the two "profile components" of the foundation subject area Technology. The other profile component is Information Technology (IT).[4] It is intended that these components are not seen as discrete subjects, but more a set of attainment targets that will need to be serviced by a wide variety of curriculum areas.

One of the most far reaching effects of the NC is the fact that all pupils from 5-16 will have to be taught the necessary information and skills, with the emphasis on process rather than content, to be able to achieve the appropriate attainment targets. In the case of Design and Technology, schools will not be able to decide that they do not wish to provide this area of the curriculum. Design and Technology, is required by law for all pupils of all abilities, ages and interests. No longer will it be taught just to those who choose the subject because they are interested in it, or to those who see its relevance to their future occupations. Design and Technology will become something quite different from that Design and Technology to offered in the past, as its content must now be relevant to all. It must have broadly based transferable skills making it a preparation for life, not for a vocation.

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[4] IT capability in the NC is cross curricula. Pupils will use IT to; communicate and handle information; design, develop, explore and evaluate models of real or imaginary situations; measure and control physical variables and movement; and be able to make informed judgements with regard to applications and their effect on society.

To meet the legal requirements of the Orders, Design and Technology will not be able to be the province of a single department, let alone the province of a single subject. A number of *Working Party Reports* were published for consultation before the Statutory Orders were finally written (National Curriculum Design and Technology Working Group, 1988; Department of Education and Science, 1989; National Curriculum Council, 1989). One of these reports, the *Interim Report*, set out to explain the new philosophy. It established that in order to deliver the NC the curriculum areas of CDT, Home Economics, Art and Design, Business Studies and Information Technology all have to work together as a team being aware of and building upon knowledge gained in other curriculum areas such as Sciences, Mathematics, and Humanities. Cross-curricula activities and links will be essential to achieve many of the Design and Technology programs of study. This is going to require teachers who are willing to work as part of teams and teachers who are able to work in partnership alongside teachers who possess differing skills and expertise.

Information Technology (IT) has a special role to play in Design and Technology, but it is not its only role. The *Statutory Orders for Technology* explain that like Design and Technology, Information Technology is not a discrete subject. The aim is to use IT as a tool in whatever context it is needed. All graduates should be unafraid of computers and be able to cope with whatever computer technology comes their way in the future.

*Industrial Contexts and Links in Design and Technology / National Curriculum* . It is envisaged that industrial links established through TVEI will be strengthened and that the good practice established under this scheme will filter into all Design and Technology activity even in the primary sector (age 5 - 11). The NC's inclusion of Business Studies into Design and Technology activities allows the design process to be more holistic.

*Pupil's Learning Strategies in Design and Technology / National Curriculum* . The NC suggests learning strategies that require pupils to carry out a needs-driven design activity. There is an emphasis on process and on *how* pupils will learn as well as *what* they will learn. Design and Technology is to be an activity subject, designing, making and evaluating, systems, environments and products. Projects are to be set in a number of different contexts that are relevant to all pupils. Pupils will need to work in a variety of ways; as individuals, as part of teams on one project, and as part of groups on individual tasks. The skills that will be required for a pupil to achieve a task will be on a “need to use basis.” This is where the teacher with single subject expertise will be an essential “commodity.” Pupils will learn that Design and Technology is all about optimization and opportunities and that not everything is a problem to be solved.

*Teaching Strategies in Design and Technology/National Curriculum*. As with all the NC subjects, progression is an important issue. It is hoped that pupils will not repeat aspects of work in a variety of curriculum areas nor if they change schools. It is also hoped that the NC will prevent pupils missing vital areas of knowledge or experience either because they have not been included in a subject area or because a school chooses not to tackle them. It is envisaged that knowledge gained in other curriculum areas, particularly in Science and Maths, will be put into context in Design and Technology.

*The Implications of the National Curriculum for Staff Development*. The implications for training for teachers is tremendous. Many teachers, both those who understand the new philosophy and those who do not, are going to need a great deal of support. All teachers will need to be facilitators rather than founts of knowledge. Managers for both the curriculum and for teams of staff will be required. Monitoring individual pupils' progress will require a new approach. Assessment of work carried out by pupils at all the Key Stages could cause many challenges and difficulties.

In-service requirements are going to come in two forms: those aspects which the school can deal with in-house, such as team management, learning to work together in teams, trusting one another and accepting that no one person can deliver Design and Technology, and in-service supplied by outside agencies (Technology Education Development Unit, 1990; LIST, 1990). It will be necessary to develop an understanding of the new Design and Technology philosophy in a wider than single school context. In-service will be needed to help overcome many teachers' fears that they will not be able to cope with implementing the new Design and Technology curriculum. There will also be an on going need for in-service from outside agencies to update teachers' expertise in areas of technology as yet unknown or missing from the individual school teams of Design and Technology teachers.

## Conclusion

Educational developments within curriculum areas cannot be seen in isolation. The large scale intervention of Government and Industry into the UK educational system has brought about fast changes across the total curriculum, culminating in the sharp focus of the National Curriculum.

Many valued, experienced teachers in the UK, not only of Design and Technology but across the total school curriculum, are feeling the pressures of these changes. These feelings are understandable. Teachers have recently become surrounded by a plethora of educational developments far beyond their curriculum area, which they must discuss, initiate, respond to, administer, and assess.

The UK is at the beginning of a new era in education in which the National Curriculum will hopefully give all pupils equal entitlement to a better, all around education. For Design and Technology, it is a time of major opportunity. Teachers will need to seize this opportunity to develop and deliver this vital area of the curriculum in a coherent form that will be accepted by the whole of the educational fraternity. They will need to capitalize on the good practice which already exists in schools. The National Curriculum will not be something that can be implemented overnight. It was begun in the primary schools in September 1989 in Science, English and Mathematics. In September 1990, Technology (with its two profile components, Design and Technology and Information Technology) will begin to be taught. But it will not be until the mid-1990s that the full National Curriculum is expected to be implemented.

Many teachers are afraid of the impending changes. A great deal of in-service work will be needed to help staff cope with the philosophy, management, assessment, and extra work load. Teachers will need to be careful that they ensure that those specialists who feel vulnerable working within this new system understand the important contribution they are able to make. It is likely that these vulnerable teachers will be those who were trained as Craft teachers and have already struggled with differing degrees of success to become CDT teachers during the 1970s and 1980s. The profession will lose some of these teachers if they are made to feel that their skills are no longer relevant. It will be important for teachers to see that although pupils will be working across the full spectrum of Design and Technology, activity teachers with special expertise will be needed to prevent the subject becoming shallow and rigorless. All teachers will need a generic grasp of technology. They will also need an understanding of the variety of methods of delivering Design and Technology that are envisaged in the NC proposals.

Teachers in the UK see the need for, and the advantages of the National Curriculum framework. Design and Technology teachers understand the need for the changes that are envisaged, accepting the challenges offered to them, and recognizing the important role of Design and Technology within a holistic context. The challenges and opportunities to teachers and pupils alike are exciting. Design and Technology can and will play a special role in preparing pupils for life, enabling them to cope with the technological uncertainties of the 21st century. It will be during the next few years that teachers will need to develop and refine further mechanisms to deliver and assess this vital area of the school curriculum.

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# *Articles*

## A Perspective of Technology Education in Taiwan, Republic of China

Lung-Sheng Lee

### A Brief Review of Taiwan's Educational System

The Republic of China was founded in 1911 and moved its seat of government from mainland China to Taiwan in 1949. Situated in the far western Pacific, Taiwan covers an area of 36,000 square kilometers (about .38 percent of the area of the USA) and has a population of 20 million. Its population density—556 persons per square kilometer—is one of the highest in the world and is over 20 times the population density of the USA. The absence of rich natural resources mandates that the Taiwanese workforce be highly productive in order that industry may be competitive; hence, a comprehensive educational system is needed to effectively develop productive abilities of the dense population.

The core of today's educational system in Taiwan (see Figure 1) is the nine-year compulsory national education program ("Kuo Ming Chiao Yu"). This includes a six-year elementary school and a three-year junior high school. Beyond these schools are two parallel three-year institutions—a senior high school and a senior vocational school. Junior college education assumes three patterns: two-year, three-year, and five-year programs. University programs last four to seven years, depending on variations within departments. Technical colleges offer two kinds of program: a two-year program for junior college graduates and a four-year

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*Figure 1.* Structure of the educational system.

*Note:* From Ministry of Education, 1989a, p. 9.

program for senior vocational school graduates. At the graduate level, the minimum length of study for a master's degree is two years, with an additional two years as the minimum required to earn a doctorate. Entrance examinations are required for admission to schools beyond the level of the nine-year compulsory education (Lin, 1985).

In the 1988-89 school year, the percentage of children of elementary-school age enrolled in school was 99.9 percent; the percentage of elementary-school graduates entering junior high school was 99.1 percent; the percentage of junior high graduates entering senior secondary school was 79.5 percent, and 45.5 percent of senior secondary graduates advanced to higher education (Ministry of Education, 1989b).

## Curriculum in Transition

In Taiwan, curricula for elementary, junior high, and senior high schools are promulgated by the Ministry of Education. Curriculum standards for all levels of school are revised about every 10 years. Revision is made by sub-committees. The members, appointed by the Ministry of Education, are curriculum specialists, teacher educators, classroom teachers, and administrators.

According to current junior high and senior high curriculum standards[1] (Ministry of Education, 1983a & 1983b), which were promulgated in July 1983 and have been implemented since August 1984, students in grades 7 to 11 must select either industrial arts ("Kung I"), or home economics with a two-hour weekly study (a regular week is 32 to 39 hours). Schools usually assign boys to industrial arts programs and girls to home economics. Some elective courses pertaining to industrial arts, like drafting, metalworking, and electronics shop, are also provided at both junior and senior high levels, but they are more vocational-oriented (characterized by "learning for earning") than the required industrial arts (characterized by "learning for living").

As shown in Tables 1 (Ministry of Education, 1983a) and 2 (Ministry of Education, 1983b), the objectives and content of industrial arts education in Taiwan is undoubtedly industry-based and technology-oriented. Its curriculum focus is in transition from traditional industrial arts to contemporary technology education and its content categories seem to mix broad occupational areas (like woodworking) with industry clusters (like the manufacturing industry).

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[1] At the elementary level, industrial arts is a component of the broad-study subject "craft work" which consists of drawing, sculpture, design, industrial arts, horticulture, and home-making.

**Table 1**
*A Summary of the Objectives and Content of Junior-High Industrial Arts Curriculum in Taiwan*

| Objectives | Content (allocated weeks) |
|---|---|
| 1. To help students to understand traditional and contemporary industrial civilization and recognize their local industrial status and trends. | 1. Introduction to Industrial Arts (2)<br>2. Blueprint Reading and Planning (6)<br>3. Ceramics Shop (5) |
| 2. To provide students with career exploration opportunities to discover their interests and abilities in the field of industrial technology. | 4. Woodworking (15)<br>5. Plastics Shop (5)<br>6. Metalworking (15)<br>7. Electricity Shop (7)<br>8. Graphic Communication (4) |
| 3. To develop students' necessary knowledge, skills, and attitudes for living in the industrial society. | 9. Construction and Livelihood (9)<br>10. Manufacturing Industry (12) |
| 4. To foster students' cooperative, industrious, gregarious, and enthusiastic personalities. | 11. Information Industry (6) |
| 5. To develop students' consumer skills and knowledge. | 12. Audio-visual Communication (7) |
| 6. To foster students' habits to coordinate doing and thinking and ideas about dignity and equality in working. | 13. Energy and Power (7) |

The implementation of industrial arts curriculum standards has led to the following supportive efforts:

- Industrial Arts Equipment Standards are promulgated by the Ministry of Education after each curriculum standard revision to set up the minimum requirements of industrial arts facility and equipment.
- Junior-high industrial arts textbooks are compiled and printed by the National Institute of Compilation and Translation, an institution of the Ministry of Education. Commercial senior-high industrial arts textbooks also have to be approved by the institute.

