The Development of Technology Education in the United States

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'A review of the history of hand skill development, manual training, manual arts, industrial arts and now the challenge of technology indicates that change occurs and is most logical and appropriate in times of ferment. Education today is in ferment and changes are being made. It is most critical that the technology education profession draws on its rich history and wealth of curriculum materials to establish a program that can explore, explain and use modern technology'[1]

'...we recommend that all students study technology: ...how science and technology have been joined, and the ethical and social issues technology has raised... . We are frankly disappointed that none of the schools we visited required a study of technology. More disturbing still is the current inclination to equate technology with computers... 'The greater urgency is not computer literacy but technology literacy' the need for students to see how society is being reshaped by our inventions, just as tools of earlier eras changed the course of history. The challenge is not learning how to use the latest piece of hardware but asking when and why it should be used'.[2]

'After the contents and the outcomes of a technology education program have been studied, a structure of what the program will look like must be designed. This should include course titles, units and competencies.'[3]

These statements typify the determined and enthusiastic efforts behind an informed Technology Education movement in the United States.

I have recently returned from an extended professional working visit to the United States and during this time I lectured and studied on developing technology education programmes for teacher training in universities and schools and witnessed interesting and exciting initiatives. There are quite extraordinary similarities between Technology Education subject development at all levels of the education establishment in the United States which parallel experiences in England and Wales. A commonly held view purports a ten year gap between the exciting initiatives and centres of excellent in the UK and those in the United States. However, although current debate mirrors experiences in England and Wales the starting points, traditions, philosophy and methods are different.

During the last eighty years the United States has progressed from an economy based on agriculture, through an industrial age to a society based increasingly on communication, information technology and service industries. The United States is no longer competitive in traditional heavy industry and faces extensive competition from other nations in developing technologies as well as nursing a continuing trade deficit.

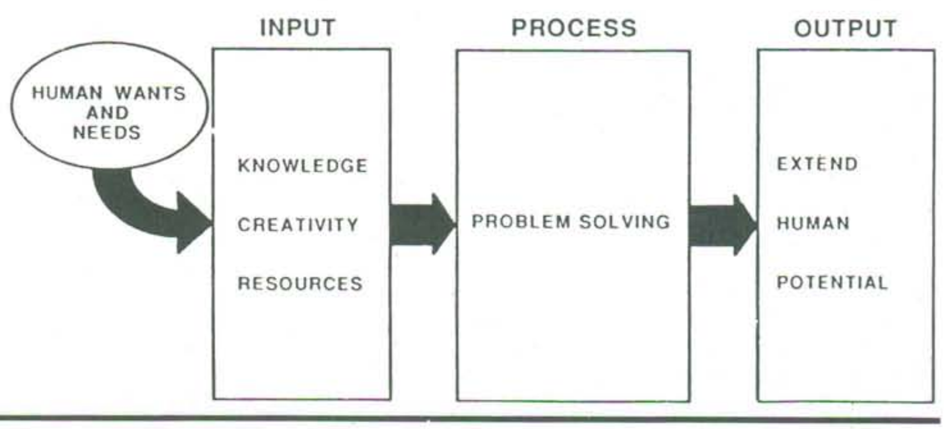
For those with a vague knowledge of developments in the United States paralleling Craft, Design and Technology I briefly document some of the events.

During the latter part of the 1800's organised systems for teaching hand skills developed and generally constituted a programme of manual or shop training and part of the general education of all youth. Manual training in high schools, often bearing names such as technical, polytechnic and mechanic arts was established predominantly in east coast states and 'shop work' became an established subject area for the high school curriculum by 1900. From time to time new dimensions were added to drafting, patternmaking, machine shop, foundry and woodwork etc. in order to keep abreast of the changing face of manufacturing industry. The Russian system of skill training, the English arts and crafts movement and the Sloyd Movement all influenced the approach to the teaching of hand skills and activity programmes in education.

