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"TOWARD APPROPRIATE TECHNOLOGIES":

AN ECOLOGICAL APPROACH TO SCIENCE AND TECHNOLOGY EDUCATION

by

Dorothy G. Blair Whitehead

B.S., University of Vermont, 1978

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF

THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE (EDUCATION)

in the Faculty

of

Education

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October 1987

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ABSTRACT

It was the purpose of this study to develop a curriculum model incorporating knowledge of natural system and of appropriate technologies. The principle criteria used to define the appropriateness of a technology was that it must contribute to the long term well being of humankind and that it should foster the continued viability of the planetary ecosystem. The curriculum model proposed is intended for application to post-secondary or secondary levels of schooling. It may be useful to curriculum developers in the fields of science and social studies.

A review of the literature in the fields of environmental education, values education, and science, technology, society education was conducted in order to develop potential criteria for a curriculum in appropriate technology. A curriculum development process based on ten steps was applied to the criteria in order to develop a curriculum model, "Toward Appropriate Technologies." Eight of the ten steps comprising the development process were completed, but the program was not implemented as a pilot program. The refined model is discussed in terms of its potential educational value in increasing student awareness of technological options and in increasing their decision-making skills relevant to the concept of a sustainable future.

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Preface:

The stimulus for this study began in 1979 while I was working in the field of appropriate technology in rural Guatemala. My job, as a fisheries biologist, was to teach local people the basics of aquaculture and how best to utilize an aquaculture system with their existing resources. To reach a site, I would hike for long hours to meet with people and discuss the various aspects of aquaculture. Over a series of visits, we would select a site, excavate the pond, put in drains and berms until finally, the pond could be stocked with fish and a feeding program undertaken.

After many months in the field, I realized that the information was not being conveyed adequately. For example, I always spoke and planned with the male head of the household as the women often did not speak Spanish or were hesitant to speak with a foreigner. However, as I was later to find out, it was traditionally the female role to care for the family animals. Hence, although I would speak with the man, he would need to tell what I said to his wife. Needless to say, a lot of information got lost in this process. In another example, I designed and taught a nine month course on fish culture to a group of health and agriculture extension workers. While the feedback received was positive, I finished the course with the feeling that again, much of the information was not being absorbed. In this case, the underlying assumptions I had made as to their needs, were inappropriate.

In both instances, conventional extension and educational techniques had been used, but after some evaluation it was clearly not working as intended. A more comprehensive framework was needed in which to

incorporate the principles of appropriate technology and education. The following document proposes a model of an educational process that is consistant with knowledge of natural systems and appropriate technologies. This educational process encourages clarification and examination of values, innovative thinking skills, self-directed learning skills, decision-making skills and skills for acting on those decisions.

CHAPTER 1: INTRODUCTION TO APPROPRIATE TECHNOLOGY

1.0 Introduction

There are many warning signs that for continued human well-being, the environment will not tolerate the rapid changes that modern technologies require of it, or the impact of "technological disasters" such as the Chernobyl nuclear accident. Accordingly, we must question how we view technology in relation to ourselves and our environment. It is proposed here that some alternatives to existing aims for technology are necessary. It is suggested that technology needs to be viewed as a tool appropriate to the long term needs of the user and the environment. A term that embodies this notion is appropriate technology.

The concept of appropriate technology can be seen as a framework from which to understand the "appropriateness" of technology. Today, appropriate technologies are a viable alternative to conventional technologies. They are making a small-scale, yet wide-spread impact especially in the area of home technologies. They can generate more long term jobs, increase economic viability of small communities and improve quality of life (Brace Research Institute, 1976; Schrecker, 1983). At the same time, in local areas they often improve environmental quality. They may be seen as a complement to large scale technologies and ecomonic renewal plans.

This chapter will endeavor to articulate the purpose and rationale for the study undertaken. As well, the rationale and definition of appropriate technologies as a whole, will be examined together with a rationale for appropriate technology education.

1.1 Purpose of the Study

The purpose of the study is to present a theoretical model of appropriate technology education as a basis for curriculum development in this area. The objectives of this study have been to 1) identify the necessary characteristics of appropriate technology education; and 2) develop a curriculum model for appropriate technology education for students at the secondary and post-secondary level. This model is expected to be useful for educators and those involved in curriculum development.

1.2 Delimitation of the Study

The study identifies characteristics of appropriate technology education and proposes a curriculum model aimed at secondary and post-secondary students. A ten step curriculum development process was used. The model proposed here has been developed to the eighth stage, but not completed to the last stage of implementation at a pilot-scale. Further work would need to be done to implement a pilot program and modify the model based on any findings from such work.

1.3 Rationale for the Study

Increasingly, young people are asked to make complex decisions involving the uses of technology and other applications of science (Mertens and Hendrix, 1982; Biological Sciences Curriculum Study, 1984). As well, all citizens in a democratic society are expected to have the skills and ability to act in an informed manner concerning issues in science, technology and everyday life. It is argued here that an appropriate technology curriculum model supports the development of such an informed and active citizenry.

Literature and courses now available concentrate on describing technologies rather than developing knowledge and decision-making skills concerning the appropriateness of technologies. The public often requests information on alternative technologies such as home energy conservation techniques, solar heating and efficient use of home resources. However, in the curricula of our school system and in community courses there is a conspicuous absence of concern for alternative technologies or even of the connections between science, technology and society. The purpose of this document is to present a proposal for filling this gap. It is asserted that an appropriate technology curriculum would provide a medium for thoughtful consideration of the many issues involved.

1.4 What is Appropriate Technology (AT)?

The literature offers a broad range of definitions of appropriate technology. This section will attempt to give an overview of definitions found in the literature and then propose a definition that is used by this document.

The Brace Research Institute (1976, 1983) offers a broad definition of what an appropriate technology must encompass:

"The choice of an AT must consider that in every culture, there is a complex interweaving of many different aspects of life, and any particular change will affect the whole. An approach which looks only at purely technical aspects would neglect the dynamic interrelationships among the technology in whatever form it takes, the users of the technology and their attitudes and values, the resource base of the region, and the economic and political structures surrounding the other factors... Finally, a basic requirement of an AT is that it should be acceptable to the people who are going to use it. Acceptability is a difficult characteristic to define -- for people may reject an innovation for any of a multitude of reasons. Nevertheless, if a technology is not willingly used by the people, it will never be successful."

Nearly 10 years later, Marilyn Carr of the Intermediate Technology Development Group stated that, "appropriate technology is now recognized as the generic term for a wide range of technologies characterized by any one or several of the following features:

1) low investment cost per workplace,

2) low capital investment per unit of output,

3) organizational simplicity,

4) high adaptability to a particular social or cultural environment,

5) sparing use of natural resources,

6) low cost of final product or high potential for employment."

(Carr, 1985)

In both of these definitions, the use of the word "technology" seems to encompass a whole range of values and techniques to support these values. It may be useful at this point, to examine the concepts of technique and technology more closely. In Social Carriers of Techniques for Development, Edquist and Edvist (1979) wrote that the concept of technology is very loosely defined and even more so the concept of "appropriate" technology:

"in many studies technology is used in a very comprehensive sense and the term often includes many important phenomena of a social character such as knowledge, management, organization of work, other elements of social organization, etc. It then becomes problematic to study the relations between technology and society."

The reasons for this is that the relation between two phenomena cannot be satisfactorily investigated if they are not conceptually distinquished from each other. Jequier (1976) suggested that the term should be based on both "hardware" and "software." He wrote,"The term 'technology' invariably suggests the idea of hardware be it in the form of factories, machines, products or infrastructures. Hardware is something visible, and even if it is not understandable, it stands out very conspicously. Technology however goes much beyond the hardware, and also comprises what can be called, by an analogy taken from the computer industry, the software. This includes such

immaterial things as knowledge, know-how, experience, education and organisational forms."

Edquist and Edvist (1979) have suggested that technique is applicable only to the material or physical elements of what is often called technology -- such as tools, machines, and implements. While technology is inclusive of technique plus immaterial aspects such as technical know-how, management, and organization. The importance of these concepts lies with the effect of techniques on society and how technology can be applied to benefit society. Jequier (1976) noted that:

"The societies which today are highly industrialised owe their development not merely to the invention and widespread application of new types of machinery...but also to major innovations and gradual improvements in organisational forms and institutional structures."

Based on the concepts of "technique" and "technology" the definitional field of appropriate technology lacks clarity. Some definitions adhere strictly to the use of "technique" as defined above. The literature abounds with appropriate technologies defined as "light-capital technology" or "low cost" technology (Long, 1984). As well, it implies "older technologies" (Betz, 1984). However, in the literature there is increasing use of a more comprehensive approach to appropriate technologies. These definitions include techniques plus cultural, environmental and other factors that are relevant to the development and implementation of a technology. This document specifically adopts the latter comprehensive definition of appropriate technology.

1.4.1 A Comprehensive Definition of Appropriate Technology

The process of technological choice is integral to a comprehensive view of appropriate technology:

"AT does not offer an absolute prescription but rather a process of choosing from among a broad range of options. The AT approach seeks to optimize solutions, wherever possible, through reliance on problem-solving capabilities of local people as well as a sensitivity to environmental and cultural impacts" (Evans, 1984).

Elsewhere, emphasis is placed on the inclusion of all degrees of sophistication of technology within the definition:

"a balanced approach to AT requires that all types of technologies -- advanced, intermediate, and basic -- be considered in the promotion of policies of development. The choice of technology should be based not only on technological considerations and sophistication, but also on economic, cultural, environmental, energy and social standards" (Schacht, 1984).

The general definition which this document will adhere to is the following: the concept of appropriate technology has been identified as technology that considers socio-cultural and ecological factors as crucial components in the design and implementation of a technology. It is a concept whereby technology is appropriate to the particular situation in which it is used. Thus, in order that a technology be considered appropriate, a process of assessment or evaluation must be carried out by the users or implementors of the technology to determine its social, environmental and economic impact.

The appropriate technology definition developed here is based on several value criteria. The fundamental underlying perception is that any technology ought to contribute to the well-being of human-beings and the planetary ecosystem in which we live. The following are the value criteria inherent in the above definition applied to this document. An appropriate technology:

1. Is environmentally conservatory. The technology is designed to maintain ecological diversity and sustainability;

2. Provides opportunity for meaningful, useful work. People should have the opportunity to provide a service or produce a product that they value and is valuable for their community;
3. Is decentralized or community based. This allows for local control and acknowledges that local people may have the best knowledge of what is appropriate for that particular area;
4. Provides opportunity for personal or local empowerment. The process for determining "appropriateness" promotes personal decision-making skills and encourages action based on those decisions. This process can enable people to effect change in a personally meaningful way;
5. Is sustainable over the long-term future. The assessment process for many current technologies does not consider the impact of that technology for the medium and long term future. The process for determining "appropriateness" uses present knowledge and skills to project the impact of a technology and aims at producing technologies that are sustainable into the future.

1.5 Why Appropriate Technology?

For many years, technology has been considered the answer to virtually all problems of society. In the last few decades, it has been realized that while technology may solve problems, it may also create new ones. Often these new problems are problems of increasing magnitude. For example, radio-active wastes persist for many years which may cause environmental and social problems for generations. During the last three to four decades both developing as well as developed societies have been confronted by many problems which can be traced, largely if not exclusively, to particular technological choices (Date, 1984; Clarke, 1984).

Date (1984) wrote that there are 4 major problems of this type facing developing countries:

a) mounting unemployment;

b) environmental degradation and pollution;

c) unequal distribution of the benefits of development;

d) increased vulnerability to policies of other nations;

He continued that three major problems facing the developed countries are similar:

a) alienation of workers from their work, from the products of their work, and from other human beings;

b) environmental degradation and pollution;

c) rapid depletion of resources.

In view of recent events in developed countries such as Canada, some would argue that unemployment should also be added to this list. Evans (1984) presented a similar view by stating there is a "present requirement for redirecting existing technology and for developing new technology that will be consonant with development needs as they are perceived in the humanistic/conserver context." Thus, there is a call for viewing new technologies and the subsequent economic and social development which follows, in a different and more humane light.

James Robertson (1985) wrote about a possible shift in the economic base and the implications of this shift:

"An important feature of an equilibrium economy will be a shift of emphasis from big technology, as in today's industry and hyper-industrial economics, to the development of advanced technologies of an appropriate form and scale. More effort will go into designing and producing machines and systems for individuals and small communities to use. These will be specifically aimed at

helping people to meet more of their own household or local needs in spheres such as food and agriculture, building, repairs and maintenance of all kinds, leisure and entertainment, and also energy and transport. More generally, the idea that technology can be appropriate or inappropriate will have a much greater influence than it does today - the idea being that technology ought to be good to work with, sparing in its use of resources, produce a good end product, and be kind to the environment." (in Carr, 1985)

Such an alternative view of technology and society endeavors to remedy some of the perceived problems of today.

Questions that may come up at this point are: "what role should this "alternative" view of technology play?" and "what is its importance for development of new technologies?" It has been suggested that appropriate technology is a concept that does have a significant role to play especially in developing countries. As early as 1977, the Advisory committee on the Application of Science and Technology to Development (A.C.A.S.T.) wrote:

"There can be no doubt that the question of the use of appropriate technology for developing countries has in the last few years gained international acceptance. Consequently, the UN Conference on Science and Technology for Development is bound to consider it." (ACAST, 1977)

Edquist and Edvist (1979) conclude that appropriate technology is a concept which will play an increasingly important role in development plans and subsequently, there are good reasons for a close scrutiny of the grounds for advancing the underlying theories and arguments. As further indication for the acceptance of this concept, Jequeir and Blanc (1983) wrote after an extensive survey of AT organizations,

"that while at times controversial, what started in the late 1960's as a rather marginal movement pioneered by a few lone innovators has now clearly become a 'growth industry' in its own right. But perhaps even more significant than the large number of organizations involved is the fact that appropriate technology, once derided as a rather pointless diversion from the real issues of industrialization and economic growth, is now increasingly recognized as a serious if still incomplete technological option for both industrialized and developing nations."

It has also been suggested by the Montreal-based Brace Research Institute, (1976) that appropriate technology "need not, and, should not be applied only to rural areas in developing countries; its basic principles are universal." Finally, Baron (1984) writes that "taken together, the books and policy statements discussed confirm that, 'appropriate technology' has achieved respectability as an approach to economic development." The literature suggests that use of appropriate technologies is a strong factor in current regional development. Further, the concept of appropriate technology may support development of new technology which foster sustainable economies and has positive environmental and social impact.

1.6 Some Examples of Appropriate Technologies

It might be useful, at this point, to provide examples of appropriate technologies. Examples include: small-scale organic farming instead of large-scale energy intensive cultivation techniques; locally built, small fishing long-liners in Newfoundland that ultilize local materials and skills; a solar crop dryer in Columbia; agricultural implements of simplified design for use in tropical agriculture; use of passive solar energy to heat Northern homes or of berms to help keep Southern homes cool. Other examples are as varied as the people and environments in which they are used. Table 1.1 provides examples of how technologies fit the above definition.

The use of appropriate technologies does not, in fact, limit the usefulness of advanced technologies. Some appropriate technology projects include the use of personal computers in an Italian biogas plant; microelectronics in textile production: a cottage industry in the US, and a family firm in the UK; and a good example of an appropriate "new" technology that warrants further description --

Table 1.1 Examples of Appropriate Technologies

Technology	Environmental	Cultural
Fishing Long-liner (Newfoundland)	construction uses locally available material; small scale, decentralized impact on in-shore fishery;	locally made; locally owned;
Passive Solar House (Canada)	use results in conservation of non-renewable resources; environmentally benign; decentralized impact on local environment;	pleasant to live in; increases local self reliance;
Lorena (Mud) Stoves (Guatemala)	uses less firewood to cook meals thereby decreasing deforestation; household environment is cleaner as smoke controlled; uses small amounts of locally available resources (clay) to construct;	increases time available to family as less time is spent gathering firewood; inexpensive to build and own;

electronic load-controlled mini-hydroelectric projects in Columbia, Sri Lanka and Thailand (Bhalla James, Stevens,1984). This description may be found in Appendix A.

