The Design of Science-Technology-Society Curriculum Materials: Features, Orientations, and Constraints

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Table of Contents

Abstract

Title: The Design of Science-Technology-Society Curriculum Materials: Features, Orientations, and Constraints

By: Gary R. Hepburn

This study used qualitative research techniques to develop a meaningful and comprehensive description of Science-Technology-Society (STS) curriculum materials. Six units that employed the STS theme were selected from the ScienceP1us textbook series to serve as a basis for developing a characterization of STS materials. Data sources included the examination of the units themselves, the examination of the accompanying teacher's guides, and interviews carried out with the unit authors. The descriptions involved the determination of features, organizational patterns, and orientations for the units. The second part of the study involved using the STS features that had already been found as a basis for questioning the authors about the reasons for their design decisions. The findings of this study present: (a) a descriptive framework for the appreciation of STS units, which highlights four distinct types of learning and the potential world perspectives found in each and (b) several factors that influence and constrain authors of STS textbook units, which leads to hypotheses concerning potential impediments to the practice of STS.

Chapter 1 - Overview

The Study

The first part of this study provides a description of the design of science-technology-society, or STS, curriculum materials. STS is fast becoming one of the more significant curriculum movements to take place in the last twenty years. The curriculum design process is a direct attempt to apply the STS theme and results in the form in which STS will be presented to teachers and, ultimately, students. One of the primary means of communicating such designs is through textbooks. The form STS is taking in textbooks is the area of focus in this study.

A description of STS curriculum materials will be developed by examining the representation of the STS theme in six science textbook units that apply the STS theme. These units came from the SciencePlus textbook series. The textbook units will be described in terms of the characteristic STS features they possess as well as the larger organizational patterns and orientations they use. The data that will be used as a basis for the descriptions will come from the examination of the textbook units themselves, the examination of the accompanying teacher's guides, and the conducting of interviews with the unit authors. The description developed will be valuable as a heuristic for meaningful examination and criticism of existing and new STS units and can be used by anyone involved with STS.

The second part of this study will further develop the appreciation of STS units by searching for factors and constraints that play a role in shaping STS units. This will be done by asking the authors for the reasons behind their design decisions in another interview. The features developed in the first part of the study will provide the decisions on which to base the questions. This will deepen the appreciation of the STS units beyond an awareness of what they are; it will provide a conception of why they are that way.

In order to gain a clear conception of the general subject and precise focus of this study, the introduction that follows will provide an account of the STS movement and then locate STS curriculum design in the framework of curriculum theory.

Chapter 2 - Introduction 1

The STS Curriculum Movement

The STS movement has become prominent in education in the 1980s and continues to be a major influence in the 1990s. In Canada, the STS approach has been endorsed and recommended nationally (Science Council of Canada, 1984) and provincially (e.g. Alberta Education, 1990). It has also received considerable support in the United States (American Association for the Advancement of Science [AAAS], 1989a). There has been great interest shown in advocating the STS theme and developing the theory and rationale behind it. In the literature, there is an abundance of writing on the subject; special issues of journals have dealt solely with STS (e.g. Lux, Gilliom, Helgeson, and Zuga, STS: Challenges, STS: Opportunities), and the 1985 National Teacher's Association Yearbook (Bybee, 1986) was devoted entirely to STS. A reasonably comprehensive theory and rationale for incorporating the STS theme into science education is in the process of being developed at this time and there is now much attention being paid to putting STS into practice. The practice of STS deals with incorporating the STS theme into school programs. This would involve policy formation, the creation of programs and curriculum materials, and gaining the support of teachers. The introduction that follows will discuss the development of the STS movement and the implementation of STS.

2.1 - The Development of the STS Movement

STS has been developed largely as a response to dissatisfaction with the orientation of the curriculum in previous years. In the 1960s and 1970s the dominant style of education, particularly at the secondary level, was a discipline-centered approach (Tanner, 1990; Yager, 1990). In science education, curriculum became more directed towards teaching the pupil to see the world as a scientist sees it rather than attempting to present the technological and social context of science. One of the main goals was to produce pupils who would be able to go on to become scientists and engineers (Bybee, 1986). This emphasis in science curriculum is often associated with the launching of Sputnik I and the beginning of the cold war, a time when curriculum in the United States was preoccupied with gaining scientific supremacy rather than promoting personal-social development (Tanner and Tanner, 1990).

The discipline dominated character of science curriculum was criticized for lacking a sense of purpose appropriate to the world encountered by students in the 1980s and 1990s (Bybee, 1986; Boyer, 1983). Perhaps the most damaging evidence that has emerged is that the perceived curriculum goals of the discipline-centered curricula were not being achieved. Brunkhorst and Yager (1986) report that less than 2% of high school graduates go on to graduate from college with an engineering or science degree. Yager and Bonnestetter (1984) found that experience in public school science appears to actually deter many students from following engineering or science careers. It would appear, as Tanner and Tanner (1990) have pointed out, that curriculum had been trying to serve a special population, the talented and gifted, at the expense of others. Given these problems, Bybee (1986) suggests a rethinking of the goals of science education by "asking the 'why' before the 'what' and 'how' of science teaching" (p. 80).

The concept of STS is not a new one. Perhaps the most influential writer on the general ideas behind STS was John Dewey (1916, 1900) who supported curriculum synthesis for the purposes of developing a social intelligence required of citizens in a free society. This relates closely to Barnes' (1976) knowledge which is available to shape action. This is knowledge which is reflexive and can be shaped by the learners for their purposes as opposed to knowledge which is held to be valuable in itself. With a rationale partly established in advance, STS advocates began to make a case for STS education. During the past ten years, much has been written on the general subject of STS and many of the major goals have been well detailed. Two of the major stated goals are making science education appropriate for all students and to promote scientific and technological literacy in students.

Advocates of STS believe that a primary goal of science education is to provide 'all students' with the science education they need to become responsible, contributing citizens of a democratic society (Bybee, 1986; Hurd, 1986; Rubba, 1991; Science Council of Canada, 1984; Waks, 1992). Science education is often attacked for not responding to the broad educational aims that justify science as a school subject. Such a consideration accounts for the switch from the sixties goal of developing scientists and engineers to the STS goal of developing a scientifically informed citizenry (Bybee, 1986). Given the increasing scientific and technological sophistication of the human environment, all students need a knowledge of science and technology to fulfil their democratic responsibilities. STS, however, does not neglect the need of preparing students for further study in science and engineering but rather endeavors to accommodate all science students (Alberta Education, 1990).

