Section Two

Through the Looking Glass: International Technology Education

Stages of Thirty Years of Technology Education in Germany

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Before the discussion about technology as a school subject of its own arouse, there were several preliminary stages which have to be mentioned, because they influenced the development of the subject. Preliminary stages were:

Industrial Pedagogy: Handicraft for Boys (Knabenhandfertigkeit, appr. since 1886)

Since Industrialization has altered conditions of living, producing, and economics the children of industrial worker had to be educated to cope with the new conditions. To maintain arts capabilities in the industrial age, boys should have courses in processing card board, wood, and metal. Basic techniques were taught, but not inventing and planning. There were no special rooms in the schools and the classes had up to 90 students. So the techniques had to be learnt in the classroom with simple means (see Figuire 1).

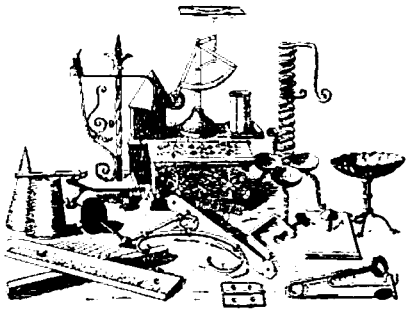

Figure 1. Handicraft Products.
Source: Sachs, 1996, p.16.

"Reform Pedagogy" Arts and Crafts (Reformpädagogik, appr. since 1900) and Restauration of "Reform Pedagogy" Arts and Crafts (appr. 1945 – 1965)

From several sources there came approaches to change handicraft to arts and crafts, to give the students more freedom to invent, design, and plan themselves

– but not in technological ways. Technology was supposed to be utilitarian only and not really educating, because humanistic education had to free of purposes including only arts and literature.

But arts and crafts could help to make pedagogical material to be used in other subjects (see Figure 2). So it could help education. Also old craft techniques were supposed to be helpful in education (see Figure 3).

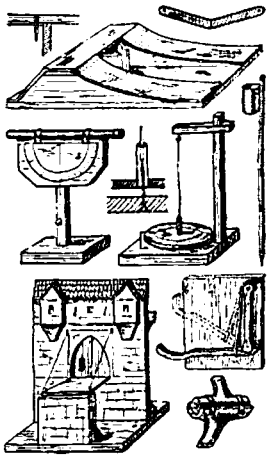

Figure 2. Products for Other School Subjects.
Source: Sachs, 1996, p.17.

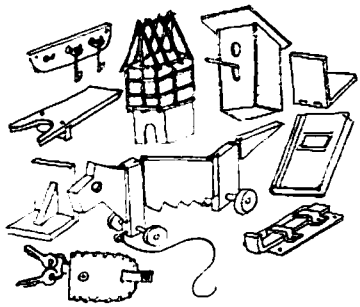

Figure 3. Craft Techniques.
Source: Sachs, 1996, p.17.

Arts and crafts should set free the shaping and designing power of children (see Figure 4).

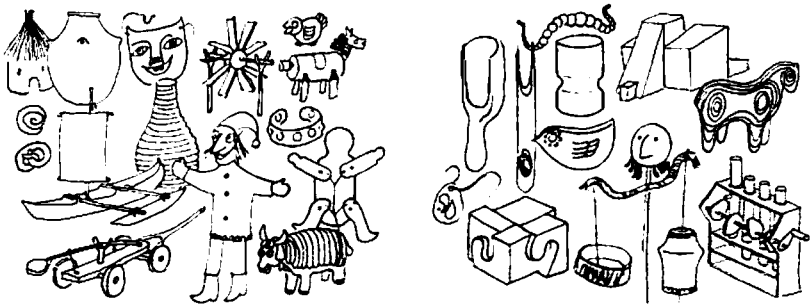

Figure 4. Shaping and Designing.
Source: Sachs, 1996, p.18.

Discovering Technology as a Field of Interest for Schools

At the beginning of the sixties, there were calls for the changing of arts and crafts to include technology. The first was an attempt to address the problems young people had when they left school with 14 or 15 years. They did not cope with challenges of a changing working environment. 1964 the "German committee on the educational system" gave recommendations to change the lower secondary education and introduce a subject "Abeitslehre" (work/career education) including hands on work.

The second was a movement starting from college and university teachers of arts and crafts. They questioned the basics of and arts and crafts and urged a new orientation towards generating education to cope with a technological world. These teachers together with many other interested people conducted from 1966 to 1977 six conferences on arts and crafts ("Werkpädagogische Kongresse"). Since nearly all participants came from arts and crafts, they had problems to structure the technology for educational purposes.

First examples look very much like before (see Figure 5), but within a short time, more technological topics were shown: static's/dynamics (see Figure 6), mechanisms (see Figure 7).

Finding a suitable structure was still a problem for the technological laymen. Another problem was caused by efforts of the Arbeitslehre group. They tried to bring through politically influenced curricula. The federal states of Germany are independent in educational matters. So, wherever syllabi for technology education were established, their character depended on the state's government. In Germany we still have a wide variety of technology/-Arbeitslehre curricula. Another source of ideas for technology education was the polytechnic education which was established in East Germany, the German Democratic Republic. Figure 8 shows these influences. The common problem for all approaches resulting from the different sources was that of the referential science.

Figure 5. Sculpture and Functional Shape.
Source: Uschkereit, Mehrgardt & Sellin, 1968, p. 47.

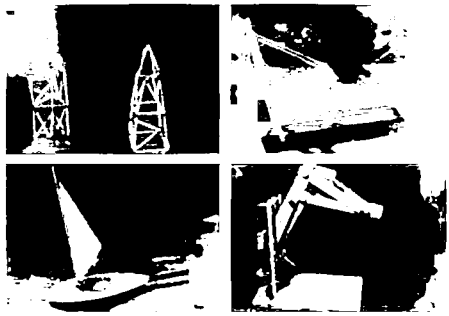

Figure 6. Statics/Dynamics.
Source: Uschkereit, Mehrgardt & Sellin, 1968, p. 51.

Engineering sciences are a so widely differentiated field that they cannot be used as a guideline for a generally educating subject technology. Polytechnic education (Wolffgramm) and some of the West German experts in technology education found a "general technology" which is a theory to reduce every technological process to the processing of matter, energy, and information. For the Arbeitslehre experts, technology can always be reduced to be a part of the labor process. For the multi aspect approach (see Figure 8), both approaches are part of its own theory, but not sufficient to explain technology with all its implications and consequences. An important part of the multi aspect approach is the splitting into "fields of action": work and production, construction and building, supply and waste management, traffic and transportation, information and communication.

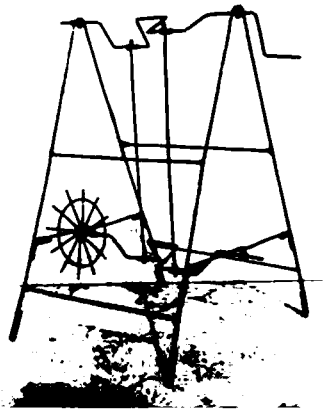

Figure 7. Mechanism.
Source: Sellin & Wessels, 1970, p. 67.

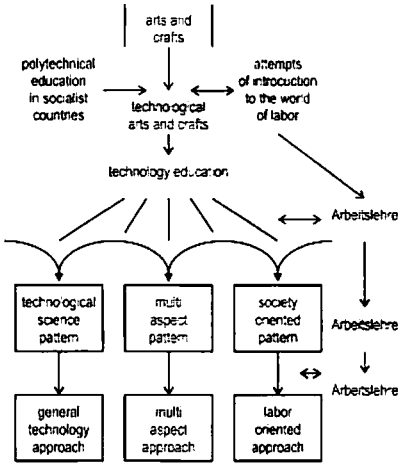

Figure 8. Approaches in Technology Education.
Source: Schmayl, 1992, p.14.

Today, most of the German curricula are structures after the multi aspect approach. One of the characteristics of it is a common set of teaching methods, which was completed and validated over the years. It comprises (Henseler & Höpken, p.53 ff):

Course of Instruction

This is a method to attain limited partial aims of technology education. It is restricted to teach knowledge and skills. Examples are: How to use a power drill, computation of a series resistor for a light emitting diode.

Design Activity

This method corresponds with an important technological action - designing. In the process of solving technological problems it emphasizes inventing, planning, designing and creating. Examples are: Designing a circuit board for an electronic circuit, Designing a time control (traffic light, flashing light, ...)

Making Activity

Manufacturing an object the pupils independently plan and organize the

production process. Examples are: Manufacturing an electronic wiring.

Design and Making Activity

Design exercise and manufacturing can be combined. This is the original method of application of arts and crafts. It includes all stages of the planning and manufacturing process. But this means also, that only few exercises can be carried out during one term.

Technological Experiment

The technological experiment can provide unknown values, which are needed in the further course of the lesson. Examples are: Determining the adhesion of various adhesives, determining the life of batteries under different loads.

Technological Analysis

In a technological analysis technological object or technical facts are examined concerning their components or factors. This can be done destructive or non destructive. Examples are: Disassembling an electric iron to see the components of a control loop (non destructive, the iron can be reassembled), opening the case of a power transistor (TO 3) (destructive).

Technological Exploration

This is a planned and purposeful investigation of institutions outside school. Examples are: Traffic light, machines in a factory or workshop.

Technological Assessment

Assessment and evaluation of technology is one of the most complex methods of technology education. It takes place after each manufacturing exercise to assess an evaluate the object made. The result can be used to evaluate the pupils standards. However technological assessment can also be a method of its own testing industrial products or even comparing types of power stations.

Project

The project is a method to enable students to solve complex tasks emerging

form the reality of life. The project activities go from planning to practical realization. Characteristics of working in a project are orientation towards product and activity, interdisciplinarity, orientation towards students, reference to situation and society, joint organization of learning processes. A project requires the removal of separation between school subjects and of 45 minute lessons.

Case Study

In a case study, a real situation is the starting point for the learning process. After an exact analysis of the problem, several possible solutions are worked out in groups and a decision is made in the whole class. The result is compared with the real decision and assessed.

Expert Inquiry

Expert inquiry is a method aiming towards reality. An Expert is invited into the classroom to answer questions about a certain, limited issue. So the students get first hand knowledge, insight, and experience.

These teaching methods are embedded in a set of technological methods, which are used in technology and also must be represented in technology education (see Table 1).

Two Schleswig-Holstein Examples for Technology Curricula

Schleswig-Holstein is the most northern federal state of Germany. As one of the first states it got an elaborated technology curriculum in 1986. The following overview (see Table 2) shows the version for Realschule, one of the branches of lower secondary education. The next overview (see Figure 9) shows the 1997 curriculum for all braches of lower secondary education. A comparison of old and new curriculum shows that the new curriculum is less rigid. It gives more freedom to the teacher to teach the matters in different ages. To facilitate spreading the new curriculum, graphic representations were developed to show the intentions. The first presentation (see Figure 10) shows the connections of the fields of action with the levels of technology education. The second representation (see Figure 11) shows the interdependence of

technological aspects with aspects affected by technology. Such a graphic representation was made for each teaching unit.

Table 1. Methods of Technology.

Methods of assigning and assessment	- developing alternative solutions and choice of solutions according to criteria of assessment - assessing consequences and danger using a technological system
Anticipating methods	- choosing and assessing the appropriateness natural laws for achieving the object - anticipating a concrete solution by drawing or simulation - assessing the function of concrete solution by a real model, by drawing, by calculations based on natural laws, by experiment, .. - planning, organising and representing the course of the process
Realising methods	- carrying out a process - controlling the course of a process - choosing and using appropriate objects, means and procedures
Simplifying/ Systematising methods	- abstract and symbolic representation of systems, subsystems and their combinations - splitting a complex system into single systems and subsystems easily to grasp - assigning relevant quantities to systems and subsystems standardisation
Analysing methods	- uncovering the natural laws, the system is basing on - explaining the mode of operation by following the causal connections between relevant quantities and subsystems - searching for errors and narrowing down errors by measuring relevant quantities at the interfaces of subsystems - determining specifics of object of operation, technological procedures and technological objects, assessing their appropriateness for a technological solution

Source: Henseler & Höpken, p.41.

Table 2. The 1986 Technology Curriculum. Overview.

7	8	9	10
Work and Production			
- Designing and manufacturing a wooden object *Extensions:* - wood and wooden materials - technical drawing	- Designing and manufacturing an object from metal *Extensions:* - Standardisation of metallic materials and machine ele-ments - Expanding the ba-sics of technical drawing	- Manufacturing an object from plastic Labour divided industrial production *Extensions:* - Estimation and orientation towards the market for product planning and sale - Ways of organising industrial production	- Casting in moulds - Machines in production processes/ From simple tools to modern automata *Extension:* - Facilities for enhancing efficiency in production
Transportation and Traffic			
- Solving technological problems of lift-ing and conveying	- Bicycle and moped, proven means of moving: analysis and repair, maintenance and care *Extension:* - Function and structure of selected machine elements	- Analysing and comparing transportation and traffic systems	- Technological development: From the carriage to modern motor cars *Extension:* - Constructing and analysing different kinds of gearing
Building and Built Environment			
- Building simple load bearing constructions *Extension:* - Comparing load bearing constructions	- Concrete as a building material, Experimenting and manufacturing simple objects	- Planning and realising a simple real building project	- Comparing conventional and industrial ways of building *Extensions:* - Unit construction systems - Heat protection and using solar energy in passive devices
Supply and Waste Management			
- Basic house equipment for supply and waste management *Extension:* - Heating systems	- Examples of technological facilities to protect the environment	- Development of energy technology/ Reinventing a energy technological plant *Extension:* - Electric energy, using energy in a comfortable way	- Constructing and testing simple facilities to exploit regenerative sources of energy
Information and Communication			
- Constructing, testing and comparing simple devices to transmit messages	- Planning and manufacturing simple devices to solve control problems *Extension:* - Different systems of control technology	- Automating technological processes with control technology *Extensions:* - Constructing and using basic digital circuits - Using computers for control tasks	- Using computers to solve specific technological problems

Source: http://www.unesco.org/education/ste/pdf_files/connect/Hopken.PDF, p. 4.

Socio-technological field of action				
Work and production	**Responsibility of man working with raw material in craftsman like production. Basic course: Communication in technology. 7. - 9. form**	**Development and employment of machines change place of work and vocation. Interdependence of man and machine in production. 7. - 9. form**	**Industrial production of article for daily use and its impact on conditions of life. 8./9. form**	
Transportation and traffic	Bicycle technology and appropriate use of means of transport. 7. form	**Car technology and its interactions with man and environment. 9. form**	Technology conceptions for environment conserving means of transport. 10. form/project	People develop technology (e.g. air craft engineering) and use it in different ways. 8. - 10. form
Construction - built environment	Former and present ways of constructing bridges- basic principles of static, selecting materials, impacts on man and environment. 7. form	People protect and secure themselves - safety systems of yesterday, today, and tomorrow. 7. - 8. form	**Dwelling in changing times - ecologically beneficial, human building and living together. 8. - 10. form/ project**	
Supply and waste management	Wrapping is a burden for environment - disposing and planning wrappings, avoiding refuse through abolishing, recycling relieves environment. 7. -9. form	Supplying and disposing garbage of a household under technological, ecological and economic aspects. 8. - 9- form	**Using energy efficiently and sustainable energies in households. 9./10. form**	Man as consumer - discriminating dealing with the supply of technical articles - analysing, testing, and purchasing products. 9. - 10 form
Information and communication	Basic electrical circuits and safety education. Basic course: Soldering. 7. form	**Impact of automation technology on man, working place and vocation. From hand control to computers 7. - 10 form**	Interchange of information, development and impacts. From the drum to wireless telephones. 8. - 10. form	bold: compulsory subject matters

Figure 9. The 1997 Schleswig-Holstein Technology Curriculum, Overview.
Source: Ministerium für Bildung, p.17 ff.

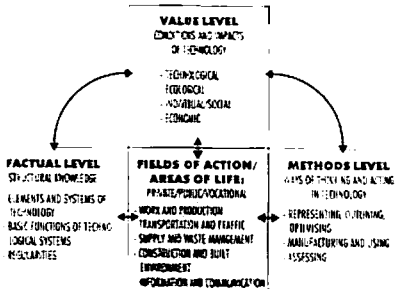

Figure 10. Pedagogical Structure of Technology Education.
Source: Ministerium für Bildung, p. 23.

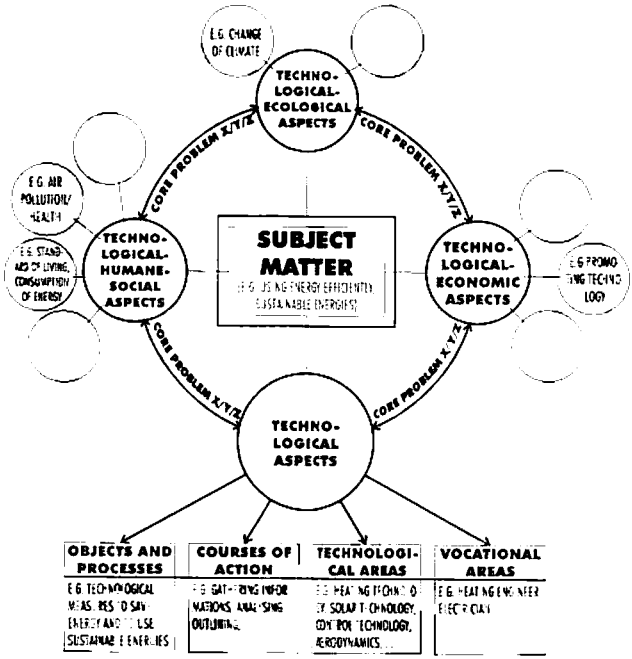

Figure 11. Interdependence of Subject Matter.
Source: Ministerium für Bildung, p. 17.