In summary, it can be said that appropriate technologies are an increasingly relevant way to develop new technologies or adapt old ones to the present and future needs of the environments in which they are employed. They are generally aimed at producing decentralized, local results adapted to a community or personal level. Jequier (1976) suggested that ATs represent what might be called the social and cultural dimension of innovation. That is, the value of a new technology lies in its adaptation to the local social and cultural environment as well as with its economic viability and technical soundness. This type of scheme encourages local employment using local resources. The methods that are used stress an awareness of long term implications for the health and welfare of society and the environment.

The questions that might be raised at this point might be are not ALL technologies supposed to benefit society? While it is agreed here that yes, all technology should be applied toward this end, most are, however, regulated by other factors. It is beyond the scope of the present discussion to deal in depth with these other factors. However, Table 1.2 presents the characteristics of conventional versus appropriate technological development economies.

A criticism of the concept of AT is that it is too vague and idealized. Edquist and Edvist (1979) wrote that,

"the concept 'appropriate technology' turns out to be a normative concept base on values, ideologies and interest disguised under a seemingly neutral expression, 'appropriate' and not inappropriate techniques should of course be

Table 1.2 A Comparison between Characteristics of Conventional and Appropriate Technologies

General Characteristics	Conventional	Appropriate
Objective:	Maximize GNP	Development of human well being
Indicator:	Level of GNP	Level and composition of GNP
Technology:	Imported	Indigenous
Mode of Production:	Centralized	Decentralized
Local Institutions:	Unimportant	Fundamental
Local Decision-Making:	Unneccessary	Fundamental
Local Solutions:	Uniform	Diverse

(after Carr, 1985)

chosen. Who dares to argue against such a statement when it is formulated in this general and seemingly neutral way?"

Edquist and Edvist (1979) then suggested that using such a broadly defined concept of AT lacks analytical and scientific value. The argument is that the concept must be more clearly articulated so as the major issues involved will be attended to. McClaren (pers comm., 1986) stated that "definition writers" have not thought enough about the consequences of their definitions. So called "blanket definitions" seem to deny a need to select the "right" tool for the "right" job on the basis of what is "right" for that particular situation. There needs to be a more solid framework with which to guide decision-makers.

In "Technology Choice in the Context of Social Values - A Problem of Definition", Paul De Forest (1980) summed up the concept of AT when he stated, "Appropriate technology has no intrinsic meaning, but can only be understood in relation to specific social, economic, and cultural referents.". He continued,

"what remains problematic and subject to dispute is the character of the relation of technological indicators to social indicators. This relation is central to appropriate technology; it is the reason the definitions of the term differ widely and judgements concerning the appropriateness of specific forms and patterns of technology remain controversial."

Thus, the concept of appropriate technologies is a response to cultural, environmental and economic concerns and is aimed at developing sustainable economies which are environmentally conservatory. Citizens who participate in appropriate technologies develop decision-making skills as well as an awareness of local cultural and environmental issues.

1.7 Why Teach AT: A Rationale for Appropriate Technology Education

An education is clearly needed with the goal of a future where technology is in balance with the needs of the human and natural environment. This type of education has an overall objective of sustained human and ecological well-being. The author contends that science and technology education today does not contribute signifiancatly toward this objective. The educational model propsed here therefore, is of a "social reconstructionist" nature and envisions change in societal, technological , and environmental interaction (Eisner and Vallance, 1979). The specific nature of this change includes better understanding of the natural world (including science and technology) as well as opportunities for students to create personally a vision of a better world.

The development of technological options, consideration of environmental impact, and awareness of socio-cultural consequences of a technology require knowledge and skills by the people involved. People need the opportunity, through education, to gain knowledge and skills in decision-making and technological assessment.

There have been calls by various educators and analysts of appropriate technology for an approach to education that supports this goal. To develop innovative appropriate technologies there is the need for education with this focus. As far back as 1958, before the concept of appropriate technology was developed, John Kenneth Galbraith suggested the need to emphasize a balanced approach to education, one that includes encouragement of creative, innovative thought. He wrote:

"One branch of conventional wisdom clings nostalgically to the conviction that brillant, isolated, and intuitive inventions are still a principal instrument of technological progress and can occur anywhere and to anyone...But in the unromantic fact, innovation has become a highly organized enterprise. The extent of the results is predictably related to the quality and quantity of the resources being applied to it."

(Galbraith, 1958)

More recently, Betz (1984) wrote that the difficulties in developing new appropriate technologies are substantial.

"We have built educational and research facilities aimed at the invention and development of tools and techniques that tend to be more capital intensive rather than less so. The difficulties to be addressed in looking at the opposite side of this coin cannot be overemphasized... It is more than a question of direction and financial resources. It is a question of the whole flux of the education system from preschool through post graduate levels. All these factors, both in the developed and the developing countries, tend to build in biases, capabilities, and value structures that make it very difficult to invent and conceptualize low capital investment alternatives."

The need for developing new appropriate technologies clearly indicates a need for educational programs which will educate people who are aware of technological choices and their implications as well as people who can generate and implement innovative appropriate technologies. Are people knowledgable enough to know how to choose a technology, or do they even realize they have a choice? Dyrenfurth (1984) wrote, "what is being done to help the nation's people adapt to and cope with the changes and demands being imposed by technology?" He suggested that not enough is being done so that people are made more aware than just aware of the existence of technology. What is needed, are programs that develop knowledge and skills concerning the application of technology. Further, that an understanding of technology and an ability to apply that knowledge is essential in all students' education.

This document contains a proposal for an educational model which will attend to these issues. The model will endeavor to incorporate a multi-disciplinary approach to technological understanding. It will include the educational disciplines of environmental education, values education, and science, technology and society education. Throughout these fields the issue of values are raised and consequently, this is a theme which is found throughout the model.

CHAPTER 2: THE LITERATURE REVIEW

2.0 Introduction to the Literature Review

The purpose of this review is to provide background information to help identify the educational disciplines which must be included in a model of appropriate technology education. It will thus also provide an overview of these disciplines to facilitate understanding of appropriate technology education in the widest sense.

Environment Canada (1984) provided input to the Royal Commission on the Economic Union and Development Prospects for Canada and urged government commitment to open dialog concerning the themes: where we are as a society, what do we want for the future and how will we attain these future goals. They wrote, "to navigate the passage to a more sustainable future, it will be necessary to steer a difficult course between social disruption and self-defeating attempts to preserve the status quo" (Environment Canada, 1984). This idea, which implies a need for a balance between progress and the status quo, provides the backdrop to this study.

In education, there are many calls amongst educators and scientists to have students examine these issues and explore alternative solutions (Mertens and Hendrix, 1982; Barnhart, 1985). The proposal by Environment Canada (1984) encourages Canadian citizens to consider their environment, employment, and lifestyle to provide for a sustainable future. Appropriate technologies, as well, employ in their design and implementation, consideration of environmental and socio-cultural factors. Thus, an education for appropriate technology must examine environmental and social concerns. Inherent in these fields are the issues of values and the interaction between science, technology

and society. The educational disciplines which endeavor to address these issues are: environmental education; values education; and science, technology and society education. The literature review will examine the rationales, definitions, and processes of each of these fields.

2.1 Introduction to Environmental Education and Appropriate Technology

The concept of appropriate technology utilises a framework from which to consider the "appropriateness" of technology. Foremost within this framework is the environment where a technology is to be implemented. In the decision-making process for appropriate technologies it is believed that primary consideration should be given to the "context" of the issue (Benmokhtar, 1983). Therefore, environmental education which examines the interaction between society and the environment and vice-versa, would seem particularly relevant to a model for appropriate technology education.

2.1.1 Rationale for Environmental Education

The field of environmental education has grown largely because of an awareness of societal impact on the environment and vice-versa. The rationale of environmental education is aimed at developing a world population that is aware of and concerned about the environment and its associated problems (Stapp, 1982). Further, environmental education is intended to encourage a lifelong learning process and development of skills in the arena of environmental action (Stapp, 1982; Johnson,Champeau, Newhouse, 1980).

Approaches to environmental education, like many educational processes, vary considerably. Generally, it has been suggested that in order to encourage people to listen and act with comprehension of the issues, the

vocabulary and idiom chosen must be compatible with the interests of the people involved (Brown, 1982). Programs are undertaken in school classrooms and in non-formal educational institutions such as museums, aquariums, and nature parks. Accordingly, different approaches are usually a reflection of the particular aims of the institution involved. However, there is general agreement on the overall principles and definitions of environmental education (Disinger, 1985).

2.1.2 Definitions of Environmental Education

It may be helpful to discuss briefly the antecedents of environmental education to gain understanding of the history of the field. The primary antecedents of environmental education were nature study, outdoor education, and conservation education (Disinger, 1985). In 1968, Schoenfeld first used the term "environmental education" in a paper, citing a paper presented to the American Association for the Advancement of Science (Disinger, 1985). In 1969, in the first issue of the Journal of Environmental Education the following early definition appeared:

"Environmental Education is aimed at producing a citizenry that is knowledgable concerning the biophysical environment and its associated problems, aware of how to help solve these problems, and motivated to work toward their solution." (Disinger, 1985)

Presently, one of the most widely accepted and most often quoted definitions of environmenal education was developed at the Foresta Institute in 1970 (Hart, 1979):

"Environmental education is the process of recognizing values and clarifying concepts in order to develop skills and attitudes necessary to understand and appreciate the interrelatedness among man, his culture, and his biophysical surroundings. Environmental education entails practice in decision-making and self-formulation of a code of behavior about issues concerning environmental quality." (Cerovsky, 1979)

Stapp (1982) suggested some guiding principles of environmental education. He wrote that environmental education should:

1.consider the environment in its totality -- natural and built, ecological, political, economic, technological, social, legislative, cultural, and aesthetic;
2.be a continuous life-long process; it should begin at the pre-school level and continue through all formal and non-formal stages;
3.be interdisciplinary in its approach, drawing on the specific content of each discipline in making possible a holistic and balanced perspective;
4.emphasize active participation in preventing and working toward the solution of environmental problems.

A general description of the characteristics of environmental education is contained in Robinson and Wolfson (1982) based on the U.S. Environmental Education Act of 1970. Environmental education has:

1.an interdisciplinary approach, emphasizing nature-human interrelationships;
2.a focus on environmental (artificially created and natural) problems relating to the community;
3.incorporation of informal as well as formal education programs and resources outside the classroom;
4.development of a conservation ethic as well as information;
5.involvement of all ages;
6.a participant-centered design that allows involvement in the choice of issues and the problem-solving solutions.

In summary, these definitions highlight the concepts that environmental education is process oriented, relating to knowledge, attitudes, and skills relating to the environment. A generalized model of environmental education has four basic components; it is holistic, multi-disciplinary, issues-oriented, and

has an action component. It also considers values, attitudes, and the necessary skills for active participation in the socio-cultural as well as natural environment. This model is applicable to urban and rural environments and can be adapted for either formal or non-formal education. The discussion will now look at each of these four areas in more detail.

2.1.3 Approaches to Environmental Education

Environmental education should be holistic. The focus is on natural systems by teaching people about natural processes, cycles and resources (Mills, 1981). The essence of a holistic approach is a focus on the interrelations of how the human species interacts with the environment. A holistic education as well implies a non-reductive perspective concerned about whole systems: learning the parts of a system with a multi-disciplinary methodology while referring back to the whole system. This process is aimed at developing a world population that is aware of and concerned about the total environment and its associated problems, and which has the knowledge, attitudes, motivations, commitments, and skills to work individually and collectively toward solutions to current problems and the prevention of new ones (Stapp, 1982).

Environmental education is multi-disciplinary. It explores an issue through a variety of disciplines. There are two basic approaches suggested to be included in environmental education: ecological and ethnological. The ecological perspective looks at relationships between living organisms and their environments, while emphasizing the biological and physical aspects of change, and examines the extent to which species are dependent on dynamic forces and the limits to their adaptability. The ethnological perspective studies humans and the environment. Its focus is through an examination of the

individual in the community, how the traditional way of life is altered by different rates of change and diffusion of ideas,and how these changes could effect the future (Aldridge, 1981). Both ethnological and ecological perspectives shed light on the dynamics of change, the survival of communities, and the extent to which environmental changes can be assimilated without destruction of species or communities. These are two important components of the multi-disciplinary nature of environmental education. Specific disciplines such as science, social studies, history, art, and science and technology education, for example, are utilized depending on the issues examined.

Environmental education is issue oriented. It is suggested that environmental education should be concerned with "real-life" issues for students such as: pollution, population, urban and rural planning, economics, technology, energy, transportation, conservation, and resource allocation (Alf,1981). Other issues include:

-energy and environmental related career decisions,

-holistic lifestyle assessments - which analyse basic human needs, lifestyles and values,

-forecasting, planning and policy formulation - which focus on managing the environment, use of resources, and forecasting the impacts of our present and alternative technological paths, and

-futures thinking - where we want to be and alternative ways of achieving those futures (Mills, 1981).

Finally, environmental education has an action component. Hungerford and Peyton write (1980): "The UNESCO-UNEP Declaration calls for individual participation in environmental issue remediation. Further, UNESCO-UNEP research reports a paucity of programs involving receivers in issue

remediation." Although reference exists in the literature relating to the need to develop action skills, the literature remains heavily weighted toward awareness of environmental problems. The inference may be made that most writers perceive that awareness can, in fact, lead to effective citizenship responsibilities. However, there also exists in the literature both intuitive and empirical evidence that this is not the case (Hungerford and Peyton, 1980). Thus, it is critical that environmental education not only include environmental issues, but also include process and content related to personal and group decision-making and action skills.

2.1.4 The Process of Environmental Education

Environmental education is an integrated process focusing on human relationships with natural and man-made surroundings. It can occur as both formal and informal education. The process of environmental education has two major components. One is termed process education while the other is the content (Mills, 1981). Process education is the way one learns regardless of subject matter. This component uses the learner's environment to instruct him. The content component is the study of human-environment inter-relationships. Both components are inter-locking and inseparable in a good program of environmental education. Environmental education provides opportunities for alternate ways of thinking , as well, it is distinct way of teaching and learning (Disinger, 1985; Mills, 1981).

McClaren cautioned that many environmental education programs are "activity-rich" but "framework poor" (n.d.). Thus, the process of environmental education can get side-tracked or given up altogether. He suggested that teachers think about their teaching strategies in a "developmental sense." To

"be able to consider what particular tasks are most appropriate at a particular age or developmental level of the children." Johnson et al.,(1980) suggested that environmental education be recognized as a continous interactive process, geared towards the level of the participant.

In summary, environmental education examines the interaction between society and the environment and utilizes a process which recognizes values and skills needed to develop a citizenry able to understand the interrelations among society, technology and the environment. The focus should be upon an educational process that is holistic, multidisciplinary, issues oriented and develops decision-making and action skills composes a complete environmental education program.

2.2 Values and Education

The question of values and education is one that prompts many divergent answers. However, even if there is no simple "right" answer, it is a question that does need to be addressed. Because the field of values education covers a wide range of activities, the focus of this part of the literature review will focus specifically on the application of values curricula to appropriate technology education. Thus, the discussion will cover the rationale and definitions of values development and specifically on the process of values clarification as an educational methodology.

Appropriate technology education is defined by the disciplines of science, social studies, and the study of technology. Therefore, when looking at the question of values and appropriate technology education, literature concerning values and the above disciplines are relevant. A field of education

concerned with science, technology and society education will be addressed in the next section of this literature review.

2.2.1 Rationale of Values and Appropriate Technology Education

Mertens and Hendrix (1982) suggested that new educational programs are needed to deal effectively with the value/moral/ethical issues raised by the application of new scientific knowledge. Rapid changes in science and technology greatly increase the need for people to have input into decisions in the areas of science and public policy. As well, there is a call for increased scientific and technological literacy of students by scientists and educators (Barman, Ruscho, Cooney, 1981; BSCS, 1984). An education that examines the "appropriateness" of technologies must be concerned with the application of technology and its consequences. The interpretation of the consequences of technology generally includes value issues.