The Science Council of Canada (1984), after a massive study of education in Canada, recommended that, "Science should be taught at all levels of school with an emphasis and focus on the relationships of science, technology, and society in order to increase the scientific literacy of all citizens"(p. 38). Much of the literature on a rationale for STS considers STS to be a means for the promotion of 'scientific and technological literacy'(AAAS, 1989a; Bybee, 1986; NSTA, 1985). STS is seen as a response to the perceived lack of scientific and technological literacy which was one of the major criticisms of discipline-centered science (Yager, 1986). Despite their widespread use, the terms scientific and technological literacy are not usually elaborated on a great deal. The American Association for the Advancement of Science (1989a) devoted the first phase of their project, Project 2061, Science for All Americans, to focusing on the substance of scientific literacy. This lengthy report determines that, in general terms, the dimensions of scientific literacy are:

> (1) Being familiar with the natural world and recognizing both its diversity and its unity
> (2) Understanding key concepts and principles of science
> (3) Being aware of some of the important ways that science, mathematics, and technology depend upon one another
> (4) Knowing that science, mathematics, and technology are human enterprises and knowing what that implies about their strengths and limitations
> (5) Having a capacity for scientific ways of thinking
> (6) Using scientific knowledge and ways of thinking for individual and soci l purposes (AAAS, 1989b, p. 4)

This conception of scientific l'teracy as having composite meaning was reviewed by Roberts (1983). In his study of the various usages of the term, he found that the term has been used in many different ways in the past thirty years. As a result of its varied usage, it has come to refer to almost all broad goals of a science program. Roberts, in pointing out that the term science literacy has become an educational slogan, considers this term to be a mixed blessing. The term itself has more to say about the multifaceted nature of the goals of science education and suggests the importance of a balance of goals. At the same time, if science literacy is to be used as a specific goal of a program, it needs to be carefully defined so as to set a clear conception of what is to be achieved.

The term technological literacy is not used as frequently in literature concerning STS as is scientific literacy but when it is used, the two are often used in tandem. De Vore (1992) describes technological literacy as follows:

> Such a [technological] literacy prepares citizens to be conversant in the language of technological systems and to comprehend the basic concepts required for understanding the dynamics, interrelatedness, and impacts of technological means at all levels of society and the natural environment. (p.61)

Kranzberg (1991) uses the term to refer to a general understanding of our technical age. He considers the theory-practice of science and the theory-practice of technology to have become increasingly interwoven the understanding of both to be crucial if citizens are to make responsible technological choices. It appears that this term, like scientific literacy, represents a comprehensive description that encompasses most educational goals involving technology.

The rationale of STS that accompanies the terms scientific and technological literacy provides some degree of clarification as to the intention of the terms. Much of the discussion of STS seems to allude to a need to educate students for the purposes of producing an informed citizenry. In recent history, issues and important events have become increasingly related to science and technology and citizens must be able to understand these in order to fulfil their responsibilities as democratic citizens able to make decisions and act competently (Aikenhead, 1986; Hickman, Patrick, and Bybee, 1987; Rubba, 1991). Advances made in science and technology have resulted in our society possessing the knowledge to control and manage our natural and social environments. This has brought both benefits and difficulties with it. In a democracy, the citizens must act as decision makers, possessing the knowledge and cognitive abilities necessary to do so. Indeed, "the changes in human attitudes . . . depend on a vast campaign of education, debate, and public participation. This campaign must start now if sustainable human progress is to be achieved" (World Commission on Environment and Development, 1987). To prepare such citizens is the goal of STS (Hickman et al., 1987). A rationale for STS is well developed by Hurd (1986):

> The STS rationale provides a holistic philosophy for education in the sciences. The curriculum is approached in ecological terms with its combination of relationships between science and society, and the addition of human concerns, including ethics, aesthetics, and values. The STS approach is designed to

> put knowledge into action through application of what is learned. The STS theme reflects the position that science courses should serve the common good of society and also promote personal development. The approach in no way denies the importance of preparation for a professional career in science, but rather introduces science's findings into a program of general education that has meaning for all youth and enables each to become a responsible citizen in our democracy. This is a vision of science education in which science, technology, society, and the humanities all can fit. (pp. 100-101)

2.2 - The Implementation of STS

As STS emerges as a major curriculum emphasis, there are several views held about where it fits into the schools' existing curriculum. The question of how STS is to be brought into practice seems to be problematic and these problems are still a long way from being resolved (Heath, 1992), although progress is being made towards the implementation of STS (Wraga and Hlebowitsh, 1991).

One of the fundamental arguments deals with how STS should be implemented into the school system. May (1992) points out that changing the present system is seen as a very difficult task and most STS proponents have adopted an attitude of tinkering with the system rather than one that calls for a massive overhaul. Hickman et al. (1987) identified three methods or options for incorporating STS into the present curriculum which are:

(1) infusion - This involves adding STS topics to

existing content in existing courses. The course remains intact with a limited number of side-ventures into STS areas when there is one that relates to the content being covered in the original course.

(2) add-ons - This option deals with the adaption of existing units or the creation of an STS units or modules which are added on to an existing course.

(3) The creation of a new course - This option involves putting together a new STS course that is designed to achieve unique STS objectives. The content of such a course could be new but could also include some of the content of a course that it may be replacing.

Hickman et al. (1987) go on to point out that each of these options have their own strengths and weaknesses. For example, infusion is the easiest option to incorporate with regard to time, money, resources, and disruption of the current system, but it is argued that it moves less towards achieving STS goals than the other methods. As one then considers add-ons and creating a new course, the investment of time, money, and resources increases. The existing school system encounters greater disruptions but at the same time the likelihood of achieving STS goals is likely to increase substantially.

Another point of debate about putting STS into the school curriculum involves where it should be located in the existing curriculum that organized by subjects. When put in by infusion or by the creation of add-ons, should it be taught within science, social studies, or technology programs that are already established in schools? Arguments have been made for the case of incorporating STS into social studies (e.g. Marker, 1992; Remy, 1990) and into technology (e.g. Brusic, 1992). Heath (1992), however, made the observation that most publications seem to support the science curriculum as the principal location of STS. In relation to STS being multidisciplinary instruction that falls into one subject area, May (1992) highlights a difficulty that is encountered when one discipline attempts to deal with another. She states that, "requests for interdisciplinary study are based on misconceptions of what constitutes a discipline in the first place, its boundaries and its modus operandi" (p. 76). There are those that argue against subject-based curriculum and support a restructuring of the entire school curriculum to accommodate programs such as STS. (McFadden, 1991; Pring, 1976).