Manual arts traditions grew from Sloyd; trade and industrial vocational education grew from more rigid approaches to the acquisition of manipulative skills. John Dewey placed the study of industry and the social implications of industrial culture as central to the educational process and declared it to be simply a matter of time before the prevocational industrial arts movement developed on several fronts in schools and towards the 1920's and as a result of legislation, trade and industrial vocational education emerged as a major education programme.

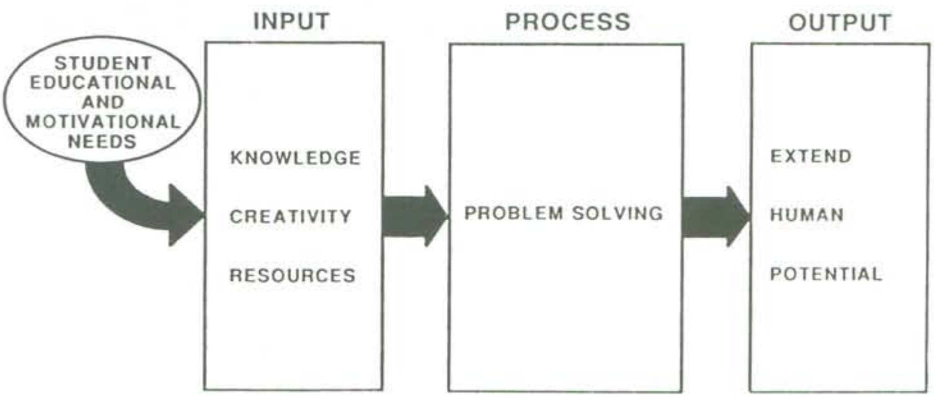
A growing dichotomy between 'prevocational' and 'general' education during the 1930's prevented a clear mandate concerning common objectives and terminology to describe programmes, activities and shop organisation. Several attempts were made to unify the profession including the formation of the American Industrial Arts Association and the American Vocational Association. The post was years brought new efforts in curriculum study and recommendations and presentations at conference in true

Figure 1 **A Model of Technology**



American tradition. A *Curriculum to Reflect Technology*[4] introduced five areas of study which clearly influence current high school teaching programmes. These were communication, construction, power, transportation and manufacturing. Gorden Wilber[5] offered a fresh perspective on the style of Industrial Arts adopted in teacher education programmes and advanced a broadening of the industrial arts concepts to include mass production, product design and manufacture, business structures and marketing education.

Figure 2 **A Model of Technology Education**



Contemporary study of developments in this subject area must include some consideration for the work of Professor Donald Maley of the University of Maryland. His initial proposals in the 1960's provided a bench mark by which others were to measure their successes. Professor Maley is an advocate of pupil activities organised as principles of investigation, exploration, analysis, testing and the use of tools and materials to solve problems[6]. A wealth of curriculum and instructional materials, research projects and programme activities were forthcoming resulting in further curriculum developments in various parts of the country notably, New York, Maryland, Illinois, Ohio and in Virginia. Inevitably schools in many states cling to vestiges of tradition by continuing an "Industrial Arts/Technology Education" philosophy; a "Design Wood/Design Metal" fence-sitting posture and passive resistance.

At this point that I highlight the fundamental difference in current development terms and draw some comparisons with those in England and Wales. The starting point in the United States lies firmly with much research and the embodiment of a philosophy, a definition, clear goals and the dissemination of information; a stance from which the latter has much to learn since the development of a CDT philosophy has tended to leave teachers short on justification. How astute of our colleagues to isolate the subject title "Technology Education"; it need not be abbreviated; the concept is acceptable at all levels of education; it is easily explained and justified by its principal characters and above all it is synonymous with a host of activities without the need for sub-titling. Is there time for us to adopt "Technology"?