This type of education supports the use of scientific and technological knowledge to help solve personal and societal problems (Mertens and Hendrix, 1982; Dyrenfurth, 1984). In these programs, opportunities should be provided for students to interact with their peers and adults regarding science and technology that will have personal impact on them (Barman et al., 1981). Applying knowledge to solve personal and/or societal problems involves values. Values must be clarified and examined in a problem-solving process in order that a solution may be reached.

2.2.2 Definitions of Values Development

Louis E. Raths, Harmin, Simon, in Values and Teaching (1978) wrote that a person formulates a value through a valuing process. They proposed that a value is developed through the following steps:

1. Choosing - the person must be able to select what he or she perceives to be good or bad freely, from a series of alternatives, and after thoughtful consideration of the consequences of each alternative;
2. Prizing - After the person makes his or her selection, he/she must be satisfied with it. He/she may demonstrate his satisfaction by publically affirming his choice;
3. Acting - The person must act upon the choice with some repetition. (in Barman et al, 1981)

Barman et al., (1981) have condensed a taxonomy of values suggested by Krathwol et al., (1964). This system is presented in three groups:

1. Awareness - A person is aware of and responds to a stimulus in his environment;
2. Acceptance of values - a person accepts that value and makes a commitment to it;
3. Preference for values - the person has formulated a general guide to values and has integrated these attitudes into a philosophy of life.

Further, they add, "because values mold our behavior, they are developed through extremely complex circumstances.... therefore, a value is not static. It is something that is constantly being shaped by our daily experiences."

There is agreement between Barman et al.,(1981) and Raths et al., (1978) that the development of values is a personal and a life long process. "It is not something that is completed by early childhood. As the world changes, as we change, we have many decisions to make and we should be learning how to make these decisions." (Raths et al., 1978) Gazda, Ashbury, Balzer, Childers, Walters. (1977) add that significant learning occurs more readily in reference to situations students perceive as problem areas and, that teachers should provide opportunities for contact with problems and facilitate personal resolution of these issues.

2.2.3 The Approaches to Values and Education

Some approaches to values and education emphasize a view that there are identifiable capacities necessary for the practice of any morality. John Wilson et al., (1975) stressed the development of empathy as well as an awareness of consequences of action. Oliver and Shaver, (1975) developed a public issues social studies curriculum that is derived from value concepts assumed in the idea of democracy. The most abstract, or highly evolved concept being a respect for human dignity. The curriculum is designed to develop student recognition of, and to resolve value conflicts in the area of public policy debates. Central to this approach is instruction and practice in the use of "rational consent" in decision-making.

Lawerence Kohlberg has identified six "stages" of moral development which are arranged in a sequence (Barman et al., 1981, Lockwood, 1975). Each stage in Kohlberg's model represents a point of view on various ethical issues. Barman et al., (1981) state: "it is Kohlberg's contention that a person cannot reach one stage before experiencing a preceding one. However, this

person could operate at one stage and revert back to a lower one in certain situations." As well, Kohlberg's research indicates that people in all cultures progress through a similar sequence. Kohlberg's theory is applied in a curriculum which facilitates and stimulates development through the stages (Galbraith, and Jones, 1976).

2.2.4 Process of Values Education: Values Clarification

In Values and Teaching, Raths et al., proposed another model of values development (1978). They argue that many people do not have a clear set of values and may be "apathetic, confused and irrational." They have developed a teaching methodology known as the values clarification process, which is aimed at helping children to be more "positive, purposeful, and enthusiastic" (Raths et al., 1978). The emphasis of this methodology is on the process of valuing rather than on specific values. Three sources of content are identified as especially suited for the clarifying process:

1) "value indicators" such as goals, aspirations, attitudes, feelings, beliefs, activities, and worries;
2) personal issues;
3) social and societal issues, such as the relationship between an individual and society and identification of societal goals.

The process of values clarification has basically three steps: 1) attention is focused on an issue in the student's life; 2) acceptance of student is communicated; and 3) an invitation is offered to reflect further on choices, prizings and actions.

The area of unconditional acceptance of student values is one which has stirred up controversy with the values clarification model. Kazepides (1977)

argued that Raths et al., are committed to a "relativistic" position with regards to values. He stated:

"There are no value criteria in the 'process of valuing' that guarantees that the life style which the person commits himself/herself as a result of the 'process of valuing' is a valuable one. The arguments of the VC (Values Clarification) proponents followed to their logical conclusions constitute a betrayal of reason and a retreat into irrationalism. How else can one characterize the unconditional acceptance of the child as the ultimate source of appeal for what is true, right or justified.?"

Lockwood (1975) pointed out that the relativistic ethical position of values clarification has some central arguments against it. The fundamental issue he said, is that it can be used to justify virtually anything. Kazepides (1977) concurred, stating that it is:

"hardly appropriate to subject them to a process which has abandoned the search for rational standards of human conduct and has adopted an extreme relativistic ethical stance. What they fail to realize is that by abandoning the search for rational standards of human conduct they deny human intelligence and choice any role in influencing the course of human history."

A repeating theme in the theory of Raths et al., as well a criticism of the theory is that the relativism or unconditional value acceptance is a "valuing process." While many may argue against Rath's equation of values with the valuing process, it still remains that the techniques of value clarification, using the described three step process can be useful in the classroom and as a life skill (Mertens and Hendrix, 1982). Mertens and Hendrix (1982) suggested an additional examination process while stressing that "methods are needed which do not impose teacher values but rather clarify student values and help students explore the consequences of alternate uses of ... knowledge."

Mertens and Hendrix's (1982) model focusses on clarifying and decision-making skills. It is an eleven step process that not only includes identifying and considering solutions but assessing and examining alternatives. The process is

summarized in Table 2.1. They write that this "model for bioethical decision-making (is) designed to enable students to clarify their own values rather than have their instructor's values imposed upon them. The model stresses examining alternative solutions to ethical problems and the consequences of these solutions."

The focus on examination of alternatives versus merely clarifying values is a crucial concept according to Kazepides (1977). He wrote:

"one can make his ideas clear although their correspondence with reality, their consistency and cogency, their worthwhileness can still remain questionable. But when one examines his ideas one subjects them to close scrutiny and investigation to determine their correctness, quality, and worthwhileness. The word examination, then, implies criteria and standards that are not implied by the word clarification."

It would seem that Mertens and Hendrix (1982) have provided and example of a successful complimentary model that provides opportunity for clarification and examination of alternatives. They report that in 1982 , the model for bioethical decision-making and the associated case-study approach were successfully implemented in a variety of situations.

2.3 Science, Technology and Society (STS) Education

This literature review has so far covered environmental education and values education as an appropriate technology educational model is influenced by environmental and value considerations. The last section of the review will cover science, technology and society education. This multidisciplinary field, like appropriate technology education, stresses the connections between science, technology and society.

TABLE 2.1 A Bioethical/value Clarifying/Decision-making Model

1. IDENTIFY PROBLEM
   -list why the issue is a value/ethical problem;
   -identify and list 5 personal values that apply to the issue;
   -rank these values (1=most important, 5=least important);

2. LIST ALTERNATIVE SOLUTIONS TO THE PROBLEM
   -at least 5 alternatives;

3. RANK SOLUTIONS
   -use your personal value preference;

4. LIST VALUES THAT CAUSE YOU TO SELECT THE PREFERRED SOLUTION

5. REPEAT STEP 4 USING THE SOLUTION YOU RANKED LAST

6. LIST CONSEQUENCES OF ACTION IF YOUR PREFERRED SOLUTION WERE IMPLEMENTED WORLD-WIDE

7. ASSESS EACH CONSEQUENCE, USING YOUR VALUES, AS BEING "GOOD" OR "BAD"

8. TALLY YOUR ASSESSMENT FOR STEP 7: DETERMINE IF THERE IS ANY DETRIMENTAL CONSEQUENCE THAT OVERRULES THE BENEFITS OF A SOLUTION

9. SCREEN YOUR PREFERRED SOLUTION THROUGH YOUR ETHICAL PRINCIPLES
   -go to step 4;
   -if in agreement, then go on to step 10;
   -if not, modify your solution and repeat steps 4-9;

10. LIST REASONS WHY OTHERS MIGHT NOT AGREE WITH YOUR SOLUTION

11. DETERMINE HOW STRONGLY YOU BELIEVE IN YOUR SOLUTION
   - 1=highly confident, 5=no confidence

(after Mertens and Hendrix, 1982)

Recently, discussion has been renewed as to the best approach to teaching about science, technology and society (STS). Brinkerhoff (1985) wrote that "we do not need expensive new courses so much as a new thread of concern running consistantly through the old ones, giving our students a sense of the social relevance of science." Others respond however, that new courses are needed that stress learning science, technology and society together in a separate course (Cunningham, 1971; Rip, 1979; BSCS, 1984). Brinkerhoff (1985) cautioned that the movement towards integrating STS is still "grassroots" and its philosophic arguments are largely unsupported by scholarship. However, there are present in the literature numerous citations related to STS courses, science and society courses, and how to adapt traditional science courses into ones that consider the social or technological implications of science. The following section is concerned with the rationale,definitions, approaches, and processes of STS education (including science and society education), technological literacy, and technological training.

2.3.1 Rationale of Science, Technology and Society Education

During the last few decades the number and complexity of social and technological problems have increased (Bybee, DeHart Hurd, Butler Kahle, Yager, 1981.) It has become apparent to many educators that students need to have knowledge and skills related to the connection of science, technology and society to solve these problems. Jequier and Blanc (1983), writing specifically about appropriate technology, stated that information alone does not assure innovative approaches to these problems. As well, Beisenherz (1982) wrote that conclusions drawn from three studies on the status of science education indicate large discrepencies between the stated goals or objectives and what

happens in the classroom. Goals related to the personal use of science and technology in every day life and to scientific literacy for societal decision-making are largely ignored in practice (Hurd et al., in Beisenherz, 1982). Thus, there is a call for more research and literature on approaches to STS and science and society education.

2.3.2 Definitions of STS

The origins of STS courses or the addition of an STS approach to traditional science curriculum is based on the increasing impact of science and technology in people's everyday lives. Rip (1981) wrote:

> "The reasons why STS courses have become as established as they now are... related both to the massive expansion of higher education and to the fact that the changes in the social relations of science now effect the majority of scientists, and not only the elite, as in the 1920's. The social pressure on scientists, as reflected in calls for more accountability and more relevant research, is now very widespread."

This situation prompted one author to propose the "Itch Theory" (Cunningham, 1971). He suggested that the majority of people concerned about the impact of science and technology, or had the "itch" as he called it, did not have knowledge and skills to take effective action. At the same time, scientists and technologists, engineers for example, had knowldege and skills but lacked the "itch" and saw no need for action. Thus, a need existed for an integrated program to educate both scientists and non-scientists about the consequences of science and technology on society and vice-versa.

2.3.3 Approaches to STS

As a result of this type of analysis, numerous models and curriculum have been developed. In 1984, the Biological Sciences Curriculum Study

(BSCS) published an interdisciplinary program designed to "educate citizenry regarding the issues of science/technology/society that have important consequences for both present and future policies." Bybee et al, (1981) argued for an expanded view of science teaching, one that originates in the connection of science, technology and society and considers "human ecology" or the relations between the human community and the total environment. Most of the literature reviewed stressed the the consequences of the interaction between science, technology and society as well as a method for informed decision-making or assessment. The question of values in proposed decision-making models were cited as an important consideration (Mertens and Hendrix, 1982; BSCS, 1984).

The goals of science, technology and society education (as well as science and society education) stress the interaction between these disciplines therefore such a program must be interdisciplinary. However, as previously noted, there are two significant approaches to this area. These approaches are reflected in the goals of the curricula. The adaptation orientation stresses the scientific process, while the STS course orientation stresses technology as an application of the scientific process. Table 2.2 summarizes the goals of a variety of models found in the literature. Generally, three goals emerge:

1. Understanding science as a process and that technology is an application of the results of the scientific process;
2. Understanding the relationship between science, technology and society and its consequences;
3. Understanding of, and the ability to use, a decision-making process for solving personal and societal problems related to these disciplines.

Table 2.2 Some Goals of Science and Society and Science, Technology and Society (STS) Courses

SCIENCE & SOCIETY	STS
-understanding science as a process;	-development of scientific literacy;
-understanding basic scientific laws and principles;	-education about the interrelationship of science, technology and society;
-understanding the relationship of science and society;	-recognition of the key differences between science (knowledge) and technology (application of knowledge);
-uses current issues;	-assessment of technological innovations;
-raises open-ended societal or ethical questions;	-raises value questions regarding society, science and technology;
-recognizes value judgements in the process of decision-making in the realm of science and society;	-includes a decision-making process for every-day issues;
-encouragement of values such as compassion and personal responsibility;	-seeks a role in creating a society where science and technology promote human well-being;
-encourages community involvement in program;	

2.3.4 The Process of STS

The process used to attain these goals suggests that new teaching methods are needed to add to the traditional methods (Mertens and Hendrix, 1982; Bybee et al.,1981; Brinkerhoff, 1985). Beisenherz (1982) concluded that teachers must have skills not normally required in the more traditional programs. The approach the classroom teacher should have is one that will "encourage and tolerate conflicting viewpoints, demonstrate technique of questioning and group discussion, foster group problem solving and decision-making techniques, and will not force closure on discussions" (Beisenherz, 1982). Addinell and Soloman (1983) added that a science and society course emphasizes pupil participation and "teachers need to provide a setting and a focus within which pupils are encouraged to discuss and offer their opinions." Further, the teacher's role is to have varying viewpoints thoroughly considered but that "while it is quite natural for teachers to express a personal opinion, it would be wrong for them to insist that such opinion is necessarily correct."

2.4 Technological literacy and Training

Miller (in Dyrenfurth, 1984) argued that because of increasing "weight of technology" in society, there is a need to systematically study industry and technology throughout a child's school years. Dyrenfurth (1984) further explained that "literacy" means not only awareness and understanding technological principles but the ability to apply the principles. Training, however, focuses on the transfer of skills and application of those skills. Despite the importance of technology in society, there is a scarcity of literature on technological literacy, and even fewer proposed educational models in this area. In the area of technological training, training models do exist but the trend

is now towards a comprehensive approach, which may be likened to technological literacy.

Many Third World countries, for example, have undertaken development projects that involve new technologies. Yet as Hancock (1984) stated: "attitudes to technology transfer have undergone a series of shifts, which began with a reaction against technology." The transfer of technology through training has become increasingly unacceptable in many situations. There is now support for a new process which includes the "know-how" or "development of human resources" as well as skills in use of a particular technology (Spielman, 1981; Morgan, 1983). It is suggested here that use of appropriate technologies with new approaches to training are ideologically consistant and can enhance overall effectiveness of the development process.

2.4.1 Definitions of Technological Literacy and Training

Technological literacy involves all the domains of human behavior traditionally used to encompass the goals of education. Cognitive, affective, and sensorimotor goals are all well represented in the literature addressing technological literacy (Dyrenfurth, 1984). Technological literacy involves a variety of technologies, educational goals, and individual perspectives, therefore, not all persons need to be technically literate at the same levels.

Morgan (1983) wrote that technological training involves the integration of the training process for the introduction of any new technology. He identifies 5 factors for this process:

1. identify common sources and methods available;
2. introduce a strategy by which to plan, integrate and implement the process;

3. identify the goals of the training - knowledge or skills or both that need to be addressed;
4. identify the educational background of the trainees, incorporate this knowledge into the process;
5. identify the specific learning objectives of the program.