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Technology Education in Malaysia

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Introduction and Background

Malaysia, centrally located in the fastest developing region of Southeast-Asia, is a multiracial and multicultural country comprising three main ethnic groups namely Malays, Chinese, Indians and the indigenous people of Sabah and Sarawak. Malaysia with a total population of 19 million is a constitutional monarchy based on parliamentary democracy. Malay and Islam are the official language and religion of the country.

The success of Malaysian socio-economic development is attributable to careful planning and effective implementation of various programmes embodied in the National Development Policy beside political stability and rich resources. The Nation's Vision 2020 launched in 1991 is aimed at making Malaysia a fully industrialised nation by the year 2020. The vision puts special priority in high technology particularly in the areas of telecommunication, manufacturing, biotechnology and industrial innovation.

Overview of the Malaysian Education System

Education as a whole is under the jurisdiction of the Ministry of Education, which is responsible for managing a comprehensive school system, ranging from primary to university level, regulating syllabi, controlling national examinations and supervising the development of education in the country.

In Malaysia, it started from primary education for a total period of six years, followed by three years of lower secondary. After sat the Lower Secondary Assessment students are streamed for upper secondary whether in science, arts, technical or vocational. After two years of upper secondary, students sat for the SPM/SPMV a Malaysian Certificate of Examination, which is equivalent to O-

level Cambridge University Examinations. Primary and secondary school education is free for students between the ages of 7 to 17 (a total of 11 years of universal education). The admission age to the first year of primary school is usually seven and the graduating age for a first bachelor degree is about 22 years old. Over 97% of seven years old kids are enrolled in the public school system. Malaysia has a literacy rate of 93%, which is one of the highest in the world. The Government is soon to make primary education compulsory for all Malaysian children. Figure 1 shows the Malaysian Education System as a whole.

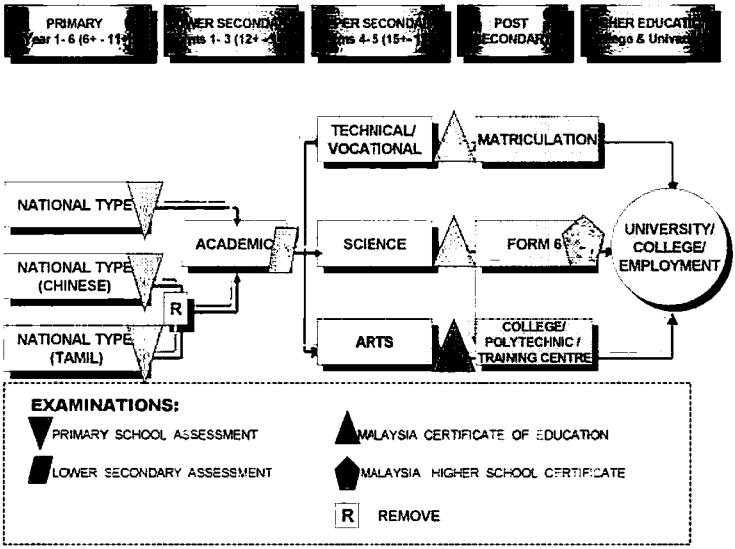

Figure 1. Malaysia Education System.

Overview of Technology Education in Malaysia

Our government sees the technology education as being important to national development. There are several ministries, public agencies and private agencies involved in the technology education to fulfill the manpower needs of industries. One of these is the National Vocational Training Council (NVTC). The Council was set up in 1989 with the objective of establishing a coordinated and comprehensive system of vocational and industrial training in line with Malaysia's economic development goals and technological development needs.

NVTC is managed by Manpower Department and it liaises closely with the Ministry of Education, Ministry of Entrepreneur Development, Ministry of Works and Ministry of Youth & Sports.

Beside that, MARA or the Council of Trust For the Indigenous People also plays the important roles for the development of Knowledge-skills manpower in Malaysia. MARA is an agency under the Ministry of Entrepreneur Development incorporated on 1 March 1966 through a Parliamentary Act as a statutory body. It responsibility is to promote, stimulate, facilitate and undertake all activities pertaining to economic and social development of the nation particularly in the rural areas.

The roles of National Vocational Training Council

- Promoting, developing and reviewing vocational and Industrial training programs at the skilled and semi-skilled level in public training institutes commensurate with the stage of technological development in the industry.
- Promoting and assisting in the development of in-plant training programs at selected industrial establishments and training institutions.
- Assessing and recommending the present and future skill needs for skilled and semi-skilled manpower commensurate with the stage of technological development.
- Establishing national trade standards and developing the training syllabi (National Occupational Standard-NOSS).
- Organizing and implementing a national program for trade skills testing and certification. In line with the recommendations of the Cabinet Committee on Training, 1991, NVTC began overhauling the skills training system in Malaysia through a major review of the national Skill Certification system (*Sijil Kemahiran Malaysia-SKM*).
- Coordinating training and development programs for trainers in public skills training institutions (training curriculum, instructors, trainees and training facilities).

The roles of MARA

To achieve the objective MARA strategically plan for the implementation of their strategies by:

- Creating and increasing the number of Indigenous People (*Bumiputera*) entrepreneurs and upgrading their level of participation in the commercial and industrial enterprises thereby creating a strong and viable business community.
- Participating actively in specific commercial and industrial enterprises through investments and management of companies as a means of nurturing and promoting *Bumiputera* participation in commerce and industry.
- Increasing the number of trained *Bumiputera* manpower at all levels and in various fields for the needs of the nation's commercial and industrial sectors. Nowadays, MARA is focusing on Knowledge-skills manpower.
- Providing other facilities and services where appropriate and to act as a trustee in areas that can help raise the social and economic status of the *Bumiputera* community directly or indirectly.

The roles of Ministry of Education

Industrial technology Education under the Ministry of Education is conducted through Community College, Polytechnics, Secondary Technical and Vocational Schools. The Polytechnics are post-secondary institutions directed towards fulfilling technical or mid-level technical manpower needs. As such course contents are more readily defined following the needs as required by each occupational area.

The Technical Education Department under the Ministry of Education was established in 1995 from a formerly small division known as the Technical and Vocational Education Division (TAVED). The major role of this department is to ensure the continuity of educational policies and progress of technical and vocational education in Malaysia. The scope of operations include providing services in research, planning, implementation, coordination, supervision as well as monitoring the development of technical and vocational education as a central agency to cover both the lower secondary level and the Polytechnics.

Teachers/Instructor Training Program

There are about 27 Teacher Training Colleges located throughout Malaysia that conduct training programmed at Diploma level for non-graduate trainee teachers for the primary and secondary schools. The courses comprise pre-service and in-service training programmed for candidates who have been accepted for teaching positions by the Ministry of Education. The teacher training programmed is for 3 years' duration, which leads to the award of Diploma in Teaching (Diploma Perguruan Malaysia).

Teacher and instructor training in Malaysia were conducted in either Universities, Colleges and training center such as Industrial Training Institute (ITI) and Center for Instructor and Advanced Skill Training (CIAST). Course content and career options are design to give Malaysia a corps of educationists fully equipped to implementation the national vision to develop the country into regional educational hub.

Besides that, Instructors/Vocational Training Officers Skill Development is one of the programs formed to increase skill and knowledge of instructors/vocational training officers and expose to latest technology and skill system parallel to industry development. This program is fully support by Public Service Department and was coordinated by National Vocational Training Council.

Also active in the area of defining training programs is the Malaysian office of the Asian and Pacific Development Center. The center's aim is to provide a regional focus for national training and research institutions. The government is setting up IT centers with responsibility for IT training in the various ministries. As an example, one such unit, the Information Technology Center of University Science of Malaysia, is responsible for extending the use of IT in the Public Works Department (JKR) and the Ministry of Works. The center is equipped with multimedia PC's, audio-visual equipment, up-to-date teaching aids, projection facilities, a visualizer and the Robotel System.

Events Related To Industrial Technology Education

Ministry of Education conducts a few programmed with the assistance of private firms such as British Petroleum Malaysia Berhad. Among them is the BP Challenge Program. In this program secondary school students are to come out with creative and innovative ideas in their project. Also involved in this program are consultants from the Industrial Design, Department of Faculty Arts and Design, MARA Institute of Technology, Malaysia.

Another project concerned with Industrial Technology Education is UREKA where it is collaboration between the Ministry of Education and Lady's Choice, producer of food products. This project is aimed at primary school students and emphasize on production and materials used.

Malaysian Invention & Design Exhibition (MINDEX) is another activity concerning Industrial Education Technology. Students from the upper secondary and tertiary level try out creative and innovative ideas that are practical towards the usage and production design and technology in manufacturing.

The Ministry of Public Works, Ministry of Human Resources, Ministry of Education, Ministry of Entrepreneur Development, Ministry of Youth and Sports, and the private sector have jointly organized the national skill competition. Right form the onset; NVTC has been actively involved in organizing the competition, particularly pertaining to the technical aspects of competition including the preparation of questions and appointment of judges.

Malaysia first participated at the World Skill Competition (WSC) in 1993, after that Malaysia through the NVTC gained admission into the International Vocational Training Organization (IVTO). Up to 1999, Malaysia has participated in four World Skill Competitions, namely in 1993, 1995, 1997 and 1999 and in 1995, ASEAN countries agreed to have the first ASEAN Skill Competition in Kuala Lumpur, Malaysia.

Industrial Relationship

A strong and close industrial technology liaison is essential in the development of curriculum in such areas. Members of the industry are closely consulted in the formulation and building of the course contents areas. Advisory committees, consisting of members of the industry, are established for each course area and they play an active role in the development of the curriculum structure and content industrial technology education.

There is a shortage of qualified IT personnel in Malaysia. What's more, many Malaysian students who choose a career in IT, leave Malaysia for positions overseas. The government has called for organizations involved in the training and retraining of IT personnel to produce better qualified personnel with the required skills and correct attitude to work with users to give them confidence in the use of IT in the workplace.

Industries are encouraged to link up their training programs with institutions of higher learning and to join forces in research and development, encouraging the sharing of expertise and facilities. According to Dato' Seri Dr. Mahathir Mohamad, Malaysia's Prime Minister, the country needs to train 7,000 IT workers a year to assist in the nation's Multimedia Super Corridor project.

Major Problems and Difficulties

- The development of NOSS is still at minimal and up to year 2001 only covers 456-job area.
- Lack of skills instructor. Most of them preferred study at Universities with concentrate more on academic rather than skills.
- Lack of training institution. Majority are own by government because of highly operating cost.
- Rapid change in curriculum due to revolution of technology will also needed for the changing the equipment (difficulties in obtaining since we have to go through lengthy processes of purchasing.
- Short of experience and skills staff in the selected area since the industrial studies is still new in Malaysia.

- Lack of Industrial relationship since every institution and company has their own policies and regulations.
- Some obstacles have to be resolved during training. Staffs are too used to the present way of teaching. Some are not willing to go for re-training due to personnel problem andsome are not ready for re-training.

Conclusion

In line with the nation's goal of making Malaysia a fully industrialised nation by the year 2020 as encompassed in Vision 2020, Malaysia places special emphasis on technical and vocational education and training. The Industrial Technology Education, prevocational training in the school curriculum, which installs technological literacy, economic awareness and social skills, is no doubt will become the platform for the process of industrialisation. The recent introduction of a new curriculum, invention, which emphasises creativity and industrial innovation, will further accelerate the process. With increased budget, improved facilities, trained teachers and sound curriculum, Industrial Technology Education will play a crucial role to meet the challenges and demands of the nation.

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The Role of Industrial Technology Education in Croatian Industrial Development

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Introduction and Background

Croatia is a country undergoing a transition in various fields, including education and industrial technology. The future of Croatian industry lies in the area of introducing modern technologies and new products, bringing out new strategic business decisions and especially developing and improving of industrial technology education. Current industrial technology education in Croatia does not match the standards of developed countries and therefore should be reformed. Such an improved and compatible educational system, formal as well as informal, would form new labour force, experts and managers who could improve the Croatian industrial sector and economy as a whole.

The formation of the global information society has made studying a life-long activity in all fields. It increasingly corresponds with continuing, i.e. it doesn't stop with a person's leaving the formal education system, but continues in different forms until the end of a person's working life. In these circumstances new ways of acquiring and transferring knowledge and expertise become increasingly important and necessary. With the aim of achieving and retaining a competitive edge in the market, companies must ensure more training for their employees, which is in accordance with the policy of lifelong learning. As a consequence of this approach to learning and training, the Croatian Chamber of Economy aims to respond to new problems, which the practice itself poses to companies.

The Present Situation of Croatian Industrial Sector

The Croatian industrial sector suffered the most in the process of transition. The past development was mostly associated with downsizing, restructuring

and introduction of market criteria under hard budgetary and fiscal constraints. The war and the break-up of the Yugoslav market worsened the circumstances particularly. The share of industry in GDP declined to 18% (Office for the Strategy of Development of the Republic of Croatia, 2001a). This decline contributed to the unemployment rate as well as to the decline of other activities of the sector.

Today the Croatian industrial sector is intensively changing and the effects of the full scale and strategically thought out restructuring of this sector are evident in many areas, from privatization to the strengthening of exports to western markets, development of new products and innovations to existing products and manufacturing processes, to increasing the level and standardization of quality, satisfying environmental protection conditions, reaching cost effectiveness, etc.

In 2001 the industry employed more than 250,000 workers, what represents 25 percent of Croatia's total workforce. Within the industry the largest total income comes from the production of food and beverages, followed by petroleum, chemicals, electrical manufacturing, paper, printing and publishing, and shipbuilding. Regarding exports shipbuilding, food and beverages lead the way followed by the metal and electrical industries. Industrial goods account for 95% of Croatia's total exports and has the highest share in Croatia's GDP (Croatian Chamber of Economy, 2002).

The future of Croatian industry lies in the area of accessing new markets, introducing modern technologies and new products, as well as forming joint ventures and strategic partnerships with foreign companies. A skilled labor force and highly educated experts in engineering and computer technology supported through technology centers at the technical schools within Croatian Universities represent a good foundation for foreign investments in advanced technologies (see Table 1).

Table 1. Level of Education in Legal Entities as on 31st March 2001.

Level of education	%
Two-year post-secondary school and university qualifications	23.03
Secondary school qualifications	38.02
Highly skilled and skilled workers	19.98
Others	18.97

Source: Croatian Chamber of Economy, 2002

The Educational System in Croatia

General Education

The educational system in Croatia comprises pre-school education, eight-year elementary education (compulsory and free for all children from seven to fifteen years of age), secondary education and higher education (see Tables 2 & 3).

Table 2. The Educational System in Croatia.

Age when compulsory education starts:	7 years	
Age when compulsory education finishes:	15 years	
The structure of the educational system:	Preschool education: - age 2-7 years.	Participation rate: 34.9%
	Compulsory primary education: - age 7-15 years; - current structure: 4+4 years.	Participation rate: 98%
	Secondary education: - age 15-19 years; - 3 and 4 years (short programs 2 years).	Participation rate: 63%
	Two year college-level and university education: non-university education (2-4 years); university education (4-6 years).	Participation rate: 31.3% (22.9% of which in university education)

Source: Croatian Chamber of Economy, Business Education Department, 2002.

The system of secondary education in Croatia comprises general education and technical or vocational education. There are two types of vocational schools: some ensure classic vocational education and training, which is organized in

schools, and others offer dual programs based on the German model.

Higher education comprises universities as the main source of scientific work (university studies) and colleges, independent higher schools and accredited private higher schools, which attach great importance to the practical application of acquired knowledge (professional studies). In Croatia there are four universities, with around seventy faculties, art academies, higher schools, university departments, seven colleges, eight independent higher schools and three accredited private higher schools.

Table 3. Schools by Types and Number of Students and Teachers in 2000.

Types of schools	Number of schools (excluding branch schools)	Number of students	Number of teachers (including teachers, administrative personnel and supporting staff)
All types	3,107	790,815	75,985
Preschool	454	130,150	6,372
Primary (1-8)	2,143	413,468	41,399
Secondary general	150	49,624	
Secondary vocational	275	146,399	20,651
University	66	70,703	
Non-university	19	26,095	7,563

Source: Croatian Chamber of Economy, Business Education Department, 2002.

Vocational Education and Training

Vocational schools in Croatia are predominantly oriented towards the labour market or offer the possibility of continuing education i.e. vocational education. In Croatia a dual system of education has been in place since 1995. Since then the number of newly opened dual programmes of vocational education and apprenticeship has been growing so that today it includes 55 occupations. Practice is represented in the ratio of 2:1 as compared to general-education and vocational theoretical curriculum. As a rule, practical training is organized in craft shops and to a lesser degree in school workshops.

Continuing Education

There are two main types of adult education – formal (which includes

accredited programmes i.e. those verified by the Ministry of Education and Sports) and informal.

The most important institutions which provide adult education include: adult secondary schools; institutions of higher education; institutions of adult education (open college extensions, open universities); private institutions which offer entire educational programmes but also short courses and seminars; companies that offer courses for management training on-the-job training associated with the introduction of new technologies.

The Croatian Employment Bureau is responsible for providing training and subsidizing the costs of employment for the unemployed and for those for whom there is a probability of such status as a consequence of the restructuring of the economy.