The structure of instruction is also a point of disagreement among advocates of the STS education. Most all descriptions seem to hold the common idea of developing the interrelationships between science and technology. Where they go from there is the point of contention. Some descriptions only require STS to relate science and technology, but others insist that it must be based on social issues, while others think it should include "making decisions" to respond to issues. Alberta Education (1990) holds the belief that while issues can be used as a focus for STS programs, this is only one possibility of many. STS programs could focus on other areas such as scientific process skills, technological applications, science and technology interactions, or the nature of science. It is also stated that an STS program is not necessarily limited to only one main focus; a balanced STS program is likely to hold more than one focus. Heath (1992) provides another example of a reasonably broad conception of the shape an STS unit can take. In describing the topics that can be selected to plan units around, he mentions the possibility of using a social issue or problem, a technological process, or concepts and principles from a particular discipline.

Hickman et al. (1987) hold a somewhat different point of view. They develop a set curricular framework that is based on three categories of curriculum goals: (1) acquisition of knowledge; (2) utilization of cognitive process skills; and (3) development of values and attitudes. The acquisition of knowledge related to science, technology, and society is to be accomplished through the study of content in the areas of STS interactions, concepts and/or topics, and STS issues. The utilization of cognitive process skills based on STS inquiries is done through processing information, problem solving, and making civic decisions. The development of values and attitudes about the practice of science, technology, and democracy can be attained as outcomes of education activities that emphasize values in the process of science, and values of a democracy. Hickman et al. further emphasize that the categories of goals are not to be considered separately in the design of units but rather should be looked at as interactive elements that make up a unit which should all be found in each STS unit. Other STS supporters, such as Waks (1992), describe a comprehensive and rigid framework for STS units.

One of the challenges to be faced in the implementation of STS involves determining where it fits into the existing subject-based curriculum of schools. There are various views on how this can be done that range from "tinkering" with the existing system to doing away with the traditional subject-based system in favour of integrated studies. Related to how STS should fit into the existing curriculum is the form it should adopt. This appears to be another point of disagreement.

The doing or practice of STS is still in its formative stage. As STS moves from theory to practice, it is likely to evolve into a general form. Many of the decisions that have to made about its form are outlined above. Curriculum designers are faced with the task of deciding how their version of STS curricula will be synthesized. The product that results will effectively define STS and do much to determine the instructional strategies (Heath, 1992). Given their importance, carefully studying these initial STS curriculum efforts would appear to be a worthwhile and important endeavour.

Chapter 3 - Introduction 2

The Curriculum Connection

3.1 - STS Theory into Practice: The Textbook

One of the most obvious ways to bring STS into classrooms is by creating textbooks that have an STS emphasis. Classroom teachers must play a key role if STS educational goals are to be achieved and if they are to do so, it is necessary that they have textbooks with an STS themes available (Aikenhead, 1992; Bybee, 1991). Aikenhead feels that it is necessary that these textbooks be provided because classroom teachers lack the time, energy, and resources to create their own STS materials. Bybee considers science teachers to need a textbook that translates STS theory into a practical classroom practice. It appears that a great emphasis being placed on the development of STS textbooks and further consideration of this aspect of STS implementation is warranted.

Textbooks that claim to put STS into practice are beginning to appear (e.g. Aikenhead, 1991; Atlantic Science Curriculum Project, 1988, 1989, 1990) and this study will focus on the representation of STS in textbooks. In order to provide a complete introduction for the representation of STS in textbooks, several topics concerning textbooks will be developed. They are: (a) the importance of the textbook in education; (b) the politics and commerce of the textbook;

and (c) the research that has been performed on textbooks.

Textbooks in education.

The textbook is of particular consequence in education because teachers are accepting the textbook as the curriculum (Klein, 1992). As Apple (1986) indicates, "Whether we like it or not, in the United States and an increasing range of other countries, the curriculum in most schools is defined by the standardized, grade-level-specific textbook in reading, mathematics, social studies, science, and so forth" (p. 12). The textbook usually provides teachers with the content, the sequence, and the aims for a course and as a result, teachers have, to a great extent, become pedagogically dependent on the textbook (Eisner, 1979). In discussing the utility of the textbook, Eisner (p. 27) gives four main functions provided by a texts: (1) they provide a high level of content expertise that few teachers possess; (2) they organize and sequence the material appropriately for the topic and for the educational ends sought; (3) they lay out the educational path to be followed by students and teachers; and (4) they usually include a teacher's version which provides the teacher with questions to ask, test items, student activities, and correct answers. Eisner also discusses some of the reasons why teachers are pedagogically dependent on texts. The fact that teachers are expected to do more, for more students, with fewer resources at their disposal puts them into a position where a textbook that organizes their curriculum for them is hard to pass up.

In science education, the textbook certainly plays a large role in the shaping of the curriculum as has been illustrated in several studies. In a survey sample of about 12000 science teachers, 90% of them claimed that they used textbooks 90%-95% of the time (Stake and Easley, 1978). From the same survey, summary statements emerged such as, "behind every teacher-learner transaction . . . lay an instructional product [a textbook or similar product] waiting to play its dual role as medium and message" (p. 13:66) and "the curriculum did not dare venture beyond the boundaries set out by the instructional materials" (p. 13:66). Weiss (1978) also found the same dependence on instructional materials in her large survey study. The Science Council of Canada (1984) found that 80% of teachers use the textbook as their main source in lesson preparation.

The textbook is a powerful determinant in what is taught in science classrooms. The way that STS is represented in the textbook is going to have a large influence on how STS will appear in practice.

<u>The politics and commerce of the textbook.</u>

Apple (1986, 1991a, 1991b) has written extensively on the politics of how the textbook is produced. When textbook publishers produce a product, their main goal is profit. The text must be one that will sell. The textbook, as a result, becomes subject to many social forces that influence whether it will be used in schools. Out of responsibility to shareholders in the company, the publisher is normally obliged to respond to these pressures. While a detailed account of the forces that shape textbooks is beyond the scope of this study, the point should be taken that publishing is competitive industry in which publishers are trying to create a sellable product that isolates as few people as possible. They tend to propagate the status quo while responding to new pressures such as eliminating gender and racial bias (Apple, 1986; McFadden, 1992).

Textbooks are a medium through which dominant institutions and groups represent their viewpoints and seek to regenerate themselves (Apple and Christian-Smith, 1991). This is accomplished largely through control over what materials are used in schools. The publishers' wish for profit puts them into a position where they are likely to produce materials that the dominant social institutions and groups approve of.

The people responsible for the writing of a textbook do play a large role in the determining what is included and how the text is structured but given the agenda of the publishers, the textbook writer will have limits placed on their autonomy (Apple, 1986). The nature of textbook writing and publishing will surely play a role in the form STS takes as it is put into textbooks.

Research on textbooks.