2.4.2 The Process of Technolgical Literacy and Training

It was suggested by Dyrenfurth (1984) that individual needs and perspectives be taken into account when designing and inplementating a technological literacy program. He also stressed the critical dimension of technological literacy is the ability "to do". He wrote, "anyone who is technically literate not only knows why, but is also able to apply that knowledge."

Hancock (1984) suggested that for the training process to be fruitful, the trainee must be "ready" for the acquistion of the knowledge and skills involved. Jequier and Blanc (1983) as well understand the importance of recipient readiness when they wrote that a "reluctance to accept innovation" is a large obstacle to training and use of new technologies. Hancock then proposed models for training that include "alternative communication, open and participatory planning, decentralization and localization" during the training process.

2.5 Key Characteristics of an Appropriate Technology Educational Model

This discussion will concentrate on the application of the previously discussed disciplines to the concept of appropriate technology. First, general characteristics of AT education will be outlined. Then, these characteristics will be applied to develop a curriculum model, "Toward Appropriate Technologies."

The design principles and specific characteristics of the model will then be discussed in chapter 3.

To begin the analyis of appropriate technology education, one must turn to the characteristics of appropriate technology itself. As has been discussed previously, some of the key characteristics of appropriate technology are:

-a holistic view of technology and its impact;

-technology must fit the particular situation in which it is used;

-local participation in the design and/or implementation of the technology.

Thus, by combining relevant knowledge of environmental education, values education, and science, technology and society education, then applying it to the concept of appropriate technologies, the suggested approach for appropriate technology education will have the following necessary characteristics: it will be holistic, multidisciplinary, issues-oriented, and have an action component. It may be useful to expand upon the above characteristics to get a more complete understanding of appropriate technology (AT) education.

1. AT education should be holistic - taking a "whole system" approach. The components of AT education work together through a variety of means to provide a holistic view of the environment and the technologies used within the environment. AT education does consider appropriate technologies specifically and explores in a whole systems fashion the definition of what is appropriate to that particular environment, culture (including attitudes and values), political and economic system. The concept of viewing a technology holistically is inherent to the definition of appropriate technology.

2. AT education should be multidisciplinary - it includes science, social studies, arts, values, and technology education. Appropriate technology considers the biological and man-made environment (socio-cutural) as the primary components to a system. A technology has to function effectively within these environments in order to be appropriate. The way in which one evaluates the merits of a particular technology is through a multidisciplinary lens. Thus, a variety of methodologies from disciplines such as science and social studies, for example, are used to study and propose solutions to problems posed by contemporary technologies.

3. AT education should be issues oriented - activities are related to issues that have personal meaning for the participants. The issues to be considered by AT education are delimited by the issue of technology and its relationship to the environment in which its used. Stress is placed on considering all options, from "alternative" to "high tech" technologies from a personal and local perspective.

4. AT education should have an action component - this includes a decision-making process that is designed to apply knowledge and skills towards appropriate personal action. Current research indicates that in practice, the action component of AT education is the predominant method that is used (Reddy, in Bhalla, 1979). The emphasis is placed on diffusion of information and encouragement of the use of the technology (Jequier and Blanc, 1983). The objective of AT education, it is proposed, is to generate the understanding of the need for informed action in relation to the use of technology.

CHAPTER 3: AN APPROPRIATE TECHNOLOGY EDUCATIONAL MODEL: "Toward Appropriate Technologies"

3.0 Introduction

The discussion has reached a point where knowledge of appropriate technologies and the educational disciplines of environmental education, values education, and science, technology and society education can be applied to the formulation of a curriculum model about appropriate technologies. Such a model can assist curriculum developers and educators interested in expanding curriculum currently available concerning science, technology and their impact. This model is applicable for secondary and post-secondary students. Although it has a multidisciplinary approach, its content is especially concerned with environmental studies, natural sciences and their application.

A ten step curriculum development model was used to formulate the model "Toward Appropriate Technologies". This method was developed by Gibbons (1986) and consists of the following steps.

1. Analyze the Situation. The context of where the curriculum will be used is studied, a purpose, goal, and/or aim of the curriculum identified, and a rationale for the curriculum stated;
2. Create a Program Design. A design is generated for the program to guide its development;
3. Develop Curriculum Content, Organization, and Goals. A comprehensive outline is developed of what students will learn and accomplish in the program;

4. Decide on Learning Activities. Activities are chosen that will ensure students master the content or goals of the program, and are organized in the most effective sequence;
5. Decide on Teaching Strategies. Methods are chosen that will enhance student achievement with the learning activities, and are organized in the most effective sequence;
6. Prepare an Environment that Supports the Program. Materials are prepared for the learning activities, the classroom and a support system;
7. Undertake a Field Test of the Program. Begin the instructional program, evaluate the program while it is underway, and make necessary improvements;
8. Determine the Comparative, Overall Effectiveness of the Program. Undertake research into other similar programs to determine the relative effectiveness of the program;
9. If the Program is Successful, Decide on a Strategy for More Wide-Scale Implementation. Choose among the models of implementation, ready the program for implementation, and manage the implementation process;
10. Reflect on the Process Undertaken to Date. Review what has been accomplished, consider the range of opportunities and renew the process of development.

(after Gibbons, 1986)

This document presents the results of this process through to the eighth stage in the above curriculum development process.

3.1 Step One: Purpose & Rationale

The purpose of the model curriculum is to have students learn about the concept of appropriate technology and how it can be applied in their lives towards the resolution of problems at every level, from those of the local community and even to those of global dimensions.

A case has been made for a curriculum which empowers people to gain knowledge and skills in decision-making and technological assessment. This is essential to attain the overall goal of a future where technology is in balance with the needs of the human and natural environment. The choosing of technological options, considering their environmental impact and socio-political implications requires special knowledge and skills. As has been discussed, this type of knowledge is often called technological and/or scientific literacy.

Education for technological and scientific literacy teaches awareness, understanding and application of key scientific and technological principles (Mertens and Hendrix, 1982; Dyrenfurth, 1984). An appropriate technology curriculum should provide opportunities that foster awareness and understanding technological options as well as application of the knowledge and skills with appropriate action. Ideally, this should happen at a personal, community and global level. Such a program would seem particularly important in the face of accelerating technological advances and the changing needs of our future citizens (Watson, 1983).

Educational institutions have been dealing with the relationship between science, technology and society through a variety of means. Some provinces, British Columbia for example, now offer Grade 11 students a course on Science, Technology and Society. The question that remains to be answered, however, is whether these courses will consider a representation of a variety of technological options. E.F. Schumacher, in his book Small is Beautiful (1973) was one of the first to point out the influence of the choice of technology on society and the need to make appropriate technological options available. Since then, there has been interest on the part of individuals and communities with the ideas Schumacher and other people of similar views. However, in the school system and community courses there is a absence of curricula concerning alternative technologies. It is proposed therefore, that an appropriate technology curriculum model would provide a framework for curriculum developers and educators to apply these important concepts.

3.2. Step Two: Design Principles of "Toward Appropriate Technologies": an AT Educational Model

To complete step two of the curriculum development process, the definition of AT education was applied to create a program design. The proposed design principles for a model of appropriate technology education, called "Toward Appropriate Technologies" are the following:

1.NATURAL SYSTEMS AS THE BASIS OF CONTENT;

By grounding the content in natural systems we look at technology from a different, more holistic perspective. We can consider the use of human tools and technology on ourselves, as living beings, and on the environment around

us (Bybee et al., 1981). The importance of this principle lies not in its identification as a precise tool, but as a profound multi-dimensional paradigm for thinking about how the world works within which to frame other, more concrete questions (Todd and Todd, 1984).

2.NATURAL PRINCIPLES ARE INTEGRAL TO PROCESS AND CONTENT;

Having natural systems as the context for our curriculum, it seems the next step is to explore the ways we can use our understanding of natural systems using scientific laws to produce more appropriate technologies. Further, we need to model these laws in our process of understanding the concept.

3.LOCAL CONCERNS PLAY A FUNDAMENTAL ROLE IN THE PROGRAM;

The curriculum should reflect the resources and needs of the local natural system. Thus, units will have local input by teacher, students and community during the class as to the concerns of their region and the impact of technology there.

4. THE DECISON-MAKING MODEL FOLLOWS A PROCESS THAT CONSIDERS TIME AS WELL AS HUMAN AND ENVIRONMENTAL ISSUES, IN A LOCAL AND GLOBAL ARENA;

The idea of sustainable technologies within local and global cultures is a concept that needs to be considered in a decision-making model if we value sustained life. This means the assessment of the impact of technology in the short-term and long-term future. Most evaluations do not consider the long-term future, leaving that up to future generations. They do not take into account long-term consequences of actions such as the horrifying persistance of radio-active

wastes. Therefore, the view this curriculum takes is one of exploration of this issue in creating a vision of a sustainable system.

Distribution of resources affects every one whether they live in the "Third World" or "developed" nations such as Canada. By using a model that looks at where our fresh produce, for example, comes from and what impact that production system has on our lives and the lives of others, we can make technological and job related decisions which better reflect the global situation (Todd and Todd, 1984).

As well, skills must be acquired in a process that does not impose teacher values but rather clarifies student values and help students explore consequences in the application of those values. (Mertens and Hendrix, 1982)

5.THE EDUCATIONAL SYSTEM IS FLEXIBLE, RELEVANT, AND EVOLUTIONARY WITH ITS LEARNERS AND THEIR ENVIRONMENT;

The curriculum seeks to create a situation where the learner has a fundamental impact on the direction in which the learning process develops. Thus, from the start, the student has choices as to which activities and learning styles will be most effective for the individual and class (Goldberg and Shuman, 1984). Further, the format is subject to ongoing evaluation to determine if change is desirable (Feuerstein, 1978).

6 ENCOURAGEMENT OF HEALING THOUGHTS AND ACTS;

Fundamental to this curriculum is the vision of a future where the world is a better place. In order for this to happen, people must have the faith, values and sense that it is worthwhile to look towards a positive future . One way in

which to do this is by development, through personal and group activities, of a sense of improving, healing and bettering our world.

7.CREATION OF A SENSE OF VALUES REGARDING NATURAL SYSTEMS;

Many scientists and lovers of nature share a sense of awe about nature. The values and belief systems underlying human interaction in natural systems are varied in intensity and type. It is important for learners to focus on how their beliefs and attitudes interact with nature and upon the role of technology in that environment.

3.3 Step Three: Characteristics of the Curriculum Model

The design principles of "Toward Appropriate Technologies" form a framework in which to develop the organization, content and overall goals of the curriculum model. The following discussion will describe characteristics of the proposed model. Specific learning activities and goals will be described in Chapter 4 of this document.

3.3.1 A Natural Systems Model of Appropriate Technology Education

The proposed model uses a natural systems or ecological approach as the basis of the curriculum design. Bybee et al., (1981) suggested an ecological approach to teaching science and technology because ecology considers "the relations between the human community and the total environment." They then suggest 5 reasons to use an ecological approach to teaching about science, technology and society:

1. The complexity and interrelatedness of contemporary problems require a holistic view using an ecological context;

2. Ecological scarcity is fundamental to many social problems, eg water and/or firewood shortages in many countries;
3. Important personal and social dilemmas can best be viewed holistically, ethically, and ecologically; thus, the human influence - both positive and negative - has to be included in any understanding of science and technology based social problems;
4. Public perceptions of social issues are directly aligned with ecological levels of study - perception of problems is best in the individual's own ecosystem; from this level the investigation can proceed toward larger and smaller levels of organization, from the global biosphere to the microscopic realms of life;
5. The issue of stewardship or responsiblity of the environment can best be explored within the ecological context which includes the factor of time: viewing issues of environmental use and social interaction responsibily from the present and in the future.

Barnhart (1985) wrote that exploration of the biological world, and particularly the relationship of individuals to the ecosystem in which they live, is the context for an appropriate technology and sustainable ecological agriculture course taught at the K - College levels. He suggested that a benefit of this approach is that students interact daily with living agricultural ecosystems which reinforces the concept that the study of nature through classroom activities is only a "sketchy description of the actual, unified, constantly changing ecosystem." Jungck (1985) as well supported addition of an ecological context to the biology classroom. He wrote that investigation in the use of appropriate technologies and agriculture, (eg organic farming, intercropping), provides many issues for the high school and college classroom. Viewing technology in

an environmental context, Howard (1982-3) noted the addition of "the crucially important ecological emphasis" to the United Nation's education program.

The natural systems approach thus emphasizes a holistic as well as a reductive perspective. As has been shown, this approach is currently in use in a variety of settings. The concept of using a natural and human ecological systems perspective encourages students to combine reductive and holistic inquiry methods. These methods are used in a multidisciplinary context to solve problems or understand issues regarding the appropriateness of technologies.

3.3.2 Centering on Issues or Problem-Solving

The model proposed here involves students in actual problem solving at levels appropriate to their understanding. Studies have shown that a problem solving approach using a "case study " provides opportunities for analytic and synthetic methodologies as well as creative and interpretive appoaches (Bybee et al., 1981). Implementation of this approach does not sacrifice student learning of content, rather it improves student motivation and increases self-directed learning (Mertens and Hendrix, 1982; Goldberg and Shuman, 1984).

The types of issues used in the curriculum revolve around actual problems concerning technology in biological and socio-cultural environments. Issues selected are relevant to the local environment and/or to student interest. Research indicates that students are more apt to acquire new knowledge and skill using issues or problems that they can relate to (Raths et al., 1978; Bybee et al., 1981) For some examples of issues used in this model, see Figure 3.1.

Figure 3.1 Some Issues and Topics for an Appropriate Technology Curriculum

Acid Rain	Food Shortages
Armaments and Nuclear Warfare	Genetic Engineering
Chemical Waste Disposal	Human Communities
Conflict Resolution	Human Stress
Conservation	Land Use
Economic Inequities -the rich/poor gap	Natural Resources
	Nutrition
Employment/Work Roles	Organic Agriculture
Energy Sources: Alternative/ Conventional	Pollution
	Technology
Environmental Degradation	Waste Management

(after Bybee et al., 1981)

3.3.3 Hands-on activities

Activities suggested in the model are designed to engage students to be full participants in the learning process. Thus, a hands-on, participative model is stressed (NSTA, 1986). This approach assumes that the best way to learn personally about natural systems and appropriate technology is to engage projects using appropriate technologies (Barnhart, 1985). Furthermore, the same activities use cooperative methodology and self-directed learning strategies. Activities such as surveys, mapping, interviews, models, simulation games, researching, debates, role playing, cooperative group work, fantasizing, art, building, exploring, sharing experiences, and stewardship are some of the activities which meet this criteria (Bybee et al., 1981; Beisenherz, 1982: McClaren, pers. comm).

3.3.4 Student as Participant

Today's student lives in an increasingly complex world, where decisions about career, lifestyle, values, ethics in the personal realm can seem overwhelming. With so many choices available, one wonders how an individual can consciously follow through and act with their intentions in mind. Education must respond to this concern by providing relevant opportunities to participate in making complex decisions. The place to begin this decision-making process is at the personal and/or local level.

A fundamental criterion of appropriate technology is that it starts within the individual and community at a grassroots level (Storm, 1982). Kerr (1982) identified participation as a key to appropriate technology. He stated that in AT education as well, it "seems to be more a matter of participation, local

development and control, social interaction, provision of feedback, and infectious enthusiasm." Mollison (1979) and Barnhart (1985) suggested the best place to start with any ideal is at the personal level. Conscious action in ones's local environment is the avenue that offers the most power for change (Barnhart, 1985).

It can be seen then, that any curriculum with the theme of appropriate technology must begin at the personal level -- viewing the student as having a direct say in his or her learning process. The student as participant enhances student responsibility; independent learning and ultimately, increasing confidence in decision-making skills and the ability to act on them (Goldberg and Shuman, 1984).

3.3.5 An Appropriate Technology Decision-Making Model

The decision-making model proposed here is an ten step process that promotes a broad understanding of the impact of technology. As many planners are aware, it is often difficult, even with the best intentions, to plan and implement technologies that are appropriate. There have been few studies which investigate this process to aid people involved in this area (Benmokhtar, 1983). Therefore, the proposed model should be viewed as a tool with which to begin an understanding of the complexities of assessment and implementation of technologies that are truly appropriate.