**Table 2**

*A Summary of the Objectives and Content of Senior-High Industrial Arts Curriculum in Taiwan*

| Objectives | Content (implemented grade) |
|---|---|
| 1. To introduce students to industrial technology knowledge and foster industrial skills for their industrialized living and advanced studies.<br>2. To ignite students' interests of design and creation, provide them with career exploration opportunities in the field of industrial technology, and encourage them to do research and invention.<br>3. To develop students' appropriate working habits and attitudes. | 1. Project Planning and Drafting (grade 10)<br>2. Industrial Materials (grade 10)<br>3. Energy Industry (grade 10)<br>4. Information Industry (grade 11)<br>5. Automation (grade 11) |

- Sponsored by the Ministry of Education or the departments/bureaus of education in provincial/special municipal governments, a variety of in-service teacher training programs are provided for industrial arts; almost all the enrollments of these training programs are free of charge.
- Through the recognition of outstanding industrial arts teachers, the annual convention, publications, etc., the Chinese Industrial Arts Education Association devotes its energies to the improvement of industrial arts education at all levels.
- The *Journal of Industrial Arts Education*, edited by the Department of Industrial Arts Education at National Taiwan Normal University, is disseminated monthly, free of charge, to secondary schools and other institutions pertaining to industrial arts education.
- Funded by the Ministry of Education or the departments/ bureaus of education in provincial/special municipal governments, serial publications and teaching aids are often provided for industrial arts teachers.
- An industrial arts consultative team, composed of industrial arts teachers, supervisors, and principals, is organized at every county and city to serve junior high industrial arts teachers.
- The yearly industrial arts project exhibition and/or student contest is/are respectively held at county/city and province/special municipality levels.

There are two university departments of industrial arts education in Taiwan, one at the National Taiwan Normal University and the other at the National Kaohsiung Normal University. Each provides both pre-service and in-service secondary school teacher training programs. In terms of the pre-service program, students are admitted following successful performance on the yearly College Joint Entrance Examination (CJEE) administered to graduating senior-high students. During their five-year period of study in the program, students enjoy a four-year tuition waiver and living expenses in their universities. One additional year is spent in secondary schools in a teaching internship. In recent years, there have been around 100 graduates annually from these two departments of industrial arts education. Faculty members in these two departments have plenty of chances to devote themselves to a variety of efforts to improve industrial arts education.

## Problems Facing Technology Education

A problem refers to "a significant discrepancy between an existing degree or amount of a characteristic ['to be' or the actual] and a preferred degree or amount of that characteristic ['ought to be' or the ideal]" (Friedman, Brinlee, & Hayes, 1980, p. 16). Today's industrial arts education in Taiwan has the following problems which are listed in a descending order of priority.

*Industrial Arts Is Seen as a Subordinate Subject*

Since both the entrance examinations for senior high school and college/university admissions are very competitive[2] and industrial arts is not included in the required subjects for these examinations, most parents, principals, teachers, and even students in secondary schools see industrial arts as a subordinate, unworthy subject.

*The Public's Perceptions are not Aligned with the Field*

The current name of industrial arts "Kung I" was translated from American "industrial arts" in the 1950s, but the term "Kung I" has been used in Chinese society for thousands of years. "Kung I", in early Chinese language, referred to polytechnic or technology, but, has been widely seen as the equivalent of handicraft after the introduction of western ways into China at the turn of this century. Hence, it is difficult for professionals in the field of industrial arts education to communicate the ideas of this field to the public.

Coupled with the public's perceptions, the educational administrators admitted numerous personnel who majored in fine arts or related disciplines to be *qualified* industrial arts teachers in the late 1960s. Many of these so-called

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[2] In 1988, for example, 112,327 applicants took the College Joint Entrance Examination (CJEE) and only 37,929 (33.76 percent of the total applicants) were admitted to one of the day-session programs in colleges or universities.

"industrial arts teachers," especially those who have been unwilling to attend in-service teacher training programs, have opposed the development of technology-oriented industrial arts education.

*Some Drawbacks Exist in the Promulgation of Curriculum Standards*

Based on Lee's studies (1986, 1987, & 1988), some drawbacks of the centralized industrial arts curriculum standards have been identified:

- The revision interval is too long, so the standards are unable to promptly reflect social changes.
- The standards lack flexibility, so they are unable to meet differences in school districts and students.
- Its decision-making process is too teacher educator-oriented.
- Its process leans toward an arbitrary judgment because few related professional inquiries such as situation analysis, experiments, and follow-ups have been done.

*Many Teachers Deviate from the Curriculum Standards*

Admittedly, the implementation of curriculum standards mainly depends upon the teacher's instruction. It is evident that industrial arts teachers' instruction in Taiwan has widely deviated from the ideal curriculum prescribed by the curriculum standards. The deviation could be a desirable modification based upon critiques of the curriculum standards, but unfortunately almost all deviation has led in a worse direction (Lee, 1987). The two predominate factors to cause the deviation are:

*Teachers' indifference*. As mentioned above, industrial arts has not been a subject required by the entrance examinations of senior high schools and colleges/universities. Lacking serious supervision and desirable expectations, many industrial arts teachers are dull or unable to reflect curriculum change in their teaching. Especially, the thirteen sub-categories of junior high industrial arts curriculum, mixing broad occupational areas with industry clusters, are really too great to be managed well.

*Teachers' overload*. At present, each industrial arts teacher is confronted by large class sizes, averaging 46 students, and about 23 teaching hours per week (more than the hours of most teachers teaching other subjects). The overload leads them to often "cut the feet to fit the shoes," i.e. trim instructional activities to what they can handle.

When industrial arts had its name changed from "Arbeit" (German word meaning "work") in the early 1960s, Wang (1960), who was the director of the Department of Secondary Education, Ministry of Education and in charge of curricular revision for secondary schools at that time, cited the following Chinese fable to claim the appropriate position of industrial arts in general education.

> In the past, an expert in general education, who thought the 3R's—*reading, writing,* and *arithmetic* were the whole of general education, hired a boat to pass

> a river. While the boat was crossing the river, he chatted away to the boatman. First, he asked, "Can you read?" The boatman answered, "No." He told the boatman, "You lost one third of your life." He then asked if the boatman could write; the boatman's answer was also negative. "You lost two thirds of your life.", said the expert. After a moment, the boat was in the middle of the river and the wind made the boat pretty unstable. The boatman asked the expert, "Can you *swim*?" The expert answered, "No" with fear. The boatman complacently said, "If the boat turns over, you will lose the whole of your life." (p. 9)

The fable indicates that descriptive, prescriptive, and formal knowledge (which can be linked to the *3R's*) is not sufficient learning for general education; praxiological knowledge (which can be linked to *swimming*) has to also be offered in schools (Towers, Lux, & Ray, 1966). Admittedly, since industrial arts education in Taiwan was greatly influenced by the USA in the 1950s,[3] it has appropriately been seen as an action-based study of functional literacy (like swimming in the above fable) in general education. Owing to the preceding problems, however, industrial arts education is still "swimming up stream."

## Future Efforts: Focus on Curriculum Change

In accordance with the plan to extend the nine-year compulsory national education to 12 years in the 1990s, the industrial arts curriculum standards are expected to be revised in the coming two years and the student's formative performance on all subjects in junior high school could be considered as the criteria to admit him/her to his/her preferred senior high or senior vocational school. This appears to be a good opportunity for professionals in this field to rename industrial arts, develop a progressive philosophy, reconstruct industrial arts curriculum, and win the public's support for industrial arts education.

## Summary

Under a centralized strategy, industrial arts education in Taiwan is required for students (mainly, boys) in grades 7 to 11. In the process of transition and characterized by the industrial-base and technology-orientation, current industrial arts curriculum mixes traditional "industrial arts" with contemporary "technology education."

Although a variety of support from governmental institutions for industrial arts education is evident, today's industrial arts education in Taiwan is still

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[3] In 1953, under some American specialists' assistance, the Department of Industrial Education at Provincial Taiwan Normal College (now National Taiwan Normal University) was founded in Taipei, Taiwan. Since that time, American industrial arts theory and practice has been widely introduced into Taiwan through frequent exchanges of Sino-America professional personnel and literature.

struggling with many problems which are mainly caused by the public's weak support. It is anticipated that the coming curriculum standards revision may effect a profound improvement upon industrial arts education.

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# Problem Solving: Much More Than Just Design

Joseph McCade

Few concepts which fall within the scope of technology education have received as much attention as "problem solving." *The Technology Teacher* alone contained seven articles about problem solving between 1985 and 1989 (Sellwood, 1989; Thode, 1989; Barnes, 1989; Ritz, Deal, Hadley, Jacobs, Kildruff & Skena, 1987, 1986a; Baker & Dugger, 1986; Forbes, 1985). A thorough review of each of these articles will help any technology teacher teach technology. Many additional articles discuss problem solving, although they may not focus specifically on it. This does not suggest that problem solving is a new concept; it has been listed as a goal of our profession since its inception. However, the recent interest in problem solving does raise some questions: How should problem solving be defined in the context of technology education? How important is problem solving in technology education? Does problem solving hold a different place in a technology education curriculum than it did in industrial arts?

This article will explore design and troubleshooting as subcategories of problem solving and will argue that the systematic evaluation of the impacts of technology (technology assessment) should be considered an equally important category of problem solving.

## Problem Solving: A Definition

Problem solving has been defined in many ways. One simple yet meaningful definition describes a problem as a need which must be met (Ritz, et al. 1986a). This need could include, among other things, the need to understand the forces of nature (science), to alter the environment (technology), or to use scientific knowledge to alter the environment (engineering).

Industrial arts, in the past, and now technology education programs have addressed problem solving. However, even the most contemporary treatment of problem solving has been primarily focused on designing new technical systems or, less often, repairing existing systems.

Unfortunately, many authors and educators consider problem solving from only the perspective of design. In fact, some use the terms "problem

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solving" and "design" interchangeably. This approach is far too limiting. Technological problem solving can be divided into three categories: design, troubleshooting, and technology assessment (impact evaluation) (see Figure 1).

Designing may be defined as proactive problem solving (Baker & Dugger, 1986). It includes not only the refinement of the original concept but also the research, experimentation, and development necessary to prepare the product for production. Innovating, creativity, and designing are closely related. A wealth of good information exists concerning design (e.g., Nelson, 1979; Hanks, Bellistron & Edwards, 1978; and Beakley & Chilton, 1973).

Troubleshooting, or reactive problem solving (Baker & Dugger, 1986), involves the recognition that technology encompasses more than innovation. The production and utilization of technical solutions is also a valid source of course content for technology education. Finding and correcting problems during the production or utilization of technical solutions is troubleshooting.

*Figure 1*. Three forms of technological problem solving.