With the central role textbooks play in education, the value of research on them is great. Much of the research on textbooks has involved the creation of instruments to measure some aspect of the material. One of the dominant forms of analysis is the use of readability formulas (Armbruster and Anderson, 1985). These formulas were designed to match the reading capabilities with the reader to the difficulty of the textbook. A similar type of research was concerned with the conceptual demands of the text (e.g. Shayer and Adey, 1981). In these studies, the conceptual level of the text was compared with the cognitive level of the students to determine whether the instruction was appropriate. Textbook research has also dealt with analysis using a checklist type of instrument (Armbruster and Anderson, 1985). The checklist directed the users attention to particular aspects of the text such as cultural and sex biases, quality of workmanship, and costs of the materials.

Much of the textbook research has used instruments that were already available in their analysis of textbooks but there does not appear to be much in the way of instruments for specifically examining STS curriculum materials. There are studies that have looked for pre-determined types of STS content, usually specific types of issues. One such study found that in the early 1980s, science textbooks were lacking in their inclusion of some STS goals. Rosenthal (1984) analyzed twenty-two high school biology textbooks that were widely used in schools between 1963 and 1983 for their treatment of social issues. She measured the space in the text devoted to each of the social issues being considered and found that the treatment of social issues decreased between 1963 and 1983. Staver and Bay (1985) examined eleven elementary school textbooks and found that only minor attention was given career or societal goals, while personal goals received greater attention, and most of the text was devoted to academic goals. In their large study of textbooks used in Canada, the Science Council of Canada (1984), the found that evidence of STS themes is found in few textbooks and when it is found, it is rarely in a balanced form. This led to the recommendation that changes be made in textbooks that would lead to greater use of the STS theme.

A basis for examining some STS curriculum materials is provided through the goal clusters developed by Project Synthesis (Kahl and Harms, 1981). These are broad goal areas in science education that are characterized by brief descriptors. It appears that these clusters emerged out of meetings of focus groups rather than from a direct examination of science education or its materials. They can be applied to any science curriculum materials but take into account areas that are specific to STS. The four goal clusters were labelled by the descriptors: (1) personal needs; (2) societal issues; (3) academic preparation; and (4) career education/awareness.

The studies referred to above measure the inclusion of specific types of STS content and basically report whether it was there or not. They are unable to provide a meaningful description of what actually is there. Such a description would provide a deeper appreciation of STS curriculum.

Aikenhead (1992) portrays the general idea of how features of STS textbooks may be appreciated. In reference to an STS textbook he has recently written (see Aikenhead, 1991), Aikenhead has suggested what he considers to be some important features of the STS textbook to be.

> Textbooks must explicitly integrate (a) societal issues that interact with science, (b) a modern view of the nature of science, (c) the literacy requirements of those who live in a society increasingly dominated by science and technology, (d) the technological world that interacts with science, (e) a feminine contribution to science (in terms of numbers of participants and new types of ideas), (f) a student-centered approach to learning (from the topics chosen to the language used), and (g) a constructivist approach to learning that exemplifies, where appropriate, the social construction of scientific knowledge itself. (p. 34)

One of the primary aims of this study is to provide a basis upon which to appreciate the features that are found in existing STS curricula. Such an appreciative system provides a rich and meaningful basis for discourse on STS curriculum materials.

3.2 - Curriculum Design

As STS textbooks or textbook units are created, they will be a result of the curriculum design process. This study is an attempt to describe STS curriculum designs and in order to do so must develop a conception of curriculum design as well as a way to characterize it. This section will deal with the former, while the next section will deal with the later.

In curriculum design, the main concern becomes the actual drawing up of curriculum proposals (Barrow, 1984). Klein (1985) describes curriculum design as the organizational pattern or structure of the curriculum. It is determined by "deliberate or enlightened decision making and should not occur as a result of omission or neglect" (p. 1169). There are many different conceptions of curriculum design offered in the literature and several of these will be discussed.

The technical perspective.

Curriculum design is often approached as an applied science. Books written on or involving the subject often outline methods that are to be followed in the production of a curriculum design. The best known of these is Tyler's (1949) model of curriculum planning. Most educators have interpreted Tyler's model as steps to be followed when attempting to construct a curriculum (Posner, 1988). The procedure was posed by Tyler as the need to answer four questions:

> (1) What educational purposes should the school seek to attain?
> (2) What educational experiences can be provided that are likely to attain these purposes?
> (3) How can these educational experiences be effectively organized?
> (4) How can we determine whether these purposes are being attained? (p. 1)

The use of these steps maintains that the ends not only justify the means but they also serve as a starting point for planning. Such a technical perspective considers planning to be a rational and linear process in which experts are most qualified to make curriculum decisions "either from studies of learners and contemporary society or by virtue of their subject matter expertise" (Posner, 1988, p. 80). Such a method is often referred to as the "means-end" approach to curriculum design.

About thirty years after Tyler's book was published, Pratt (1980) presented his conception of curriculum design that was also based on the means-ends approach. Pratt sets out steps that should be followed in the creation of a curriculum design. First, the needs of the students must be assessed. Second, the restraints such as time, money, and personnel have to be considered. Lastly, the curriculum plan should be set out specifying aims, objectives, and criteria of performance. Although Pratt emphasizes the needs of the students in his view of curriculum design, the fundamental idea of laying down objectives and performance criteria in advance remains.

Both of these views of curriculum design insist on specification of the desired ends of learning and from there the designer, in a process of rational decision making, selects the appropriate means to accomplish those ends. In such an approach curriculum design is seen as an applied science and becomes essentially a technical matter in which a pre-specified series of steps is followed to yield the curriculum.

The deliberative perspective.

There are writers who object to the means-ends approach in that it separates the ends from the means and that it does not adequately describe what curriculum designers actually do when they set out to design a curriculum. The fundamental emphasis that emerges in considering the views of these writers is an emphasis on the process of deliberation in curriculum design.

Schwab (1970) still considers curriculum design to be a technical matter but he brings forth the idea that the planning process is not characterized by a series of steps to be carried out in a pre-specified order but rather that the process of deliberation is of central importance.

Deliberation is complex and arduous. It treats both

> ends and means and must treat them as mutually determining one another. It must try to identify, with respect to both, which facts may be relevant. It must try to ascertain the relevant facts in the concrete case. It must try to identify the desiderata in the case. It must generate alternative solutions. It must make every effort to trace the branching pathways of consequences which may flow from each alternative and affect desiderata. It must then weigh alternatives and their costs and consequences against one another, and choose, not the right alternative, for there is no such thing, but the best one. (p. 36)

Schwab promotes the use of "practical" language to describe curriculum design rather than allowing too close a connection with any one theory as has been the case with most curriculum development.

Walker (1971) also stresses the role of deliberation in curriculum design. He considers the three elements of curriculum design to be its platform, its design, and the deliberation associated with it. The platform is a set of beliefs and values the curriculum designer brings to the task. Decisions about the curriculum design are made through the process of deliberation in very much the same way Schwab described it above.