A traditional or classical approach to decision-making has been described by Benmokhtar (1983) as having eight steps. They can be stated simply as:

1. understanding the problem;
2. collecting the information;

3. analysing the information;
4. conceiving possible solutions
5. evaluating solutions
6. applying the solutions
7. testing or evaluting results
8. Modifying solution if necessary

Goldberg and Shuman (1984) suggested a similar model which includes the group process as well. The steps in this process are:

1. identify the problem or issue;
2. establish group goals;
3. state relevant facts, assumptions, and constraints;
4. brainstorm solutions;
5. choose a "best" solution;
6. analyze and decide about the components of the proposed solution;
7. evaluate the solution;
8. synthesize a total solution;
9. write a final report on the solution.

Mertens and Hendrix (1982) added the value or ethical component to their decision-making model. Steps such as: rank solutions by personal value preference, list values or principles that lead to a chosen solution, as well as evaluating consequences of proposed solutions are investigated in their decision-making process.

It would seem important to merge a systems approach to the notion of appropriate technology to attain a workable decision-making process. Benmokhtar (1983), when describing a new approach geared toward appropriate or soft technologies, recommended an approach to decision-making which gives primary importance to an analysis of the problem within its context as well as in time and space. Bybee et al., (1981) in their "human ecology" model of science, technology and society approach to science education, described a classroom process that leads to: identification of new problems; interpretation of personal/social problems; decisions about possible

solutions to problems; personal action; application of results to other situations; and increased scientific understanding and social awareness.

The decision-making process proposed in "Toward Appropriate Technologies" focuses on thorough analysis of the context of a given technology and includes time as an important consideration. The model can be summarized as follows:

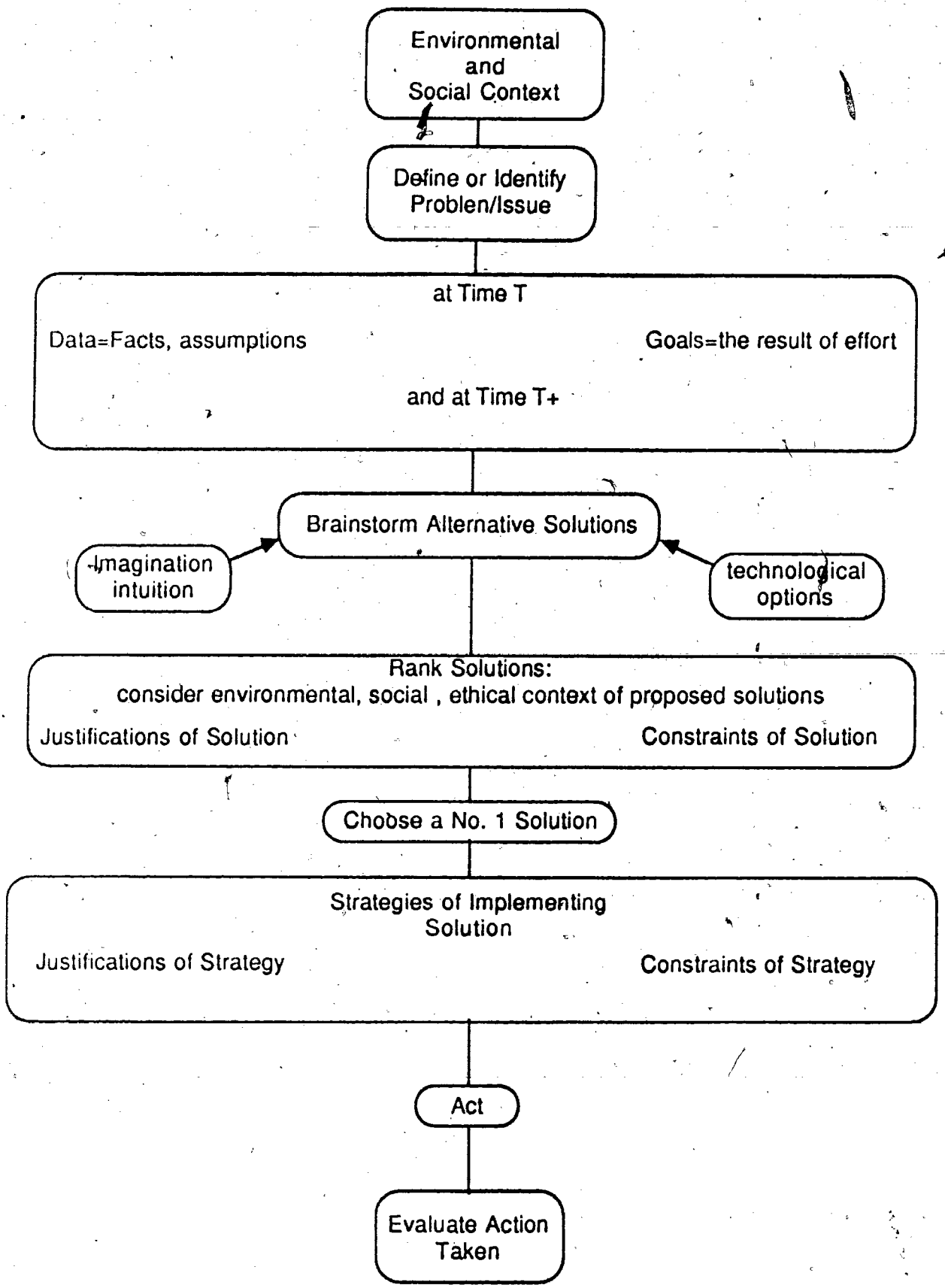
1. Identify the environmental and social context of the problem or issue;
2. Define the problem;
3. List the Data (facts, assumptions, constraints) of the problem and the Goals of the solution at Time T.
4. Brainstorm alternative solutions;
5. Rank solutions: consider the environmental, social, ethical context as well as the justifications and impediments to a solution;
6. Choose a solution that best fits the defined goals of the solution, list reasons why others may not agree with this solution;
7. Check to see if solution still works at Time T+ (future);
8. List strategies for implementing solution;
9. Take action on the proposed solution;
10. Evaluate action taken.

The model can be seen in Figure 3.2.

3.3.6 Considering values: education versus indoctrination

It may be useful, at this point, to delve more fully into the question of values in an appropriate technology educational model. Inherent in the concept of "appropriate" technology is a framework for deciding just what constitutes "appropriateness." Further, the implication is that this decision-making process

Figure 3.2 An Appropriate Technology Decision-making Model



As has been discussed in the literature review regarding values, a value framework facilitates the decision-making process. Yet the question arises, does this model lead to the indoctrination of certain values, or does it educate learners about the interconnectedness of social systems (which embody values) and natural ecological cycles? Certainly, values are inherent in this and, some would argue, every curriculum. The point of debate is whether through the learning activities a student could, at the end of an activity, come up with a decision contrary to the bias of the model. Curriculum development must grapple with this issue.

The perspective this model employs is use of values clarification skills in an examination process (Mertens and Hendrix, 1982). Students learn skills in a process that does not impose curriculum or teacher values but clarifies their own values and encourages examination of consequences of those values (Beisenherz, 1982; Mertens and Hendrix, 1982). Hence, the proposed model encourages clarification and examination of values in a holistic light but does not, through its methodology, indoctrinate certain values in learners.

Yet, by acknowledging the inherent nature of values in every-day life, an education for understanding and appropriate action in the area of technological use, must define the values it is based on. Some values that have been identified by value educators as being worthy are such concepts as: empathy, democracy, human dignity, justice and equality, and self actualization and cosmic consciousness (Wilson, 1967; Oliver, 1970; Kohlberg, 1970; Barman, et al., 1981). The principles of this model AT curriculum do, in fact, put the curriculum in the "social reconstructionist" school of curriculum analysis (McClaren, pers.comm). The design principles proposed by the author, encourage examination of values such as encouragement of sustainable

ecosystems for continued human well-being, consciousness of the interconnectedness of social systems and planetary ecology; encouragement of healing thoughts and actions, and values about the interaction of learners within the natural environment and the role of technology therein. As well, the curriculum seeks to develop skills in cooperation, self-directed learning, and decision-making as skills that are valuable life-skills for the future (Beisenherz,1982; Watson, 1983).

3.3.7 The Role of Action

The role of action in this model is central. Activities are geared toward individual and group action through decision-making and participation in class projects. It is suggested here that this method increases engagement in the learning process to enhance the transition from mere awareness of a problem or situation to action towards a solution. This process has been identified as crucial to environmental education and science education if one is aiming to educate for the future (Hungerford and Peyton, 1980; Watson, 1983).

Another factor in the action process is the ability to seek alternatives or innovations and to have the skills to apply solutions. Innovation in the development of appropriate technologies requires the individual to be able to change from a traditional frame of reference and look at a problem from a different perspective. To take, for example, a complicated technology and make it more efficient or to use a technology in a new context. The ITDG (Intermediate Technology Development Group) of Great Britain has been instrumental in the success of this approach. Yet, it has been suggested that to do this requires a "different" type of education than provided by contemporary schools (Betz, 1984). An education is needed that provides opportunity to create innovative

approaches to problems and opportunities to try out innovations to see if they work. Few classrooms today use this approach, because it can make classroom management difficult and it requires additional tools and time.

While it may not be possible or desirable to change the school system overnight to allow for innovation, it is certainly possible to modify the approach to classroom instruction to encourage innovation. This demands some changes to instructional strategies and classroom environments. It seems clear that this approach is desirable and will enable more students to understand and apply their knowledge regarding appropriate technologies.

3.3.8 Evaluation

There is evidence of use of an appropriate technology approach to evaluation in the literature (Feuerstein, 1978; Masterton, 1984). Jequier and Blanc (1983) wrote that evaluation in the decision-making and implementation process of appropriate technologies is a important step. As well, evaluation of action taken is evident in many decision-making models. One approach was described as an "action-research, non-directive, educative community self-study" (Feuerstein, 1978). While another used a six-step assessment model which addresses major design principles of the curriculum, meets the expectations of the community and operates within various other limitations (Masterton, 1984). These evaluation models indicate relevance of the use of participant evaluation in the educational process. Further, this approach is consistent with the concept of appropriate technology.

Several criteria may be applied to the evaluation process employed by the model curriculum "Toward Appropriate Technologies"

1. Emphasis is placed on a process that participants can understand and apply - thus it is geared to the capability levels of the participants;
2. A holistic or integrated approach is used - where students are involved in the evaluation process from the beginning and the results of the evaluation is in great part for the participants;
3. Participants identify the purpose or goals of the program;
4. Participants define indicators or evidence that goals have been reached;
5. Participants give examples of evidence that goals have/have not been attained; and
6. A report is generated, organizing and synthesizing the results of the evaluation and communicating the results.

In summary, the purpose, rationale, design principles, and key characteristics of an appropriate technology curriculum model have been described. The focus of the proposed model is on natural systems and the interaction of society and technology as a part of an on-going natural system. The following chapter will describe how this model may be applied to specific curriculum goals, objectives, teaching strategies and activities.

CHAPTER 4: INSTRUCTIONAL STRATEGIES AND LEARNING ACTIVITIES

4.0 Introduction

A major objective of this study was to identify the necessary elements of a curriculum model for appropriate technology education. As has been seen in Chapter 3, the curriculum model is based on natural systems and includes a decision-making process as well. This chapter elaborates on the process of applying this model: instructional strategies and learning activities. It is not intended to develop a comprehensive activities package for the model. Rather, the purpose is to demonstrate how the model may be applied to the learning environment.

4.1 Step Four: The Learning Activities

Five themes organize the content of the curriculum model "Toward Appropriate Technologies". The activities are centered around the following themes: Natural Systems; Appropriate Technology; Technology Assessment; Personal Use of Technology; and Bioregionalism. The following section contains the goals, objectives and learning outcomes of each of the five units. As well, specific activities are proposed. The activities are designed to be implemented in a sequential manner. In this way, knowledge and skills are developed not only in relation to content but to personal and group interactive skills as well.

4.1.1 THEME 1: NATURAL SYSTEMS

This theme investigates natural systems and in particular, the way humans have historically used tools and technology within natural systems. As

well, this unit addresses the impact of technology on environmental and cultural natural systems.

Goal:

1. The "Natural Systems" theme will provide students with the opportunity to examine natural systems specifically in the context of human-technology interaction.

Objectives:

1. By the end of this unit, the student will have gone through the process of experiencing, studying, analyzing, decision-making, and acting on the theme of this unit.
2. Using this process the student will learn about:
    1. Natural systems;
        a. biological
        b. physical
    2. Humans in Natural Systems;
        a. use of technology
        b. environmental impact
        c. cultural impact
    3. How this relates to personal, local and global issues;
        a.personal ecology and needs
        b.community ecology and needs
        c.global ecology and needs.

Learning Outcomes:

Students will gain/demonstrate:

1. An understanding of human-natural systems (theory and process);

2. An understanding of the impact of technology on environment and culture;
3. The student will demonstrate application of this knowledge to his/her personal life and community life through the major activity (the class garden) of the unit.

Learning Activities

Major "Natural Systems" Activity:

Create a class garden, modelled on your local community natural system which includes people and technology. This garden may be an activity which is completed at the end of this unit or, preferably, one that continues into the next theme with a reduced degree of activity. This would enable students to plant fruits and vegetables that require a longer growing period.

Using the garden as the activity strand which runs throughout the unit, the following sequence may be useful:

1.Create an organizing matrix or tool with which to systematically understand local natural systems. When doing this activity remember to be concrete and thorough and use everyday examples;
2.Spend some time at the science resource center in class:
-read literature about natural systems
-view movies on ecosystems
-research laws and principles of natural systems theory;
3.Do a "jigsaw" to cooperatively research the history of human-ecosystem interaction;
-develop a "new" approach to humankind living in natural systems with this information;

4.Create a model of an ideal global natural systems-human interaction.

-apply this model in the class garden;

5.Experience the solitude of nature: take a walk alone through a park or nearby outdoor space, concentrate on what you see, feel, smell, and touch;

6.Write about your use of technology and how that effects culture and environment in a journal:

-write down your ideas then draw connecting lines, pick out the most important ideas to you, is there a pattern?

7.In pairs or trios, do a values clarification exercise on ecology and personal needs, put them in order of importance;

8.Make up a plan to incorporate this understanding in your own lifestyle;

9.Role-play the roles and relationships of a nearby natural ecosystem: be as realistic as possible;

10.Visualize and feel with your senses the "perfect natural place" for you where humans and nature co-exist in harmony;

- as well, visualize the "perfect urban environment."

11.Go outside your school, put on a different "lens" with which to see, be imaginative!

-identify green spaces, man-made things, round, smooth things, sort and classify what you find;

12.Locate a site for your garden;

13.Take a field trip to a city park, or wilderness area;

-identify types of ecosystems, habitats, wildlife,and flora;

14.Organize your garden site: get permission, decide on what to put in garden, plan layout, organize group tasks;

15.Dig, haul earth, mulch, and add compost/manure;

16.Plant your garden;

17.Ongoing from now on: regular tending of garden;

18.Pick a subject of personal interest concerning pollution, environmental degradation, poor living conditions or any relevant local situation; research it, write up a 2-3 page synopsis and tell somebody outside of class about this issue;

-share your experience with the class;

19. Create personal ideas or hypothesize about the impact of technology on society and the environment;

-teach someone else in class about your hypothesis;

20. Care for a spot or situation in your local environment and try to make it better: eg clean it up, write to aldermen, mayor, find out who is responsible and write/talk to them;

21. Go to a nearby area which is environmentally degraded, observe what you see:

-use the following skills:

classifying,comparing,contrasting, inquiring, and synthesizing;

22. Write in your journal how you would relate openly and with warmth to people or animals living in poor conditions; what would you do, say to them;

23. In a cooperative group: problem solve the following situation:

-a group of concerned citizens have proposed turning a local empty lot in town into a "wilderness park" but there is opposition to the idea from local developers and business people. They say that the town, with its high unemployment, needs the jobs to be created from land development. The wilderness park proponents say that if the lot is developed then there will never be a local park. It is the last piece of open space in town. Something has to be done quickly as meanwhile, unscrupulous people are using the lot as a dump.