Teachers and planners from United States with experience of the system on this side of the Atlantic maintain the ten year development gap between our two nations. After experiencing teacher training, state administration and school life in the United States I appreciate how this opinion is formed. Our strengths and centres of excellence lie with the efforts of practitioners in schools and those with responsibility for initiatives who have developed acceptable and legitimate CDT activity with a meagre consensus of philosophical guidelines; some would maintain that it is they who are assembling the philosophy. There is little doubt that we excel in creating stimulating practical design activity but more than a superficial glance will reveal a shallow philosophy and an almost complete absence of a contextual backcloth. We still have time to put a national act together if we are to remain the envy of our western friends if only because there are problems looming on the horizon for them if they do not benefit from our experiences.

There appears to be a tenuous relationship between technology education protagonists at university and state administration level and the traditionally practical industrial arts/vocational education classroom teachers who transform philosophies into action; compared with the situation in England and Wales few teachers have been activity encouraged to engage in subject development programme and in-service provision is not as generous as in the UK. Consequently, there is a greater gap between theory and practice in the United States than in England and Wales since the theory is on a higher conceptual plane and the practice at a lower operational level. There is no doubt that the bedrock of vocational and industrial arts is deeper than it was in handicraft but this vocational millstone has an academic respectability and greater depth at all levels of education from elementary school through to the higher echelons of university education; clearly an advantage for the initiators of Technology Education change.

The definition of Technology Education as with CDT is directly related to the nation's level of technological development, understanding and the rate of dissemination of technology through that nation. "The country's level of technological development plays a significant role in shaping the meaning given by that nation to technology"[7].

Todd maintains that a definition will be determined by the operational definitions of technology a nation has such a: i) tools and hardware, ii) production of goods and services, iii) systems of construction, transportation and communication, iv) a body of knowledge of practical value, v) a philosophy of thinking and doing. Todd is able to parallel these definitions with levels of national development: indigenous, emerging, developing, industrialised, cybernetic and describes the United States as cybernetic although it displays characteristics of earlier levels. His definition of technology is clearly acceptable, "Technology is the application of knowledge, tools and skills to solve problems and extend human capability"[8]. However, there is little consensus on the fundamental issues concerning the nature of technology and whether it emerges as a concept or as a process.

It is within this national context that I highlight the efforts of the State of Virginia and its attempts to instigate a Technology Education programme from five to sixteen. The Commonwealth of Virginia is making a bold stance in promoting Technology Education in the face of deep traditions founded on the state's natural resources, consequently subjects such as 'woodshop' and 'transportation' are the sacred cows of its industrial arts programmes.

In 1986 the Virginia Department of Education attempted to determine what should be reasonable to expect pupils to know by the turn of the century in the context of technological literacy. The committee charged with this task consisted of representatives from business, industry, education and various associations. They were concerned with research and planning and to deliver their findings in one year. Implementation of the findings is to be completed in the schools by 1990. These efforts were a direct response to federal criticism which sharply attacked the inadequacy of public schools in preparing students for the twenty first century. The federal board warned that pupils were not being prepared adequately to take full advantage of the opportunities that will be created in the technological workplace of the future. The challenge for educators,parents, business people and public officials is to sharpen the educational focus to meet new needs. What follows reflects the findings of the committee.

An extended search has led to a working definition of technology education: that technology is the study of the application of knowledge, creativity and resources to solve problems and extend human potential. "This is applied to a systems model of input, process and output paralleling human wants or needs which feed into the inputs of knowledge, creativity and resources these become processed through study and solving problems which result in an extension of human potential"[9]

See Figure 1.

Technology is seen as a process recognised by its products and their effects on society. Technology education is "the school discipline for the study of the application of knowledge, creativity and resources to solve problems and extend human potential"[10]

See Figure 2.