Walker and Schwab both consider the curriculum design process to be much less linear than Tyler or Pratt would have it be. Objectives become less central in the process, and the means and the ends are developed together. The process of deliberation is central. Although the idea of rational curriculum planning is not entirely abandoned, the actual process is less defined and more context specific aspects of the process are recognized.

The professional practice perspective.

Barrow (1984) argues that the whole process of curriculum design may well be radically misconceived. He suggests that there is no one best way to design curricula and that there are many sensible ways of proceeding when one sets out to design curricula. Barrow sums up his position in stating that:

> . . . we don't want curriculum designers in the sense of people adept at telling us formally how curricula should be set out, or laying down an invariant order of steps to be taken in formulating curriculum. We want people to design particular curricula in intelligent ways. Much of the divergence between designers and between theories of curriculum design is essentially irrelevant, since it boils down to quibbling about how best to start tackling the problem, and how best to make an impact, rather than arguing about what a coherent curriculum proposal should involve. (p. 67)

Barrow essentially rejects a technical rational view of curriculum design in favour of recognizing the diversity of design procedure. In doing so, the concern with setting down any one procedure becomes a questionable endeavour.

Donald Schon (1983) takes a similar position in his generalized discussion of professional practice, of which design of curriculum would be an example. He looks at professional practice as an activity that is not bound by dichotomies of technical rationality.

> It is this sort of situation [problems encountered in practice] that professionals are coming increasingly to see as central to their practice. They are coming to recognize that although problem setting is a .ecessary condition for technical problem solving, it is not itself a technical problem. When we set a problem, we select what we will treat as the "things" of the situation, we set the boundaries of our attention to it, and we impose upon it a coherence which allows us to say what is wrong and in what directions the situation needs to be changed. Problem setting is a process in which, 'interactively', we name the things to which we will attend and frame the context in which we will attend to them. (p. 40) ('emphasis' mine)

Schon is able to separate the technical problem from the non-technical process of solving it. He further supports the view that professional practice is a process that defies attempts to define it as a technical process.

The importance in curriculum design of the views put forth by Barrow and Schon is that they de-emphasize looking at it as a technical process to be explicated. Instead they realize that curriculum design is context bound and essentially problematic in character.

3.3 - Characterizing Curriculum Design

Closely related to the different ways of conceptualizing curriculum design are different ways of characterizing the designs. In the case of this study, STS curriculum designs are going to be characterized and it is important to decide on an appropriate way to do so. The methods of characterizing the designs can grouped into the analytic and holistic approaches. Both of these approaches will be considered along with an examination of how these two views may be resolved and also how curriculum may be affected by social forces.

Analytic characterization.

As discussed above, the means-ends approach to curriculum design considers the determination of the objectives to be the first step in creating a curriculum design. The sources of these objectives were varied. Using Tyler (1949) as an example, he listed three main sources of objectives: the learners, contemporary life outside the school, and subject specialists. The objectives from each of these areas were to be considered in relation to the school's philosophy as well as educational psychology. Since the objectives came before other aspects of the curriculum, they were the main determining factor. A description of a particular curriculum design would be best carried out by determining the objectives.

Schwab's (1970) deliberation approach to curriculum design was different than Tyler's in that it removed objectives from their central position but similar in that it he considers five curriculum "commonplaces" that must be part of any deliberations. These "commonplaces" are similar to Tyler's sources of objectives. They are the learner, the teacher, the subject matter, the milieu, and the curriculum specialist. Because Schwab, unlike Tyler, considers curriculum to be less an object than it is a series of events made possible through deliberation, it stands to reason that it should be specified by the decisions that produce it (Posner, 1988).

Stenhouse (1975) defines curriculum as "an attempt to communicate the essential principles and features of an educational proposal in such a form that it is open to critical scrutiny and capable of effective translation into practice" (p. 4). In doing so he makes clear how he thinks curriculum should be specified, in terms of principles and features. It is worth noting, however, that Stenhouse differs from the means-ends model and uses a process model which was intended to improve practice by approaching it through the improvement teaching and learning (Barrow, 1984). In the process model Stenhouse (1975) has "noted the shortcomings of the ends-means model in education, and looked towards the specification of principles of procedure which refer to teacher activity" (p. 90). The process model also involves specification of content. Although his perspective is somewhat different that Tyler's or Schwab's, Stenhouse still feels that communicating the features and principles is central to characterizing curriculum design.

The three cases discussed above take an analytical view in that aspects of the design are selected for specification in order to characterize it. Although each differs on precisely what should be specified, each of them does in fact focus on single facets of the design process as they see it.

Holistic characterization.

The holistic view tends to look at a curriculum design as a whole and tries to characterize the complete design. Although there may be different areas with respect to which a design is considered, it always comes down to a bottom-line description of the design as a whole. Several types of holistic specification of curriculum design will be discussed. Terms that are used to label the types include orientations, emphases, and models.

Curricular orientations are discussed by several authors. Eisner (1979) considers orientations to be indications of the values and premises behind curriculum decisions. Curriculum designs are usually based on particular orientations and awareness of these allows one to recognize the assets and liabilities of each position. This involves not only being aware of what has been included in practice, but also what has been left out. Eisner went on to develop and describe five curricular orientations that could be used to classify existing curricula or guide thinking in the development of new curricula. The five he identified are ones that focus on (a) development of cognitive processes, (b) academic rationalism, (b) personal relevance, (d) social adaption and social reconstruction, and (e) curriculum as technology.

Miller (1983) also developed curricular orientations aimed at helping teacher to "clarify their approach to teaching and learning" (p. 2). Miller was careful to point out, as was Eisner, that it is possible for an individual to draw from more than one orientation. He called these groups of orientations meta-orientations.

Miller (1983) also describes seven practical and theoretical dimensions that are used in developing his orientations. They are: (1) educational aims; (2) conception of the learner; (3) conception of the learning process; (4) conception of the instructional process; (5) conception of the learning environment; (6) the teacher's role; and (7) conception of how learning should be evaluated. Eisner (1979) developed a similar set of dimensions of curricular planning. Although the consideration of these dimensions represent the areas that are examined to determine the orientation, in the end they are considered with reference to their bearing on an orientation.