Technicians can be satisfied with abilities in design and/or troubleshooting. However, technologists must add the ability to critically analyze the impacts of technical solutions in order to predict possible outcomes and choose the most appropriate solution to a problem. Of course, they must also re-evaluate existing solutions. Most practitioners in the field would agree that evaluating the impacts of technology is an important part of technology education. However, finding a way to integrate impact evaluation into a program can be difficult. Encouraging students to approach the impacts of technology with a well structured, analytical process (problem solving) should result in significant learning.

## How Important Is Problem Solving?

Few would argue that teaching problem solving is unimportant. Whether an important component of technology education curriculum (Baker & Dugger, 1986) or the central focus of technology education curriculum (Barnes, 1989), current thinking in the field seems to strongly support the importance of problem solving. Perhaps the most persuasive of these arguments is based upon the explosive growth of technology. Because so much of what students need to know has not yet been created, it makes little sense to teach students the most up-to-date technology if they do not exit with the ability to continue learning (Barnes, 1989). The development of problem solving ability is a key factor in creating an independent learner.

## What Place Does Problem Solving Have In Technology Education?

Problem solving was an important ability in industrial arts because it allowed the student to overcome certain stumbling blocks which were inevitable in producing a well crafted product. Problem solving in most aspects of industrial arts, in practice if not in theory, was a spin-off skill. Although it was rarely planned in a specific manner, some degree of problem solving ability was almost always imparted to students.

Technology education changes problem solving from simply a means to an end into the end itself. Rather than use problem solving to produce a product, the product becomes one of many ways to teach problem solving.

## Teaching Technical Problem Solving

Regardless of which of the three types of technical problem solving are taught, three basic concepts should be attended to. These concepts are: (a) a model for problem solving, (b) systems to subsystems approach, and (c) necessary prerequisite knowledge.

Many good problem solving models are available. Most models have between four and eight stages. The larger models provide more detail; however, a four-step model like the one that follows includes all the major steps but remains concise. Regardless of which model is chosen, it should be reviewed with students using examples to explain each step: (a) identify the problem, (b) postulate possible solutions, (c) test the best solution, and (d) determine if the problem is solved.

An understanding of a problem solving model can help students understand the process of problem solving. However, attention to content should not be neglected. Students who are taught to solve problems in a way which gives little attention to the content of the problem will have great difficulty transferring the learning to other situations (Thomas & Litowitz, 1986). In such situations, students can be taught to solve problems without becoming problem solvers.

Because technical systems are involved, an understanding of systems and subsystems is another important component of technology education (Ritz, Deal, Hadley, Jacobs, Kildruff & Skena, 1986b). A system is a group of components which work together to accomplish a common goal. Many times the component parts of a system are themselves systems, thus becoming subsystems. Two concepts are important in relationship to this definition. First, it is important to recognize that each system or subsystem has a discernible function. Understanding how a system or subsystem operates is frequently important when solving technical problems. Second, the relationship between systems and subsystems is important. Subsystems can also affect each other. The need to understand the interdependence and function of systems and subsystems will become more apparent when discussed in the context of design, troubleshooting and technology assessment.

Problem solving is a higher level thinking skill. This type of thinking involves analysis, synthesis and evaluation. These cannot occur in the absence of appropriate supporting learning (knowledge, understanding and application). The cognitive domain taxonomy (Bloom, 1956) supports this idea (see Figure 2).

*Figure 2.* Bloom's cognitive domain taxonomy: “The Building Blocks of Learning.”

Simple knowledge or even understanding of a content area will not by itself provide a sufficient basis for solving problems involving that content. However, knowledge and understanding are necessary for solving complex problems. For example, any one who has tried to understand something about which they have little or no knowledge usually ends up with little or incorrect understanding. Knowledge is foundational to understanding. Imagine trying to apply knowledge without understanding. Suppose an individual is aware of many types of building materials like plywood, drywall, nails, screws, etc. However, this person has no understanding of how these materials are used and no experience with them. Now imagine this individual attempts to build their own house; frustration would result from a missing link in the chain of things necessary to apply knowledge.

In order to explore the level of cognition necessary for problem solving, a person named Hypothetical Harry will be used. In search of a career, Harry decides to find out what skills he would need to become a building inspector. The first thing he discovers is that there are many different types of building inspectors: electrical, plumbing, structural and others. This type of system (the whole building) to subsystem (electrical, plumbing and structural) is analogous to the type of analysis Harry will be required to do when he inspects buildings. In order to conquer the task of deciding if an entire electrical, plumbing or structural subsystem of a building is safe for occupancy, Harry will find it necessary to divide the problem into manageable pieces.

The building inspector's job sounds interesting to Harry but he decides the salary is not enough. While investigating the building trades Harry discovers that architects can have good incomes. However, this job sounds a bit more challenging. Harry begins to realize that an architect must understand all of the subsystems of a building (analysis) and he or she must recombine the component parts of these subsystems to create new solutions. In other words, an architect is expected to combine the subcomponents of electrical, plumbing, mechanical and structural systems to meet the requirements of a variety of different building projects. Harry can quickly conclude that this job would require not only the ability to divide systems into smaller systems and then to divide the systems again and again but also the ability to recombine these systems. Anyone who is good at recombining systems to create new solutions (synthesis) must first be capable of dividing the systems in the first place (analysis).

Just about the time Hypothetical Harry decides to go back to college in order to become an architect he wins the lottery. Now Harry's career aspirations shift from making money to spending and protecting his new found wealth. Harry must constantly make decisions about what to buy or which tax shelters are the best this week. The reason Harry finds this “work” so exhausting is that he is constantly evaluating which of several alternatives is the best answer to the problem at hand. To make the best evaluations Harry must be able to break the problems into digestible bits of information (analysis). He should also be able to see potential connections between varied solutions (synthesis) in order to compare them.

Harry is not the only person who must have the ability to evaluate. As consumers and citizens every individual should possess these capabilities.

Problem solving may require analysis, synthesis, evaluation, or a combination of these. The building blocks which support these various levels of learning may be supplied by the teacher, sought out by the student, or teacher and student may share the responsibility for discovering these prerequisite skills.

The more abstract forms of learning, problem solving included, cannot occur without the foundation of concrete learning. Despite well intentioned claims to the contrary, how much of what is actually accomplished in education progresses beyond the concrete levels of knowledge, understanding and application? Education which involves abstract learning is rare and it is certainly more difficult to produce and evaluate than a system which focuses on the retaining of facts. However, analysis, synthesis and evaluation level thinking skills are essential to the development of a competitive work force. Figure 3 illustrates the relationship between this type of abstract learning and problem solving.

*Figure 3.* Levels of learning.

## Teaching Design

A key in teaching design is the essential element creativity plays in this type of problem solving (Thomas & Litowitz, 1986). Every technology teacher should examine their teaching style to determine its effect on students' ability to generate alternative solutions to a problem. Does the laboratory experience students have encourage diversity or demand conformity? The product oriented, skill development strategies typical of the industrial arts philosophy rarely celebrate diverse solutions (Clark, 1989). The need to efficiently transfer skills is one which bleeds over into technology education because a knowledge base is a prerequisite to developing problem solving ability. However, efficiency should not be allowed to overshadow effectiveness; they should be balanced. When teaching design, a strategy must be developed which not only tolerates but rewards alternative solutions. This type of problem solving should involve a divergent as opposed to a convergent thinking process (Hatch, 1988). Students who are encouraged to take control of their own learning will be much more likely to develop a broad rather than narrowly focused approach to problem solving. The idea that students can help teach themselves (Villalon, 1982) is appropriate for teaching design.

The temptation is present to simply teach divergent thinking the way one might teach multiplication tables. The problem with this approach lies in the critical role creativity plays in the type of divergent thinking which is required to come up with truly unique solutions to problems. Can one teach creativity?

Can an educational system so steeped in convergent thought encourage or even tolerate divergent thinking?

A discovery method of learning can be utilized in the teaching of design. When students are faced with the need to know certain information, they will seek out that information. This requires them to work their way down Bloom's Taxonomy of Learning, perhaps even jumping around a bit filling in the gaps as they find need. For example, suppose a student wants to assess the impact of a coal gasification. First, the student must satisfy him or herself that they understand what coal gassification is (knowledge and comprehension). Second, the student should begin to ask questions like: how is coal converted to a gas, why is this process desirable, what type of pollution can be eliminated by coal gassification, and will new problems be created? In this second step the student breaks the problem down into managable chunks (analysis). Finally, the student brings the answers to all the smaller questions together in order to answer the question: considering both the positive and negative aspects of coal gassification, what should be done with this technology (synthesis and evaluation). This method casts the teacher as guide and facilitator. The student becomes an investigator (Sellwood, 1989). The following illustrates a design brief in which the student uses this investigative approach. When using this approach, care must be exercised to insure that each student obtains the prerequisite knowledge. As has been mentioned, proper attention to context is necessary if students are to transfer the problem solving process to new situations.

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Design Brief
Introduction to Control

A paper shear can cut fingers as easily as it cuts paper. Design a control system which will reduce accidents by forcing the operator to press two buttons at once to start the shear. Follow the steps below in finding your solution.

1. Identify and document what you will use as the components of your control circuit (i.e., signals, decisions, actions).
2. Identify and document what type of logic you will use in the decision section of your control circuit.
3. Draw a wiring diagram for your solution and discuss it with the instructor.
4. Wire the circuit you have designed; have the instructor check the circuit before testing it.
5. Evaluate your solution; return to a previous step if necessary.

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The design brief becomes a launching point for the student. It is intended to define the assignment without being too limiting.

**Teaching Troubleshooting**

Troubleshooting involves a systematic approach to locating and correcting problems in existing systems. A much more structured approach can be applied to teaching troubleshooting than can be applied to teaching design. Usually the knowledge and understanding necessary can be identified by the teacher and delivered in a structured fashion. This process begins when the teacher helps the students identify the subsystems involved in the system under study. Next, the function and operation of all subsystems must be completely explored. Finally, a troubleshooting system can be taught. Troubleshooting combines three factors: (a) interrelationship of systems and subsystems, (b) subsystem function and operation (what and how), and (c) a search strategy.

Each subsystem has a function which the student must know. This answers the question: What does the system do? Students must also understand the operation of each subsystem, or how each subsystem performs its function. Without an understanding of what each subsystem function is, it becomes very difficult to determine if the subsystem is functional. Equally problematic is an attempt to isolate a malfunction within a subsystem with no knowledge of how the subsystem performs its function.

Most subsystems are affected by the other subsystems within the same overall system. An understanding of the interrelationships of each subsystem to be troubleshot is essential to success. An inefficient search strategy cannot only waste time but may cause the true source of a problem to be overlooked. A binary search strategy is the most efficient search method. If each successive step in the search divides the remaining alternatives in half, a problem can be isolated very quickly. Good diagnostic charts are organized in this fashion. In fact, students who are accomplished in the three factors in problem solving will be able to write their own diagnostic charts (see Figure 4).