Responsible Agencies

In Croatia higher education is within the remit of the Ministry of Science and Technology. The Ministry of Education and Sports is responsible for education up to that level (primary and secondary) including the definition of a part of the general education in dual system programmes.

The Ministry of Craft, Small and Medium-Sized Enterprises is responsible for: list of occupations within the dual system; implementation of programmes in craft workshops; licensing of schools that take apprentices; enrolment plans and regulation of apprenticeship examinations.

Financing of Vocational Education and Training

The State Budget is the main source of financing of secondary vocational education. The costs for all schools in Croatia amount to around 3% of GDP (Office for the Strategy of Development of the Republic of Croatia, 2001b). Vocational schools are permitted to make supplementary income through their own activities.

National Priorities

The priorities for vocational education and training development include the following:

- Design of the new framework of education and training policy in the context of economic restructuring and life-long learning;
- Revision of the national framework of occupations, evaluation and certification:
- Training of experts for the revision of the main curriculum;
- Development of the system of training for teachers in vocational schools and trainers;
- Further development of the dual system of education;
- Design of the framework for then development of continuing training.

Importance of the R&D system for the Croatian Industrial Development

It has been known for a long time that a correlation exists between the development of R&D and the development of a society as a whole. Besides the undoubted role of R&D and new technologies for the overall development of every society, including Croatian, its close connection to education, especially higher education, should be emphasized. Institutes and universities are places where new ideas are created and spread, and therefore places where human potentials are enhanced.

R&D in Croatia has been stagnating since the year 1991 (Office for the Strategy of Development of the Republic of Croatia, 2001c). The main reasons for this situation are: a lack of awareness of the importance of R&D and its potentials for the development of the society as a whole.

Presently, the main goal of the developmental strategy of R&D in Croatia must be: a complete change of the present way the system functions. R&D should be given a much more significant place in the society, new laws should be adopted on R&D and high education, the international value system should be applied, a reasonable autonomy along with accountability of scientists/engineers should be respected, and more funds should be allocated.

As a result, the R&D system would become completely compatible with the one in developed countries, there would be a drastic change in the role knowledge plays in everyday life, and scientists/ engineers would exert

influence in all aspects of societal life. An educational system would be established which will be appropriate for coping with constant new innovations worldwide.

Conclusion

Relation between education and industrial development is very important for the directing of national educational and research activities. The nature and intensity of cooperation between educational and industrial sector depend on how much are the partners both willing and trained for such cooperation. If economic development is based on the strategy of a learning society and the knowledge - based economy, industry will make an interested partner to education, a partner willing to invest into applied and developmental research and specialist graduate studies which are on the line of its developmental plans.

The Croatian industrial sector suffered the most in the process of transition during last decade of the 20th century, and now the main objectives of future Industrial Sector Development are: new industrialization toward new employment, export orientation, creating incentives for investment and attracting foreign direct investment, restructuring and commercialisation of the public sector and its governance, improvement of management skill in the business sector, targeting measures for horizontal measures of support creating conditions for a fast introduction of IT and related technologies and skills, and improvement of the efficiency of government services.

A crucial issue for the quality of further growth is an educational level improvement of human resources in all parts of industrial sector. Due to economy restructuring, there are strong needs for re-training of (un)employed persons (the rate of unemployment in Croatia is surprisingly high) and additional training of adults is needed if they are want to keep their jobs. A special problem poses the lack of coordination of educational production with the needs of labour market, which intensifies the problem of unemployment. Unemployment, namely, is not only the result of the decrease in the number of vacancies; it is a structural problem as well. On one hand, there is a surplus of

educated people whose qualifications are not needed, and, on the other hand, there is a shortage of people with particular qualifications.

Due to ever-increasing significance education has for national development, and due to ever more rapid scientific, technological and social changes, educational systems of all countries tend to improve and to adapt to the requirements of the new time. Countries in transition, to which Croatia belongs, have additional reasons for structural changes of their educational systems. Their transition from planned to market economy has to be facilitated, as well as the transition from politically monistic into a democratic civil society, and their joining European Union needs to be alleviated. Transition imposes new demands on population: people have to master new skills, the skills that will qualify them for a successful coping in a competitive society of rapid changes.

On the basis of what we have just said, what might be concluded is that it is necessary to introduce such structural changes of the Croatian educational system, which will improve its efficiency for the purpose of a faster social and economic development, and inclusion of Croatia into European integrations.

Other conclusions may include:

- A two-way feedback between the R&D system and the spreading of technological achievements should become more common.
- State institutions and private owners should support the cooperation between universities and industries in order to promote innovations, enhancing the profitability of R&D, and achieving benefits for all participants.
- Higher education programs on science and technology must apply a scientific approach to resolving problems.
- Cooperation between universities and industries must be stimulated in order to help the education of scientists and introduce the lifelong advanced training and develop understanding for industry needs and industry's awareness of the need for advanced education of experts.
- State institutions must apply solutions, which stimulate innovations as part

of their science and technology policy.

- The solutions could include cooperative research centers and networks, technological incubators and science parks, and the creation of advisory bodies for small and medium enterprises.
- Special policy measures should be implemented, and national innovation systems need to be formed to establish a connection between science and technology.
- Technological lifelong education should be stimulated with all the measures of state policy. National institutions of higher education and also intense international cooperation must contribute to that.

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Industrial Technology Education: An Indian Perspective

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Introduction and Background

Technology teaching has evolved as technology has advanced. During the industrial era of the 20th century, it was taught in the schools as industrial arts, reflecting the industrial society. As advancements have catapulted us into a faster moving, more highly sophisticated, technological society, technology education has made content adjustments that reflect these changes. Generally, the public is unaware of these changes in curriculum and content and, therefore, the field must contend with a lack of support despite major strides to advance the subject matter.

Issues relating to ITE vary according to the prevailing social/cultural context in each country. This issue is not as simple as it appears to be there are number of factors influencing each. Since there are people present here from a number of different countries having different systems of education, therefore let me begin by what 'technology education' teaches.

In a word, it is about INNOVATION! It is about how people think! It is how to apply technology in the solutions of problems facing society. The aim is to solve problems and create opportunities within a realistic context. That context can start with the student's everyday environment and progressively move into more global issues. Examples of technology problems and learning situations could be the cleaning of a stream that has become polluted, the creation and fabrication of an invention to solve a household problem, or designing and building of a habitat for a unique situation. The thinking process is closely related to that of an engineer, hi-tech worker, designer, or an architect. Students use their ingenuity with tools, materials, processes, and resources to create solutions and opportunities for themselves and others. The nature of learning

goes from the very early years of just "knowing" to more developed applications that relate to the medical, agricultural, energy and power, information and communication, transportation, manufacturing, and construction technologies. It is a new and dynamic subject in our institutions that is as fast moving and as up-to-date as the thinking of technology in our society! It is future workforce thinking!!

Importance of Technology Education

A central role of an educational institution is to offer a curriculum that gives its students a basic understanding of the society in which they live. While our society is certainly both democratic and technological, not enough emphasis is placed on the technology component through school curriculums. People are losing touch with a fundamental aspect of society due to the fact that educational institutions impart so little understanding of our technological base. We risk underestimating the importance of the assessment of technological change or assuming that the assessment of technological change is entirely a scientific process.

Overview of the Indian System

Since Independence in 1947, the technology education system has grown into a fairly

large-sized system, offering opportunities for education and training in a wide variety of trades and disciplines at certificate, diploma, degree, postgraduate degree and doctoral levels in institutions located throughout the country. Even though the system boasts of institutions comparable to the best in the world, quality of education offered in the majority of institutions leaves much to be desired. In the year 1947-48, the country had 38-degree level institutions with intake capacity of 2,500; and 53 diploma level institutions with intake capacity of 3,670. The intake for postgraduates was 70.

There was rapid expansion of the system in the next 20 years. By 1967-68, the number of degree level institutions had increased to 137 with intake capacity of 25,000; and for diploma to 284 institutions with intake capacity of

47,000. In the next 10 years (in 1977), the system capacity increased only marginally to admit 30,000 students for degree courses, 60,000 for diploma courses and 6,000 for postgraduate courses.

The system capacity increased very rapidly in the next 20 years, with the major role being played by the private sector. The system by 1997 had 547 degree institutions with admission capacity of about 131,000; and 1,100 diploma institutions with admission capacity of about 184,000. Admission capacity for postgraduate courses had been increased to 16,900. Out turn of Ph.D.s' were about 370 annually.

In the year 2000, the total size of the system had increased to 4,146 institutions with approved intake capacity of 544,660. These include 838 engineering degree institutions with admission capacity of 232,000 students; and 1,224 engineering diploma institutions with admission capacity of 188,000. Approximately, two-thirds of these institutions were in the private sector. Postgraduate education was being offered in 246 institutions with admission capacity of 21,460.

Institutions of Importance

The States and Union Territories have played an important role in the development of technology education by establishing a large number of fully funded and aided technology institutions and by providing adequate policy support. At the apex of the technology education system in India are the seven Indian Institutes of Technology (IITs) located at Mumbai, Delhi, Kanpur, Kharagpur, Chennai, Guwahati and Roorkee, established with the objective of imparting world-class education. These have been established by the Bureau of Technology Education (BTE) of GOI and are directly funded by it.

The IISc Bangalore was established to offer postgraduate education and to conduct research in various areas of basic sciences, engineering and technology. It is yet another world-class institution and is directly funded by the BTE. The Indian Institutes of Management (IIMs) located in six cities

(Ahmedabad, Bangalore, Calicut, Kolkata, Indore and Lucknow) are institutions of excellence established by the BTE with the objective of imparting high quality management education and training, conducting research and providing consultancy services in the field of management to various sectors of the Indian economy.

In the second tier are the 17 Regional Engineering Colleges (RECs). These have been established, one each in the major States, to meet the growing requirement of trained technology manpower for various developmental projects. On the basis of the recommendations of a High Powered Review Committee, GOI has renamed 7 RECs (Allahabad, Bhopal, Calicut, Jaipur, Nagpur, Rourkela and Silchar) as National Institutes of Technology (NIT) and declared them as deemed universities for ensuring high standards of education and research in these colleges on the pattern of IITs. Over the years, the BTE has also established several other institutes for imparting quality education and conducting research in specialised areas. These include the Indian Institute of Information Technology (IIIT) at Allahabad; Indian Institute of Information Technology & Management (IIITM) at Gwalior; National Institute for Training in Industrial Engineering (NITIE) at Mumbai; National Institute of Foundry & Forge Technology (NIFFT) at Ranchi; Indian School of Mines at Dhanbad; Sant Longowal Institute of Engineering & Technology (SLIET) at Longowal; North-Eastern Institute of Science & Technology (NERIST) at Itanagar; School of Planning & Architecture (SPA) at New Delhi; and 4 Tecnology Teachers' Training Institutes (TTTIs) at Kolkata, Chennai, Bhopal and Chandigarh.

In addition to the above, there are a number of universities and deemed universities that have earned a name for themselves. These include Anna University in Chennai; Jadavpur University in Kolkata; Bengal Engineering College at Sibpur; Birla Institute of Technology at Pilani; Birla Institute of Technology & Science at Ranchi; Thapar Institute of Engineering & Technology, Patalia; Institute of Technology of BHU at Varanasi; Punjab Engineering College at Chandigarh; and Pune Engineering College at Pune.

Despite the efforts of the MHRD in implementing the National Policy on Education-1986 (revised 1992) and of the AICTE in regulating the technology education system and ensuring quality, several weaknesses have occurred in the system. Some of these are:

a) Due to multiple controls on the system, most institutions lack authority in matters of faculty appointments, student admissions, structure and content of programmes, student evaluation, and financial management;
b) Resource constraint combined with low resources utilization efficiency;
c) Wastage of available resources in the form of high dropout and failure rates;
d) Poor quality and relevance of programme offerings due to infrequent revision of curricula; delays in the conduct of examinations and declaration of results; and
e) Low quality of teachers and severe teacher shortages in areas critical for enhancing economic competitiveness (an AICTE estimate puts the total teacher shortage at 4,500 during the year 2000, and this figure is likely to increase to 5,000 unless schemes are devised to induct industry personnel for teaching and a larger number of postgraduates join the teaching profession).

The informal sector forms an important component of Indian economy. Selected polytechnics are being provided with central assistance by the BTE to develop trained manpower in the informal sector of the economy and the local community. However, the ongoing efforts are not adequate to meet the requirements of the informal sector and the community.

Vision, Mission, and Objectives for Technology Education

The Technology Education System in India has grown to covering more than 4,000 institutions with an intake capacity of more than 500,000 students per year and offering courses at the diploma, graduate and post-graduate levels in most branches of engineering and technology, architecture, pharmacy, computer applications, and management. The ready employability of engineering graduates particularly in the areas of Computer Science &

Engineering, Electronics & Communication Engineering, and Information Technology in the last few years have led to a large scale expansion of educational and training facilities in areas having both current and potential large demand.

The quality of education and training being imparted in the technology education institutions varies from excellent to poor, with some institutions comparing favorably with the best in the world and others suffering from different degrees of faculty shortages; infrastructure deficiencies; curricula obsolescence; lack of autonomy in academic, financial, administrative, and managerial matters; poor involvement in knowledge creation and dissemination, and poor interaction with community and economy.

Recognizing that skilled manpower of high quality can play a major role in economic development and in export of technology and services, and observing the growing demand for Indian professionals particularly in the area of software engineering in all parts of the globe including the highly developed countries, the GOI has decided to give very high priority to human resource development in engineering and technology.

Sector Context and Rational

Sector Context

With India opening its doors to multinational corporations and the advent of globalization and technological advancement, the need for improvement of quality in Technology Education system in the country is acutely felt to meet the requirements of industry and to enhance its effectiveness, efficiency and outreach for societal development.

Though the GOI and State Governments have intervened to avoid obsolescence in facilities and infrastructure in the institutions through several schemes (modernization and removal of obsolescence; thrust area development; quality improvement programs, etc.), obsolescence of facilities and infrastructure continues to be experienced due to rapid changes in technologies

and at times due to inadequacy of funding. The problem is aggravated by the absence of a system for regular maintenance of equipment and facilities. IT infrastructure is generally inadequate in institutions.

There are only the barest minimum laboratory facilities available in many of the institutions and consequently very little research activity is undertaken. In the absence of a culture for sharing of resources amongst institutions or with industries or R&D organizations, there is under utilization of resources and wastage. Engineering degree institutions and polytechnics have not succeeded to any noticeable extent in developing linkages with industry and community and rendering service to them even though these are considered essential activities of all institutions.

Industry often finds engineering college graduates weak in professional practice, thus necessitating long duration on-job training for making them professionally useful. There is also a mismatch between student demand/ labor market needs and institutional output and training modalities. In certain fields there is an over supply of skilled manpower resulting in large-scale unemployment. At the same time, there is shortage of skilled manpower in certain critical fields that are vital for enhancing economic competitiveness.

There is a general decline in the quality of education due to two major reasons. The curricula offered by most degree institutions today are rigid and outdated and do not meet the needs of the labor market. Curriculum implementation is also poor. The large scale and rapid increase in the number of degree and diploma level institutions during the recent past has led to an acute shortage of teachers in the technology institutions in general and in the newly introduced specialized disciplines in particular. Most of the teachers, due to lack of exposure to the recent advances in their fields, are unable to contribute to modernization of curricula.

Research and postgraduate education in engineering and technology is confined to approximately 200 institutions in the country. Nearly 50% of the

seats approved for post-graduation in engineering and technology remain vacant and of the admitted students, only 70% complete the course. Regardless of the parent discipline, most of the postgraduate in engineering and technology are absorbed in the Information Technology industry. Research has also suffered and the small annual out turn of PhDs (about 400) appears to be declining. As a result, there is an acute shortage of teachers with postgraduate qualifications, let alone doctorate in engineering and technology.

Global demand for IT professionals is increasing. According to IT Task Force estimates, the Indian IT industry would reach a level of US$100 billion by 2008, of which US$50 billion would be for software export, US$30 billion for domestic software consumption 11 and US$20 billion for the hardware sector. To achieve the target level, availability of quality manpower in IT is most crucial. India is not only lagging behind in the production of postgraduates and Ph.D.s' in IT but a good portion of those produced are not of the desired quality. Compared to 10,000 postgraduates and 800 doctorates produced in computer science per year in USA, the corresponding numbers produced in India are only 300 and 25. A Ministry of Information Technology report has indicated that only 30% of the out put of the IT supply sector is of quality acceptable for high level skills.

While the procedural (financial) audit, which is mandatory, is carried out in minute details, there is no systematic evaluation of institutional performance. There is no recognition or reward for good performance. There are no incentives for excellence. Also, feedback system from lower levels to higher ones, from students on courses taught, from employers (client system) and evaluation of teacher's performance is nonexistent in most institutions. There are wide variations between states and regions in the development of educational infrastructure. The southern and western states are well ahead in their capacities where as the eastern and northern states are lagging. Due to liberal policies, four states, namely Andhra Pradesh, Maharashtra, Karnataka and Tamilnadu have permitted establishment of private institutions, which admit 50% of the students on full fee payment basis. The quantitative increase

also had its repercussion on the quality of technology education due to mushroom growth of self-financing private engineering colleges/polytechnics in the country, particularly in the Southern region.