- in groups, create a community action plan to implement your proposed solution;

24. Harvest your garden for your celebration and/or continue to tend the late plantings if your plan is to keep the garden going through the entire program;
25. Plan a celebration of your harvest and completion of the unit, try to include a feast with garden produce;

4.1.2: THEME 2 APPROPRIATE TECHNOLOGY

Appropriate Technology -- an introduction to a view of technology that is emerging in developing and developed countries alike. Appropriate technology is a concept that includes consideration of ecology, culture, and technology. Inherent in the concept is the design of a technology that best fulfills the present needs and future possibilites of the ecology and culture where it will be used.

Goal:

1. The "Appropriate Technology" theme will provide students the opportunity to clarify and examine the concept of appropriate technology.

Objectives:

1. By the end of this unit, the student will have gone through the process of experiencing, studying, analyzing, decision-making and acting on the theme of this unit.
2. Using this process the student will learn about:
    1. What is appropriate technology (AT);
        a. literature definition
        b. personal definition

2. What options exist for using AT;

   a. at the personal level

   b. at the community level

   c. at the global level

3. What would be the impact of AT if in use at;

   a. the personal level

   b. the community level

   c. the global level.

Learning Outcomes:

Students will gain/demonstrate:

1. An understanding of the elements included in the concept of AT;
2. An ability to apply this knowledge to personal, community and global issues;
3. An understanding of the impact of AT, if it were in use in personal, community and global situations.

Learning Activities

Major "Appropriate Technology" Activity:

In small groups, construct an appropriate technology for use in your class garden.

Using the construction of an appropriate technology as the activity strand which runs throughout the unit, the following sequence may be useful:

1. Researching literature for AT definitions;
2. Discuss the concept of AT with an engineer or other person knowledgeable about technology;

3. Examine a food product that you use: draw the network of how this product reaches you: include an analysis of which network and product-use is inappropriate to the most appropriate;

   consider: economy, energy, personal tastes, time demand, aesthetics, social impact, and environment;

4. Create a personal definition of AT;
5. In small groups, synthesize the literature and other research for a comprehensive definition of AT;
6. Identify personal and class resources for using technology appropriately: what are my/our AT options?
7. In small groups, using school resources, plan and construct an AT such as a solar dryer, or field tool for use with your class garden;
8. The above is an ongoing project: schedule regular time slots to complete this task;
9. Experiment with AT design: redesign a technology that you personally use everyday. Consider changes to your lifestyle, major or minor design changes;
10. Imagining yourself, family and planet if AT were in wide spread use, write about this in your journal;
11. In pairs, do a values clarification exercise about personal view of appropriate technology uses;

    -make some decisions regarding what changes to make in your lifestyle (if any) based on this clarification;

12. In a group of 4, brainstorm ideas for personal AT use;
13. Outline a plan of action regarding personal use of AT;
14. Organize family resources for participation in an AT project such as recycling;

15. In a cooperative group, implement a study of community AT options; practice group skills;
16. Explore the local community for nearby ATs. This may mean something as simple as a compost bin or as elaborate as a passive solar house;
17. Visit SPEC energy house or other local appropriate technology;
18. Create a collage using images and text about the potential impact of AT globally and/or locally;
19. Formulate an opinion or argument pro/con AT: debate or present this in class;
20. Apply what you've learned: using your AT criteria, re-design something in your life or community such as a local shopping mall, road system or town plan;
21. Celebrate your success: plan a presentation of your projects; invite the school community, parents, friends and other interested people.

4.1.3 THEME 3: TECHNOLOGY ASSESSMENT

Technology Assessment -- an experience-rich theme of the process of technology assessment. Particular emphasis is on development of a strong theoretical framework from which to look at technological possibilities using a socio-cultural and environmental basis.

Goal:

1. The "Technology Assessment" theme will provide students the opportunity to gain knowledge and skills in technology assessment.

Objectives:

1. By the end of this unit, the student will have gone through the process of experiencing, studying, analyzing, decision-making and acting on the theme of this unit.
2. Using this process the student will learn about:
    1. the process of technology assessment;
        a. factors involved (technology, environment, socio-cultural)
        b. problem solving
    2. the opportunity to participate in a personal or community technology assessment situation.

Learning Outcomes:

The student will gain/demonstrate:

1. An understanding of the factors involved in technology assessment;
2. An ability to use the proess of technology assessment
3. Experience in a relevant technology assessment situation.

Learning Activities

Major "Technology Assessment" Activity:

Participate in a cooperative group technology assessment. Using the provided organizing tool, group communication skills, and cooperative effort; organize the tasks to be done, complete these tasks, report on the results, and debrief the process at the completion of the technology assessment.

Using the Technology Assessment and the Appropriate Technology Decision-making Model (see Figure 3.2) as the activity strand which runs throughout the unit, the following sequence may be useful:

1.Research the literature on Technology Assessment (TA);

2.Brainstorm ideas of "how to do a TA";

3.Define what elements would you personally include in a TA? write about this, with a rationale, in your journal;

4.Compare and contrast different models of TA;

5.Develop a model or framework, based on the appropriate technology decision-making model for a local or global TA;

6.Directly observe a TA process by visiting local planning office or by inviting a speaker to class;

7.Teach some one else in class part of the TA process;

8.Participate in a cooperative group technology assessment; consider the following 2 situations : pick one

-development of salmon fish farming along coastal waters; OR

-the use of genetically modified bacteria to control frost damage in crops.

Use the AT Decision-Making model and cooperative group skills;

9.Try out new group skills in the group TA;

10.The above is an ongoing project until tasks completed: schedule regluar time for group work;

11.Attend a local or provincial TA;

12.After this experience of others' view of TA, discuss this in class;

13.Imagine a "holistic" TA; what factors would it consider?;

14.Give and receive feedback about group process;

- pick a particular skill with which to work on;

- try to identify what others are working on;

15. Plan a TA for a family technology; look at things you regularly use and take for granted: TV, cars, telephones etc.
16. Report back to class on the completed group TA tasks;
    -look for problems, oversights, biases in TA;
17. Compile written results, include statements on problems and biases, what you would do differently next time.

4.1.4 THEME 4: PERSONAL USE OF TECHNOLOGY

Options for personal use of technology -- applying the concepts of technology assessment and appropriate technology to personal use in and around the home.

Goal:

1. The "Personal Use of Technology" unit will provide students with the opportunity to apply the concepts of appropriate technology and technology assessment to personal uses of technology in and around the home.

Objectives:

1. By the end of this unit, the student will have gone through the process of experiencing, studying, analyzing, decision-making and acting on the theme of this unit.
2. Using this process the student will learn about:
   a. Student requirements and use of technology;
   b. Family requirements and use of technology;
   c. Community requirements and use of technology;
   d. How to assess and order in degree of importance these needs and uses of technology;

e. How to act with knowledge and skills using the above process.

Learning Outcomes:

Students will gain/demonstrate:

1.Knowledge of requirements and use of technology at a personal, family, and community level;

2. Values clarification about the need for and uses of technology;

3. Application of knowledge, skills and values towards some personal or group action.

Learning Activities

Major "Personal Use of Technology" Activity:

An Energy Resources Analysis of the School: Challenge -- Redesign the School.

Using the Energy Resources Analysis as the activity strand which runs throughout the unit, the following sequence may be useful:

1.Identify personal uses of technology;

2.Classify personal and family uses of technology;

3.Evaluate use of technology in the home;

-evaluate the needs of yourself and family;

4.Take a "blind walk" through your house and yard, listen for and feel what technologies are in use at your home;

-observe personal and family requirements and uses of technology;

5.Imagine what your ideal home would include;

6.Formulate an hypothesis about an "ideal" technology for your home;

7.Go visit another family in their home -- a family of another culture if possible -- observe their use of technology;

8.In pairs, listen, attend and clarify the importance of what your ideal home or living space would include, why?;

9.Conduct an Energy - Resources analysis of the school: look at, for example, water use, energy (type? kilowatts? patterns?), paper consumption, use of space, type of building, etc;

10.Using this information, redesign the school; consider the above plus: best use of classroom space, student/teacher/staff comfort requirements, aesthetics, appropriateness, etc;

11.This activity requires several class periods: regular individual and group work should be scheduled until completion of tasks;

12.Organize a personal plan for creating some aspect of your ideal personal space, write the plan in your journal;

13.Communicate to others about your plan, why you chose it, and how you will implement it;

14.Create a model of the future of your school in your community using new technologies.

-What are the costs and benefits of these technologies? implications for jobs, education and lifestyles? Draw conclusions based on your study;

15.Simulate, in class, technology use at home, school or in the community;

16.Create a project for an appropriate technology in your home setting;

17.Develop a support group in class to discuss and renew plans and actions concerning your home project;

-use group skills:active listening, clarification,extending;

-cooperate to serve others in your group;

18.Construct or implement this project;

-draw conclusions about the costs and benefits of your model and its implementation;

19.Make recommendations for the individual and group projects based on these conclusions, write this in your journal.

20.Celebrate your success: share your plans and projects with your School Board, Principal, and Staff;

4.1.5 THEME 5 BIOREGIONALISM

A central element of the concept of bioregionalism is the importance given natural systems in the region. Natural systems and cultural patterns help to define a "bio-region." In this unit, students will learn about technology from a bioregional perspective.

Goal:

1. The "Bioregionalism" unit will provide student the opportunity to learn about the concept of bioregionalism and how it may challenge conventional community and global planning.

Objectives:

1. By the end of this unit, the student will have gone through the process of experiencing, studying, analyzing, decision-making and acting on the theme of this unit.

2. Using this process the student will learn about:

A. Bioregionalism;

1. literature definition
2. personal definition

B. How does technology fit into a bioregional framework;

1. technology assessment

2. appropriateness

C.What would the future be like if bioregionalism were adopted at community, provincial, federal and global levels?

Learning Outcomes:

Students will gain/demonstrate:

1.An understanding of the concept of bioregionalism;

2. An ability to apply this concept to human-environment-technology interaction.

Learning Activities

Major "Bioregional" Activity:

Create a bioregional plan for your community: organize a 10 year plan to move your community towards that ideal.

Using the Bioregional plan as the activity strand which runs throughout the unit, the following sequence may be useful:

1. Look at a variety of maps of Western Canada and/or BC (or your local region):

-examine the purposes and values those maps ultilize;

-some areas on maps you could look at: bioclimatic zones; forest resources inventories, water resources, wildlife distribution paterns, tourism and recreation areas;

2. Examine and compare these mapping systems;

3. Take a quiz that evaluates your local knowledge;

4.Keep a bioregional journal:include newspaper clippings, thoughts on local developments, and notes on the local flora and fauna;

5.Research the definitions of "Bioregionalism"

6.Visualize your bioregion; what are its boundaries;

7.Map out its boundaries;

8.Communicate/discuss in small groups the definition of Bioregionalism;

-while in group, change roles of facilitator,

-give and receive feedback about group skills and the discussion process;

9.Formulate a personal definition of Bioregionalism, use photograghy, art-work or writing to portray this in your journal;

10.Teach another class member about your definition, how you came to this understanding; exchange ideas;

11.Create a model for Bioregional plannning;

12.Do a field study of community needs that require planning;

13.Generate ideas, by brainstorming, for a class project.

14.Create, with others, a sense of value and caring in your Bioregional vision, incorporate this into your class project;

15.Organize a 10 year plan to move your community towards your bioregional model. Cooperate in a group for researching and planning your project;

16.Imagine a future with a bioregional framework, write an essay outlining your idea in your journal;

17.Role play the proponents of differing planning models of regional development;

18.Observe the town planners in action;

19.In class, role play or simulate that job;

20.Evaluate your models in small groups of 3;

21.Make a presentation to municipal planners of your plan, include steps and timeline for implementation.

4.2 Step Five: Instructional Strategies

This appropriate technology curriculum concentrates on utilizing group and self instruction tasks as well as incorporating group and personal activities in the experiential mode. The role of direct instruction is limited to the beginning of the program to introduce concepts and to guide students on task.

This method of instruction was chosen because of the nature of the content and the model's design principles. Appropriate technology is responsive to the social and ecological environments where it is employed. It should follow then, in an appropriate technology curriculum, that the process by which students learn should be responsive to students. Further, when developing the use of appropriate technologies, knowledge and skills must be acquired to implement a technology. This requires a process that encourages self and local knowledge, confidence and skill in inquiry methodology, as well as the ability to apply knowledge and skill. It is proposed here that self-directed learning and cooperative group work are the methods which best meet these educational demands.

Appropriate technology is not only a technological development method but as well, a personal development method. In an appropriate technology curriculum, instructional methods should encourage development of community and personal skills as well as project the reality of the usefulness of the acquired knowledge and skills. Thus, it can be seen that group skills as well as personal development are an important part of an appropriate technology curriculum.

Group work is thus both a means and an end in itself in this curriculum. The means through the individual learning the content as well as the process of group interactive skills. Group work facilitates the students taking the lead on what they want to learn and encourages the teacher to be more of a guide to aid that learning. Groups also satisfy the fundamental human need to socialize. Students learnessential life skills: how to cooperate and how to be effective group members.

Finally, two important points that enhance the overall effectiveness of the program are that the teacher should:

1. Create an environment for learning: establish order, build self-control, cultivate a cooperative learning environment. "If you can't control them, you can't teach them" (Gibbons, 1986).
2. Model the strategy that the students should employ in the class room by being cooperative, guiding and open to learning with them.

Student motivation is a primary consideration during curriculum development. The curriculum includes activities that provide extrinsic as well as intrinsic motivation.

Self-directed learning is an integral part of this curriculum. Self-instruction is a process that prepares students to become life-long learners. It recognizes that students are entering a future where information and instructional content will increase. Learners will not be able to master all the data they may need. Thus, skills such as critical thinking and problem-solving will aid students to prepare for the future. Further, the ability to locate and use resources is a necessary skill for life-long learning. A self-directed learner will

be able to use his or her resources to effectively study and act in real-life situations.

In summary, this chapter has demonstrated how the proposed model may be applied to the learning environment. A sequence of activities has been suggested for each of the five units described. Sample class activity plans may be found in Appendix B. Instructional strategies have been discussed, while a discussion of classroom preparation (step 6) may be found in Appendix C. As well, the results of the model's formative evaluation (step seven) may be found in Appendix D. This chapter plus appendices, present the curriculum development process through to the seventh step. The concluding chapter will discuss factors which influence implementation of the proposed model as well as some implications if such a model were to be adopted.

CHAPTER 5: DISCUSSION AND CONCLUSIONS

5.0 Introduction

This chapter will discuss the factors which infuence the applicability of the proposed model, "Toward Appropriate Technologies." Factors such as viability of the appropriate technology concept, appropriate technology and innovative education, and development of levels of moral reasoning will be discussed. Further, some examples of education about appropriate technologies are examined to demonstrate the need and relevance of the model, thus completing the eighth step of the described curriculum development process. Finally, some posibilities for implementation of the curriculum model are presented.

5.1 Viability of Appropriate Technologies

The Organization for Economic Co-operation and Development's (OECD) Appropriate Technology Directory was first presented at the United Nations Conference on Science and Technology for Development in Vienna in August, 1979. The directory contained some 277 organizations working in the field of "appropriate", "intermediate", or "low-cost" technologies (Jequier and Blanc, 1979). Since that time, the number of organizations has grown to reach an estimated one thousand organizations world-wide (Jequier and Blanc, 1983; Willoughby, 1985). Clearly, the rise in the number of organizations involved with appropriate technologies is an indication of the increasing use of ATs throughout the world today.