Assuming that a communications class contains a unit on telecommunication, a part of that unit might include telecomputing. The networks computers use to communicate would probably be an important consideration within this sub-unit. One good way to teach students about computer networks would be to ask them to create a troubleshooting scheme for isolating problems with such a network. The teacher might provide written resources to help students identify the systems: (a) purpose, (b) inputs, (c) outputs, (d) component subsystems, and (e) interaction with outside systems. In this way, students can be allowed to "research" the information needed to solve this problem. Such an assignment follows:

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Creating a Diagnostic Tree

A diagnostic tree is a device that guides the troubleshooter through a series of steps which efficiently and correctly identify a malfunction. Creating a diagnostic tree requires not only a thorough understanding of the system involved but also an understanding of how to efficiently search for a problem. Complete the following steps in creating your own diagnostic tree. Carefully document your work. Every diagnostic tree should contain three basic components: preliminary checks, system output test, and problem isolation. Proceed as follows:

1. Identify the purpose of the system. Identify the input and output points of the system.
2. Determine how other systems might effect the system under consideration.
3. Identify all subsystems (components which contribute to the function of the system under consideration).
4. Determine how each subsystem performs its function.
5. Devise and conduct a test which will determine if supporting systems are functioning. (This is your first set of tests.)
6. Devise and conduct a test which will determine if the entire system is functional. (This is your output test and will be a second test.)
7. If the system is not functional, devise and conduct a test which will split the system in half (or as nearly in half as possible).
8. Repeat step seven until the malfunction is isolated. Correct the problem.
9. Retest the output of the system.

*Note:* Devising the test for a system or subsystem requires an understanding of what the function of the system is; you are determining if this function is being achieved. An understanding of how the function is achieved is also important because a test will usually grow out of this knowledge.

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**Teaching Technology Assessment**

Although the evaluation of impacts of technical systems is an important philosophical consideration in technology education, it is often difficult to find the time or a method to address this point. Not only should time be made in the curriculum for work with impact evaluation, but also students should be guided during their experience by a systematic method of inquiry which stresses the development of critical thinking skills. Students should practice evaluation frequently enough to begin to synthesize these experiences into a coherent technological value system.

Wise producers and consumers of technology must be capable of the type of critical thinking necessary to see beyond shallow, short-term considerations and select the most appropriate technologies. Well thought out arguments are built in much the same way technical systems are designed. Discrete pieces of information or arguments are combined in a logical fashion which leads to a well supported conclusion. This is similar to the relationship between systems and subsystems. In fact, one way to explain analytical thinking is to consider it the ability to identify and/or create both the discrete pieces of information and the logical links between this information. Once the logical links between discrete pieces of information can

*Figure 4.* Partial computer network system diagnostic tree.

be identified, correct conclusions can be made. Critical thinking skills involve the analysis of the logic behind an argument. Eventually students should progress beyond analyzing others' arguments to producing their own. An example of such an assignment follows:

Technological Impacts of Transportation Systems

Directions: You may sign up for a topic below. Prepare a one page summary to be submitted the day of your presentation. The presentation should include a brief (5 minutes) discussion of your topic and conclude with a short class discussion. The emphasis of this assignment is on your ability to draw logical conclusions. Collecting technical information will help you draw conclusions; however, it is not the ultimate purpose here. Once you have collected the information, use it to come to a logical conclusion. You will be evaluated on how clearly the facts and your arguments support your conclusion. Present both sides of the issue, then take a stand and justify it. The discussion following your presentation should involve the controversial nature of your topic. Have two or three questions prepared to start the discussion. Include this sheet when you turn in your summary.

Evaluation: Your presentation will be evaluated on the following three criteria:

| | | Possible | Actual |
|---|---|---|---|
| A. | Organization and Presentation | 5 points | |
| B. | Content and Persuasiveness | 10 points | |
| C. | Written Report | 5 points | ______ |
| | Total | 20 points | |

Topics:

- America's bridges die of neglect.
- Transportation systems and the greenhouse effect.
- Alternative fuels and the internal combustion engine: A step forward or sideways?
- The role of the automobile in the transportation systems of the future.
- Trucking vs. rail transportation.
- The impact of the trucking industry on rail and water transportation.
- The automobile and mass transit—the bus.
- America's roadways: An investment which limits options for future transportation systems.
- The automobile, a deadly weapon.
- Drunk driving: More should be done/we are doing too much now.
- The automobile, a form of recreation: Auto racing.
- A love affair with old cars: Antique cars—are they safe?
- Automotive air pollution: Still a problem?
- Asbestos and the transportation industry.
- The impact of the automobile on our national economy.
- Marine transportation and pollution; oil spills.
- The automobile and stress.
- Seat belts and school buses.
- Only insured drivers may legally drive.
- State inspections: Necessity/annoyance.

- Other topics by approval of instructor.

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## Summary

As the field of industrial arts evolves into technology education, problem solving should take on an increasingly important role in the curriculum. Students cannot be considered "technologically literate" until they understand that technology involves making changes to our environment to solve problems or meet human needs. Equally important is that students appreciate that the solution to one problem often creates other problems and/or other benefits.

Design has long been an important part of industrial arts. However, design must be integrated in all aspects of technology education. Students will be much more likely to appreciate the important role technology plays in their lives if they have been provided with the opportunity to become designers and solve technological problems.

Unfortunately, problem solving and design are sometimes thought to be synonymous. When designs are produced, some troubleshooting will generally occur, unless the prototype works perfectly the first time. This approach, if it is the only experience with troubleshooting, neglects the fact that most people's experience with technology involves trying to solve problems created by technologies which they did not design themselves. Students should also be given the experience of locating and correcting problems in existing technological systems.

Many of the problems involved with technology go well beyond conceptualizing, creating and maintaining technological systems. They involve the fact that technological solutions almost always create some impacts which are undesirable and sometimes unforeseen. It is not enough to simply recognize that these problems exist, or even to discuss them in detail. A systematic method of identifying and dealing with these impacts must be developed. The increasingly powerful technologies of the future will almost undoubtedly create extremely dangerous impacts on society unless these technologies are carefully controlled. The way for this control to occur in a democratic society is to prepare the majority of the electorate to make wise choices about technology. This requires that today's students demand consideration of the impacts of technology when they become adults.

In order to prepare the type of technologically literate citizenry necessary to control technology, three things must occur. First, people must view technology as the way in which we change our environment to meet our needs. Second, it must be understood that when technological solutions are implemented new problems are created. Finally, identifying these impacts, both before and after a solution is identified, and balancing these impacts against the original goals of the technology must become a way of life.

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# Department Executive Officers' Administrative Roles and Responsibilities In Industry/Technology Education

William Paige and William Wolansky

There is extensive literature devoted to the roles, responsibilities, tasks, and changing expectations of departmental executive officers (DEOs) at the college or university level. Several conditions have changed regarding the roles and responsibilities of these department chairpersons or heads in the last two decades.

The role is becoming more complex because of rapid social and economic changes. The role is also becoming more diverse as departments get larger and interrelationships with other academic departments are encouraged. These increased pressures on the DEO, may be the reason there also is evidence of a higher turnover rate. With increased responsibilities, there is a need for better administrative preparation to meet the demands of current conditions. Strategic planning, assessment, staff development, resource allocations, and cost benefit analysis forecasting call for more formal preparation. The most critical concern is that there is insufficient knowledge regarding the DEOs responsibilities now and in the future to effectively prepare people for this position.

Coffin (1979) reported that department executive officers, whether designated as heads or chairs of departments, constitute the largest proportion of administrators in universities. The immediate responsibilities of the department executive officer are most critical to the welfare and efficient functioning of an academic department. Research by Wolansky (1978) made particular note of the fact that: "For the most part, the departmental exective officer is appointed principally by virtue of his/her academic achievement and intellectual standing rather than proven managerial ability" (p. 55).

There is a need to re-examine the criteria for screening and selecting DEOs who would best serve the contemporary administrative needs of a department. For example, several other criteria for screening and selecting DEOs that may be as important as academic achievement are: program development, public relations, administrative style, communication skills, leadership, and professional involvement. However, lacking empirical evidence delineating the

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critical roles and tasks of a DEO, it is equally difficult to prescribe reliable and valid criteria for the selection process. This study attempted to discover what responsibilities the current Industry/Technology Education DEOs perceived as critical to their functioning in such positions. The DEO's represented departments identified through the Industrial Teacher Education Directory which is inclusive of a diversity of industry/technology education programs.

John Bennett (1982) reported that “Serving as a department chairperson has become both more important and more difficult in recent years. Many of the factors that have given the position greater significance have also aggravated its burdens” (p. 53). Lee and VanHorn (1983) observed that the increasing sophistication and costs of academic programs coupled with inflation and decreasing government financial support, have led to a much stronger demand for greater attention to operational efficiency.

Turner (1983) and McLaughlin, Montgomery and Malpass (1975) have provided evidence that few department executive officers had any administrative experience before assuming their leadership role at the department level. When considering the nature of the role of the DEO and the ever increasing magnitude and complexity of responsibilities associated with this position, it is unfortunate that little effort is made to prepare people for the task. McKeachie (1972) observed that “even though the department chairmen are the key individuals in determining the educational success of the colleges and universities, they have remained generally ill-equipped, inadequately supported, and more to be pitied than censured” (p. 48). It is quite evident that DEOs are increasingly being faced with an enlargement of responsibilities and dwindling of resources which lead to increased job related pressures. Also, the increasing diversity of constituencies served by academic departments forces the DEO to be knowledgeable and functional in a variety of arenas. These constituencies include students and alumni, colleagues, legislators, taxpayers, and employers. The DEO must accommodate the expectations of each which calls for administrative and political astuteness. The ability to reach acceptable compromises on critical issues is paramount. Frequently, faculty and students are not aware of the pressures and expectations placed on their DEO. The position of a DEO is in a constant flux, at times requiring immediate attention to the most pressing problems. Such unexpected demands contribute to frustration and high turnover rate.

There is ample evidence of a high turnover rate among department executive officers. Heimler (1967), Falk (1979), and Jennerich (1981) suggested that the high turnover rate was, in part, due to the value-conflicts, frustrations and ambiguities of the role. Roach (1976) indicated that “...80% of administrative decisions are made at the department level” (p. 15). He also observed that even as the DEO “...shifts from a purely subject-matter specialist to a planner and developer of department programs, he still remains an instructional catalyst, resource allocator, arbitrator/human relations expert, and a partner in shaping the institutional goals and mission” (p. 15). Finding out what the critical roles and tasks of department executive officers are at a given time, may be helpful in the process of screening and selecting DEOs. However, research relating to possible future changes in administrative responsibilities of department executive officers as compared to the present is almost nonexistent. Unless administrative responsibilities of a DEO are identified, prioritized, and validated, it is unlikely that appropriate preparation will be provided. This study was conducted with the intent of creating an initial data base of the administrative responsibilities of DEOs in industry/technology education. This seems essential to enable researchers to monitor the continual evolution of the DEO's role.

## Purpose

The specific purpose of this study actually was threefold: First, to develop a profile of department executive officers of industry/technology education according to their job title as head or chair, type of department, years of administrative experience and extent of formal administrative preparation; second, to determine DEO's perceived importance of various administrative responsibilities; third, to investigate whether or not there were any significant changes taking place in the duties of department executive officers in industry/technology education. There was also an interest in examining the perceptions of relatively new DEOs as compared to those with more extensive experiences.

## Methods

The methods employed in conducting and reporting this research included: (a) the development of an instrument, (b) the identification of a study sample, and (c) a sequence of procedures for analyzing the data.

### *Instrumentation*

The instrument used in this study was developed based on the instrumentation and the results of previous studies conducted by Wolansky (1978), Price (1977), Roach (1976), and Smart (1976). These studies concluded that a department executive officer's major administrative responsibilities included: department governance, curriculum development, faculty development, student affairs, budgeting and control, quality of work life such as faculty welfare and work environment, public relations, facilities management and fund raising. These nine categories seemed most inclusive in viewing the DEOs role as an administrator in its broadest context.