Higher Education as a whole including the engineering education, is highly subsidized with 90% of operating costs in most public funded/ aided institutions coming from the Government. In spite of shortage of funds, the atmosphere to generate resources is mostly lacking due to deficit-financing method adopted by governments. Fees charged to students by most public institutions represent no more than a small fraction of the real costs, and are governed by limits fixed by the concerned governments. While a few institutions in the private sector are utilizing the fee earnings and donations for providing high quality professional education, a large number of private institutions are being run on a commercial basis making significant savings by curtailing expenditure even on critical teaching and laboratory inputs.

Rational

It has been recognized that only by competing successfully in the globally interdependent world economy, can aspiration of Indians be met. For this to occur, production of technology manpower of international standards is a precondition. For overall development of each state and the country as a whole, investment in technology education is a must. GOI and states have been investing to produce quality manpower. Private initiative has also come but only in those areas where substantial demand has arisen. Because of lack of investment from private providers in areas that are crucial for nation's development (but may not have easy returns, e.g., new and 12 emerging technologies, research etc.), public funding of technology education is necessary to develop manpower in the crucial areas of market demand.

Indian policy framework (NPE-1986 and revised in 1992) and planned investment for the last 50 years has resulted in production of internationally acceptable manpower through such institutions as the Indian Institutes of Technology, the Indian Institutes of Management, etc. However, because

policies have not been implemented in the right spirit in all other institutions in the country, the overall picture considering all engineering and polytechnic institutions in the country is not encouraging. Efforts are needed to bring all these institutions to a high standard and improve the quality and responsiveness of the system as a whole.

Recognizing the importance of technology education for national development, the country has committed itself to the development of quality technology manpower, and already taken several policy initiatives. These are:

a) National Technology Policy Statement (1983)	d) National Policy Initiative for Technician Education (1998)
b) National Policy on Education-1986 (revised 1992)	e) Information Technology Policy (2000)
c) Technology Policy Vision for India 2020 (1996)	f) India as Knowledge Superpower: Strategy for Transformation (2001)

Strategies for implementation of policy directions through transformation of the technology education system have been developed through the work of several committees. These include:

a) Mashelkar Committee Report on Regional Engineering Colleges (1998)	e) IT Manpower Advisory Committee (2000)
b) Rama Rao Committee Report on Post Graduate Education in Engineering and Technology (1999)	f) Raju Committee Report on Networking of Engineering Institutions (2001)
c) Indiresan Committee Report on Technology Teachers' Training Institutes (2000)	g) Swaminadhan Committee Report on Mobilization of Additional Resources for Technology Education
d) Draft Policy Guidelines for Training Teachers of Polytechnics and Engineering Colleges (2000)	

There are several other initiatives planned. These are:

a) Mission on management of technology education	d) Expanding the role of Technology Teachers' Training Institutes to include staff development for engineering colleges

b) Upgrading Regional Engineering Colleges to National Institutes of Technology, and granting Deemed University status to some of them	e) Conducting national level competitive examination for admission to engineering colleges (this has already been initiated)
c) Encouraging private sector institutions to attain very high standards	

Because of shortcomings in the system restricting production of quality manpower, the GOI has decided to reform and enable the system through systemic transformation supported by reforms in policies governing the functioning the technology education sub sector. This is to be achieved through intensive drive for excellence in well-performing engineering colleges and some selected polytechnics to make the system much more demand driven, quality conscious and responsive to rapid economic and technological change occurring both at national and international levels. The system is planned to be reformed to not only address the needs of the organized sector of the economy but to also cover the needs of unorganized and rural sectors.

Through the well established policies, planned strategies and GOI and states vision of development for technology education system, the ground has been thoroughly prepared for the take-off stage which should bring in far reaching quality improvement in the technology education system. The Technology Education Quality Improvement Program of the GOI would support ongoing efforts of the Central Government and State Governments in this direction. The proposed program will focus on systemic transformation of the sub-sector to cover, among others, the following aspects:

a) Quality of education and hence the quality of engineers and technicians	g) Development of management capacity of officials at national, state and institutional levels
b) Quality of faculty	h) Encouraging strategic partnerships with specialist organizations
c) Promoting research culture	i) Leveraging technology for quality enhancement and extending outreach
d) Optimizing resource utilization	j) Empowerment of institutions with accountability

e) Interaction with and extending benefits to industry and community.	k) Enabling institutions to generate and retain finances
f) Enabling institutions to sustain gains from the program	l) Sustainable decision-making mechanisms

Conclusion: Challenges for Technology Education in India

The challenge is not whether technology should be offered or how it should be taught. The real challenge is how it will be possible for our country to maintain a competitive technological advantage if it continues to ignore teaching about technology and innovation. To maintain its superiority as a technological leader, our country must teach and emphasize the study of technology beyond its use a a delivery system for other subjects. As technology plays an increasingly important role in our society and affects our everyday existence, our ability to understand, use, and manage it in our daily lives requires that it become a significantly supported educational initiative rather than one ignored by legislation. Fortunately, the groundwork has been completed with help from our nation's most prestigious science and technology agencies. The important step in progress is the realization that our technological superiority and affluence as a nation will not continue unless our populace is educated to take advantage of the opportunities that now exist.

A major consequence of accelerating technological change is a difference in levels of technological ability and understanding. The workforce of the future must have the ability to use, manage, and understand technology. Indeed, technological literacy is vital to individual, community, and national economic prosperity. Beyond economic vitality is the realization that how people develop and apply technology has become critical to future generations, society, and even the Earth's continued ability to sustain life.

Suggestions for Policy Makers/Decision Makers to Advance Technology Education

Past funding for technology as a part of science, mathematics, and technology education has existed only when used as a delivery system for the other two subjects. Technology as a knowledge base or as a way of teaching

innovation where students are involved with tools, materials, processes, and resources to create solutions and opportunities has been omitted. The Department of Technology Education has undervalued the thinking and content applications of technology unless it has been tied into the delivery system for other subjects as in educational or instructional technology. The science and technology agencies have supplied funding to nurture this content area. At the same time, our society has become characterized as being very technologically oriented. However, legislation to support the thinking processes involved with and utilized in the creation of technology and innovation has been nonexistent. It is urged that the inclusion of technology in mathematics, science, and technology education legislation as a subject area with a knowledge base as used by engineers, hi-tech workers, designers, and architects rather than just a delivery system for the other subjects. Further, that the technology teacher be given the same opportunities as their peers in concept-based instruction and assistance with investigating the ideal scope, sequence, and curricula content in our country. This means requiring meaningful professional development for technology teachers through rigorous summer institutes that will further their teaching skills. Institute tax credits for beginning technology teachers with strong content preparation and tax incentives to businesses who provide assistance to local schools to help with science, mathematics, engineering, and technology teacher enhancement could advance the progress towards technology study.

Section Three

Models and Variables for International Cooperation

Finnish - Zambian Bilateral Project for "Practical Subjects" : 1974-90

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Introduction and Background

Education is generally supposed to be one of the most important factors for national development. Development projects/programs have been aimed at developing literacy and through that prosperity and technological independence. Development of the industrialized countries has been a model. Development aid in education was usually started by missionary stations. At independence nations usually became aware of the broader needs for education, and the national education systems were created. At the dawn of new technology there are new needs.

Zambian Education History

History can be divided in various periods:

1. During the colonial time churches took care of education, particularly of Secondary Schools.
2. Zambia became independent in 1964. In the beginning the school system remained as it had been, focusing on literacy.
3. In about ten years the Government decided about the school reform and new curricula. It was realized that there was a lack of craftsmen and a request was made in 1974 to the development aid authorities in donor countries to give assistance in education in order to guarantee career interests of the Primary School leavers.

Concerning technological education vocational institutions were already

existing in the country at the colonial time, even Technical Secondary Schools, and skilled craftsmen were trained properly. Problems were born after 1964 when the respect of white collar work grew greater than respect of blue collars, and practical subjects, where ever they were realized, were removed from the Primary schools.

The yearly population increase in Zambia has been great. That has caused increasing problems in education and in allocation of funds for schools, school construction, teacher training, textbooks, etc. The Primary School enrolment statistics show the increase (see Table 1).

Table 1. The Increase of Primary School Enrolment Statistics.

Year	Total Primary school enrolment statistics
1964	74,643
1969	127,163
1974	146,555
1979	162,520
1984	205,606
1985	217,476

Source: Ministry of General Education. Youth and Sport. 1989; in Coombe, et al. 1990.

At the same time of that massive enrolment increase the Unit Expenditures for Education have been strongly decreasing (see Table 2).

Table 2. The Decrease of Unit Expenditures for Education.

	1970/74 to 1975/79	1975/79 to 1980/84	1980/84 to 1985/86	1970/74 to 1980/84
Primary	-15.3%	-19.9%	-38.3%	-32.1%
Secondary	-34.0%	-25.7%	-42.8%	-51.0%
Teacher Training	-32.2%	-13.8%	n.a.	-41.6%

Source: Kelly, 1988; in Coombe, et al. 1990.

Development Aid

The philosophy of development aid has also gone through various development stages:

1) During the colonial time the development aid was usually given by the churches. The approach was versatile, developing agriculture and literacy and training craftsmen. At that time most of the infrastructure was also created: electricity, roads, railroads and water reservoirs were constructed.
2) In 1960s, 70s and 80s, when the developing countries began to strive for independence, the global "white man's consciousness" was awaken and various kinds of development aid projects were organized. The project director or teacher from overseas was called "The Expert". The projects were mostly transfer of technology; continuity for creating the infrastructure; constructing power stations, waterways, agriculture systems and industrial facilities. Skill education was a natural part of the projects in order to be sure about maintenance of technology after the project. The leadership of the projects was usually at the hands of the ex-patriots; the local people were trainees and workers.
3) In 1980s and 90s a new idea was born in development aid ideology: Aid should start only from the national (recipient countries') initiatives in order to guarantee the success. The idea was to commit the governments to take care of the continuity of the programs, when the ex-patriots would leave the country. As well funding was given to the local authorities instead of keeping it in the hands of the ex-patriots.

Finnida

Finnida, the Finnish International Development Agency was founded in the 1970s when the idea of development aid spread globally. The Swedish aid was one of the models. Zambia was in 1980s and 90s one of the main receivers of the Finnish aid. Another African country focused at that time was Tanzania.

Funding the Finnish aid programs has had some problems in the home country. The total is decided yearly in the government budget. Recommendation of United Nations has been 0.7 % of the GNP, but the Finnish share has in average been closer to half of it and nearly never fully realized it, except in 1991 it was once high enough, 0.8 %. Finland also has in the past been careful for the funds given as aid. E.g. SIDA, Swedish

International Development Agency, gave already in the 1990s funds directly to the recipient government offices to be used. That worked but there were often some problems; e.g. it was possible to use the funds for other purposes than agreed in the yearly aid negotiations. Finnida kept the funds strictly in hands. That can be called a "from top to down" –approach. In the 1990s it was, however, considered as the best way to guarantee the success of the aid.

Later on the interests to give also multilateral aid have been increased. Through that the Finnish authorities have had the representatives also in the global funding agencies, World Bank and IMF. Today part of the aid is channelled through European Community, Also the Non Governmental Organizations (NGO's), have increased their share.

In the 1990s Finnida decided to strengthen education personnel in order to anchor the projects better in education systems. Also a school textbook project for SWAPO (Namibia) had begun in the 1990s. Later on it was started also in Zambia. The National Board of General Education (NBGE) was asked to take the responsibility of the Zambian Practical Subjects project administration in 1986. NBGE refused because development aid did not belong to the duties of another government agency. (In 1986 there was a Law in the pipeline about collaboration of different government branches in development aid but not ready for positive decision.) University of Jyväskylä was asked the same, and it refused. Rauma Teacher Training Institute, University of Turku, was also asked, and it agreed. So the project was administered in 1986 – 90 by Mr. Kolehmainen, who worked as an inspector in the project in 1980 – 82, and later on wrote his doctorate about the project (Kolehmainen, 1988; in English 1990).

The Finnish education aid history can be seen in four different streams:

1) The church aid, which was strongest, however, in Namibia in the 1900s, but is today spread all over the world and also channeled through Lutheran World Organization. Also the other NGO's can be counted in this group. even if they had their strongest growth in the 1980s.
2) The first steps in education project aid by Finnida were taken in 1974 –

1988.

3) Instead of projects the co-operative assistance increased from 1988 on. That might also be called "associate education aid".
4) The aid channeled through the EU.

Every stream was also continuing during the following streams.

Today there might be a new growth becoming. The NGO's and other interest groups are demanding raise in the aid funds. As well the Finnish development aid agency is following keenly the development of interests of the international organizations. United Nations, UNESCO and UNICEF have recently emphasized development aid. "Education for All" started in 1991. In 2000 the UN gave the MDG (Millennium Development Goals) Statement focusing on the problems of development in the world, e.g. to halve the poverty in the world before 2015. In 2003 – 2012 the UN has "the Literacy Decade" particularly for the poorest countries and women. "Essential life skills" (UN, 2002, A/57/218) might be focused also on Technological Education.

Practical Subjects

Zambian government asked for international aid for education. Finland offered the services, and a bilateral Finnish-Zambian Practical Subjects (PS) project began in 1974. The aim was briefly "to assist in re-introducing Practical Subjects Teaching in Zambian Upper Primary Schools". Also two other education projects; consultation for Audio-Visual Library Services and Special Education, began at the same time. Before that Finnida had no experiences in education projects. As well the first teachers recruited as experts or specialists had not so much experiences about development aid or of work abroad. So the projects were practical experimenting, learning by doing.

According to the Zambian Primary School curriculum Practical Subjects was supposed to be elementary woodwork and metalwork education at general education schools at "Upper" Primary grades. The Secondary Schools already had Industrial Arts education, which was more or less vocational. The project

started by recruiting a couple of Finnish teachers. Because of the lack of the facilities in the schools the start was to organize a tool box to be given to every Primary School. The tools were selected together by Zambian and Finnish authorities. Finnida organized short training for the new personnel. Also some Summer University courses were organized. From 1977 on teacher training in PS began in Zambia. Every Primary School teacher was trained in the 1980s and 90s in woodwork and metalwork skills, even female teachers.

Lecturers were trained for the Teacher Training Institutes in 1983. Workshops were designed and constructed for the 12 Teacher Training Colleges, and equipped with tools and machinery. As well workshops were planned and constructed for Upper Primary schools from 1982 on. Totally in 1974-90 the project trained about 10,000 teachers, donated about 3,000 tool sets and constructed PS workshop for about 35 % of the Upper Primary schools.

Author's Participation

The author's practical participation in the project happened in 4 evaluation tours in 1978 – 1988, about two weeks each, and during 15 months in 1.10.82 – 31.12.83 as an invited "Training Specialist", training PS "Regional Advisors", who were supposed to become lecturers at the 12 Teacher Training Colleges. There were 27 trainees, and 23 of them were posted 1 – 2 months after training.

The author was never responsible for the project as a whole. Statements were asked by the Finnida officials on details quite often, because the author was taking care of the same education in Finland. As the first information about the project at the international forum a conference paper was written by the author in 1984 (Kananoja, 1984) and presented in Stockholm, Sweden. At the last visit (1988) the author made PATT research for pupils and teachers in Zambia and published the document in a conference in the US (Kananoja, 1992).

In a piece of research finally made about the project (Kolehmainen, 1988 &1990, p.65), the year 1983, when the author was working in Zambia, is

missing; deleted or forgotten. Also in that year some progress was done, however:

- An academic training course was organized and run for 27 teachers by the author. It has been called an "in-service" training course. It, however, gave a competence as a college lecturer and an upgrading, so actually it was further training.
- The first real PS model workshop in the project was constructed in the course program and a guide booklet on it with slides was published (Kananoja, 1984).
- PS education in all the 12 Teacher Training Colleges was supervised twice by the course lecturers during the teaching practice of the participants.
- Publishing pedagogical literature in the project also began. Every course participant wrote a thesis and every lecturer wrote his/her lectures. These papers, 27 thesis and 5 other quite comprehensive booklets, were published in 1984 (ed. Kananoja).
- A piece of research was started by sending a questionnaire to the regional and municipal education offices in order to find out the impact (Kananoja). Unfortunately full response was not received before the end of the author's contract.
- Four new Finnish staff members were introduced in their jobs.
- The author worked as the only Finn at the project headquarters in Lusaka about half a year in 1983.
- Practical negotiations with SWAPO (Namibian refugee administration), UNIN (United Nation's Institute for Namibia in Lusaka) and SIDA (Swedish International Development Agency) were started about collaboration. SIDA had a project called SHAPE, Self Help Action Plan for Education.

Later on also the Finnish school authorities were interested for education projects, and the author became a member and NBGE representative in home country in 1990s in two "Specialist groups on development aid in education" both in the Ministry of Foreign Affairs and in the Ministry of Education. A similar group was run also in the NBGE by the author.

Development aid should be bilateral. That should also mean activation of "development aid atmosphere" in the donor country. With that in mind the author wrote articles in teachers' journals and activated the Finnish schools, teachers and pupils, in order to help them to find out the importance of development aid. Schools produced in Finland about 5,000 agricultural hoes for Zambia in 1984-85. They were delivered in Zambia by the author and the Chairman of the Finnish Technical Work Teachers' Association in –85. As well a friendship relation began with the Zambian Association. Unfortunately after some months the contact efforts were not successful any more.

Project Evaluation

In 1990 the project ended. It had been a long lasting effort. The final evaluation of the project was made in 1993 by an evaluation expert from the UK, Dr. Cracknell. The report was very critical. Actually the criticism was directed to the aid authorities for bad planning and organization, not to the personnel. The problems were e.g. "...missing policy support and 'negative attitude' from the side of the major target groups and involved parties" (Finnida, 1994). However, the veteran experts were not very happy when listening the publication of the report. It seemed that the evaluator had not so much experiences in education. He had also used some problematic references as his basic material, and obviously did not have all the important ones. The approach seemed to have been quite narrow.