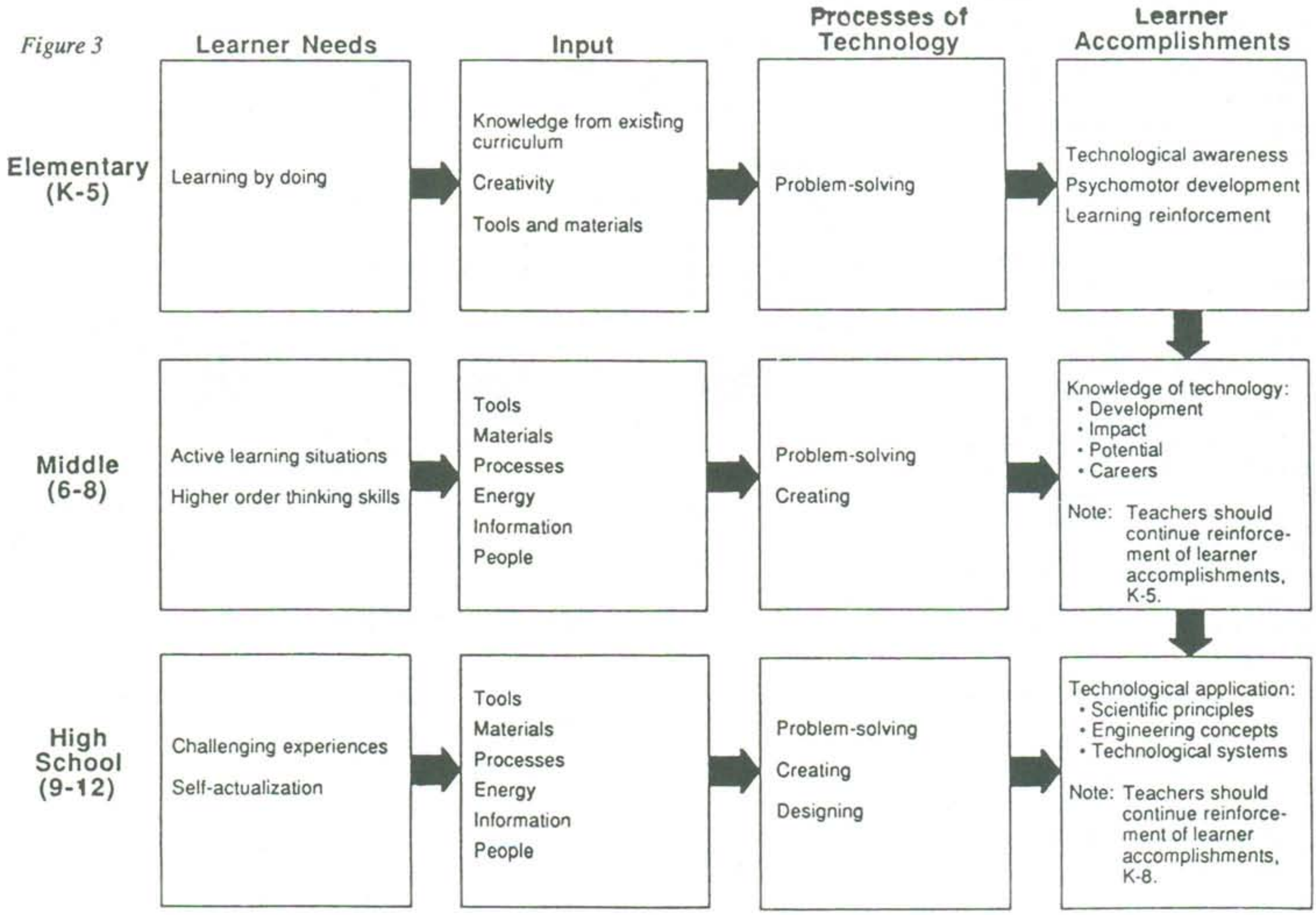
There is a firm belief, lacking in British education, that every person has the potential for reasoning and problem-solving, imagining and creating, and for constructing and expressing through the use of tools and materials. From this combination of ingenuity and resources, technological activity develops. The notion of excitement through discovery and experience and accomplishment through hands-on applications may sound similar to us and should not be underestimated in the context of the American reputation for getting things done through corporate effort, consensus and agreement.