Embodied within the nine categories are various skills or administrative duties such as working with committees, coping with departmental and campus politics, and building alliances. Twenty-nine tasks were identified as representative of a wide range of administrative duties and were compiled from those administrative duties identified in the literature. A listing of these 29 tasks is provided later in the text. It must be recognized that the above nine categories of administrative responsibilities and the list of 29 tasks may still not be all inclusive. For purposes of this study, no attempt was made to identify any of the 29 tasks as being specifically related to any one of the nine categories.

The questions that were selected from previous studies and the additional items in the form of questions based on the 29 tasks were combined and formatted into the final instrument. This instrument then was validated for inclusiveness of content by a jury of eight senior DEOs from major universities. Jury members were selected on the basis of their extensive experience as DEOs and their reputation as national leaders in the field.

*Population and Sample*

The population consisted of all chairs and heads of departments that offer degrees in industry/technology teacher education listed in the 1985-86 Industrial Teacher Education Directory (Dennis, 1985). The sample included a total of 104 DEOs from the eastern, mid-western, and western regions of the country. These regions were established by first designating the Mississippi Valley Industrial Teacher Education Conference membership boundaries as the midwestern region. The other two regions were composed of those states lying east or west of the Midwest region. There were a total of 35 DEOs in the east and west, and 34 in the Midwest. This stratification was done because the researchers were interested in discovering if any regional differences actually existed.

Sixty of the original 104 surveys were returned. Fifty-eight of these were found to be usable. No follow-up of nonrespondents was attempted due to the time of the academic year when the survey was distributed which was during the latter part of the Spring semester. The late mailing may have contributed to the relatively low response. Since this study was concerned primarily with DEOs having responsibility for teacher education programs, it was considered that the group would be reasonably homogeneous and therefore a small sample would be acceptable for providing necessary data for analysis. It is recognized however, that the results may have been biased by the number of nonrespondents. Therefore, caution should be exercised in interpreting the results.

*Procedures*

Instrumentation was developed as reported, the sample was drawn as described, and the instruments were mailed late in the Spring semester of 1986. The DEOs were asked to provide demographic data and to rank the nine categories of administrative responsibilities as to their relative importance. They also were asked to report the time they devoted to the nine categories and to the 29 tasks contained within and to indicate their perceptions of whether this time on task was changing. Collection, coding and analysis of data followed after the decision was made that an adequate return of the sample from each region was available. The statistical analyses included percentage distribution, rank order, ANOVA, Pearson Product Moment Correlation and The Scheffe Multiple Range procedure.

## Results

In an attempt to develop a profile of DEOs in industry/technology education, the respondents were asked to provide demographic information. Results are reported in Table 1.

**Table 1**
*Demographic Profile of Sample*

| Characteristics | N | Percentage |
|---|---|---|
| Total Years of Professional Experience | | |
| 1 to 5 years | 17 | 29.3 |
| 6 to 10 years | 15 | 25.9 |
| 11 to 15 years | 11 | 18.9 |
| 16 and over | 15 | 25.9 |
| TOTAL | 58 | 100.0 |
| Previous College Administrative Experience | | |
| Yes | 26 | 44.8 |
| No | 32 | 55.2 |
| TOTAL | 58 | 100.0 |

**Table 1 (continued)**

| | | |
|---|---|---|
| Years of Previous College Administrative Experience | | |
| None | 32 | 55.2 |
| 1 to 4 years | 15 | 25.9 |
| 5 to 9 years | 5 | 8.6 |
| 10 or more | 4 | 6.9 |
| No response to question | 2 | 3.4 |
| TOTAL | 58 | 100.0 |
| Number of Semester Credit Hours of Administrative Courses | | |
| 0 semester credit hours | 2 | 3.5 |
| 1-3 semester credit hours | 4 | 7.0 |
| 4-7 semester credit hours | 7 | 12.0 |
| 8-11 semester credit hours | 15 | 25.9 |
| 12 or more semester credit hours | 30 | 51.6 |
| TOTAL | 58 | 100 |
| Age | | |
| 0 - 29 | 0 | 0.0 |
| 30 - 34 | 9 | 15.5 |
| 35 - 39 | 8 | 13.8 |
| 40 - 44 | 17 | 29.3 |
| 45 - 49 | 18 | 31.0 |
| 50 - above | 6 | 10.4 |
| TOTAL | 58 | 100.0 |

The majority (53.4%) of DEOs had the official title of chair. When asked if they had any previous administrative experience at the college level, 32, or 55.2% indicated that they did not. Of the 26 respondents who had previous administrative experience, 24 responded to the question regarding the number of years of the previous experience. The majority with previous administrative experience (62.5%) reported having from one to four years experience. However, 13 of the 32 with no previous college administrative experience reported having had administrative experience at the secondary school level. Over half (51.6%) of the respondents reported having taken 12 or more semester credit hours of administrative courses. Nearly 60% of the respondents were between the ages of 40 and 49, while no one was under the age of 29.

The relative importance of the nine categories of administrative responsibilities was determined by having the respondents rank order the nine categories. The results are presented in Table 2. Since the mean is more widely used and better understood than other ways of designating central tendency, the authors decided to present the data in this manner rather than the median.

**Table 2**
*Mean Rankings of the Responsibility Categories*

| Responsibility Category | N | M-rank | SD |
|---|---|---|---|
| General Department Governance | 58 | 2.62 | 2.09 |
| Curriculum Development | 58 | 3.20 | 2.01 |
| Budgeting & Control | 58 | 3.62 | 2.08 |
| Faculty Development | 58 | 4.06 | 1.89 |
| Student Matters | 58 | 4.44 | 2.59 |
| Quality of Work Life | 58 | 5.31 | 2.50 |
| Public Relations Management | 58 | 5.43 | 2.66 |
| Facilties Management | 58 | 5.44 | 2.27 |
| Fund-raising Activities | 58 | 7.17 | 2.64 |

Within the nine identified administrative roles and responsibilities, the top five were (a) general departmental governance, (b) curriculum development, (c) budgeting and control, (d) faculty development, and (e) student matters.

After ranking the nine categories of administrative responsibilities as to their relative importance, the respondents were asked to indicate the amount of time they devoted to each category. The resulting mean-time distribution is summarized in Table 3. The decision was made to express the average time that a DEO devoted per week to a particular category recognizing that the time DEOs would devote to a particular category is dependent on many factors. For example, in the early and latter parts of a semester a DEO may spend considerable time with student affairs while spending almost no time in this category during the middle of a semester. Several respondents elected not to complete parts or all of this section of the questionnaire, therefore, the *n* for these data ranged from 42 to 46.

**Table 3**
*Mean Weekly Time (hours) per Responsibility Category*

| Responsibility Category | N | M (hours) | SD |
|---|---|---|---|
| General Department Governance | 44 | 9.37 | 4.86 |
| Student Matters | 43 | 7.47 | 3.84 |
| Public Relations | 43 | 7.30 | 4.73 |
| Quality of Work/Life | 44 | 6.72 | 4.19 |
| Faculty Development | 46 | 5.99 | 4.09 |
| Budgeting | 45 | 4.96 | 3.51 |
| Curriculum Development | 45 | 4.77 | 3.16 |
| Facilities Management | 42 | 3.79 | 3.06 |
| Fund-raising | 43 | 2.85 | 2.76 |
| TOTAL | | 53.22 | |

The DEOs reported spending an average of 53.22 hours per week attending to their administrative roles and responsibilities. This finding is corroborated by Coffin (1979) and Sharpe (1955). This demanding schedule implies extended hours per day, extended hours per week, or both. DEOs spent most of their time attending to five categories: (a) general department governance, (b) student matters, (c) public relations, (d) quality of work life, and (e) faculty development. As indicated in Table 3, a DEO devotes approximately 37 hours or 69% of a 53.22 hour work week to the top five categories of administrative responsibilities. These reported hours do not include the time devoted to the other nonadministrative functions such as teaching, research or service. One limitation of this study was that the researchers did not address the nonadministrative functions of DEO's.

While the DEOs are currently devoting a considerable amount of time to the above categories, they also were asked to provide their perceptions regarding spending more time, the same amount of time, or less time on these tasks in the future. The respondents reported (Table 4) that they expect to spend an increased amount of time on the following: departmental governance, curriculum development, budget and control, faculty development, and student matters. It is interesting to note that departmental governance is recognized as the most important category and governance tasks such as preparing department budgets, assigning teaching loads, and planning and conducting departmental meetings are also perceived as consuming a growing percentage of their time. This increase in time devoted to departmental governance may result from the fact that 68% of the responding DEOs administer multiprogram departments that provide preparation for teacher education, industry, vocational education, safety, etc.

**Table 4**
*Perceived Changes in Time Spent on Administrative Tasks in the Future*

| Task # | Description | N | More Time (%) | Same Time (%) | Less Time (%) |
|---|---|---|---|---|---|
| 1. | Interpreting the philosophy and goals of Ind. Ed. & Tech. | 55 | 36.4 | 45.4 | 18.2 |
| 2. | Explaining university and departmental policies to faculty and students | 56 | 45.5 | 49.0 | 3.5 |
| 3. | Stimulating and rewarding innovative ideas/efforts | 54 | 37.0 | 51.9 | 11.1 |
| 4. | Preparing departmental budgets and monitoring expenditures | 58 | 62.2 | 29.2 | 8.6 |
| 5. | Preparing specifications for new equipment and facilities | 53 | 32.0 | 34.0 | 34.0 |
| 6. | Planning, delegating & directing program activities | 55 | 41.8 | 47.3 | 10.9 |
| 7. | Seeking graduate assistantship through grants, projects/gifts | 56 | 48.2 | 41.1 | 10.7 |
| 8. | Monitoring advances in technology that positively impact curriculum innovations | 55 | 54.5 | 34.5 | 10.9 |
| 9. | Planning periodic review of curriculum offerings/programs | 54 | 44.4 | 46.3 | 9.3 |
| 10. | Assisting faculty members in solving problems relating to teaching/nonteaching tasks | 54 | 22.2 | 64.8 | 13.0 |
| 11. | Redesigning and retooling instructional equipment and physical facilities | 53 | 41.5 | 41.5 | 17.0 |

**Table 4 (continued)**

| | | | | | |
|---|---|---|---|---|---|
| 12. | Screening and admission of students with sound educational background | 53 | 26.4 | 56.6 | 17.0 |
| 13. | Keeping records on equipment and instructional supplies | 53 | 26.4 | 52.8 | 20.8 |
| 14. | Soliciting donations of teaching materials | 49 | 36.7 | 49.0 | 14.3 |
| 15. | Pursuing issues relating tenure/promotion and reappointment | 53 | 35.8 | 52.8 | 11.4 |
| 16. | Maintaining faculty and students' morale | 52 | 61.5 | 34.6 | 3.8 |
| 17. | Assisting faculty to embark on self-renewal programs | 53 | 45.3 | 45.3 | 9.4 |
| 18. | Assigning teaching and research loads to staff | 50 | 62.0 | 56.0 | 18.0 |
| 19. | Supervising classroom teaching & projects | 52 | 15.7 | 46.2 | 38.5 |
| 20. | Monitoring the performance of duties in which the teachers worked out their own schedules | 54 | 24.1 | 51.8 | 24.1 |
| 21. | Seeking affiliation of dept. to reputable associations | 53 | 37.7 | 39.6 | 22.7 |
| 22. | Organizing periodic exhibition of laboratory products | 48 | 14.6 | 41.7 | 43.7 |
| 23. | Initiating teacher production of teaching aids | 49 | 18.4 | 51.1 | 30.5 |
| 24. | Supporting/assisting students' fund-raising efforts | 44 | 6.8 | 50.0 | 43.2 |
| 25. | Striving for state, national/ international recognition of departmental programs | 53 | 43.4 | 35.8 | 20.8 |
| 26. | Planning & teaching own class; research and publications | 57 | 38.6 | 38.6 | 22.8 |
| 27. | Enlisting the cooperation of business/industrial leaders | 49 | 46.9 | 38.8 | 14.3 |

**Table 4 (continued)**

| | | | | | |
|---|---|---|---|---|---|
| 28. | Seeking trial demonstration of modern teaching equipment and latest instructional models | 47 | 29.8 | 48.9 | 21.3 |
| 29. | Planning/conducting departmental meetings; attending university administrative meetings | 57 | 71.9 | 24.6 | 3.5 |

The third purpose of this study was to investigate whether or not the DEOs perceived changes in administrative roles and responsibilities and if differences existed between regions. The independent variables for this part of the study included (a) type of department [single or multiple program], (b) years of administrative experience, and (c) number of semester credit hours of administrative courses.