One of the "findings" in the evaluation was, that the project was done too early(!); the Zambian education and aid authorities were not ready for it. However, at the same time when the evaluation took place there was a big evaluation research as an impact study going on by UNZA, the University of Zambia, and some of the results were already available. The attitudes of the parents, education authorities, teachers and pupils towards practical subjects and the project were very positive. The economic situation in the country had also become worse than before, and the need for advancing practical education and so supporting local entrepreneurship had become greater. The preliminary results of the research and the possible new positive support for the subject

were commented in the evaluation report as "A More Hopeful Scenario Ahead?" (Finnida, 1994, pp.28-29).

Unfortunately the negative criticism of the PS project seems to be long lasting. E.g. in "Synthesis Study on Evaluations and Reviews, 1988 to mid-1995", the sad history of the project is represented once more, and "ironically", as it is said, "...the need and positive attitudes for same type of aid are increased after the termination in Zambia" (Koponen, et al., 1996, pp.149-150).

The idea was that Zambian government should gradually take care of the subject. However, after 1990, the status of the subject has been weakened in the schools. Quite many PS classrooms have been taken for academic subjects and most of the tools are not anymore in the schools; they are disappeared, stolen, sold, replaced, etc. The stress from the academic subjects at the school level has grown and the "weak" new subjects like PS have given room for them. There has been no general public idea of the benefits the PS could bring for the society. The education officials had the traditional Secondary School and University education, which did not mediate the message of the importance of economic-technological education.

Discussion

The PS project has been accused for bad approach in the terminal evaluation. However, the "wrong decisions" were done generally in the project administration in Finland or in Zambia. Usually the problems were discovered when it was too late for changes.

Project essentials:

1. The start for the project was a request from Zambia, not an one-sided push from Finland. - The project has been criticized e.g. about being too much "top-down planning". It was, however, the only usual method in the 1980s – 90s. When the new approaches came, they were not immediately introduced to the project.

2. The need for practical subjects in Zambia was real and urgent before, during and after the project. The effort was to satisfy that need. However, termination of the project was not done appropriately.
3. Generally the attitudes of the public towards the project were positive. That was taken care of by organizing information in the Zambian Press, Radio and TV about the project (mostly by experts Vuojala and Rasinen).
4. The project was quite reasonable considering the costs and the scope; PS reached all the regions, education administrators, teachers and pupils (and families) in the country and had the potential to start a real national economic-technological development.
5. "Zambianization" happened naturally in the project administration. The project was done at the Curriculum Development Centre under Zambian leadership and with Zambian colleagues; each Finn having a Zambian counterpart. Commitment increased naturally, when the older teachers and officials had new vacancies and trips to and opportunities for studies in the donor country. The project funds were, however, in Finnish hands.

Problems

Throughout the project duration, the following problems were identified:

1. The project lasted for about 16 years. The projects of technology transfer, which the Finnida people knew best, usually are quite short and easy to administer; the machinery will be imported, training is done, production will start, maintenance is taken care of. Instead of a couple of years, in education the projects should last at least one generation; that was not internalized at Finnida.
2. More attention should be given to project planning. When aid comes from post-industrial culture to a country where a mixture of pre-industrial, industrial and post-industrial cultures exists, a thorough consideration about the program should be done. In practical education it should mean quite versatile basic skills. – Considering the cultural factors in this project, they would not mean focusing on traditional crafts technologies, because the respect for "Western technologies" was the start of the project, but relating the project with local needs. On the other hand, more attention,

especially in the beginning of the project, could have been given also to local skills.

3. The Finnida personnel had inadequate experiences in education or education projects. The yearly task of the development aid personnel was to use all the government money given. The work done in the office for PS was the same as for a project in technology transfer, which used hundred times more funds. As well it is usual in the administration to switch the vacancies; so one administrator was responsible for the project maybe only for one year; then another ignorant one had the post, etc. The decisions were not based on expertness on a special field, in this case education.
4. The Finnish experts did their work mostly as well as they could in a different and exotic culture. One of the problems might have been that the experts were possibly also too independent. An expert was working usually for two years and had the freedom to introduce new ideas. When he left, the following expert had different ideas to introduce. – The project documents gave the "terms of reference" for the project but they were quite broad and permissive. As well the statements and requests in the evaluation reports were usually not fully followed or realized. It seemed that nobody took care about these problems in administration.
5. To write the final evaluation of the project when a relevant research project was in the pipeline was one of the mistakes in evaluation. – This was also due to the changes of Finnida personnel. – It would have been taken only one more month to wait for the final research results from Zambia.
6. It seemed that there was an order to finalize the project with the 1993 – 94 evaluation. In private correspondence between the author and the evaluator, the latter strictly denied the possibility of an "ordered termination statement". However, the evaluator says in the report: "... Finnida came too early...- ...and backed out too soon..." (Finnida 1994, 5). So it is evident that an euthanasia was ordered for the project.

Continuation?

Towards a sustainable international assistance model, the following

observations were identified:

1. Finnish Development Agency has later on acknowledged the importance of education in development aid. Finnida (Government Office) has education personnel today. In the National Board of Vocational Education there was an office for development aid, "FTP", "Forestry Training Project". That office is privatized now and has taken responsibilities for also general education under the same abbreviation which now means, however, "Finnish Training Partners International".
2. Development aid today is given more and more as co-operative assistance, not as projects. E.g. in education the donor sends personnel to the Ministry of Education in a developing country. That assistance will influence the authorities and the system as a whole. In Zambia these "associate education persons" have been working later on for a couple of years. However, they could not anymore focus on PS only but had to advice the whole education sector.
3. It seems that education as a sector has not been very independent in the Finnish development aid. In the yearly program reports it is quite often handled under chapters of culture or social and humanitarian aid. Maybe the low number of programs and low funds are the reasons to hide education under more comprehensive titles.

Lessons Learned

Through participation in this project, the following lessons were learned:

1. Development aid projects should have leadership of experts of the areas concerned. If that kind of personnel does not exist in the project management, it should be hired.
2. The "experts" should be well trained before leaving for the project.
3. A project should be evaluated only on its original philosophy. If the development aid philosophies change, it is the problem of administration, not of the project itself. New ways in the air for project planning or running should not be decisive when making decisions about the long-term project and its possible continuation.
4. If requests, new needs or problems are expressed by the evaluation teams

in the official evaluation documents, the project administration should appreciate them, make efforts to satisfy the requests and solve the problems immediately.

5. Successful aid is crucial; form of aid not (should it be a project or assistance).
6. Attitudinal problems of administration in evaluating the impacts or considering the results of research should be solved.
7. Education should be considered as a special area, where the inputs should last a lot longer than in other areas or fields of development co-operation.
8. If development aid is done in practical education, teaching, teacher training, etc., it is utmost important, that the administration personnel should also have field experiences in it.
9. Concerning technological development aid:
   - Tools from a donor country might be the most valuable possession in the village, "new technology".
   - If a major part of the population is living in the countryside in pre-industrial society, aid should cover all the possible development stages of technology.
   - The possible need to "jump over" the western technological development stages from pre-industrial to new technology should be thoroughly considered both in project administration, in a single village and schools.
10. Concerning evaluations, the approach – and so most of the end result – is naturally dictated by the donor. Also the evaluator usually has the "need to come again". So the evaluations in 1978 – 1988 maybe did not "want to rock the boat" (Finnida 1994, p.26) because the idea was to survive and continue. In final evaluation the order seems to have been to sink the boat, and it was done. So all the evaluations seem to have fulfilled the expectations...

At the moment there seems to be no intentions to start any Practical Subjects programs more at Finnida – even if there might be needs in many countries for that kind of co-operation. – The assistance has new strategies as mentioned. With these the responsibilities for development and impact will also be on the

recipient country. The only problem of the donor will be to have good enough manpower, "...exceptionally well-qualified and experienced educationists as Education Advisers..." (Coombe, et. al., 1990, p.x). That would presuppose a lot of training, support for educationists to have the first experiences in developing countries, research projects, international attitudes, etc.

The NGO's have after the PS project also been interested in Practical Subjects' activities. Finnish Voluntary Services (FVS: KEPA) started in the 1990s a couple of projects on Finnida funds in Namibian (SWAPO) refugee camps in Angola and also in Nicaragua. These consisted of woodwork shops for furniture production, brick making and house construction. As well a Technical Secondary School was supported in a SWAPO camp in People's Republic of Congo. The author has been participating also in planning and following up these efforts.

Concerning the global movements for eradicating illiteracy and poverty in the world according to the resolutions of the UN and Unesco, the author is happy having had the opportunity to participate in the progress. Working in Zambia actually gave the start for "thinking globally, acting locally". The author's doctoral research on the development and dependence of technology education on social and industrial development was started. To become acquainted with the conditions in Zambia gave a new and different starting point and realization for the idea of socio-cultural development. Later on the author had the opportunity to participate a Conference for Education for All in Nice in 1990. As well a conference called "Technology Education for All" was organized by the author in Finland in 1991.

It is my hope that this meeting in Japan and book to follow will have success also in the form of development co-operation in developing countries.

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International Cooperation in Technology Education: A Review of Three Cases

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Introduction and Background

New World Learning

A technologically rich knowledge-based economy relies primarily on the use and generation of ideas rather than highly skilled physical abilities, and on the appropriate application of technology rather than the transformation of raw materials or the exploitation of unskilled labor. Knowledge is being developed and technology is being applied in new ways. Product cycles are shorter and the need for innovation is greater. Trade is increasing worldwide, increasing competitive demands on producers. The global knowledge economy is transforming the demands of the labor market in economies throughout the world. It is also placing new demands on citizens, who need more technological skills and knowledge to be able to function in their day-to-day lives.

Equipping people to deal with these demands will require a new cooperative model of education and training, for lifelong learning. A lifelong learning framework encompasses learning throughout the life cycle (from early childhood to retirement). It encompasses formal learning (schools, training institutions, universities); non-formal learning (on-the-job and household training); and informal learning (skills learned from family members or people in the community). It allows people to access learning opportunities as they need them rather than because they have reached a certain age.

Lifelong learning is crucial to preparing workers to compete in the global economy. But it is important for other reasons as well. By improving people's ability to function as members of their communities, education and training increase social cohesion, reduce crime, and improve income distribution.

Developing countries and transition economies risk being further marginalized in a competitive global knowledge economy because their education and training systems are not equipping learners with the skills they need. To respond to the problem, policymakers need to make crucial changes. They need to replace the information-based, teacher-directed, directive-based rote learning provided within a formal education system with a new type of learning that emphasizes creating, applying, analyzing, and synthesizing knowledge and engaging in collaborative learning throughout the lifespan (McCombs, 1991). This paper briefly reviews cases in Chile, Egypt, and Belize where collaborative efforts in implementing technology education programs have served to meet the life-long learning goals of citizens while enhancing their technological literacy (Sadler & Schwartz, 2000).

Developing Citizens to Participate in the Global Economy

In traditional industries most jobs require employees to learn how to perform routine functions, which, for the most part, remain constant over time. Most learning takes place when a worker starts a new job. In the technologically based knowledge economy, change is so rapid that workers constantly need to acquire new skills. Businesses can no longer rely solely on new graduates or new labor market entrants as the primary source of new skills and knowledge. Instead, they need workers who are willing and able to update their technological skills throughout their lifetimes. Countries need to respond to these needs by creating education and training systems that equip people with the appropriate prerequisite skills of thinking technologically.

The foundation of such technological thinking can be taught in technology education based activities such as problem solving, designing, creating, and making. These activities are instructional strategies that support unique ways of coming to know technology and do technology. The cognitive processes that students' develop while engaged in technological activities support the fundamental underpinnings of the new world learning being called for by such international institutions as the World Bank and UNESCO (Adey & Shayer, 1994; Hernán & Marín, 2001)

Basic Literacy.

Today's one-world economy demands that people develop their knowledge and abilities to their fullest potential. A significant part of this developmental process and one measure of success is the development of a globally literate society and literate individuals. Raising literacy levels and lowering illiteracy levels are significant challenges in every one of today's societies, and particularly a challenge to our 21st century educational systems.

A literate person is commonly referred to as an educated and cultured person and as might be expected, functional levels of literacy vary from one society to another and from one individual to another. To the layperson, literacy is often associated with reading and writing, and sometimes even speaking and mathematics. But there are many other important forms of literacy including music literacy, art literacy, history literacy, technological literacy, social studies literacy, etc., that also deserve equal attention in our one-world economy. And today, a new form of literacy is gaining the attention and respect of all the inhabitants in our one-world global society. It is called technological literacy. A person cannot attain a functional level of technological literacy, however, unless a functional level of the basic literacy's has first been achieved.

Technological Literacy.

The responsibility for the development of a technologically literate and capable global society does not reside with one nation or even a small group of nations, nor does it reside just with our nations' individual educational systems. The responsibility resides with all the inhabitants of this great planet Earth. As our one-world economy continues to be fed by the technological engine of change and thus grows increasingly dependent on technology, it heightens our awareness that the study of technology in a formalized teaching-learning environment has become the international imperative for the21st century.

All the inhabitants of our global society are stakeholders in this technological literacy effort. As educators, we have an important role to perform and we need to perform it well. We need to ensure that all students who leave our

educational systems have an understanding of the history of technology and the very nature of the technological world in which they live (Pearson & Young, 2002).

If the key decision makers in our educational systems are to design and implement programs that align with our world leaders' perspectives, then they must strongly encourage and fully support the creation of life-long teaching-learning environments that communicate to our greater global society the importance of learning about technology and learning to do technology through appropriate application, research and inquiry. The subject area that supports these teaching-learning environments is commonly referred to as technology education or applied technological studies. Technologically literate and capable people possess the ability to use, manage, apply, assess, and understand technology. In other words, technologically literate and capable people know about technology, they know how to do technology, and in the process of "learning about" and "learning to do" they also learn how to assess and apply technology at a level commensurate with their cognitive, psychomotor, and affective stages of development in applied contexts with human intervention (Bugliarello, 2000).

International Cooperation in Technological Education

Within our efforts to develop a technologically literate and capable global society, we must always be cognizant of the fact that it is impossible to know everything there is to know about every technology that has ever been developed or that will be developed at some future point in time. Furthermore, it is short sighted even to attempt to design a program around such an endeavor. It is possible, however, for teachers and educational systems to spend their productive time in a classroom-laboratory environment teaching and researching applied technological concepts and principles. The resulting goal, therefore, would be to prepare students with a deep understanding of the application of technological systems, theories, and principles with the ability to manage technology and its place in our one-world economy (Martin, 2002). However, these goals often remain elusive in developing countries and

transitioning economies.

The challenges facing education and training systems in developing and transition countries are immense. They must raise the level of achievement of learners in the basic skills of language, mathematics, science, and technology. They must equip learners with new skills and competencies. And they must do all of this for more learners with different backgrounds, experiences, levels of motivation, and preferences. Achieving these goals requires a fundamental change in the way learning takes place and the relationship between learner and teacher. Fundamental issues addressed in initial implementation of teaching and learning programs designed to achieve functional levels of technological literacy require a new understanding of how students learn.

Shared Lesson Number One

Of first concern and a prerequisite across each of the cases reviewed is equipping learners with the skills and competencies they need to succeed in a technologically driven knowledge economy. This requires mastery of a set of knowledge and competencies. Three categories of competencies have been found to be of critical or "key importance" (OECD, 2002; Rychen & Salganik, 2001):

- *Acting autonomously*: Building and exercising a sense of self, making choices and acting in the context of a larger picture, being oriented toward the future, being aware of the environment, understanding how one fits in, exercising one's rights and responsible, determining and executing a life plan, planning and carrying out personal projects.
- *Using tools interactively*: Using tools as instruments for an active dialogue; being aware of new tools; accommodating to the potential of new tools; being able to use language, text, symbols, information and knowledge, and technology interactively to accomplish goals.
- *Functioning in socially heterogeneous groups*: Being able to interact effectively with other people, including those from different backgrounds; recognizing the social embedded nature of individuals; creating social capital; being able to relate well to others, to cooperate, and to manage

and resolve conflict.

The concept of competency has several features. Competency is strongly related to context, combines interrelated abilities and values, is teachable (though can be acquired outside of the formal education system), and exists on a continuum. Possession of the key competencies contributes to a better quality of life across all areas of life. Performing in the global economy and functioning in a global society requires mastery of technical, interpersonal, and methodological skills. Technical skills include literacy, foreign language, mathematics, science, technology, problem-solving, and analytical skills. Interpersonal skills include teamwork, leadership, and communication skills. Methodological skills include the ability to learn on one's own, to pursue lifelong learning, and to cope with risk and change (Pellegrino, 2002).

Measurement of interpersonal and methodological competencies is in its infancy. Some private businesses use personality testing, and many companies and organizations are trying to measure interpersonal skills as part of performance evaluations. Nowhere, however, has a set of national (or even local) expectations of performance been established. In contrast, most countries have standards for technical skills and several have been tested across countries (Pellegrino & Chudowsky, 2001).

Chile

Technical and Technology Education in Chile

The links between teacher education and technology education have taken a particular direction in Chile which is related to the educational reform currently on course, and within the context of this reform to the program implemented in schools since 1995 known as ENLACES. The Chilean education system comprises a total of 12 years of schooling of which the primary level (Basic Education) is of 8 years and the secondary level (Middle) is of 4 years, offering general and technical-vocational curriculum in separate schools or comprehensive ones. The majority of schools in Chile are State subsidized but may be managed by municipalities or private institutions. There are also a

small number of non-subsidized private schools.