Dealing specifically with science education, Roberts (1982a) developed the concept of curriculum emphases. Roberts makes a distinction between the content of curriculum and the intent of the curriculum. "When teachers and textbook writers shape curriculum materials, they invariably imbed subject matter content in a contextual web of intent for the student" (Roberts, 1982b, p. 211). In other words, two textbooks may have the same content yet at the same time they may have different "feels". The seven curriculum emphasis developed by Roberts (1982a) are summarized as:

> (1) The "everyday coping" emphasis - deals with science being used to control one's environment -- be it real or technological.
> (2) The "structure of science" emphasis - deals with how science functions intellectually in its own growth and development.
> (3) The "science, technology, and decisions" emphasis - deals with distinguishing science from technology, first, and subsequently distinguishes scientific/technological considerations from the value-laden considerations involved in personal and political decision making.
> (4) The "scientific skill development" emphasis - deals with developing fundamental skills required in scientific activities.
> (5) The "correct explanations" emphasis - deals with students learning scientific ideas and accepting the authority of a group of experts to determine the correctness of ideas.
> (6) The "self as an explainer" emphasis - deals with the students realizing their place in the intellectual and cultural institution of science and becoming an explainer of events, for their own purposes.
> (7) The "solid foundation" emphasis - deals with science education being organized to facilitate the understanding of future science instruction. (pp. 246-249)

The intent of the curriculum is what defines the curriculum emphasis. The intent of the curriculum goes beyond the selected content of a course and answers the question: Why should students study science? Roberts (1982a) claims that a legitimate curriculum emphasis takes at least five to six weeks to develop so a single emphasis could be used in a science unit. Roberts also found that when a unit was written with a particular emphasis in mind, it seemed to exercise some control over the depth and breadth of the subject matter as well as the inclusion or exclusion of optional subject matter. Matching a curriculum with an emphasis is a way to make explicit what the curriculum is attempting to achieve. Knowing this allows those involved with the curriculum to proceed with understanding.

Another form of holistic characterization is provided by Joyce and Weil (1986). They went about identifying models of teaching. For each model they consider the underlying theories, the research that has tested them, and how they can be used. Each model is discussed in terms of four concepts that describe the operation of the model itself. These are its syntax, social system, principles of reaction, and support system. The models developed by Joyce and Weil focus on instructional strategy. Although this is not completely distinct from content being taught, the content is not of primary concern.

Each of these holistic characterizations of curriculum design attended to the whole of the design as opposed to separate parts as was the case in the analytic characterizations. Each method seems to have its value in that the information provided by each gives a helpful description of a design. At the same time each method commits to either the parts or the whole while ignoring the other or only noticing it in a subsidiary way.

Resolution of analytic and holistic.

The analytic, which attends mainly to the parts of a curriculum design, and the holistic, which attends to the whole of a design, are really just differences of perspective. The fact of the matter is that each is important and as a move is made away from a technical perspective on curriculum design the whole design process becomes problematic (Barrow, 1984; Schon, 1983) which, in turn, makes characterization problematic. The idea of choosing between analytic and holistic methods becomes very uncertain. There is, however, the possibility of doing both which is elaborated on below.

When discussing the problem setting nature of technical problem solving, Schon (1983) refers to the how the professional must select the "things" of the situation which will they will pay attention to. In an attempt to determine the "things" of a professional practice, Schon constructed a description of what is taken into account during professional activity by observing professionals in action. He determined how they actually tackled a situation to which there were no simple or standard answers in order to expose what had, to that point, been a tacit process. In one of these cases he was in a design studio at a school of architecture. By observing the studio master reviewing the work of a student who was struggling with a particular design, Schon is able to observe several aspects of the design that are taken into consideration in the design process. These aspects were grouped into clusters which formed design domains. So what Schon did was directly observe which aspects of the task were discussed (i.e. the things of the situation) and cluster similar concerns to form the domains of design. This method provides both insight into the nature of the design process and insight into the nature of the product created. The nature of the final product is illuminated through a recognition of the features that where considered by the designer in creating the finished product.

These features could be considered the parts or particulars of the complete entity or curriculum, and finding these would increase our understanding of the complete entity. Polanyi (1969a) claims that an effort to define a complete entity will aim to do two things: (1) identify its parts or particulars and (2) describe the relation between its parts. In describing this method of understanding Polanyi states:

> We can see two complementary efforts aiming at the elucidation of a comprehensive entity. One proceeds from a recognition of the whole towards an

> identification of its particulars; the other, from a recognition from a group of presumed particulars towards the grasping of their relation to the whole...[This process involving] alternation of analysis and integration leads progressively to an even deeper understanding of a comprehensive entity (p. 125).

Polanyi (1969b), in describing the ontological aspect of tacit knowing, claims that what is knowable in terms the individual parts of a comprehensive entity is less than that which is knowable in terms of the complete entity. Knowledge of the complete entity may be equated with a knowledge of the curricular orientation represented by the features. The orientation held by a curriculum may be understood in terms of its features and the relationship between them.

Polanyi and Schon both direct attention to both the parts and the whole. Attention to one only deepens the understanding of the other. This seems to be a sensible way to approach STS textbook units. STS curriculum designs may be considered in terms of their features, to use Stenhouse's term, and its overall orientation. The orientation may develop out of recognizing the relationships between the parts.

Social forces affecting curriculum designs.

An understanding of a curriculum design gained through a knowledge of its features and overall orientation is valuable but it fails to account for how it got that way. An enhanced awareness of curriculum may be affected by recognizing the distortions in the curriculum as a result of the social structure in which it is placed. In attempting to communicate the features of a curriculum, it is possible to neglect the fact that curriculum is a social construction and the form and purposes of that construction will be determined, at least in part, by the social context in which it was developed. If we are to be aware of such distortions in the intended curriculum, we "must attempt to move the 'interpretive' approach beyond its traditional concern with producing uncritical renderings of individuals self-understanding, so that the causes of distorted self understanding may be clarified" (Carr and Kemmis, 1986, p. 137). These distorting conditions are some of those which constrain the curriculum. It is argued that through an awareness of how the original aims and purposes of the curriculum have become distorted or repressed we gain the ability to will give us the ability to free ourselves from these interests (Carr and Kemmis, 1986). It follows that the identification of constraints on curriculum becomes a viable and important function of educational research.

This study is an attempt to provide an understanding of STS curriculum designs. Although the intent is not critical in nature, an effort will be made to provide an awareness of some constraints that affect the creation of the designs. The benefit of a more vigorous critical treatment of these curriculum designs is not being de-valued, but rather is beyond the scope of this study.