While examining whether differences existed between DEOs with varying years of administrative experience and the weekly time devoted to the nine administrative categories of responsibilities, no significant difference was found at the .05 alpha probability level. Similarly, no significant regional differences were found for any of the three independent variables. When examining the data for category 3, "Public Relations," in isolation, there was a significant difference between groups based on years of professional experience. Results are shown in Tables 5 and 6.

**Table 5**
*Means and Standard Deviations for Time on Public Relations Management by Years of Professional Experience*

| Experience | N | M hours/week | SD |
|---|---|---|---|
| 1 to 5 years | 13 | 7.85 | 4.62 |
| 6 to 10 years | 10 | 5.37 | 3.53 |
| 11 to 15 years | 8 | 11.44 | 5.34 |
| 16 or more years | 12 | 5.58 | 3.80 |

**Table 6**
*Analysis of Variance of Time/Week on Public Relations Management by Years of Professional Experience*

| Source | df | Mean Squares | F | F-prob |
|---|---|---|---|---|
| Between/Within groups | 3 | 71.1464 | 3.8197* | 0.017 |
| Within groups | 39 | 18.6264 | | |

*p < .01.

The Scheffe Multiple Range test revealed that DEOs with 11 to 15 years of professional experience tended to spend significantly more time in public relations than DEOs with 1 to 5 years, 6 to 10 years, or 16 or more years.

A closer examination of administrative perceptions regarding specific tasks was also conducted in relation to the three independent variables. Using a single classification analysis of variance procedure, the analysis for task #7—seeking additional sources of funding (e.g., graduate assistantships through grants/projects, or gifts from friends and alumni of the department) was found to be significant as reported in Tables 7 and 8.

**Table 7**
*Means and Standard Deviations of Perceived Changes in Task 7 (Seeking Additional Sources of Funding) for Years of Professional Experience*

| Groups | N | M Perceived Changes | SD |
|---|---|---|---|
| 1 to 5 years | 17 | 3.56 | 0.51 |
| 6 to 10 years | 15 | 3.71 | 0.61 |
| 11 to 15 years | 11 | 3.00 | 0.45 |
| 16 or more years | 15 | 3.13 | 0.83 |

**Table 8**
*Analysis of Variance of Perceived Changes in Task 7 by Years of Professional Experience*

| Source | df | Mean Squares | F | F-prob |
|---|---|---|---|---|
| Between/Within groups | 3 | 1.53 | 3.88 | 0.014* |
| Within groups | 53 | 0.39 | | |

*p < .01.

Results of this analysis showed that there were significant perceived differences between classifications of DEOs by length of professional experience regarding this relative time change devoted to task #7. Further analysis using the Scheffe Multiple Range procedure, revealed that DEOs with 11 to 15 years of professional experience tended to perceive this relative change in this administrative task differently from other groups. It also was found that there was a statistically significant relationship between years of administrative experience and rating of the public relations duty as portrayed in Table 9.

**Table 9**
*Pearson Correlation Coefficients for Broad Administrative Responsibilities by Years of Experience*

| Independent Variable | General Admin. | Budgeting & Control | Curriculum Development | Public Relations |
|---|---|---|---|---|
| Years of Experience | 0.165<br>(n=58)<br>p=0.21 | -0.086<br>(n=58)<br>p=0.52 | 0.097<br>(n=58)<br>p=0.46 | 0.296<br>(n=58)<br>p=0.02* |

*p < .05.

**Table 10**
*Pearson Correlation Coefficients for Broad Administrative Responsibilities by Administrative Coursework*

| Independent Variable | Faculty Develop. | Budgeting & Control | Curriculum Development | Public Relations |
|---|---|---|---|---|
| Formal Admin. Coursework | 0.32 (n=57) p=0.018* | 0.148 (n=57) p=0.27 | 0.146 (n=57) p=0.28 | 0.066 (n=57) p=0.63 |

*p < .05.

Analysis of the data using Pearson Product-Moment Correlation reported in Table 10, regarding the relationship between formal administrative coursework completed by the study sample and the broad categories of administrative responsibilities, revealed a statistically significant relationship between the amount of formal administrative coursework taken by the study sample and the ranking of the category of faculty development. It was apparent that the DEOs with the more coursework in educational administration ranked the category of faculty development as a higher priority than those with less coursework. This implies that administrators with more extensive formal preparation also tend to encourage the professional development of their faculty members.

Analysis of the data categorized by the three regions yielded no significant differences. The nine categories containing the 29 tasks were perceived similarly by the DEOs regardless of region. The time devoted to each task by the DEOs also was found to be no different from one region to another.

## Discussion and Implications

While extensive analysis of data was performed, only those results where significant differences were found or pertinent interpretations could be made are reported in this article.

It was most evident that the DEOs surveyed perceive their primary responsibility to be that of providing leadership not only in the governance duties but also in the process of curriculum development and innovation. Considering the current economic constraints under which many industry/technology education departments are working, it's understandable that the DEOs ranked “budget and control” as third most important on the list of responsibilities.

The analysis of data yielded few differences between groups of respondents with the exception of the group with 11 to 15 years of professional experience. The members of this particular group essentially were more concerned with the image or public relation aspects of their departments. It may be that this group is still highly motivated and views public relations as more vital to the sustained support for numerous aspects of their departments than the three other experience groups. This particular experience group also appeared to be the most supportive of their faculty.

Observing that the largest percentage of the sample had from 1 to 4 years of administrative experience and were between the ages of 45 and 49 years, implies that there is a substantial turnover in DEOs. This finding is confirmed by the research by Heimler (1967) and Jennerich (1981) and also may be attributed to the fact that the majority of the DEOs are appointed as chairs for a term of five or fewer years, making it more likely that some would not wish to serve a second term.

Among the most encouraging findings was that 51.6% of the respondents reported having taken 12 or more semester credits of administrative courses. This study did not attempt to identify the specific administrative courses that currently are being provided, however, the results of this study suggest a need exists for more administrative coursework directed toward departmental governance, budget and control, and faculty development. Such additional preparation may take on a variety of forms. The needs of the administration in a particular region may best serve as the immediate basis for additional study.

There was a discrepancy regarding the relative importance of some of the nine categories of administrative responsibilities listed in Table 2, and the amount of time devoted to these responsibilities listed in Table 3. While a particular category may be ranked as important in terms of a DEO's responsibility, the time devoted to that specific category may or may not be consistent. For example, the DEOs ranked curriculum development second in importance, but devoted only 4.77 hours/week to this category which ranked seventh in terms of time devoted to this role. There was agreement, however, on the importance and the time devoted to the category of governance. This finding is in keeping with Lee and VanHorn (1983) who observed that the increasing sophistication and costs of academic programs, coupled with inflation and decreasing government financial support, have led to a much stronger demand for greater attention to operational efficiency.

After reviewing the related literature and examining the results of this survey, the authors are convinced that limited insights and a lack of consensus about the administrative roles and responsibilities of DEOs of industry/technology education still exists. This view is shared by Edmunds (1987). He suggested that “More indepth studies need to be undertaken to determine the types of changes that have and are taking place. Additional research efforts might include identifying (a) the characteristics of successful leaders, (b) the external and internal influences upon the role of the administrator, (c) the current channels used to become a departmental leader, (d) the relationship between job satisfaction and future leadership development, and (e) the differences, if any, between leadership training for industrial teacher education administrators and that of other educational area leaders. DEOs represent both sets of interests—teaching and administration.” While the authors agree with Edmunds' views, it is most important to realize that if the DEO is to lead and influence others, the motivation must come from the commitment to the discipline itself.

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# *Research Digest*

## CTTE/ITEA NCATE

A. Emerson Wiens

The technology teacher education profession has entered a new era not only because of the switch to technology as the knowledge base, but also because of the adoption of the CTTE/ITEA Guidelines by NCATE as the official standards against which all technology teacher education programs seeking NCATE approval will be evaluated. Although the Guidelines are presumed to have a positive influence in shaping these programs, one recognizes that other factors and other groups have, perhaps, an even stronger shaping influence. These would include internal administration and faculty, other accrediting associations such as NAIT, public school teacher demand, and last, but not least, the state certification requirements and entitlement program. The question being addressed by this study is: To what extent are state plans and certification requirements complementing the CTTE/ITEA Guidelines, and to what extent are the states causing deviation from the Guidelines?

In consideration of the impact that the state has on teacher education programs, a survey instrument was sent to the 50 state supervisors of technology/industrial technology/industrial arts education in September, 1989. Information was sought regarding (1) the state plan name, (2) curriculum design, (3) the degree to which the state schools have adopted the state plan organizers, and (4) state requirements regarding two technology related academic content areas that are included in the CTTE/ITEA Guidelines. Thirty usable responses were received for a 60 percent return.

Figure 1 lists the various names used by the states. Five states still use Industrial Arts in the title while ten states (32 percent) use the ITEA/CTTE preferred term "Technology Education." The name chosen by the largest number of states is "Industrial Technology."

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*Figure 1.* Name of program (n=30).

The organizers used in designing the curricula in the responding states as identified in Figure 2, show a dominant technology education bias with considerable variation. Only one state still uses the more traditional industrial arts subject matter designators exclusively, while three others use these in addition to some set of technology organizers. But only 40 percent use the ITEA/CTTE preferred list of four organizers. Teacher preparation programs in all of the other states, if they complied with the state organizers, would be expected to explain their deviation, however slight (which most are), from the ITEA/CTTE Guidelines. Perhaps the most interesting set of organizers reported in this study is being developed by Arizona. In addition to transportation and communication are categories such as “mechanisms, controls, structures, etc.”

*Figure 2.* Organizers used by states (n=30).

In response to the question regarding the date of the organizer change, 23 of the 30 respondents—a significant majority—stated that their states had changed since 1980 with the dates indicated in Figure 3. Nearly 75 percent (17 of 23) had undergone the change since 1985. This is perhaps the greatest amount of change in the shortest period of time in the history of state supervision of industrial arts/technology education.

*Figure 3.* Year organizers were changed (n=22).