The educational reform that begun in the early nineties focuses, within the perspective of improving quality and securing equity in educational provisions, on four main components:

- Improvement programs at basic and secondary education levels. Technology education is now required for two hours per week for each basic education student in grade 5-8.
- The production of curriculum frameworks that may be operationalized at school level. Technology education has a specific curriculum framework as a result of the educational reform effort.
- Lengthening of the hours of schooling and of the school year.
- Strengthening the capacity of the teaching profession. A major infusion of professional development has been made available to teachers. In recent years specific in-service training have been conducted for technology education teachers at the Universidad de Atacama, located in Copiapo', Chile.

The World Bank approved a $75.75 million loan in March, 2002 to support Chile's initiative to provide basic, secondary and technical/technology education and training programs to adults, especially unemployed youth and the working poor. The program aims to ensure that Chileans acquire the skills and knowledge needed to meet the demands of a competitive, rapidly-changing economy. A World Bank representative recently commented that "Chile has made enormous progress in the last 10 years in improving the quality and coverage of primary and secondary education, and now it is time to focus more attention on those who have already left the school system," said Myrna Alexander, the World Bank's Country Director for Argentina. "This program will raise the standard of that education, by upgrading workers' reading, writing, problem-solving and analytical skills."

The Lifelong Learning and Training Project will concentrate on strengthening the capacity of low-income and poor adults, by providing them with a range of basic and secondary education and training opportunities.

improving the quality of technical/technology education, and strengthening the institutions that deliver training services.

"Chile will benefit by having a more highly-skilled labor force that will make the country more competitive in the global economy," said Juan Prawda, World Bank Project Task Manager. "A more competitive labor force contributes directly to reducing poverty."

The project will enable about 120,000 adults to complete and certify their basic and/or secondary education which includes instruction in technology. Another 142,000 technical secondary education students and 65,000 technical tertiary education students will benefit as their training facilities will improve, and 250,000 adults will gain access to distance-education training modules. The project will support the training of 12,000 workers of about 6,000 small and medium enterprises. In addition, the project will establish a system of national competency framework in nine sectors of the Chilean economy.

Arab Republic of Egypt

Technical and Technology Education in the Arab Republic of Egypt: The Mubarak/Kohl Project

The National Technical and Vocational Education and Training (NTVET) program aims at upgrading technical education and vocational training in the Arab Republic of Egypt. With extensive cooperation from the Federal Republic of Germany, the program focuses on industrial secondary schools, aiming at upgrading education and training in such, gradually becoming similar to what is being applied in Germany in terms of following a cooperative system (the Dual System) for education and technical training. The program goal is align the system with the requirements of the labor force, in order for program graduates to qualify for direct entry into the local labor market. The Program is based on the participation of main partners to train and qualify trainees, being: Private and Public sector companies, government agencies and ministries, and community leaders.

The program at 10th of Ramadan City (TRC).

One of the best methods to present a brief overview of how industrial and technology education programs are organized and delivered is to present a simple case. The following describes a typical technical training program implemented under the NTVET program at 10th of Ramadan City.

Surveys at the project location indicated, there was an urgent need for skilled mechanics and electricians able to maintain and repair modern factory equipment. The local textile industry was looking for qualified ready-made garments workers, spinners and weavers. For these vocations, a 3-year training program was established in September 1995, following the German dual system of vocational training adapted to Egyptian needs. Ninety factories took part and signed training contracts with 250 trainees.

Objectives and implementation.

The objectives of the program are to ensure that the trainee stakeholders and the responsible agencies of the NTVET Dual System implement a joint program that is focused on the future oriented needs of the Egyptian economy, respond to local economic and technical training needs, and contribute to the strengthening of the national system for industrial and technical training. In order to meet these program objectives, trainees attend a technical secondary school (Sultan El Ewais School and Experimental Technical Secondary School) twice a week, where they are taught general knowledge and technical theory.

Practical training takes place in the factories four days a week. It is complemented by special courses carried out in training workshops. Practical training is organized by the 10th of Ramadan City Investors' Association through a Regional Unit for Dual System (RUDS) office. The companies provide a monthly educational stipend for the trainees and contribute to the running costs of the RUDS.

Recently, four additional trades - weaver, shoemaker, spinner and construction mechanic have been added to the program. Currently, the project has 1,000 trainees under contract in more than 150 companies Twelve percent

of trainees are female. At the conclusion of the 3-year training program, successful trainees receive two certificates, one recognized by the Ministry of Education, the other by the Investors'' Association and the German-Arab Chamber of Commerce. In 1998 and 1999, about 450 graduates completed the training successfully.

In addition to the dual training, the project offers courses to upgrade the skills of staff employed by the partner companies. These short-term courses generate revenue that in turn is used to pay instructor incentives and finances school facility/workshop maintenance. To support the project, the German cooperative contribution supplies the schools with modern machines and laboratories, prepares the teachers and instructors for their new duties, and supports the factories in the practical training activities. The project's activities have expanded to other locations such as New Salheya, Alexandria, and Bilbeis, where similar training schemes have been implemented. The project summary and data for the case described at the TRC training site are shown in table 1.

Project Summary Data - 10th of Ramadan City

Official Program Name

Introduction of a Cooperative (Dual) System of Technical and Vocational Education and Training (TVET) – MKI-

Project Sponsor Agency

Ministry of Education

Egyptian Executing Agency

Association (TRCIA) and Private Sector Companies

Location

10th of Ramadan City (TRC)

Project Start Date

January 1994

End of Current Phase

December 2004

Table 1. Summary of Occupational Training Program Graduates and Student Demographics.

Occupation	Number of Companies*	Number of trainees and Out of This Number Female Trainees					
		1 Year		2 Year		3 Year	
		Total	female	Total	female	Total	female
Construction Mechanics	22	19	-	32	-	-	-
Electronics	47	81	27	79	7	69	3
Finishing	17	38	-	-	-	-	-
Mechanics	57	70	-	78	2	58	-
Ready-Made Garments	26	47	41	67	44	36	12
Spinning	12	19	-	37	-	-	-
Weaving	22	48	-	51	-	47	-
Total		323	68	344	53	200	5

Apprentices

Graduation year	Number of passed exams	Dropout rate in %	Failing rate in %
1998	202	1.5	0
1999	215	5.7	0
2000	216	4.9	0.4

Belize

Technical and Technology Education in Belize: Technical/vocational education and training project (TVET)

The Government of Belize (GOB) recognizes that there is a need to provide more cohesion and rationalization within the TVET education sub-sector through the introduction of effective national planning and coordination. In view of this, on January, 2000 GOB submitted an application which was approved a year later for assistance from the Caribbean Development Bank (CDB) in strengthening the technical and vocational training system within Belize. The objective of the project is to enhance the quality and capacity of the technical and vocational education and training (TVET) sub-sector of Belize to satisfy the skilled manpower needs, at the intermediate level, of the various contributing economic sectors and to increase the access to a wider cross

section of the population.

The project will assist in addition to the provision of new and enhanced physical facilities, open- entry/open-exit modularized programs to facilitate the training/retraining and certification of the existing employed labor force, the self employed, secondary school graduates, and unemployed who possess the necessary entry prerequisites. The competence and certification provided would enhance the earning capacity and social well being of those graduating from the programs to be provided by facilitating upward mobility in jobs and greater success in their entrepreneurial endeavors, all leading to a reduction in poverty levels.

Review of Technical and Technology Education

During 1999, the Ministry of Education and Sports (MOES) commissioned several studies involving the primary, secondary and TVET sub-sectors. These studies have informed the development of the Education Sector Strategy 1999-2003. The education sector of Belize, like others of the Region, comprises pre-school; primary; secondary and post-secondary/tertiary levels with TVET being integrated at both the secondary and the post-secondary levels. For the purpose of this review, emphasis will be place on the current situation of TVET.

TVET

TVET, which represents a broad mix of programs, intended to prepare students for entering and progressing in the world of work is offered at the secondary and post-secondary level of the system. Non- formal TVET is provided for out-of-school youths and adults through institutions and programs operating outside the formal school system by several Governmental agencies and Non-Governmental Organizations (NGOs).

MOES provides TVET through the Technical High and Secondary School and Centers for Employment Training (CET's). The Ministry of Human Development, Tourism and Youth through the Youth Department operate several non-formal programs for out-of-school youths. The Belize Organization

for Women and Development (BOWAND), Belize Enterprise for Sustained Technology (BEST), Youth Start Plan and the 4-H Club are some of the primary NGOs, which offer non-formal vocational education for out-of-school youths.

The Non-traditional Skills Training for Women Project and the Youth Start Plan, promote the participation of women in areas of technical and vocational skills where females have traditionally been under represented. The existing CET's, currently provides training to participants from these non - traditional programs, and is expected that this relationship will be strengthened by the project, which is expected to contribute significantly to promoting gender equity in TVET.

Through the six Technical High Schools and the technical departments of secondary schools, MOES provides technology education in a wide range of technical specialties, such as Building and Construction Technology: Home Economics; Food and Nutrition; Clothing and Textiles; Mechanical and Electrical Technology; Business Education etc., all leading to the CXC Examinations. These secondary TVET programs provide a foundation for career development and do not produce persons immediately ready for the workforce, rather these programs seek to foster a broad understanding of technology and serve as pre-vocational programs.

There is currently a high demand for TVET in Belize to meet the need for the estimated 14,600 new workers in the short term, as well as for improving the productivity of an estimated 67,000 existing workers in the workforce. Of the 11,720 students who are currently enrolled in secondary schools approximately 2,000 are likely to access post-secondary education. The existing CET's currently operate day and evening classes (CET- Belize City operates three shifts) at capacity and report a large unsatisfied demand There is also an urgent need to bring into the economic main stream, several thousand young people who are both educationally and socially marginalized by improving and facilitating access to education and training. While CET is not geared to deal

fully with this population, a small number who have qualified through GOB and the NGOs pre-vocational programs have enrolled in and benefited from CET programs.

The project, by focusing on critical TVET system issues, is designed to complement these developments and contribute to an effective, comprehensive and integrated education and training system capable of producing citizens with the kind of knowledge skills and personal attitudes and attributes which the country needs to drive its economic and social development.

Management

The Employment Training and Education Services (ETES) has specific responsibility to restructure and develop the country's TVET system to increase the TVET contribution to Belize social and economic development by significantly increasing the number of individuals who are qualified to be employed or self-employed. ETES is the service area, which is responsible for the development and coordination of CET programs. Centers for Employment Training are administered by Managers who report to the Director ETES and are responsible for the day-to-day operations of the Centre. They are supported by Assistant Managers who are responsible for training. Counselors and Placement Officers provide support services to assist with the rounded development of the student and facilitate access to the labor market.

Competency Based Education Curriculum Design & Certification

Unlike its academic counterpart, vocational/technology education curriculum is based upon identified occupational needs of a particular locale. That is, TVET programs provide occupational competencies, which are suitable and relevant to the local labor market and better serve the needs of business and industry and emerging technologies. Thus, curriculum justification extends beyond the school setting and into the community. Just as the curriculum is oriented toward the student, support for that curriculum is derived from employment opportunities that exist for the graduate.

The TVET programs which are in operation are derived generally from technical programs of regional and other overseas examining bodies (CXC, GCE and City and Guilds) which are not tailored to meet the specific needs of the local market conditions. In other cases, especially involving the pre-vocational and short courses, there are no properly developed programs where the curricula are determined and developed in a rational and systematic manner involving competent, technical and professional workers. This basic deficiency was found to impact negatively on the integrity and quality of the training.

In this light, competency-based methodologies are almost non-existent in the system with the exception of its use in the CET's since the inception of the first CET in 1992. Presently, MOES operates CET's in four Districts: Belize City, Cayo, Corozal and Toledo and GOB has committed to the establishment of at least one CET in each of the six districts to provide training in occupational skills which are suitable and relevant to the local labor market and economic opportunities. Furthermore, instructors both present and past were provided with various in-house training on competency based education methodologies. Most important to note, Program (Craft) Committees are established to provide guidance and relevance to curriculum development, implementation and monitoring of trainee achievement throughout their training.

The CET model is a holistic structure, which promotes the trainee as the centre of all training. Given the various needs and levels of trainees, an open entry/open exit system is ideal in ensuring that students start training when space is available and complete training whenever training requirements are met, based on each student's self-paced capabilities. Programs should be highly individualized since students start and finish training at different times, and require variable lengths of stays in order to complete their training. A prerequisite to the CET training is on-the-job training, which allows for a first-hand experience on the "real world". The success of CET's is placed on the rate of related job placement of its students. More specifically, the project assists in developing a more effective system geared towards modularized competency based curricula for levels I, II and III derived from agreed standards in the

relevant areas of:

- Agriculture Electronics
- Automotive Trade Building Trade
- Air Conditioning and Refrigeration
- Data Processing
- Tourism, etc.

These programs also include a core component of: Mathematics, English Language, Life Skills, inclusive of interpersonal relations and teamwork.

Development of Occupational Testing and Certification

Presently, there is not a national system for occupational certification, which can be used to place workers at the appropriate level of their competence within the workforce and assist business and industry with their proper selection, placement and remuneration. Future plans call for the development of an occupational and certification scheme appropriate for certifying the occupational competence of CET graduates as well as workers in the labor force who have acquired competence on the job but who currently have no certification. Work is currently being done that will develop systems and mechanisms for skills testing and verification of competence within CET and other approved institutions for the on-going assessment of competence for certification.

The TVET system in Belize is based on a model that is integrated and articulated at all levels of the education sector. The education and training system of Belize as a whole will be expanded with the introduction of CET's in all of the Districts. Training opportunities will be provided for more than 20,000 persons over the next ten years. Through their training, participants will enhance their access to the job market, productivity in the work environment, opportunities for promotion to supervisory and management levels, and potential for undertaking even more advanced training. The number of nationals employed within the country is therefore expected to increase significantly. Easy access to adequately trained manpower will also be an attractive inducement to potential investors, thus paving the way for further

expansion of the productive sectors within the economy and increasing the likelihood for the long- term economic and social advancement of Belize

Conclusion

The emphasis in this paper has been on presenting a brief overview of technical and technology education programs in three developing countries, Chile, Egypt, and Belize. In each case the overarching goal has been found to be the development of a technologically literate and capable citizenry or applied technology professional capable of participating in a one-world economy. In each countries case, a set of salient condition exist that have supported the success of each countries programs, albeit each quite different in scope and structure. The author has visited and observed each technical education program reviewed and offers the following as a basic guide towards cooperative implementation and planning of industrial and technology education programs.

Adopt a set of professional standards for the emerging technical/technology education program. The purpose of the standards should be to serve as a guide for all who contribute to the administration, management, and instruction of the technical/technology education program. Let the focus of the standards be on content, student assessment, professional preparation of students, and program development in accord with industry input and guidance. The content standards, for example, should serve as the basis for developing new technical/technology studies programs.

The content standards must:

(1) focus on the knowledge and abilities needed by a countries students in a formal or informal educational program;

(2) be developmentally appropriate;

(3) focus on the knowledge and abilities needed by a countries business and industry sector;

(4) provide a basis for developing meaningful, relevant, and articulated curricula at all educational levels;

(5) promote content connections with other fields of study, and

(6) promote active and experiential learning, research, technology management, technology transfer, appropriate, and sustainable technology.

Student assessment standards must be developed to assist in collecting information on student learning, understanding, and capability and using that information to inform instruction. Professional development standards for all who administer, manage, and teach in the program will guide in designing pre-service and in-service programs for the preparation of technical and professionals in a given field. Program standards will provide guidance in designing the technical/technology program – its program of study, curriculum and assessment, teaching, equipment and resources, and the teaching-learning and research environment.

A Professional Call to Cooperative Action

As you can readily see, there is much work that needs to be done and we haven't even mentioned anything about the act of implementing a technical or technology program. If we are serious about developing international cooperation and developing world-class technical/technology programs that hold as its product the development of a functional professional level of technological literacy and capability in every student, then we will have to commit ourselves to sharing expertise and investing in human capital.

A technology education program that is institutionalized at the early stages of a students formal education has the potential to invigorate an entire educational system with high interest, student-focused content; we will have developed a program that empowers all students; we will have developed a program with totally new concepts and a totally new way of looking at our technological world; and we will have created a teaching-learning and research environment that prepares students to be capable problem solvers, who know that the solutions developed to solve one technological problem may in fact create other technological issues and problems, who appreciate the relationships between technology, society, and the environment, and who have the ability to use content and skills learned in other curricular areas such as math and science as

tools for solving and managing technological problems. The development of a functional professional level of technological literacy and capability that is appropriate and sustainable in each of our students must be the product of all technical and technology studies program.

Through the good application, use and management of technology, we have and we can continue to change the world we live in today. We have used and managed technology to satisfy our needs and wants including the ways we cure diseases, provide food, and communicate with one another. We have learned that the accelerated pace of technological change inspires some people, empowers others, and alienates still others. We have learned that societies create, manage, and use technology according to their expressed goals and values. We have also learned that technology is the engine that drives our one-world economy and the leaders of the most industrialized, developed, and powerful nations of the world have learned to use and manage technology for the betterment of their countries. Unfortunately, what we have not done is to develop a world-class educational program that prepares students in a much formalized way to be technologically literate and capable in a professional capacity. Today, we stand at the threshold of an opportunity to develop in each country, a varied set of technologically related educational programs – programs that will serve as a model for others to emulate in the spirit of committed educational service to all citizens in our new one world technological economy.