The 'mission' of the Technology Education programmes is to ensure that citizens are prepared to live in and contribute to a competitive and technologically based society. The mission is amplified by goals that lead to the development of a technologically literate people.

"Consistent with their abilities, interests and educational needs pupils completing a Technology Education programme will achieve the following goals:

1. Comprehend the dynamics of technology, including its development, impact and potential.
2. Employ the technological processes of problem-solving, creating and designing.
3. Analyze the behaviour of technological systems and

Figure 3



sub-systems, including the tools, materials, processes, energy, information and people involved in systems.

4. Apply scientific principles, engineering concepts and technological systems in the processes of technology.
5. Discover and develop personal interests and abilities related to a wide variety of technology-oriented careers."[11]

The Technology Education curriculum proposed spans grade 'K' (pre 5 years olds) to grade 12 (17 year olds) involving elementary, middle and high schools.

See Figure 3.

Several elementary schools in Virginia have been concerned with developing 'model' Technology Education programmes through research funded by national enterprises such as NASA and directed by researchers based in university teacher education departments. The model for infusion of technology into the elementary school is concerned with helping pupils to learn and achieve educational goals of the complete elementary school programme. There is a strong emphasis on learning by doing, investigative, creative, problem-solving activities leading to a technological awareness in pupils. These experiences expose pupils to technology, develop psychomotor skills and provide the basis for informed attitudes about the influence of technology on society.

See Figure 4.

Technology activities are integrated into the total elementary curriculum and reinforce learning while pupils gain a technological awareness and a more refined attitude towards technology in society. In fact Technology Education focuses on the development of technological awareness and therefore technological literacy. It is quite clear that this is an infusion programme to be responsibility not of additional teachers but of existing elementary school teachers. This mandate is reflected in the hypothesis that learning can be reinforced by developing a technological awareness that explores:

1. How people create, use and control technology
2. The application of knowledge in mathematics, language arts, social studies, science, health and fine arts by solving problems associated with technology.
3. The use of tools and materials to foster a personal interest in technology.
4. The development of self-confidence through the use of technology.

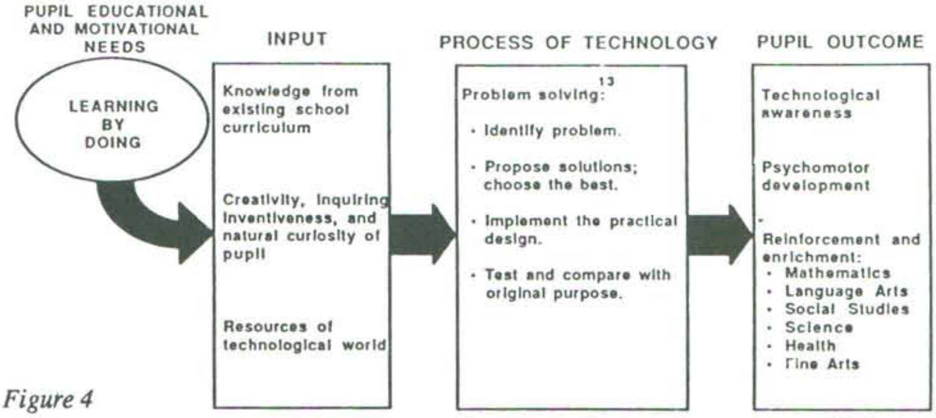


Figure 4

Middle school Technology Education provides 'active learning situations' and 'higher order thinking skill development' for participants. It is at this stage the processes of problem-solving and creating extends pupil understanding of the development, impact and potential of technology and careers in technology. Again the building blocks are made quite clear in well-defined, positive objectives.

See Figure 5.