With this much change in the last five years at the state level, one would expect the public schools to be lagging. The cold reality is that the market still dictates which teachers get jobs, i.e., those prepared to teach more traditional programs or those prepared to teach technology education. In an attempt to determine the degree to which the public schools are in step with their respective state curricula, the respondents were asked how many schools in their states complied with the new organizers. Those responses, shown in Figure 4, ranged from 25 percent to 100 percent. Several supervisors responded somewhat cynically with, “Depends on whom you ask,” “Who knows?” and, “Saying it doesn't make it happen.”

Finally, an attempt was made to ascertain the degree to which states were requiring prospective teachers to take coursework in global studies and the socio/environmental impact of technology. The ITEA/CTTE Guidelines call for content in both of these areas in the competencies section. As shown in Figure 5, over half (15 of 26) of the respondents to this question require neither area while only 3 require both. Socio/environmental impacts studies were more likely to be required (35 percent - Figure 6) than were global studies (15 percent - Figure 7).

*Figure 4.* Percent of schools following new organizers (n=22).

*Figure 5.* States requiring related coursework in international/global dimensions and social/environmental impacts (n=24).

These data clearly show that the ITEA/CTTE NCATE Guidelines are not fully supported by state certification requirements although considerable progress has been made in the last five years. The ITEA/CTTE Guidelines themselves were developed in the last five years, but by a more homogeneous group of educators than is represented by the state supervisors and the state programs. How are NCATE folio reviewers to respond to such variations among states? Certainly, in many academic areas the state does not dictate the teacher preparation program. For example, just because the state does not require international/global studies and socio/environmental impacts as part of the certification requirements, does not prevent a teacher preparation program in that state from requiring them unilaterally. On the other hand, for an institution to serve the state and the schools within that state, the program must include the state-approved organizers in order to certify students.

*Figure 6.* States requiring a course on socio/environmental impacts of technology.

*Figure 7.* States requiring a course on international/global dimensions of technology.

Our discipline is currently in a state of flux, although by far the majority of movement is in one direction: technology education with the four organizers - communication, transportation, construction, and manufacturing. States have been slower to recognize the need for course work in the international/global dimensions and impacts of technology. Considering the relative status of state plans and the necessity for teacher education programs to comply with state requirements, the rigid application of CTTE/ITEA Guidelines by the folio reader/evaluators may be three to five years premature. ˚

# *Book Reviews*

**Naisbitt, J., & Aburdene, P. (1990).** ***Megatrends 2000: Ten new directions for the 1990's*****. New York: William Morrow and Company, Inc., $21.95 (hardcover), 384 pp. (ISBN 0-688-07224-0)**

Reviewed by Daniel A. Levy

John Naisbitt & Patricia Aburdene offer prophecies regarding the nature of contemporary society in *Megatrends 2000: Ten New Directions for the 1990's*. Naisbitt and Aburdene are well known for their earlier work, *Megatrends*, in which they accurately described trends of the 1980s. Many are taking a close look at *Megatrends 2000*; as of July 1990, it had been on the *New York Times* Best Sellers list for twenty-five weeks. In addition to the book's broad appeal, educators in technology education may find it helps clarify important directions for the field.

It may be foolhardy to predict the impact of events across a ten year period, but Naisbitt and Aburdene are looking at trends which are already occurring. They do not dwell on negatives. In their introduction, they credit those who report on crime, drugs, AIDS, deficits, and other crises as doing their jobs. Doomsayers will be let down; the authors do not see the world coming to an end. Their mission, as they see it, is to "point out information and circumstances that describe the world trends leading to opportunities." They may be proven wrong in their overly positive view, but they have provided a context within which to view world events. They suggest that without such a frame of reference we tend to miss much information.

If you fear you may already be missing out on a major trend, I will not keep you in suspense. The ten trends, listed by chapter titles, are The Global Economic Boom of the 1990's, Renaissance in the Arts, The Emergence of Free-Market Socialism, Global Lifestyles and Cultural Nationalism, The Privatization of the Welfare State, The Rise of the Pacific Rim, The 1990's: Decade of Women in Leadership, The Age of Biology, Religious Revival of the Third Millenium, and Triumph of the Individual. These chapters are the body of the book, surrounded by introductory and concluding chapters, extensive endnotes, and an index.

The first chapter, "The Global Economic Boom...," describes, in part, the information economy, its creation of high-paying, challenging jobs, and the lack of enough adequately trained workers in the U.S. to fill those jobs. According

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to Naisbitt and Aburdene, “There are not nearly enough people with college degrees or advanced vocational and technical training to fill the more than 2 million new managerial, administrative, and technical jobs coming on-line annually.” If our mission in education is not yet clear, consider also their emphasis on retraining: we must upgrade the skills of 120 million people in the U.S. work force today.

The importance of education is emphasized again in the chapter on the rise of the Pacific Rim, when Naisbitt and Aburdene emphasize the positive correlation between improvement in education and global competitiveness. Other trends are equally important in technology education, including management and leadership trends, and new roles for women. *Megatrends 2000* emphasizes the impact of the arts in the 90s, including a greater job growth rate than other professions. It will become increasingly important for all undergraduates, and especially students in technical fields, to increase their study of the arts, humanities, and social sciences. Starting during the 1990s, Naisbitt and Aburdene claim, the arts will replace sports as our dominant leisure activity. Perhaps we have buried the last vestige of “art” in our field at a time when society's needs have come full circle.

Anyone reading *Megatrends 2000* is likely to come away with a clearer, and no doubt more positive view of world events. Although the authors back their general assertions with specific cases, you may be aware of studies which reach different conclusions. You may also see other trends which transcend those selected by the authors. The important point, according to Naisbitt and Aburdene, “is to craft your own world view, your own personal set of megatrends.” °

**Marcus, A. I., & Segal, H. P. (1989). *Technology in America: A brief history.* San Diego: Harcourt Brace Jovanovich, $10, 380 pp. (ISBN 0-15-589762-4)**

Reviewed by John R. Pannabecker

This book on the development of technology in America by Alan I. Marcus and Howard P. Segal should be of special interest to those who teach technology education and its educational heritage, the history of technology, and the history of industrial education. The organizational approach of the authors is conventional by intent, based on the identification of "specific, dominant cultural notions and social themes for different eras in the American past" (p. iv), such as colonial manufacturing America or the development of America as a social unit from the 1830s to 1870s. The authors affirm the importance of the history of technical and organizational aspects but they concentrate on the "impact of American society and culture on technology, rather than vice versa" (p. iv).

The book is organized into three major parts: (a) From the Old World to the New: 1607 to the 1870s; (b) Systematizing America: The 1870s to the 1920s; and (c) From Industrial America to Postindustrial America: The 1920s to the Present. Each part is approximately the same length, however, the first part covers a relatively long time period. This compression of such a long period is unfortunate, but is consistent with the authors' intent to emphasize the years after 1830.

In the first part, a variety of topics are covered such as mills, master-apprentice system, arms manufacture, printing, textile production, transportation systems, photography, and agricultural change. This book is, however, more than a simple account of technological themes. The emphasis on American social patterns is especially evident when the authors show how certain technologies developed differently in America than in Europe, for example, road design and construction (p. 58), rail transportation (p. 68), and factory design (p. 107). The influence of major ideological or social aspects such as mercantilism, colonial governance, the Constitution, and Jeffersonian and Hamiltonian perspectives are interwoven into the analysis without being over-emphasized.

The second part (1870s-1920s) is the most detailed period of American history covered in the book. This part corresponds closely to the period covered

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by Charles Bennett (1937) in his second volume on the history of industrial education and thus may be especially useful to teachers of professional courses in technology education. The authors concentrate on technological systems, not only in the physical sense but also as a conceptual framework. The Centennial Exhibition of 1876 in Philadelphia serves as a symbol for the developing concept of systems. The notion of systems is further illustrated through traditional themes such as electrification, communications, and factory organization.

It is in the first chapter of this second part that Marcus and Segal mention the Russian System of tool instruction and its introduction to America (p. 170). It is only later in the second part (chapter six) that the development of industrial education is discussed, and then primarily from a vocational perspective and in the context of systematizing factory work. The teaching of technology (e.g., through industrial arts) for the purposes of general education is overlooked. The authors are to be commended for having included educational aspects, but the coverage is heavily oriented to engineering education and organizations and thus does not reflect a very broad view of technologists in general.

The breadth of themes covered in this second section would, however, compensate for the scant attention to the heritage of technology education if the book is being used as a supplementary text. Topics range from the changing urban environment and leisure technology (sports, bicycles, automobiles, and motion pictures) to domestic technology and military technology. Domestic technology, for example, is treated as part of the systematizing of workers and the workplace and includes women and their work. The systematizing of spectator sports and the production and marketing of sporting goods are interpreted in the context of the rise of the middle class. Marcus and Segal conclude the second part with a summary of the period's static and hierarchical notion of systems.

The final part of the book consists of two chapters: the period from the 1920s to the 1950s when technology was generally perceived as a social solution and, in contrast, the period from the 1950s to the present when technology has usually been viewed as a social question. Part three begins with the emergence of a new concept of systems for which the Hawthorne experiments serve as the initial illustration. This new notion of systems is characterized by complex interrelationships, flexibility, and integration and is illustrated by such topics as the government and social engineering (Hoover and national planning; Roosevelt and the New Deal), revitalizing rural America, production techniques, new marketing and delivery technologies, mid-century high tech (computers; transistors), and military technology.

In the 1950s, criticism of technology, professionalism, and expertise increased as Americans acknowledged both the positive and negative aspects of technology. Chapter topics are varied but tend to focus on high-profile technologies that have often been the center of social controversy such as nuclear power, space flight, high-tech electronics, agriculture, and biotechnology. Divergent perspectives reinforce the authors' emphasis on how technology reflects dominant social patterns.

The book ends with a concise summary of the authors' philosophical perspective including a critique of technological determinism in which technology is viewed as a cause or a solution for social problems. Technological determinism "reduces society and culture to objects upon which technology acts" (p. 359). In contrast, the authors emphasize that technology has been a "manifestation or reflection of cultural and social perceptions; it is a human product" (p. 360).

Certain aspects of the book are, however, inadequately covered or integrated into the text. Visual illustrations are few in number and do not illustrate either the complexity of technology or its relationship to society and culture. The authors' attempt to contrast systems in the second and third parts is not as convincing as it might have been, for example, through the use of illustrations, schematics, or line drawings in the discussion of specific technologies. The interaction of non-Caucasian groups in the development of the social and cultural fabric of America is virtually absent.

In a survey text, it is difficult to communicate the complex nature of decision-making and the uniqueness of patterns of technological development. Although the authors contrast the American experience with that of Europe in the first few chapters, the distinguishing features of the American experience are less clear in later chapters. This lack of continuity is disappointing, especially when some major systems such as contemporary nuclear power generation and public rail transportation in America and Europe could have served as contrasting reflections of differing social patterns. Despite these shortcomings, this book should be considered seriously as a supplementary text in professional courses and main text in other courses where the history of technology is a central part of the course. The book's conventional organization and thematic approach coupled with its emphasis on social and cultural patterns make it very accessible as a beginning text. Not only will the text help technology educators to reinterpret the development of their field, it will stimulate them to reflect on how they perceive technology, communities of technologists, and their part in the American experience.