Some have argued that the appropriate technology concept represents a maturation of Western thought through knowledge of the interactive nature of

human-kind, technology and the environment (Drengson, 1982). It is, as well, an attempt to go beyond the simplistic options of either uncritical acceptance or rejection of technology (Willoughby, 1985). In many ways, the concept of appropriate technologies grew from the rejection of "high-tech" and stressed simplistic technologies as an alternative. As understanding increased concerning the relationship between people, technology and the environment, so has the scope of how to define "appropriateness." The emphasis on "appropriateness" of technology acknowledges the positive value of technology yet, it also attempts a critical examination as well.

This more thorough definition of appropriate technology responds to many critics of the concept. Appropriate technology has been criticized due to its lack of definitional clarity (Rybczynski, 1980; Edvist and Equist, 1979). Rybczynski (1980), criticized the "movement" for suggesting uses of "simplistic" technologies that often don't work. Yet, since that time, the use of appropriate technologies has expanded to using computer micro-chips, mini-hydroelectric dams, solar energy, fish hatcheries and many other well designed technologies (Bhalla et al., 1984; Carter, MaCaulay, Coffey,1986; Carr, 1985). Clearly, these "appropriate" technologies are not simplistic, they are a sophisticated approach to tailor technology to suit the situation in which it is used. Studies of the technical, ecological and economic viability of appropriate technologies show that, although the approach does require continued innovation and refinement, it does offer a workable alternative to traditional technologies (Willoughby, 1985).

Why then, is this viable approach to technological innovation not in wide-spread use? It is suggested here, that as in any innovation, there is first a pattern of original separation as new technologies and approaches emerge,

followed by integration as they become established (Hancock, 1984). Currently, we are in the integrative phase, where the concept of viewing technology "appropriately" is more evident in conventional decision-making. For example, large organizations such as the World Bank and the United Nations use an appropriate technology approach to development. In the United States, growth of appropriate technology industrial companies continues to expand. As this integrative phase continues, there will be an expanding commercial or business involvement and lessened "evangelical" fervor by appropriate technology organizations. There will be less news about AT organizations per se but more appropriate technologies evident in the market-place. Yet, in spite of this growth process, there are considerable obstacles to expanding the role of appropriate technologies.

A number of sources cite "social forces" supporting maintainance of the status quo, a lack of adequate policies to promote appropriate technologies, and a "reluctance to accept innovation" as factors limiting the utilization of appropriate technologies (Burch, 1982; Stewart, 1983; Jequier and Blanc, 1983; Willoughby, 1985). It is beyond the scope of the present paper to discuss the limitations placed by political and social forces on the general dissemination of appropriate technologies. However, a societal reluctance to accept innovation is an important consideration for any education that examines appropriate technologies. The discussion will therefore focus specifically on the applications of innovation in an appropriate technology curriculum model.

5.2 Appropriate technology education: innovation in the classroom

Appropriate technologies involve innovation. Thus, appropriate technology education must present a learning environment that encourages

innovation through use of innovative teaching strategies and opportunities for students to create innovative solutions to problems. Societal reluctance to accept innovation, as noted by Jequier and Blanc (1983), poses a considerable challenge to educators. Many people will not consider an innovation until it is "proven." This applies to the classroom teacher as well as the student. Betz (1984) noted that appropriate technology education involves looking at a problem from a different perspective and finding creative, innovative solutions. He also cited that current education does not provide this type of education. Therefore, what is needed are course materials and teaching strategies that encourage innovation as well as teacher skills that can support this approach to education.

Teaching strategies that encourage participation and student directed learning have been identified as "optimum innovation strategies (Havelock and Huberman, 1978; Kerr, 1982). The creative, self-instructed and independent learner, may be best suited for creating new, appropriate solutions to current problems. The proposed model, "Toward Appropriate Technologies" uses several educational processes that encourage innovation in the classroom 1) self-directed learning, 2) student as participant, and 3) cooperative group work. As has been shown in Chapter 3, each of these characteristics is congruent with the concept of appropriate technology.

Many of today's classrooms would require significant changes in the approach to education if an appropriate technology curriculum were to be implemented. Teachers would need skills in value clarification, knowledge of appropriate technologies, and the ability to provide a learning environment that fosters innovation, cooperation and student directed participation. Teachers would need the skills to accept and encourage opinions different from his/her

own as well as challenging students to consider the consequences of such an opinion. Further, teachers should be willing to get out of the classroom with his/her students into the community. With an AT education, time is spent actually building, creating, designing, and implementing appropriate technologies. Often, this means time spent in "the field." In service workshops for teachers could provide training for necessary skills as well as the basis for creation of a support network among teachers involved in appropriate technology education.

Another innovative aspect of the proposed model is the inclusion of "value" or "moral" principles. As stated previously, two principles of the model are encouragement of healing thoughts and acts, and creation of a sense of values regarding natural systems. These principles are a reflection of Schumacher's (1977) meaning of appropriate technology. Schumacher's definition of technology would include the idea of "wisdom" in the decision-making process. Acknowledging and planning an education for Schumacher's "levels of being" or Kohlberg's "stages of moral development," for example, presents an opportunity for heated debate within educational circles.

The debate centers around whether or not education can or even should, involve value issues. But, as has been shown previously, value issues are becoming increasingly relevant to today's student. Many scientific and technological issues involve values and thus, decisions about them involve values (Mertens and Hendrix, 1982; Barman et al., 1981). Just as the concept of appropriate technology attempts to fit technology in a cultural (value) system, appropriate technology education must support clarification and examination of student values.

The model "Toward Appropriate Technologies" presents two perspectives regarding values. The first is a clear instructional strategy that supports clarification and examination of student values. Curriculum activities include the proposed decision-making process "An AT Decision-Making Model." This approach is consistent with current literature on education for scientific or technological decision-making. In this way, clarification of values encourages the individual to define his or her values without outside pressure as to what the values should be. The examination process supports investigation into the consequences of those clarified values.

The second value perspective of the model is presented when students are asked to think and act on ways to "make the world a better place" and to create a "sense of values" about nature. This feature responds to the reality that 1) there are levels of value development and that 2) all values are not as "worthwhile" as others (Willoughby, 1985; Kazepides, 1977). Thus, values such as caring to improve our world and to value nature are deemed to be worthy of value. However, it must be stressed that by providing opportunities to examine values such as "caring", the instructional strategies do not "force" a student to come to the same value. Opportunities are given to clarify, reflect, and examine relevant issues -- but the student is left to draw his or her own conclusions. This approach to values ultimately encourages development of student confidence in his or her ability to make value decisions and act on them. Thus, it empowers student abilities in an analogous manner to the process of appropriate technology.

5.3 Step Eight: Curriculum Review: A Look at Three Curricula

The curriculum model, "Toward Appropriate Technologies" was compared with current literature and knowledge of other programs as part of the curriculum development process. Step eight of the process is to examine the effectiveness of the proposed program. Thus, a curriculum review comparing the the proposed model and three curricula was undertaken to to further understanding of the need and relevance for a model such as "Toward Appropriate Technologies" and completes this step. This review may be found in Appenidx E.

5.4 Implementation of an Appropriate Technology Curriculum

The model described in this document is a framework of a curriculum model geared to be applied towards developing a theory of appropriate technology education. Its purpose is to provide a framework for curriculum developers and educators to:

1) modify the curricula that they are currently using in the area of science and technology to encompass an appropriate technology approach;
2) use the model and its charactieristics to create a full curriculum for appropriate technology education.

The implementation phase of the model would be geared towards modification and tailoring the model to fit the level where it would be used. Thus, this curriculum model may find as one of its purposes, the presentation of an evolving model, that successfully incorporates environmental, social and future concerns of people and technology. It is based on sound, practical concepts. However, it must be stressed that further work would need to be done

to assure that the work done to date be furthered into a practical, quality program that best suits the level in which the curriculum would be implemented. This means working with educators or curriculum developers who are presently active in science and technology education to modify existing programs or more fully develop the proposed model.

This discussion presents implementation possibilities for the proposed model (step nine in the curriculum development process.) Implementation will be discussed concerning wide-scale implementation as well as specific examples of how this model may be implemented.

5.4.1 Some examples of model implementation

Some possibilities for implementation of this program are with community organizations and/or with the provincial school system. Michael Fullan in his book The Meaning of Educational Change (1982) writes that there are 15 factors affecting implementation. These can be divided into 4 groups:

1. characteristics of the change,
2. characteristics at the School District level,
3. characteristics at the School level,
4. characteristics external to the local system.

The discussion will examine these factors in relation to implementation with community organizations and with the provincial school system.

In a case of an innovative change to any system, Fullan cautions against initial wide-scale implementation (pers comm). In this case, a small-scale, local implementation program is proposed. Community organizations which offer educational programs may have good prospects for implementation. A small scale program would facilitate increased participation at the implementation

level, a factor that may increase chances of success (Fullan, 1982). Some organizations that may be receptive to this program are community colleges, School Board Night School programs, and the various non-profit "alternative" technology or "alternative lifestyle" organizations through out the province.

The characteristics of the proposed model, as has been shown, would involve change in the educational system. Fullan (1982) wrote that for successful implementation of change there are several factors that need to be examined. These are: need and relevance of the change, clarity, complexity, and quality and practicality of program.

5.4.2 Characteristics of change at the Local Level

The characteristics at the School District or community organization level need to be considered as well. The factors are 1) the history of innovative attempts, 2) the adoption process, 3) central administrative support and involvement, 4) staff development and participation, 5) evaluation, and 6) Board and community characteristics (Fullan, 1982).

Community organizations are interested in innovative new programs provided the instructor organizes the program. If the instructor approaches an organization and is adequately prepared, the support structure is there in the case of community colleges and night schools. Non-profit organizations offer a different challenge. They are generally underfunded and understaffed. Often, the staff and Board members of (largely) volunteer organizations are overworked as well. This could present serious problems for program continuity. More research would need to be done concerning the staff development, evaluation and characterisitics of the Board and community for development of appropriate technology education for community organizations.

The characteristics at the school or individual organization need to be addressed. In this instance, what is the staff like? what are their concerns and frames of reference? This would vary significantly from community colleges and night schools to non-profit organizations. The non-profit organizations may offer more philosophical support than the other organizations. Secondly, one must look at the relationship between the instructor/innovator of the program and the rest of the staff. Care must be taken to be open and adaptive to proposed changes made by staff and Board members.

5.4.3 Characteristics of External Factors

Finally, the role of government and external assistance need to be examined. In all of the community organizations, money and support needs to be found to buy materials and pay for staff. Most likely, these organizations will seek support from external sources. One charitable organization that grants money to programs like this one is the Helen and George Varis Foundation of Toronto. Initial support could be sought from this or other similar sources.

In summary, to implement this curriculum at the community level, the instructor must approach the organizations, be adequately prepared with rationale, activities and teaching strategies, and have instigated a search for funds toward materials and staff costs. The advantages of implementation at this level are the benefits of starting small and the ability to have personal input to the change process.

5.5 Implementation of "Toward Appropriate Technologies" at the Provincial Level

Implementation at the provincial level in the context of Science and Technology 11 provides a different situation altogether. As has been shown in the previous section, the basic characteristics of the proposed curriculum support the need and relevance of the program. They are presented clearly and with a quality framework. However, the format of the curriculum model would need to be expanded to include more activity plans to aid the teacher in implementation.

At the school district and provincial level there is a perceived reluctance to consider alternatives to traditional views of technology. The political implications of assessing sustainable alternatives constrasts with the policies of the current provincial government. This situation may limit the possibilities for a curriculum model such as "Toward Appropriate Technologies" to be implemented through the provincial system.

However, if it were to be adopted, the process would begin with the Science and Technology 11 development committee. The implemenation would be province-wide as an optional unit for the course Science and Technology 11. If acceptable to the committee this offers several advantages. This process would provide administrative support and staff development training as well as a structure for comprehensive field testing and evaluation.

At the school level, teachers are already employed to teach Science and Technology 11 and would simply include this optional unit. Funds for in class materials would probably still need to be sought. The curriculum guide (teacher

and student reading material) would be funded. One factor which has been considered during the development of this program is the role of the teacher as a facilitor/guide rather than one of direct instructor. This role may be a new one for many teachers. Therefore, there is a need for a support network by way of inservice workshops, reading materials and ongoing evaluation of the program. Suggestions have been made in this document concerning instructional strategies. However, it remains the responsibility of the school system to allot monies for in-service workshops and evaluation of the program.

In summary, the implementation process for "Toward Appropriate Technologies" could follow two paths. Both offer distint advantages and disadvantages. What this would seem to indicate is more research and inquiry is needed to follow through on these possibilites. Program development staff at the community organizations and Science and Technology 11 need to be contacted and brought into the curriculum development process. Negotiations and further refining of the model can be made at that time.

5.6 Conclusions

This document began with a personal anecdote which provided the author the stimulus to the study. Although rural Guatemala and fish ponds may seem distant from the present discussion, it may be helpful to bring the concluding discussion full circle back to the circumstances in which it began.

The use of the model would have made some broad changes to the work with appropriate technologies in rural Guatemala. In the proposed model, primary focus is on natural systems and student development of self and local knowledge as the basis to the study of technological options. This contrasts with the model undertaken by the author where the emphasis was on learning

by "transfer" of information. In the model described in this document, the students begin by identifying relevant local needs and continue by developing knowledge and skills to meet those needs. The role of the teacher is to facilitate the clarification and examination of local needs as well as development of knowledge and skills. This is in contrast to the approach which was used, whereby information which the teacher had was the focus of what needed to be taught and learned.

The decision-making model proposed in this document is an addition to the appropriate technology education taught by the author in the early 1980's. Skills needed to take personal action are developed using this process. During the author's work in Guatemala, there was very little emphasis on the "campesino" or rural peasant learning how to make decisions. The decisions were made only by the "technician" and discussed with the interested person.

The problem with the latter approach, is that often, as soon as the "technician" is no longer available, the information and decision-making process comes to an end. The local people have not developed adequate knowldege and skill to continue using an innovation such as an appropriate technology. Thus, if an educational process such as "Toward Appropriate Technologies" were undertaken, there is an increased likelihood that the any innovation undertaken would continue, even after the course or educational process was finished.

This type of education, one that promotes knowledge of natural systems, technology, and cultural systems is as relevant to the rural "campesino" as to his Canadian comtemporary. It develops students' "internal" mechanisms to apply their knowledge and skills in a self-directed manner. It is argued here that is by

this method that individuals can take effective action in an increasingly complex world. An education for appropriate technologies empowers students to view their environment ecologically, holistically and with a positive future orientation.

In conclusion, the conceptual framework for viewing technologies within natural systems as proposed in the model developed here warrants further research and applications. Research into the current use of appropriate technology curricula by community organizations and/or school systems would further the validity of the model. As well, applying the model to develop a specific curriculum with teaching units, materials, and bibliography would prove useful to science and technology educators.

APPENDIX A

This case history from the 1984 work Blending of New and Old Technologies (Bhalla et al., 1984) describes the projects: "In most developing countries electricity for lighting or cooking is rarely available outside the main urban centres, but most of the population lives in rural areas, and therefore cannot benefit from this form of energy. Furthermore, the spread of employment-creating industries to rural areas has been hampered, to some extent, by the lack of power. Planners have tended to concentrate on large, centralised generation, either hydro, thermal or nuclear, and as so have accepted the Western critiera for investment in electrical generating systems. But the diseconomies of electricity distribution with these systems have prevented the resulting power from reaching the rural populations, particularly in mountainous regions where the topography itself prevents wide distribution. In many areas, micro-hydro power promises to be the most economic alternative for such decentralised power production.

"To be economically viable and competitive with alternatives such as diesel power or grid extensions, the capital cost of micro-hydroelectric plants must be kept down by pragmatic design: using simple turbines and minimum cost civil works... Recognising this, a hydro engineer and an electronics engineer, both from the UK, designed a low-cost electronic devise to fit into micro-hydroelectric schemes in order to control the electrical output from the alternator (that is, controlling the "load" rather than the "flow"). Its true versatlity has become increasing apparent as new schemes have been introduced. It has been widely accepted as a major step forward in making micro-hydroelectric plants viable for small rural communities."