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Challenges in Technology Education: Need for New Strategies in International Cooperation

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Introduction and Background

For the past 15 years, efforts have been made to promote Technology Education (TE) in schools from kindergarten to secondary education level. Seminars, conferences and international meetings have been held to exchange views, experiences and even to chart out strategies to improve TE. In lieu to that, Japan International Cooperation Agency (JICA) in collaboration with Aichi University of Education (AUE) conducted four group courses on Industrial Technology Education for 40 participants from 26 developing countries since 1999 (ITE).

These courses were very instrumental in raising awareness among participants, exchanging views and experiences of various countries. The courses had a great impact on raising awareness to respective countries, for example the establishment of "Association for Promotion of Technology Education in Tanzania." These efforts are the results of JICA's ITE courses. The paper has identifies crucial challenges facing the development of Technology Education in Developing Countries and the way forward. These challenges, gives room to identify opportunities associated with them and areas for improvement. The impact of education particularly primary education to economic growth has been discussed. The paper also advocates the need for new strategies and international cooperation in the field of ITE in developing countries which is the theme of this International Symposium.

The paper throws the challenge to all participants to come up with action plans which will improve provision of ITE to developing countries and create

an environment for establishment of ITE Society to spearhead the achievement of Technology Education for All.

Education as a Tool Towards Economic Development

Education in general is the cornerstone to development and drives a country's future. It enables societies to absorb knowledge and adapt to technological change. It exercises a direct influence on national productivity and prosperity, and through this education helps to raise the status of poor people from poverty. Education is thus very instrumental in economic development of any nation by having knowledgeable skilled workers, technologists, technicians, professionals, managers and leaders. But, primary education has a great impact on economic development.

It is taken to be the most effective and cost-efficient means to social-economic development in the society. Economic prosperity and the reduction of global poverty in developing countries cannot be accomplished unless primary education has been given a priority in development plans.

Though, every nation in the world recognizes that primary education is a fundamental human right as ratified in 1989 on the convention of Rights of the Child, limited public resources and competing public spending priorities have prevented many governments from effectively addressing the challenges of Primary education development. Various studies have shown that primary education has a significant positive impact on economic growth, earnings and productivity (Nehru & Dhareswar 1994). Almost all the newly industrialized economies that have experienced dramatic growth in the past 25 years, such as Hong Kong, China, the Republic of Korea, and Singapore, has achieved universal or near – universal Primary education by 1965. This helped increase productivity and laid foundation for an equitable distribution of the benefits of rapid growth. In contrast, countries with uneducated population cannot expect to increase incomes and well being (Lockheed & Verspoor 1991). Also, studies have shown that, schooling of girls alters behaviour in ways that lowers fertility by 10%, reduces child mortality by 15%, improve household health by influencing

nutritional and health care practices, and improve children's school performance.

Enhancement of Education Quality Through Technology Education

Education quality is perhaps the most elusive concept to measure. It is like beauty, there is lack of education benchmarks that are comparable from one country to the other. Yet, it is most important because it sets standards that define the intellectual environment which in turn conditions the vision and capacity of the graduates and the capacity of a nation to manage its affairs well.

There are many factors that influence the education quality. These factors include: environment surrounding the school, supporting inputs, enabling conditions, community culture and climate, teaching and learning environment, all of which affects the output. The quality of graduates is judged by all stakeholders who are the pupils themselves, parents and the society. They will be curios to know whether schools are producing learned people who have also learned how to learn, creative, confident, having good character and able to solve problems and contribute to community initiatives. The community become disappointed when graduate pupils lack these attributes.

Quality education goes hand in hand with the incorporation of TE in schools curriculum and ensuring its effective implementation. Thus, TE is very instrumental in developing knowledge and skills which make the pupils be creative, innovative and confident in analysing issues and look for appropriate solutions. It enhances pupils to work together in a team spirit, increases attitude towards work and the desire to produce quality products/works. Such skills and attitude towards work will definitely enhance the quality of graduates.

Although most of the developing countries are aware of the importance of the TE in national development, still TE is marginalized in most of the nations and unpopular to stimulate the interest of the students, parents and the public to develop it. In such a situation, TE cannot yield the expected results to improve social and economic welfare of the society. Countries which have promoted and interpreted TE in their educational plans have attained a higher economic

development. In short, strengthening of TE improves the quality of education at any level.

JICA's Industrial Technology Education Courses: Lessons learned

The initiative made by JICA and AUE to conduct these courses for developing countries need to be commended by the world over. These courses were very vital in raising awareness of the challenges facing technology education development in these countries. Different countries exchanged views, knowledge and skills about ITE and participants were very much exposed to activities done by pupils and students in primary and secondary schools. Participants were exposed to the results of ITE in the production of tools, goods and services through Industrial visits and meetings. The lessons learned from these courses are that the challenges facing ITE in these countries are as those faced by the education sector in general. These challenges are complex and interrelated, varying from poverty, population growth, poor learning and teaching environment, inadequate human resources and rigid education policies. It is not possible to have a solution to one challenge alone, since they are depending on each other.

Despite having all these challenges, the main setback for most of the low and medium-income countries is the lack of proper strategic plans to translate the political will into real fiscal monetary commitment to ITE promotion in schools and out-of-school population. To reverse this trend, most of the developing countries need to formulate new strategies so as to create strong awareness among decision makers, politicians, planners, academicians, technologists and the community as JICA did through these group courses.

Efforts made by participants after the courses: Tanzania Case

After going back to respective home countries, most of the participants started to formulate their own strategies on promoting ITE in their countries. Tanzania one of the East African Countries decided to establish a non-governmental organization, the "Association for Promotion of Technology Education in Tanzania" (APTET). Tanzania, felt that this is one of the effective

strategy to promote ITE in the country. It was not a simple job, bearing in mid that there are bureaucratic procedures to register such a society. Eventually, APTET was registered in February 2001. It needs Zeal and commitment to establish such an organisation. Most of the associations are very useful in raising awareness to the community, particularly to government leaders, education administrators and teachers. At present it has 65 members who are primary school teachers.

APTET expects to strengthen and improve the status of ITE in the country by designing programmes and formulating strategies that will give ITE priority in development plans. The vision of APTET is to have a nation which is technologically literate. APTET is still in its infant stages, but given the necessary inputs such as financial and human resources to implement its objectives, for sure it can make an impact in promoting ITE in the country and become a role model to other developing countries.

APTET future challenges

APTET future challenges lies in getting more members particularly from 124,000 teachers in primary and 36,200 in secondary schools scattered all over the country. Tanzania being one of the low-income countries has an area approximately 945,000 square Kilometres including 60,000 square Kilometres of inland water with a population of about 34 million. About 80% of its population lives in the rural areas where communication and transport infrastructure is not good. It is the challenge to APTET to cover the whole country. APTET believes that, teachers are very instrumental and effective in advocacy work and in transmitting knowledge and skills to pupils and the community surrounding the schools. By having such coverage, ITE awareness and promotion will reach most of the rural and urban population; this will enhance quality of education and accelerate economic growth. The second challenge for APTET is the provision of ITE to out-of-school pupils. There are many pupils who do not go to school for various reasons and those pupils who have finished the primary education but had no opportunity to continue to secondary education. Transition rate from primary to secondary education is

about 30%, that means most of the pupils goes back to rural areas and a small to urban areas to work as unskilled labour. About 6% of the pupils who have graduated from primary education are absorbed in Vocational and technical training institutions for crafts skills. This population is very important in the economic growth of the country especially in rural settings, thus being the second target in APTET activities. To ensure that these challenges are overcome, APTET will have to establish regional and international cooperation and work closely with other development partners and the community.

Challenges Facing the Development of Industrial and Technology Education

Challenges faced by developing countries in the provision of quality education at all levels, particularly in low and medium – income countries does not differ very much from one country to the other. The educational characteristics particularly on ITE are almost the same. The main challenges, facing the development of ITE in developing countries are as follows:

Poverty

Poverty is the main challenge in developing countries which affects the development of education. For example in Africa, more than 40 percent of its population live below the US$1 a day poverty line and the incidence of poverty have increased since the late 1980s. The GNP per capita average US$488 in 1998, ranging from about US$100 in Democratic Republic of Congo, Ethiopia, Eritrea and Mozambique to more that $2800 in Botswana, Gabon and South Africa. Despite gains in the Second half of the 1990s Sub-Saharan Africa enters the 21st century with many of the World's low-income countries.

The poor and least educated households are unable to send their children to school and some are forced to send their children to unlawful labour, thus increases the number of illiterates in the country. Also, high external debt in developing nations has diverted scarce resources from priority education programmes that's why development of ITE in these countries is lagging behind. Without major advances in ITE, developing countries will not be able to take advantage of trade and development opportunities in a technology–driven

and rapidly integrating world economy.

Rapid population growth

Rapid population growth in these regions frustrates the effort to achieve universal primary education. Most of the educational development targets cannot be met due to these growth rates. Figure 1 shows the fertility rates in developing countries. Total fertility rates in Africa are the highest in the region at 5.5 in 1997 compared with 3.3 in South Asia, 2.7 in Latin America, 1.8 in East Asia and Pacific. By 2015 Africa will probably have 45 percent more children than it did in 1996.

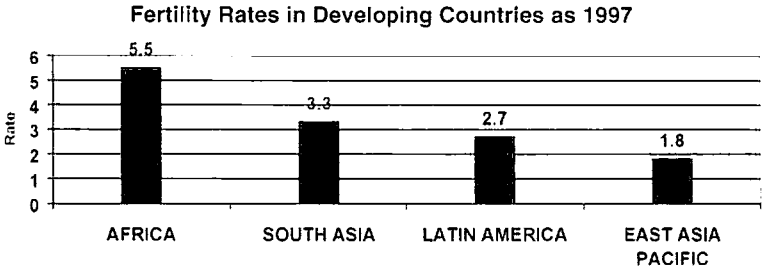

Figure 1. Fertility rates in Developing Countries as 1997.
Source: World Bank data.

Effective life skills and reproductive health programs, combined with efforts to ensure access and continued participation of girls in primary and secondary education, have been the key to slowing population growth in many countries. Thus home and life skills which are part of in technology education are essential elements and effective in slowing down the rapid population growth.

Learning/Teaching Environment and Infrastructure

All developing countries have TE included in the primary and secondary curricula, under the subject name Industrial Arts/crafts. Areas taught are home economics, carpentry, knitting, cooking, arts, music, crafts, life-skills, clothing, agro-based technology, nutrition and computer literacy. In many countries curricula are overloaded with content and often theoretically taught rather than stressing for hands-on practical teaching, which promote understanding and application of scientific facts.

In some countries, classes are conducted in open and often under the tree or in a make shift classroom. In most of the rural settings, classrooms are overcrowded or shared up to 150 pupils in rooms with two teachers, teaching in opposite direction. In rural areas often classrooms have inadequate or no desks at all. Pupils have to sit on the floor or stone blocks while listening to the teacher. This situation disrupts the writing ability of the pupil and often pupils do not concentrate in their studies.

Most of the schools in rural areas lack clean water to provide a healthy learning environment. The cleanliness of the school compound and availability of clean water at school are significant factors to make students concentrate in their studies and creates desire to have quality goods/services. In most of low-income countries, there is 1 textbook for 10-20 pupils in primary schools and 1 textbook for 4-5 students in secondary schools. Also, there is lack of teaching aids, equipment, chemicals and tools for doing scientific and technology experiments. This situation is more serious when teaching industrial arts subjects, which are taught in most cases theoretically.

Technology Education Teachers

About 15% of all teachers in developing countries are Science are Technology teachers, these teachers are not enough to impart the necessary technological knowledge and skills to pupils. Most of the primary schools do not have any technology education teachers at all. This is one of the reasons why more pupils are losing interest in technology education, which is too often badly taught or hardly taught at all. Most secondary school teachers in developing countries never receive proper training in technology education, so it is hardly surprising that their students tend to express little interest in this critical area.

Also, low salaries, low remunerations and lack of teacher housing etc. may be partly responsible for lack of new recruits and retention in ITE teaching profession. in developed countries teachers with 15 years experience may earn about an average of US$20,000-27,5000 annually. This is hundred times the

earnings of teachers in developing countries. In Peru, all teachers, regardless of the level they teach or their experience, earn little more than US$4,700 a year. In Philippines, teachers are paid more than US$10,640 annually. In low-income countries of East Africa, teachers' salaries are around US$1,000-2,500 annually, while in other professions salaries range about US$2,500-7,000 annually. As such teaching profession cannot attract more qualified, committed and hands – on persons. It is obvious that technology education will suffer most in such environment, where competing pay for such skills are offered.

Provision of Technology Education to Out-of-School Pupils

The urgent challenge facing developing countries is the provision of technology education to almost 284 million children aged 12 to 17 who are out-of-school due to various reasons. The number is expected to reach 324 million by 2010 due to high population growth. They will be part of the 884.7 million illiterate adults and of the 1.3 billion people living on less than on US$ a day.

Figure 2 shows the illiteracy rates estimates for age 15 and above for developed and developing countries. By the year 2000 developed countries had about 1% of illiterates in that group while developing countries had 78%. This population is very big and vital in contributing to the economic development of these countries, therefore there is a need to equip them with the knowledge and skills which will help them in problem-solving, tackle a wide range of tasks and prepare them for the world of work or engage themselves in self-support a activities.

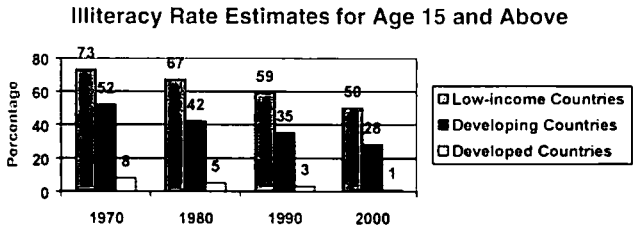

Figure 2. Illiteracy Rate Estimates for Age 15 and Above.
Source: http://www.unescostat.unesco.org.

Educational Policies and Financing

Most of the developing countries lack coherent and appropriate education policies which can be translated into increased financial support to fulfil the educational goals. Increased budget only, does not necessarily improve the quality of education; it should be supported by appropriate policies and involvement of other development partners and the community. Taking an example of Korea Vs East African countries, it is be evidenced that appropriate policies and proper allocation of the national budget and attainment of Universal primary education can enhance the economic growth. Korean economy in the 1960s was at per with or even behind East African countries. In 1962 Korea's GNP was US$87, while in East Africa was US$ 90. In 1996 Korea's GNP had reached US$10,600 while that of East Africa was around US$320.

Korea gave first priority to primary education and attained Universal primary education in 1965. In contrast, although, East African countries declared a strong commitment to primary education, their budgets reflected the governments' stronger emphasis on higher education. Countries which have adopted stronger and flexible policies had their countries attain higher education qualities.

Educational Research and Development

The importance of research for the development of any nation cannot be over emphasized. Currently, most of the developing countries devote less than 1% of their GNP in R&D, while developed countries devote as much as 4% and above of their GNP. Tanzania, for example devotes only 0.35% of her GNP. Funds devoted to education research are always minimal in most of the developing countries. Researches in ITE in primary and secondary education are almost non-existing. The challenge in this area is to develop sustainable relevant research, dissemination and application to improve the quality of educational policy and practice in ITE.

The Impact of HIV/AIDS on Education

HIV/AIDS is the most devastating disease affecting the education sector in

developing countries. UN Joint HIV/AIDS programme (UNAIDS) estimated that by the end of 2001, over 40 million people were living with HIV/AIDS, 37.3 million of them adult and 2.7 million children under 15 years.

The epidemic's grip on Africa has been by far the deadliest, but no part of the world is immune (Figure 3). Most devastating and far-reaching, perhaps, is epidemic's impact on education systems. HIV/AIDS is draining the supply of education, eroding its quality, weakening demand and access, drying up countries' pools of skilled workers. Half of the world's 15,000 new infections every day occur among 15- to 24- year olds (1999).

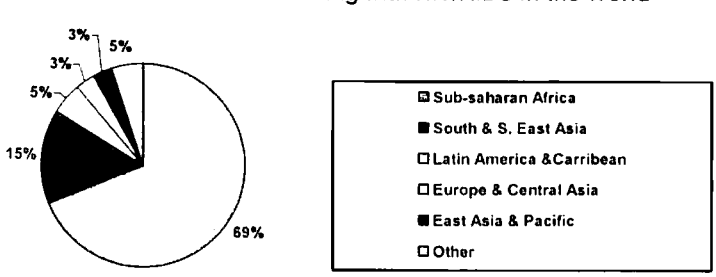

Figure 3. Adults and Children Living with HIV/AIDS in the World – Total 40 Million People

Global efforts should be sought to help developing countries manage the epidemic's impact on education systems and improve these systems capacity to reduce vulnerability to HIV/AIDS and to implement quality skills-based prevention programs particularly in schools.

Formulation of New Strategies

In improving ITE in developing countries there is a need to formulate new strategies, which will enhance the development of ITE in these countries. Each country will have to formulate its own strategies on how best to develop ITE within the framework of the education sector. Challenges and areas for improvement should be identified with associated opportunities. Six crucial areas which need attention are:

1. Raising awareness and commitment of politicians, decision makers.

planners and community.

2. Strengthening of Technology education teacher training and capacity building for educational planners and curriculum developers.
2. Developing vocational and technical education programmes for out - of-school pupils
3. Production and provision of adequate teaching materials, textbooks and tools for ITE.
4. Enhancing education research and networking with research institutions.
5. Establishing and/or enhancing country ITE associations/societies.