Pupils should be able to:

1. Identify the historical, current and future developments of technology and assess their impact on earth and space.
2. Apply critical thinking to solve problems.
3. Use tools, materials and processes safely.
4. Strengthen creative abilities, self-image and personal potential.
5. Explore technologically oriented careers.

Typical course titles include 'Introduction to Technology', 'Inventions and Innovations' and 'Exploring Technological Systems'.

The high school model expresses a belief in self-initiated programmes through challenging experiences. Content challenges the pupil to apply scientific

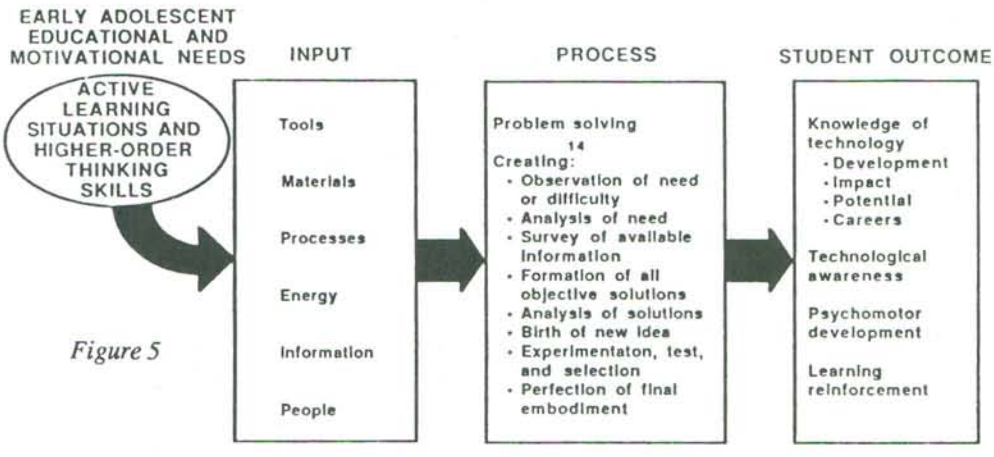


Figure 5

MIDDLE SCHOOL COURSE OPTIONS
GRADES 6-8

Sequence	Course	Suggested grade
I	Introduction to Technology	6
II	Inventions and Innovations	7
III	Exploring Technological Systems	8

principles, engineering concepts and technological systems.

See Figure 6.

Objectives necessitate:

1. Evaluation of technology's capabilities and impact.
2. Application of design concepts to solve human problems.
3. Employment of resources to analyses the behaviour of technological systems.
4. Application of scientific principles, engineering concepts and technological systems in the process of problem-solving, creating and designing.
5. Development of personal interests related to careers in technology.

Underpinning the high school programmes are three 'constructs':

1. Servicing — a sequence for pupils who enter the service sector and not continue schooling beyond high school.
2. Systems — a programme provided for the majority of pupils to strengthen the individuals ability to live and work successfully in a competitive international society.
3. High Technology — provides a programme for students who have the potential for future careers in science and engineering.

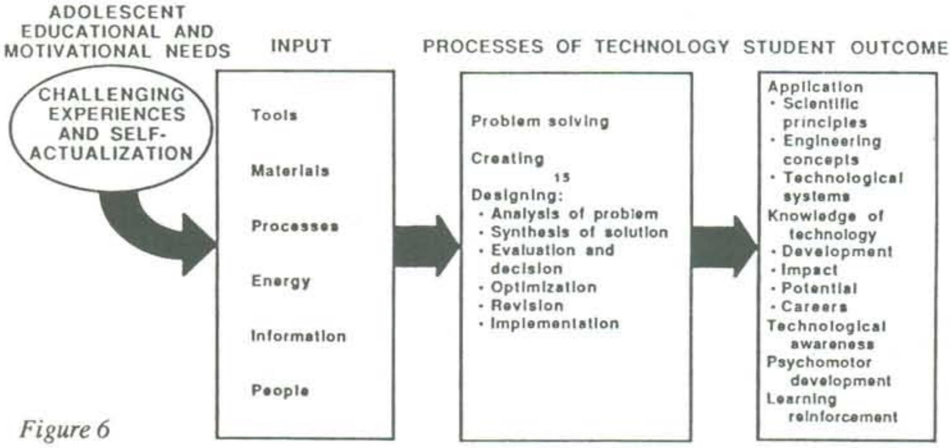


Figure 6

Constructs and titles give a number of course options designed to meet the needs of three broad ability ranges.