APPENDIX B

SAMPLE ACTIVITY PLANS:

ACTIVITY: Experiencing the Solitude of Nature: nature walk

CONCEPTS:

By spending up to one half hour alone in a natural setting the student experiences nature more fully.

TIME REQUIRED:

Appropriate transportation time to site (site can be in school yard IF there is a nearby natural setting -- students fan out along perimeter); 15 minutes to get students settled; up to 30 minutes of solitude; time to return to class.

MATERIALS:

Comfortable clothes and shoes; appropriate outdoor gear (rain gear, jackets, warm socks, hats etc); ensulite pad or thick magazine to sit on (if ground wet or cold); Extra teacher or parent.

SITE:

Ideally a meadow or wooded area that provides space for students to spread out in close proximity without being in site of one another. Site and route should be checked out by teacher previous to nature walk.

PROCEDURE:

Teacher briefs students and staff on procedures and safety measures; Teacher leads class to site in a single file line, while walking indicate an appropriate site for the 1st, 2nd, 3rd, etc student to stop until all students have a spot; Students make themselves comfortable and listen, feel, smell their site;

When 30 minutes are up teacher returns to first student and one by one gathers class together.

Return to classroom.

Extension Activity:

Write about the nature walk, how it felt to be alone in a natural setting, what you saw, felt and heard in your journal.

RESOURCES:

Environmental Education Program

contact: Milt McClaren

SFU Faculty of Education

Burnaby, BC

ACTIVITY: Inquiry into natural systems theory and process: an individualized learning resource centre

TIME REQUIRED:

1-2 5O minute classes

CONCEPT:

Using a resource centre approach to learning about natural systems can facilitate individualized learning and be beneficial to students who are uncomfortable with "sciences".

MATERIALS:

Films, videos and/or filmstrips on ecology, biology;

Tapes/ recordings of natural sounds: waves, the forest, bird songs,calls;

Magazines such as Nature Canada, Geos, National Geographic;

Literature: an excellent text is GAIA An Atlas of Planet Management other biology, ecology texts;

PROCEDURE:

Teacher sets up resource centre , preferably in a corner of the classroom, with comfortable viewing areas for filmstrips/videos/movies, adequate lighting and seating for reading;

Ideally, this centre will be set up for the duration of unit for easy reference;

Teacher introduces the concept of natural systems and poses investigative questions for the students to research;

-may be done individually

-may be done in a group with research tasks divided up and then the students share with each other what they found out;

-a sample question could be: What is the role of the tree canopy in tropical rain forests? what happens when the area is logged? OR How does modern agriculture model natural systems or does it? What are the effects of chemical pesticides and fertilizers?

Extension Activity:

Develop a new approach to a humans as part of natural systems. What would it involve? Share your ideas with a partner.

RESOURCES:

School library for texts, visuals on ecology/biology;

Local teachers of biology, science;

Government Conservation Officers, Dept of Fish and Wildlife, Environmental Protection Service;

Books:

GAIA: An Atlas of Planet Management

by Dr. Norman Myers, General Editor 1984

Anchor Press/Doubleday and Co: Garden City NY

Environmental Conservation

by Raymaind F. Dasman

1976

John Wiley and Sons:Toronto

SAMPLE ACTIVITY PLAN: Theme 3

ACTIVITY: Participate in group to problem solve a relevant current technological assessment.

CONCEPT:

An activity which stresses a problem solving model of a real life situation.

Presents an alternative view of technological needs;

TIME REQUIREMENTS:

1 class period

MATERIALS:

Handouts of reading material on TA situation related to student use of technology such as TV or telephone communication; markers, pens; newsprint for writing;

PROCEDURE:

Divide class into 2 groups;

Hand out copies of reading material to each group and have students read;

Have each group divide up assessment tasks into the following groups:

-People

-Economy

-Environment and Resources

-Tools

Each sub-group writes the assessments on newsprint;

report back to small group and share information;

Gathering class as a whole, have one student from each small group tell about their TA.

RESOURCES:

"Technology Assessment/ Environmental Impact Assessment: Toward Integrated Impact Assessment"

by Alan L. Porter and Frederick A. Rossini

in

IEEE Transactions on Systems,Man and Cybernetics, Vol SMC-10 No. 8 August 1980 p.417-423

SAMPLE ACTIVITY PLAN: Theme 4

ACTIVITY: Observe personal and family requirements and use of technologies.

CONCEPT:

Observation of family uses of technology can focus attention on the experience of each student and lead to clarification of personal and family needs.

TIME REQUIRED:

An afernoon or evening at home to observe family use of technology; 1 fifty minute class to discuss results and use the "Questions to ask Yourself" chart.

MATERIALS:

"Questions to Ask Yourself" handout;

Newsprint paper for group

Markers and pens

PROCEDURE:

The day before class, Teacher explains the observation techniques such as recording types of appliances in use, home insulation and structure of house, conservation techniques in use(if any) etc. Have students record these;

In class the next day, hand out the "Questions to ask Yourself," chart and have students fill it in;

Divide class into groups of 5 and compare results; each group should record similarities and differences on newsprint with markers;

Put up newsprint on wall and have each group report back to entire class;

Ask class an extending question such as : what are the implications of your use of technology? Are there any recomendations you can make to better use your personal resources?

RESOURCES:

BC HYDRO Energy Conservation Office

Energy Engineering Dept

625 Howe St

Vancouver, BC V6T 2T6

APPENDIX C

PREPARING THE SETTING

This curriculum is flexible and adaptable to a variety of settings. However, there is a process each individual teacher should consider before embarking on this program. Please consider the following sequence:
Learning Events; Materials and Methods; Roles and Relationships; Environments; Conditions of Operation; Patterns of Organization; and Process of Development.

Learning Events: The learning activites have been prepared and sequenced from simple to more complex. Teachers should feel free to adapt the activities and sequence according to their students needs.

Materials and Methods: This curriculum is extensively supported by a variety of means: literature, networking and local resources. Instructional methods are covered in the instructional strategies section of this document (Chapter 4). The primary function of the teacher in this case is one of a guide for self-instruction and a trainer of skills.

The following are general instructional aids to support the curriculum:

Connections: a curriculum in appropriate technology for the 5th and 6th grades
Edited by J. Melcher. 1980 NCAT;Butte Montana, USA

Organizations:

National Center for Appropriate Technology
Box 3838
Butte, Montana 59701
USA

New Alchemy Institute
237 Hatchville Road
East Falmouth, MA 02536
USA
(617) 563-2655
Publishes "New Alchemy Quarterly" about the Institute's research and educational programs concerning development of sustainable technologies.

Brace Research Institute
McDonald College
McGill University
Ste Anne de Bellevue
Quebec, H0A 1C0
Publishers of the Handbook of Appropriate Technology

The Canadian Federation of Independent Businesses
15 Coldwater Road
Don Mills, ONT
M3B 3J1

Integral Urban House
1516 5th St
Berkeley CA 94710
USA

Institute of Man and Resources
Little Pond
Souris, RR No.4, PEI
C0A 2B0

Sudbury 2001
PO Box 1313
Sudbury, ONT
P3E 4S7

Roles and Relationships

This curriculum encourages the role of the teacher and student to be co-learners in the process of education. The student should feel the teacher and his or her peers in the classoom are supporting his/her efforts. The learning environment should be a reflection of a natural system with interaction, flexibility, diversity, interdependence, and evolution (etc). Thus, the content and learning process reflects a living system with its inherent lessons. The

student with the teacher as a guide can evolve into an active participant of the system. Everybody benefits with the dynamic outcome of the program.

Environments

The physical environment is influential to the success or failure of many new programs. In this case, the way to set up the program would be to have a flexible classroom arrangement with trips outdoors to investigate the natural world.

A sample classroom may look like this:

-Movable chairs and desks, set up in a circle;

-a learning resource center to one side of the room

-books, magazines , films, tapes (audio and video)

-large pieces of newsprint paper for group work

-markers, pens, chalk

-access to out-of-doors

-some community outdoor gear

-a known routine for how to get outside

-some comfortable chairs, rug or cushions for imagining, visualizations

-access to a shop or work room to work on AT projects

Conditions

The support network for teachers involved in this program will vary from situation to situation. Making use of the printed resources and organizations mentioned in this guide will enable any teacher to have a basic support network. However, it is important to involve other people at the administrative, community and provincial level as well. Some possibilites include:

-hook up with a computer network;

-establish contact with other teachers using this curriculum;

-make use of your local town or city planning department;

-contact local environmental centers;

-contact local or provincial energy consultants or architects;

Some administrative concerns to be examined are financial and legal aspects of the program. For example, money needs to be found to purchase materials for the students projects; insurance needs to be checked to see if outdoor trips are covered and under what conditions.

Organization

Recognizing that all curriculum exists within a sometimes inflexible organization is the first step of change. This curriculum is ideally set up within the organizational framework of individualized learning and with large block of time. However, the author recognizes that this is not always possible. We must work within certain organizations as they evolve.

Given the present framework of the provincial high school, this program could be split up into many single class time slots. Some classes could be devoted to individual work, others to project work, field-trips, or group discussion and problem solving. What is necessary is a balance of individual and group work; study and experiential work. The classes should feel comfortable for students and teachers alike. Some classtime needs to be used for organizational tasks by the class, such as timelines for task completion, how people are progressing, and new directions of the class.

APPENDIX D

Model Formative Evaluation

This curriculum underwent a formative evaluation through a workshop entitled "Appropriate Technology and Your Home." The review gave positive results. However, it indicated areas that needed further clarification and noted that activities that are more engaging and powerful would result in a better program. Following is a description of the process and some results.

The workshop was held on Thursday March 13, 1986 from 7:30 to 9:30 pm and was attended by 7 people from the UBC Family Housing community. Advertising was done for the workshop in the local newsletter and by word of mouth by the instructor. It was offered free of charge.

The workshop was designed to cover improved decision-making skills concerning the theme of "appropriate technology." Four activities were emphasized:

- -defining appropriate technology:literature was reviewed using the "jigsaw" method and information was shared concerning a variety of AT definitions;
- -conceptualization of a vision of a home with AT: a visualization exercise;
- -in groups of two, sharing and prioritizing that vision;
- -participants create a plan for implementation: what is feasible for you? and how you can go about acting on that plan?

The instruction was largely in the form of guiding the activities and supporting/facilitating the participants' visions.

Results of workshop review process:

In general, the feedback received verbally, and via a written evaluation, was positive. Participants were focused on the activities and were pleased to have participated. Participants who did the last exercise achieved the objective for the workshop: a concrete appropriate technology idea, commitment to that idea, and a plan for action towards their particular vision. Some examples of these are:

-one woman was interested in solar drying of foods: she saw that she could try this summer to take advantage of this technology to dry "okra" which is a vegetable only available seasonally here in BC;
-another was interested in "human-powered" technology for her home: she decided to research recipes for and then use her hand grinder for grains etc. instead of the food processor;
-another had a vision of organic gardening using composting: she decided to build and use an efficient compost system to gain the experience;

The written feedback received at the end of the workshop indicated that the participants liked the discussion and person to person aspect of the activities while focussed on "our own environment:our homes." Another person wrote: "...in a way, envisioning something deals with our major goals, and prioritizing them helps us to see the ones that need our attention and being brave to take a step forward."

Although the general thrust of the evaluation was positive, a couple of people had suggestions for an area of improvement: they wanted to hear about concrete examples of appropriate technologies. An overview or summary of AT would "help widen the scope of our ideas during the visualization."

As a result of this formative evaluation several changes were made to the model. First, focussing on a smaller number of research articles for the definition

of AT in the first activity would be advantageous. This would free up more time to give and discuss more concrete examples of these types of technologies. As well, more visual examples of alternative technologies would be a high impact educational aid in this instance. Finally, each activity was reviewed to ascertain:

-is group work being used for activities that a person singly can not do for him or herself?

-what educational mode is being experienced through the activity?

-is this mode maximally engaging for the individual? With these questions in mind, many activities were altered or more fully developed.

Appendix E

Two programs stand out as contempories to "Toward Appropriate Technologies:" The New Alchemy Semester and The National Center of Appropriate Technology's Connections - A Curriculum for Appropriate Technology for the 5th and 6th Grades. The New Alchemy Semester is designed for college age students while the NCAT program is for the elementary level. "Toward Appropriate Technologies" is designed for secondary and post-secondary levels. As well, this curriculum was compared to a Science, Technology and Society course: British Columbia's Science and Technology 11. The four curricula are described in Fig 5.1.

The approach to content taken by "Toward AT's" is similar to the New Alchemy's program: a blend of academic studies and hands-on work. As well, it is similar to the interdisciplanary approach of Connections. Science and Tech 11 is less clear of its approach to the content, however, it may be inferred that it seeks to make connections between science, technology and society and have students respond critically to current technological issues.

The seven principles of the proposed appropriate technology education model described here, give this curriculum a strong theoretical framework which is based on natural systems. The model is similar to Connections and the New Alchemy Semester but is apparently developed more fully than in Connnections. Due to lack of data, it is hard to ascertain the depth of the New Alchemy program. The Science and Tech 11 approach stresses knowledge of technologies as applications of science. In Towards AT's, the focus is on natural systems as the basis of the content and stresses technology in that context.

Figure 5.1 A Comparison of Appropriate Technology Curricula

Level	Course Content	Course Goals and Objectives	Format
New Alchemy post-secondary	Regional Resources; Biological Agriculture & AT; Ecosystem Design; Applied Studies in Ecological Design;	n/a	Fulltime 4 course semester
Connections Grade 5-6	Intro to AT; Conservation; Transporation; Waste; Recyling; Renewable Resources; Solar Models; The Food We Eat; Growing Your Own; A Community of Appropriate Technologies;	Goal: a new approach to teaching how our energy, food, transportation and economic systems interact	Fulltime course or integrated into existing social studies or earth sci. 108 page guide

Level	Course Content	Course Goals and Objectives	Format
Sci & Tech 11 Grade 11	Core Topics: High-Tech Rec; Medical Tech; Shelter - Tech of the Home; Computer in the Workplace; Resource Management; Forestry; The City; Telecommunications; Transportation; Tech of Warfare; Energy: Environmental tradeoffs; Waste: Technology's By-Product; Food Production & Distribution; Space; The Future;	Goals: to provide students with opportunities to: Develop an appreciationof the interactive natureof sci, tech, and society; Gain knowledge of tech as applications of related sciences; Develop the ability to respond critically to tech issues; Expand their awareness of career options in sci & tech	Fulltime course
"Toward ATs" Secondary/ Post-secondary	Core Units: Natural Systems; Appropriate Technology; Personal Use of Tech; Bio-Regionalism; tech. assessment;	The purpose of the program is to have students learn about the concept of AT and how they can apply it in their lives towards resolution of local or global problems;	Fulltime or integrated into existing science or environmental studies;

Turning to look at the topics covered, the New Alchemy program is strong on ecological principles and their application. It only offers an optional discussion series on implications to personal and global uses of their work. Connections covers the specific ecologically sound technologies thoroughly, but only devotes one of ten lessons to a "community of appropriate technologies": a social view of appropriate technologies. Science and Technology 11's content stresses the use "high technology" and doesn't offer examination of alternative technologies. The content of "Towards Appropriate Technologies" stresses the interaction between human-kind, technology and the environment using an ecological and social framework from which to examine the appropriateness of different technologies.

Given the small sample of offerings in the area of appropriate technology curricula, it seems to indicate that "Toward Appropriate Technologies" offers a more comprehensive framework from which to base learning activities than Science and Technology 11 or Connections. It also appears to be more systematically developed than the current program of the New Alchemy Semester. Thus, it satisfies Fullan's (1982) requisites that the proposed change have sufficient clarity, complexity and depth.

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