3.4 - The Value of Research on STS Curriculum Designs

There are many different individuals and groups who would benefit from a greater awareness of STS curriculum designs. Such people could be working at the theoretical level, the curriculum designing level, the policy level, or the implementation level with respect to STS. The understanding of STS that may be gained from this study leads to the development or enhancement of what Vickers (1965) called an appreciative system. In describing the making of appreciative judgements he states,

> Such judgements disclose what can best be describes as a set of readinesses to distinguish some aspects of the situation rather than others and to classify and value these in this way rather than in that. I will describe these readinesses as an appreciative system. I will call them a system because they seem to be organized as a whole, . . . being so inter-related that a change in one part of the system is likely to affect and be dependant on changes elsewhere. (p. 67)

Vickers further claims that these "readinesses" need to be learned. The creation of such a system is considered a central constant in professional practice (Schon, 1983). Accepting the view that curriculum design is problematic and defies technical means (Barrow, 1984; Reid, 1979) points to the need for those involved to be aware of what a given design is or is not offering.

Reid (1979) refers to the need for practical reasoning and deliberation in the making of curricular decisions. Using deliberation as a basis for making curricular decisions he suggests that there must be multiple theories for multiple contexts and that no one curriculum theory is going to successfully make curriculum decisions.

> . . . by adopting a narrow frame of reference for the statement of curriculum problems, it [curriculum theory] has drawn attention away from the need for careful appreciation, . . . and presented problems as reducible to questions of appropriate objectives, content, and methods. The deliberative approach demands that we test such assumptions, and enquire whether curriculum problems may not sometimes be problems of administration, personal relationships, ideologies, community life, or democratic participation. (p. 203)

Reid makes clear the value of appreciation as a basis for deliberation. He goes further and points to how such a process can sometimes reveal some of the problems behind the problems (i.e. social constraints).

Returning to this study, the comments above provide the basic reason why an appreciative system for the examination and appraisal of STS is valuable. This is particularly true in light of STS being a relatively modern type of curriculum in early stages of implementation. The appreciative system gives those involved in creating and using curriculum a basis for discourse and appraisal of it. Although there are many groups who will be involved with STS, two of them will be highlighted in this discussion; the designers themselves and the teachers who will be using the designs. In addition, an examination of STS implementation represents an attempt to bridge the gap between theory and practice. This will also be discussed.

STS appreciation for curriculum designers.

Curriculum designers are directly involved in the initial translation of STS theory into STS practice. There is an obvious need for those involved in creating STS curriculum materials to be aware of the range of decisions available to them so that they can construct a complete curriculum that is capable of achieving STS goals. A thoughtful curriculum can be established only when the person creating the curriculum is aware of the choices available as well as the implications of including some features and not others. The use of an appreciative system allows a curriculum writers more conscious control over the curriculum materials they produce. A background of design possibilities is developed, against which they can be more aware of the particular design they are working with. Schon (1983) stressed the importance of the appreciative system in professional practice as it brings various decision points to the designers attention and enhances their appreciation of the design task by providing "back talk".

STS appreciation for teachers.

An appreciative system for the appraisal of STS curriculum materials is necessary if intelligent consideration of STS units is desired rather than blind acceptance of what is offered. STS curriculum materials are a recent educational development and there is a need for those who encounter them to be able to be perceptive and make a meaningful criticism of them. Teachers are the ones who must be most able to appreciate the features of a curriculum design; both what is there and what is not. Teachers make decisions in the course of planning instruction and adapt the curricular materials to meet their needs (Ben-Peretz, 1982; Rosier and Couper, as cited in Finegold and MacKeracher, 1985). If these teachers are able to appreciate the features of a good STS design, they are more likely to effectively implement STS into the classroom and, hopefully, participate in the deliberative process that many writers regard as being central to curriculum design.

The development of an appreciative system gives teachers, researchers and others that may be concerned with STS an instrument of interpretation. Nicholson (1984) makes the distinction between background interpretation and foreground interpretation. Background interpretation is tacit or subconscious interpretation that we are constantly engaged in. Foreground interpretation is a means of approaching a problem so that our thoughts are guided by conscious choices. The use of an appreciative system will help the consideration of STS move towards foreground interpretation. It will also provide a language of discourse that will allow, as Stenhouse (1975) encourages in his definition of curriculum, "critical scrutiny" of the educational proposal. The idea of the proposal is important as Stenhouse considers it to be a translation of an educational idea into a hypothesis to be tested in practice.

> The crucial point is that the proposal is not to be regarded as an unqualified recommendation but rather as a provisional specification claiming no more than to be worth putting to the test of practice. Such proposals claim to be intelligent rather than correct. (p. 142)

Stenhouse makes reference to the idea of the curriculum proposal being tested through practice. This ties the notion of curriculum research to the definition of curriculum and Stenhouse recognizes the central location of the teacher as a researcher. Research becomes the natural and necessary result of curriculum and, by being so, leads to the development of better curriculum. An appreciative system for teachers and others involved is necessary.

Eisner (1991, 1979) has referred to educational connoisseurship extensively in his writing. Connoisseurship has been generally defined by Eisner (1979, p. 193) as "the art of appreciation". Connoisseurship is vital to developing the necessary conditions for educational criticism because it lays down the qualities that are to be perceived and discussed in creating a meaningful criticism. Putting the teacher in a position to be a connoisseur of STS curriculum further points to the need for an appreciative system with to consider curriculum proposals.

The curriculum theory-practice gap.

As STS moves towards establishing itself in the practice of education, it must bridge the gap between theory and practice. There is much consideration of the gap between curriculum theory and curriculum practice (Klein, 1992; McCutcheon, 1985) and putting STS into practice is a practical example of attempting to bridge that gap. The study of the attempt to move STS into practice may provide insight that will hold great theoretical value.

The lack of correspondence between theory and practice is what is referred to be "the gap". Two views of implementing theory are often at the root of this topic: the means-ends approach and the deliberative approach. Reid (1979) advocates the deliberative approach and emphasizes the need for an appreciative system for all involved. The support for deliberation that would include teachers is strong in the recent literature. It is often linked to a view of teachers becoming more educated as to be more aware of their practice as well as features and options in curriculum design (e.g. Barrow, 1984; Ben-Peretz, 1975, 1982; Haysom, 1985; Klein, 1992; Stenhouse, 1975). Such a view is of curriculum practice necessitates the genuine understanding of curriculum designs that are offered.

This study deals with the theory-practice relationship with respect to STS and indirectly examines aspects of it.

In addition, an attempt is to be made to help narrow that gap by developing the appreciative system. This study has potential value in this area as well as in the others discussed in this section because it increases the awareness of the individuals involved with STS. It may enlighten various distinct practices related to STS implementation and, equally as important, is that it may provide a basis for communication between the different groups involved.

3.5 - The Study Focus

The present study aims to identify several features of STS textbook units. With each feature identified, key design decisions are highlighted that provide the basis for an appreciative system that may be used in future examinations of STS units and in discourse about them. Organizational patterns used in STS units as well as major orientations will also be identified in terms of their features. The orientations, when considered in relation to the features, will provide a deeper appreciation of how the parts of an STS unit relate to the completed whole. The final stage of this study will consist of a critical examination of the factors that influence the design decisions made by the unit authors with respect to the identified features.