"We believe at the elementary school level the emphasis should be on technological awareness and at the middle school level it should be explorations in technology and finally at the high school level we should focus in on the advances of the applications of technology"[12].

Figure 7.

Dr. Dugger, Professor and Program Area Leader at Virginia Polytechnic Institute and State University, highlights an infusion methodology at the elementary school level leading to a global perspective of technology at the middle school and a more specific technological systems and applications methodology at the high school.

Many schools are, of course, in the process of change wisely anticipating almost complete implementation by the mid-1990's. Implementation is to gather pace at the commencement of the 1989 academic year in all schools and by the year 2000 all Virginia's public school pupils and 1500 secondary teachers in the subject area will be benefiting from Technology Education programmes. It is possible to believe that the dissemination of this adventurous plan will be effective if viewed in the context of the support materials and resources proposed by a task force monitoring existing facilities. New facilities will reflect the need for less heavy specialised equipment and more diverse, flexible accommodation. Characteristics of the accommodation

Figure 7

Program Constructs	Program Titles				
	Communication Technology Program	Control Technology Program	Production Technology Program	Design Technology Program	Introduction to Engineering Program
Hi-Tech Courses	Computer Applications*	Digital Electronics*	Research and Development*	Engineering/ Architectural Design*	Challenges of Engineering*
Systems Courses (Core)	Communication Systems	Control Systems	Production Systems	Drawing and Design Systems	Engineering Systems
Servicing Courses	Graphics	Electricity	Construction		

*Internships should be available as an optional approach for studying these areas.

will be "adaptability, working space, modular units, improved space efficiency and more concern for project and component storage"[13]. The programme funding will be supported by the state.

The preparation of teachers through in-service is recognised as one of the keys to successful dissemination of fresh ideas through a foundation summer school course in 1988. Summer schools are of five weeks duration and form part of a credit accumulation scheme typical of those found in most universities. The course will concern itself with understanding philosophy, concepts and planning and will be followed by teacher preparation courses; it is recognised that courses will be needed which go beyond initiation stages to enable teachers to develop technology learning activities. Local curriculum councils are investigating and restructuring teacher pre- and in-service education and providing workshop sessions for key teachers who will be the agents of change in schools. Moderation of teacher performance, monitoring technological development and the assessment of pupils endeavour remain topical issues of debate. However, what constitutes a technological literacy and the establishment of agreed aims and objectives have presented few major problems for curriculum planners.

Traditional courses are seen as taking only a small portion of Technology Education time in the classroom; for example, woodworking processes and equipment will continue to be utilised in subjects such as production, manufacturing and construction but more emphasis will be placed on how to solve problems, developing creativity and understanding systems. Protagonists believe these ideas will be more effective in preparing youngsters for a more competitive world and productive life.

That most Americans are moving toward"... virtual scientific and technological illiteracy ..."[14], has fuelled the fire for the inspired teacher trainer and enthusiastic, motivate teacher of Technology Education much as Prime Minister James Callaghan's Ruskin College speech did for potential CDT practitioners in 1976. The fundamental differences between the two scenarios are typified by the unique thoroughness of the philosophy and depth of foundations and resource bases created through initiatives, international conference and research in the United States but a general underestimation of the reluctance to change displayed by teachers with stronger, narrower traditions than many held in the United Kingdom. From a starting point behind that of the UK a five year period has been set to one side to dramatically adjust the nature of teaching in a major subject area and deal effectively with associated training and resource implications.

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