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# *Editorials*

## Why I Didn't Respond to Your Questionnaire

John V. Gallagher

One role I must play, as a scholar, is to actively participate in the research activities of other technology educators. Generally, this means responding to research questionnaires to which I feel qualified to contribute. Either I will complete the research instrument, or, if the content is out of my area of competence, return it with a note stating the reason for not completing it.

However, your questionnaire falls into neither of the above categories. It contains a number of serious defects which threaten its reliability, validity, and generalizability. This places me in the dilemma of whether to spend time responding to a clearly defective survey instrument. I didn't respond to yours for one or more of the following reasons. I'm sorry.

*Reason 1. You failed to review the literature and available data bases.* You are asking for information on technology education that is readily available or published recently.

*Discussion:* A researcher owes the respondent the courtesy of using a systematic process of research to obtain information to answer the research questions/hypotheses. The use of data collection instruments should be the last resort to obtain information because it is unavailable elsewhere.

*Reason 2. You failed to field test your data collection instrument and revise it.* Your instrument has vague instructions. Your terms are not defined. I started to respond but became frustrated because the lack of internal consistency and mutual exclusivity of the variables confused me. You sent me an instrument which has a sloppy format, confusing page layout, misspelled words, incorrect grammar, etc. You didn't tell me what the limits of the study are so I feel that I will never finish your instrument.

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*Discussion:* How can a respondent give reliable and valid information on an instrument with these and other defects? Too often, the researcher skips the step of conducting a field test. A multiple step field test and revision cycle will eliminate most defects in the survey instrument. The researcher should conduct a final field test with a small sample of members of the population to be surveyed, make corrections, and only then send the final version of the instrument.

*Reason 3. You timed your data collection effort poorly.* I received your instrument three days after the date you wanted me to respond so my input cannot be included in your research. Or, you gave me only a week to respond and your instrument arrived during my midterm grading week or at the end of the semester when I was grading term papers and final examinations. Or, your instrument arrived during winter break (or summer vacation) when I was away and the due date passed before I returned.

*Discussion:* Make it convenient for the respondent. Give the respondent sufficient time to complete the instrument. Make allowances for delayed mail, holidays, conventions, or academic year events when your respondents are from the academic community. Print follow-up copies of the instrument well in advance so they may be mailed to non-respondents weeks before the return date. Budget your study so you can use *first class mail* for all data collection activities both *to* and *from* the respondents.

*Reason 4. You failed to honestly identify yourself.* Who are you and why should I spend my valuable time to give you information?

*Discussion:* Researchers in technology education need to identify their sponsoring organization and the function they perform in the organization. If the sponsoring organization is generally unknown to technology education respondents, then a paragraph explaining its roles and purposes is needed. Graduate students conducting technology education thesis or dissertation research should identify their status in the cover letter accompanying the instrument. Graduate advisors should add a signed statement to the cover letter stating that the instrument is part of an approved thesis or dissertation, that the advisor reviewed and approved the instrument, and that he or she requests respondent cooperation. A copy machine facsimile of the advisor's signature is appropriate but the researcher should personally sign each cover letter.

*Reason 5. You failed to justify the research.* Your assertion that the research will make “a valuable contribution to technology education” doesn't motivate me to spend my valuable time responding.

*Discussion:* In the cover letter, provide a purpose statement and a statement of need briefly describing how the research findings will fill a gap in the body of knowledge of technology education. Describe how the researcher, the respondent, or others can use the research results.

*Reason 6. You didn't promise me an abstract of the results if I request it.* What am I going to get out of my time spent responding?

*Discussion:* Provide the respondent with a place to check on the instrument to request an abstract of the results of the research or a separate postcard to request an abstract if respondent confidentiality is necessary. The respondent spends time reflecting on the items of the data collection instrument. The respondent needs to grow from the research and often wonders how he or she contributed to the results. An abstract will allow the respondent to compare the results with his or her own views and learn from the research.

*Reason 7. You failed to say please and thank you.*

*Discussion:* Researchers sometimes get so involved with their research procedure that they fail to attend to common courtesies. Make your thank you active in voice, personal, in the first and second person, direct, and brief.

## Summary

Experienced survey researchers will find nothing new here, yet we continue to receive poorly designed and conducted surveys in the mail. This threatens the integrity of our discipline, because this causes us to wonder whether survey research data is valid and reliable. Poor instrument design also leads to low instrument returns, further threatening the generalizability of the findings.

Technology educators conducting mailed surveys face a difficult challenge in obtaining a representative response rate. The request to complete an instrument imposes upon the valuable time of the respondent. The past history of poorly designed research instruments places a negative bias on the process. I cannot emphasize enough the importance of screening a prototype research instrument through a multiple-cycle field test and revision process to eliminate threats to validity and reliability and to make the instrument “respondent friendly.” ˚

# "Doing" Craft

Richard D. Lakes

Technology educators have distanced themselves from industrial arts practitioners with fashionable messages that deny the usefulness of a handicrafts-based curriculum in today's push for technological literacy. At this time in the evolution of the field, it may be useful to briefly discuss the assumptions that once fashioned an alliance between industrial education and handicraft labor. Students might derive a greater understanding of the importance of this connection in project assignments which use the handtools of our artisan heritage, a pedagogical process called "doing" craft.

The idea of "doing" craft may simply suggest that execution is more important than expression. For example, Clyde Jones, a North Carolinian folk artist, litters his front lawn with assorted animals he creates from logs. This yard artist, unschooled in the practices of fine woodworking, uses a chainsaw to shape the figures he crafts. Jones, like others who engage in whittling, for instance, view the outcome of their work as subordinate to the immediate pleasures they gain from creation (Condon, 1990). It is not just therapy to forget your pending economic or social difficulties, and seek emotional release in the manipulation of tools and materials. Rather, craftsmanship offers a unification of art and labor. Lewis Mumford (1952) eloquently describes the aesthetic process in handicrafts when he writes:

> He [craftsman] took his own time about his work, he obeyed the rhythms of his own body, resting when he was tired, reflecting and planning as he went along, lingering over the parts that interested him most, so that, though his work proceeded slowly, the time that he spent on it was truly life time. The craftsman, like the artist, lived in his work, for his work, by his work; and the effect of art was merely to heighten and intensify these natural organic processes—not to serve as mere compensation or escape (p. 62).

Craft labor, therefore, is an art form relying upon the intuitive and tactile senses, or personal knowledge, as Michael Polanyi (1958) has noted, of its practitioners. The craft labor of the family of instrument makers in Cremona, Italy, for example, contributed to shop fabrication practices that are unknown today because machine-designed replication of Stradivarius's violins and the

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chemical analysis of his varnishes fail to uncover the mysteries of this master instrument maker. The highest level of artistic development among skilled crafts workers is connoisseurship, Polyani has suggested, and connoisseurship does not require scientific prescription (or technological innovation) in order for practitioners to successfully engage in their work. “Rules of art can be useful,” Polanyi (1958) has written, “but they do not determine the practice of an art; they are maxims, which can serve as a guide to an art only if they can be integrated into the practical knowledge of the art” (p. 50).

The work processes of medieval master masons are a case in point. With limited geometric knowledge to guide them, skilled masons with just hammer and chisel were able to hew stones to exacting proportions (as well as design intricate stone tracery). How did they do it? Unschooled in Euclidean principles and stereotomic computations, the cathedral builders had a series of primitive construction aids to help them: steel square, wooden template, and string lines. Still, gothic construction was quite detailed, and these remarkably talented men, unable to understand the underlying mathematical principles of vault construction, nevertheless managed to erect their memorials to God (Shelby, 1972).

Artisans in general may follow some scientific rules but more often rely upon their personal knowledge to ensure accuracy in “doing” craft. The ability to “hear” one's trade, for instance, helps a carpenter gauge when nails are driven tightly into wood. A plasterer's trowel “chatters” when the material is workable to a smooth surface. The wheelwright listens for a sound when applying hot iron to the cold wheel: a “pop” says that the cooled tire has contracted firmly onto the wooden rim and the spokes have drawn up tightly in their felloes. There are no rules of science here; craft knowledge is developed from long-standing practices — the folk tradition. “Reasoned science for us did not exist” (p. 19), wrote George Sturt in The Wheelwright's Shop (1923), an autobiography of his craft business in rural England. He continues:

> A good wheelwright knew by art but not by reasoning the proportion to keep between spokes and felloes; and so too a good smith knew how tight a two-and-a-half inch tyre should be made for a five-foot wheel and how tight for a four-foot, and so on. He felt it, in his bones. It was a perception with him. But there was no science in it; no reasoning. Every detail stood by itself, and had to be learnt either by trial and error or by tradition (p. 20).

Still, the time came when Sturt began to realize that modern production methods were cheaper and, for economical reasons, would displace traditional methods of workmanship in his shop. Machine-manufactured spokes, for instance, were readily available; hence, Sturt purchased them for his shop instead of having his men hand-hew spokes from aged hardwood stock. And the installation of gas-driven woodworking machinery in 1889 was, for him, a much needed measure of cost efficiency. Yet Sturt knew that he too was responsible for ushering out the age of craft:

> And from the first day the machines began running, the use of axes and adzes disappeared from the well-known place, the saws and saw-pit became obsolete. We forgot what chips were like. There, in that one little spot, the ancient provincial life of England was put into a back seat (p. 201).

What can technology educators gain from presenting their students with "doing" craft? Because craft labor is rooted in the work culture of artisanship, the mutuality of shop labor, and the social organization of work (apprentice-journeyman-master relationships), the technology education laboratory gives students an opportunity to develop reciprocal exchanges of knowledge, allied decision making, and voluntary organization of tasks and duties. Practical application should be accompanied by readings in labor history, labor laws, collective bargaining, labor-management relations, labor union activities and membership, the union label, occupational safety, industrial democracy—all are based upon collective histories of tradesworkers negotiations on the shop floor. Students may need to be reminded that the practice of job seniority, for instance, was established through craft tradition: the most valued jobs went to the journeymen who were employed in the master's workshop; apprentices were expected to run errands, deliver goods, and perform custodial duties for as long as one year into their indentures before they would ever be allowed to use a handtool.

Technology education students may benefit from "doing" craft because the activity itself may stimulate a political philosophy of labor alliance and industrial protest. By virtue of its handicraft basis, students engaged in craft labor may begin to acknowledge the debilitating effects of machine technology, and seek solutions to the degradation of industrial work on the shop floor. Craft labor may be an "aesthetic - in - opposition," a term that Peter Dormer (1988) used to distinguish handicraft production from industrial technology. For example, the lining of a nuclear reactor and a reed basket are both beautiful, he suggests, but the reactor's beauty "is chilling" because it "tampers with nature," whereas the basket is organic, "in harmony with nature" (p. 135). Yet handicraft production also reinforces personal relationships between crafts workers and customers, and distinguishes itself from the impersonality of mass consumption of factory-manufactured goods: "With a single piece of furniture made by a man or a woman in a craft studio in Pennsylvania, there was the suggestion of a personal relationship between maker and user, but with a car mass-produced in Detroit there was not" (Dormer, 1988, p. 139).

Technology education students may develop a craft ethic that places greater emphasis upon the importance of customer relations in today's service economy. This ethic, derivative of the master's social relations with his purchasing public, once set a high priority upon skillful execution of the work, dignity of labor, honesty of techniques, and integrity in choice of materials to be used. Perhaps "doing" craft will help students reclaim the artisan legacy: personal service and quality workmanship go hand-in-hand.

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# *Miscellany*

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