To incorporate these strategies in the national education development plans there is a need to work hand in hand with other developing partners and involving parents. business community and the society.

International and Regional Cooperation

One area of greater importance in promoting ITE in developing countries is the establishment of international cooperation which is vital in bridging the ITE knowledge gap between the developing and developed countries. Developing countries need to speed up their economic growth through education particularly in the area of ITE. To do so, there is a need to have an independent non-governmental apex international association/Society which will be the top-most body to coordinate the development of ITE activities in developing countries. This body will work together with other partners like JICA, UNESCO, World Bank. UNICEF UNEVOC etc to help developing countries accelerate their economic performance through integrating ITE in development plans.

Regional Cooperation

Establishment of regional/sub-regional cooperation among countries belonging to a particular region will strengthen and support, individual country ITE strategies. For low-income developing countries, it might be very difficult to implement some programmes because of the economies of scale and high fixed costs associated with those programmes, particularly in the provision of

adequate teaching materials, textbooks and equipment. Regional/sub-regional cooperation can also contribute to increasing the size of the population to be served, thereby allowing greater economies of scale.

Regional ITE Centres

Regional cooperation can be enhanced by establishing regional/sub-regional ITE centres. These centres will advise governments in the region to formulate policies that will promote and strengthen ITE programmes for the formal and in-formal education. Regional centres have been instrumental in carrying out basic and applied researches, sharing of experiences and dissemination of research finding to the community. The centres will also enhance capacity building in field of teacher education and formulate programmes to enhance in-service training particularly for ITE teachers.

The centres will establish networking among themselves and to other international bodies. These centres will advise governments on technologies and methodologies to be applied in the region to suit the regional environment and culture. JICA have been active in supporting regional centres, such as African Institute for capacity Development (AICAD) and SUA Centre for Sustainable Rural Development (SCSRD) at Sokoine University of Agriculture in Tanzania.

Country/Regional ITE Associations/Societies

One of the best strategies in promoting ITE at regional or country level is to establish an ITE association/society, which will be non-governmental organization (NGO). Various NGOs have been very vital in improving the livelihood of most of the people in the community, by supplementing the efforts made by respective governments in a specific area of concerned. Country ITE societies will act as pressure groups to raise awareness to politicians, policy makers, teachers and the community. They will formulate and implement ITE programmes to suit their cultural and environmental condition of that particular country. These associations will need technical assistance to fulfil their mission and objectives.

Conclusion

In order to strengthen and develop ITE in developing countries, there is a need to focus mainly to primary education and out-of-school pupils. That's where the impact of ITE will be felt most and thus contribute to economic development. It is anticipated that, the symposium will come up with action plans which are implement able in developing countries, so as to improve the situation of ITE in these countries and create an environment of attaining "Technology Education for All" goals. Lastly, developing countries are urged to establish national/Country societies/associations which will promote and spearhead ITE activities in their respective countries.

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Afterword

Working Together: Building Technological Cultures

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Introduction and Background

Technology education has progressed and developed multi-directionally throughout the world. Each country has established differing visions for its utilization in their schools. Some have thought of it as general education, while others have considered it as career or vocational education. However, throughout the world, education ministries see technology education as a vehicle to both improve the workforce (career focus) and the citizens of each country (literacy focus). Depending upon the societal needs, the focus vacillates between career education and technological literacy.

All education exists to improve individuals and/or societies. Depending on the individual educational needs of a country, the focus of technology education changes. There are purists that feel that technology education exists for the preparation of the future workforce, and others who believe that cultures have evolved and technology education is for all citizens, thus the technological literacy focus.

To this researcher, both focuses are essential and both can exist in any culture. When philosophers try to exclude one focus from either vision, a splintering within the practitioners (the technology education teachers) occurs. As we move into the 21st century, it is essential that we realize that both visions are practical and both need to be supported as professionals position our subject with government policy makers and business and industry.

Technology education in the United States had its roots in the Russian,

Sloyd, and English systems of education. One of its processors, industrial arts, was a blending of both the general education and career education focuses. During the latter half of the 20th century, both camps (career and literacy) tried to redefine themselves and a splintering occurred within the profession. Followers of the Association for Career and Technical Education tended to support the career focus of technology education, while followers of the International Technology Education Association tended to support the focus of technological literacy. This has caused confusion within the educators who are not actively involved in their professional teaching associations. There are approximately 36,000 technology education teachers in the United States (Ndahi & Ritz, 2003). The percentages of those who are active in professional associations are low, less than 20 percent (Starkweather, 2003).

From my international conversations with technology education professors, there appears to be support for the oscillating outcomes for technology education. I believe that we need to continue to move forward with our educational agendas and we need to be cognizant that both focuses are reality and that both need to be accepted if we are to make an impact to the educational systems of our individual countries.

With this said, we need to include both in our discussions and educational programs. To build self-supporting economies, countries need both qualified workers and intelligent citizens. For most countries to advance economically, they need to produce food, supply their citizens with consumer products (housing, transportation, clothing, leisure accessories), and share information to improve the quality of life (consumer, political, educational, etc.). People who are hungry have little time for learning. With full stomachs, the mind can be expanded and the quality of life for all can be explored. Without a supporting economy, little time is directed toward education and the improvement of individuals and society as a whole. Education of the elite is outsourced.

Content for the Study of Technology

Across the world, there exist varying content-bases for technology education

ranging from technological literacy to career education. This has resulted due to differing philosophies purported by local and national leaders of our profession. Throughout our practicing careers, we have heard of varying content and delivering strategies to base our technology teaching upon. We learned *what and how* to teach technology education in our initial teacher preparation. The decade we were schooled, usually determined what content we taught.

We were also influenced by the curriculum established for the locale we were hired to teach. The larger the school system, the larger the amount of instructional materials we had at our disposal. Other teachers within the school positively or adversely affected what we taught. Local supervision, in many cases, shaped the content that was delivered on the local basis. State and country influence also helped in determining what was delivered.

During initial preparation, *what were the influences of other nation's efforts in technology education on your knowledge-bases?* This remains a cultural question today. During my early education, I had read of the Russian and Sloyd systems and their influences on the development of technology education (Cochran, 1970). Later I learned that countries that were colonized usually followed the curriculum of the mother country. Great Britain had the most influential effect on its colony's technology education programs. Today Great Britain continues to have its worldwide impacts for using the design and technology problem-solving approaches to the study of technology (*Technology in the National Curriculum*, 1990). All of you understand the past history of the development of technology education in your country and which nation's practices influenced the development of your instructional curriculum.

As countries and professionals mature in the technology education teaching profession, philosophies of what should be the content of technology education have changed. Networking, usually through educational system and association meetings, has influenced each of us. So have association literature, curriculum guides, books, and international presentations changed what and how we teach technology.

It should be noted that professional memberships are low and that people usually take the *path of least resistance.* Many teachers follow *the textbook or have a technology education program that is strictly process/project-based.* They teach CAD, rockets, electronic circuits, or a wood working project.

Most state/provincial or national associations sponsor conferences for the professional development of their teachers. They also sponsor curriculum writing workshops to develop course outcomes, activities, and/or curriculum materials. These works have been influential in changing the content-base for technology education.

Much curriculum work has been undertaken without a well defined research-base to support the content of the curriculum. During the 1960s, much money was set aside by governments for experimental thrusts in curriculum development for technology education. These grants were funded in response to the launching of the Russian Sputnik and for the building stronger skills in mathematics, science and technology education, i.e.. U.S. National Defense Education Act. They were in response to the lack of scientific *know-how* of the host countries. In the U.S. educators and politicians wanted our youth to win the space race. Influential U.S. technology education programs that were established based upon research were the American Industry Project (University of Wisconsin-Stout) and the Industrial Arts Curriculum Project (The Ohio State University) with its resulting World of Construction and World of Manufacturing curriculum.

American Industry analyzed industry and outlined its component parts, i.e., finance, materials, marketing, communication, transportation, etc. (Cochran, 1970). Curriculum materials resulted from this research, but not textbooks.

The Industrial Arts Curriculum Project was also research-based. It determined that the major fields of industrial technology were construction and manufacturing (Cochran, 1970). The key to the success of this project was the resulting textbooks and national system of training teacher educators in

implementing these programs. Today the systems of construction and manufacturing remain as systems of technology that are taught solely or integrated into other technology education curriculum structures.

One of the major influences the Industrial Arts Curriculum Project (IACP) has had on technology education programs in the U.S. has been the use of its research and development activities. These include the land assault vehicle (CO_2 racing cars), rocket (originally solid fuel, now air/water pressure), and constructed storage barns. For student organizations like the Technology Student Association (TSA), competitions continue to be held at the regional, state, and national levels for the CO_2 racing cars. Often when you ask American teachers to explain or describe what their technology education curriculum is, they usually describe it by the activities they engage youth in, i.e., barn building, maglev vehicles, CAD, CNC, etc.

Jackson's Mill Industrial Arts Curriculum Theory proved the pivotal curriculum shift for technology education content in the U.S. The curriculum framework that resulted from this study was based on the philosophies and personal research of this 20 member group selected to participate in this curriculum effort. It identified four curriculum organizers for the study of technology: communication, construction, manufacturing, and transportation (Snyder & Hales, n.d.). This increased the systems of technology from the IACP manufacturing and construction content-bases.

Later in the 1980s another research effort was funded in the U.S. Under the leadership for Savage and Sterry, the *Conceptual Framework for Technology Education* emerged. This framework identified the technological method for solving-problems and further revised the content organizers for technology education to include communication, bio-related technology, transportation, and production (Savage & Sterry, 1990). Production technology included manufacturing and construction and added processing technology under this system organizer. Processing technology systems included content for processing such products as food, energy, and chemicals, since these products

are not thought to be produced as other manufactured products are, i.e., putting sub-assemblies together. Processing technology uses processes such as mixing, heating, forming, etc. to form products.

Again, the research-base for these curriculum changes remained individual philosophies and individual research and development. Curriculum materials and textbooks were developed during the 1980s based upon this curriculum work.

During the 1980s and 1990s the British design and technology movement also began to influence the study of technology worldwide, as did the *Jackson's Mill Curriculum Theory* and the study of the pillars of technology, information, materials and energy, which emerged from The Netherlands (deVries, 1987).

Not until the second half of the 1990s did a truly research-based effort occur for technology education curriculum in the U.S. The International Technology Education Association felt a need to establish a content-base for technology education. The Association positioned itself with the National Science Foundation (NSF) and National Aeronautics and Space Administration (NASA) and had funded the Technology for All Americans Project. The work of this project produced *Standards for Technological Literacy* (ITEA, 2000)

Content Validation

The Standards Project has been the largest research-based curriculum development effort in the U.S. A team of researchers led by Dugger researched and validated the content for technological literacy. Over 4000 individuals reviewed and validated the content standards and benchmarks for the study of technology, including members of the National Research Council and the National Academy of Engineers. The resulting standards and benchmarks have provided the technology education profession with validated content for designing curriculum to teach technology education. These standards have now been translated into Japanese, Finnish, and German. They have provided for a major international sharing of valid knowledge to plan programs that can lead to technological literacy for the citizens of the world.

The International Technology Education Association has collaborated with other nations to establish Centers for Technology Education in Australia, Chile, Finland, Germany, Greece, Japan, New Zealand, Netherlands, Spain, Taiwan, and United States. The Centers share the mission of the International Technology Education Association and provide access to instructional and curriculum materials. This creates a worldwide communications network for technology education professionals.

Professional Development

After a research knowledge-base is established for our discipline, how do we most effectively use it to shape curriculum designs for technological literacy? The usual way to do this is through professional development and curriculum redesigns by universities and country, state/provincial, and local education systems. U.S. teacher education institutions are experimenting with curriculum redesigns to prepare new graduates to base programs upon the content derived from technological literacy. The Council on Technology Teacher Education (CTTE), in conjunction with the International Technology Education Association and National Council for the Accreditation of Teacher Education, has redesigned its standards for structuring teacher education programs (Schwaller, 2003). The new standards are based upon delivering the *Standards for Technological Literacy* (ITEA, 2000) and the companion standards, *Advancing Excellence in Technological Literacy: Student Assessment, Professional Development, and Program Standards* (ITEA, 2003). Table 1 summarizes these teacher preparation standards. Time will show how successful the U.S. teacher preparation institutions will be in developing teachers who can deliver programs based upon technological literacy standards.

Table 1. Teacher Preparation Standards

Subject Matter Standards for Technology Education	
Standard 1	The Nature of Technology
Standard 2	Technology and Society
Standard 3	Design
Standard 4	Abilities for a Technological World

Standard 5	The Designed World

Effective Teaching Standards for Technology Education

Standard 6	Curriculum
Standard 7	Instructional Strategies
Standard 8	Learning Environment
Standard 9	Students
Standard 10	Professional Growth

Efforts are also underway to provide professional development activities for practicing teachers in how to incorporate technological literacy standards into their curriculum. This was first guided at the national level by the International Technology Education Association. Now efforts are underway at the state/provincial levels.

Across the U.S. there is a severe shortage of qualified (licensed/certified) technology education teachers (Ndahi & Ritz, 2003). Too few university students are enrolling in technology education teacher preparation programs. To combat this shortage, states and universities are developing alternative programs that lead to teacher licensing (Ritz & Copeland, 2002). These programs are referred to as alternative licensure programs (universities) and career switchers programs (state governments). Few of these alternatives use the *Standards for Technological Literacy* knowledge-base as their core for teacher preparation. The Council on Technology Teacher Education has and continues to work on recommending alternatives, so these alternatively prepared teachers can gain the knowledge needed to deliver technological literacy (Sanders & Litowitz, 2002).

Other groups that must be influenced to cause programmatic change include equipment/instructional materials vendors, school and university administrations, and government employees and state and national legislative groups. Vendors must develop new instructional systems and text materials that assist teachers in delivering the literacy standards. School-based

administrators must be educated to understand the difference between technological career and literacy focused programs. They must be convinced that all students need to develop technological career and/or literacy capabilities.

University administrators also must be educated so they understand that technological literacy is a required teacher preparation program. Funding is needed to redesign facilities, and program and course changes must be approved so faculty can deliver new courses such as agricultural, medical and biotechnology, communication and information technology, etc. Table 2 lists course possibilities that can be implemented in the university teacher preparation curriculum to assist in developing abilities to deliver technological literacy. Laboratories such as technological systems, production technology, and energy, power and transportation must be developed and properly equipped.

Table 2. Proposed University Technology Teacher Preparation Courses

Design and Technology	Technology and Culture
Communication Design	Technology and Society
Industrial Design	Exploring Technology and Modern Industry
Technological Foundations	Technological Systems
Industrial Materials	Energy and Power Technology
Materials and Processes Technology	Manufacturing and Construction Technology
Basic Energy Systems	Production Technology
Technological Systems Control	Agricultural, Biological and Medical Technology
Graphic Communication Processes	Transportation Technology
Professional Foundations	Field Experiences
Fundamentals of Human Growth & Dev.	Observation and Participation
Curriculum for Technology Education	Middle School Student Teaching
Instruction for Technology Education	High School Student Teaching
Advance Classroom Practices	
Assessment, Evaluation and Improvement	

Legislatively, technology educators must work to have laws enacted to enable technology education to become a core subject or an elective that is required to be in our schools. Some school systems have elected to omit technology education programs in lieu of academic standards requirements. Others are working to increase academic requirements and removing technology education from programs of study. More positively, some have had technology education as a mandate for state/provincial systems and countries as a whole. We all need to increase our efforts in positioning legislation to support the continued growth of technology education.

Conclusions

Globally, sharing of technology education information is underway. An increase in cooperation is apparent. Associations and foundations have sponsored international conferences. These have increased in number in the past 10 years. Several journals are now available on an increasingly international basis.

Workshops within conferences are being specially design to assist professionals to share their ideas on increasing the career and technological literacy of their populations. PATT (Pupil's Attitudes Toward Technology) Conferences are an excellent example of this sharing. The International Technology Education Association has international sessions at its conferences and an annual international luncheon is promoted so technology education efforts can be shared. The Council on Technology Teacher Education (CTTE) has conducted an international workshop where seven countries explained their structure for delivering technology education. The Council will also publish a 2005 yearbook on *International Perspectives for Technology Education*, Williams, editor. We are attending an international conference sponsored by Japan International Cooperative Agency and Aichi University of Education. International cooperation is active and increasing. Through these types of professional development, the human resources so vital to the development of technology teacher education are being enriched.

Cooperation is a key variable as all nations move into the 21st century. The globe has been somewhat reduced in size with modern transportation and communication systems. By sharing what we do at home through conferences, workshops, and listserve chats, all nations can benefit. When research and refined philosophies produce new ideas on how to improve the delivery of technology education, these ideas need to be shared. This sharing causes synergy which can lead to new ideas and improved program delivery.

All should leave this meeting knowing that we need to make the extra efforts to share with others. Cooperation can spread the many benefits of technology education.

As you plan for new programs, be sure to establish baselines and collect data on your new trials. We need data to prove to others, university, school system, and government personnel, how technology education can contribute to the betterment of our societies.

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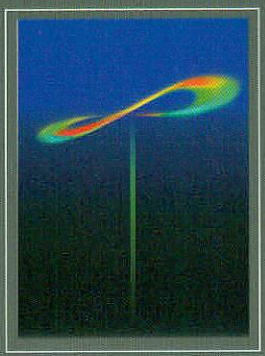

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