Chapter 4 - Methods

The Methods

4.1 - Introduction to the Methods

This study has the purpose of providing a meaningful description of STS textbook units that will serve as a appreciative system for the appraisal of the STS units that were used in this study and other STS curriculum materials that were not used. The description was developed in three main stages, with each stage extending the description to make it more comprehensive. Each stage was initiated to yield a particular type of knowledge that can be summarized as follows:

Stage 1 - **The features** - The features are characteristics or qualities of STS units. In a particular unit a given feature may be present to varying degrees or absent.

Stage 2 - **The organization and orientation** - The organization and orientation of a unit both refer to how the features are related in the unit. The organizations come from perceptions of similarities and differences between units but the orienatation relates to the fundamental organizing principle around which the unit operates.

Stage 3 - **The constraints** - The constraints are factors that impinge on the design of STS units. They relate specifically to the writing of the units by the authors and the reasons why they made the design decisions they did. The features will serve as a basis for identifying decision points from which the constraints can be determined.

The methods by which the information referred to above will be found is the specific concern of this section of the present study. Appropriate methods must be selected in light of the data sources that exist. The data sources that are available in this study are:

(a) the textbook units themselves

(b) the accompanying teacher's guides

(c) the authors who wrote the units.

The methods that were used to gain the information were the examination of the units and teacher's guides as well as the conducting of interviews with the authors. The methodology of this study will be examined in terms of its theoretical framework and its connection to the literature on methods and those used in other studies.

Theoretical framework.

Like any knowledge, that which may be gained through the creation of a list of STS features is derived from what Habermas (1972) referred to as knowledge-constitutive interests. In his elaboration of these interests, Habermas identifies three distinct human interests from which knowledge results: technical; practical; and emancipatory.

The development of STS features would correspond to the practical interest. The practical interest strives to understand and clarify the conditions for meaningful communication and dialogue (Carr and Kemmis, 1986). Through medium of language, subjective meaning of the actor is understood and communicated to others. Carr and Kemmis describe the appropriate methodologies of research that strives to connect action to intention as the interpretive or hermeneutic sciences. Hermeneutic studies strive to understand aspects of a text by reference to what is believed to be the motives or purposes behind its creation. Hermeneutics has been described as a mode of educational research which attempts to discover the meaning behind educational practices (Odman, 1988).

In this case, the meaning of the textbook unit that attempts to present students with the STS theme is the object of interpretation. The determination of the features comes from experiencing the unit through a growth of understanding that occurs as the unit is examined. This process of examination and growth repeats itself as the unit is further experienced and is what Gadamer (1975) is referring to in his reference to the hermeneutic circle. Gadamer describes this process as follows:

> Whenever someone wants to understand a text, he [sic] always formulates a projection. He projects before him a meaning of the whole as soon as the initial meaning is indicated. Such intimation occurs only because one

> is already reading with certain expectations of a determinate meaning. In working out such a preliminary projection -- which is, of course, continually revised as there is a further penetration into the meaning -- consists of the understanding of what is there. (p. 236-237)

This understanding that is developed as the examination goes on leads to an enhanced ability to provide a description that will express the meaning of the text, or in this study the STS unit.

The value of identifying features of STS units is related to Eisner's (1991, 1979) conception of connoisseurship. In order to explain this concept Eisner uses the example of an experienced wine-taster. A connoisseur of wine is someone who has, through tasting many wines, developed an appreciation for the qualities of wine and is able to appreciate a particular wine with reference to these qualities. In effect, a connoisseur of wine is able to appraise and discuss wine through an awareness of various qualities of the wine. In formulating a list of features for STS units, various qualities of those units are made explicit. Knowledge of these qualities allows one to appreciate any STS curricula with reference to these same qualities and forms the basis of an appreciative system for STS unit appraisal.

The framework established by the identification of features has been described in psychological literature as constructs (Kelly, 1969a). A construct is something created by an individual in order to make sense of their world. It is a bipolar reference axis that is used to construe similarity and dissimilarity between objects and events. An individual's system of constructs determines their personal orientation towards the events that they encounter and is a personal affair; each person does their own construing. A single construct is a member of a system of constructs. This portrays the idea of dimensionality. A single construct used to construe a feature of a design may be referred to as what Kelly (1969b) a 'dimension of appraisal'.

The creation of the appreciative system then feeds back into the methodology of the study by providing a rather comprehensive tool for re-examining a unit as a whole. Polanyi (1969a) provides insight into the process of understanding a complete entity in relation to its parts. He claims that a deeper understanding of a comprehensive entity is achieved by moving one's attention from an awareness of the parts that form the complete entity to an awareness of the complete entity and then back to the parts again. This process of moving back and forth from the particulars to the complete entity explains how an explicit knowledge of STS unit features can lead to a deeper knowledge of the unit as a whole. The pre-understanding of the features can be enlarged upon if they are considered against the horizon of the whole. Polanyi's conception of achieving an understanding points to the necessity of relating the features found to the unit as a whole which will be a task of this study. This is the way in which the larger organizational patterns of the units and their orientations will be examined.

The final part of this study involves eliciting reasons for including or not including the features in a given unit. In doing this a critical element is introduced into the study. The reasons why the various design decisions were made in the creation of a unit provide a sense of the factors that play a role in making the unit the way it is. Without examining the reasons why the unit takes the shape it does, a distortion of understanding is permitted. When these reasons are exposed, a deeper understanding is sought that permits reflection upon the influences on a unit and, if these are undesirable, how they can be corrected (Carr and Kemmis, 1986; Ewert, 1991). Using the features as a basis, this part of the study is concerned with gaining a critical perspective on STS units. The knowledge-constitutive interest behind doing so is that of emancipation (Habermas, 1972).

Connection to the literature.

Anderson and Burns (1989) describe the type of research used to develop features as descriptive. Descriptive studies attempt to communicate the nature of a phenomenon. A follow-up to this sort of research is associational in which the researcher is engaged in trying to relate certain features to others. The methodology of a descriptive study requires the researcher to encounter the subject or object of study and to describe it. One of the more well-known descriptive studies, and perhaps the largest, was conducted by John Goodlad (1984) on schooling in the United States. In discussing the method for the study he states, "The first step in any program of examination and reconstruction is to determine what now exists" (p. 15). This statement clearly identifies the place where any such descriptive study should begin.

Most studies that deal with textbooks or textbook units tend to use a previously created instrument and use it to evaluate the textbook (e.g. Rosenthal, 1984; Staver and Bay, 1985). Such studies have little to offer as a meaningful description of STS materials because they derive the characteristics being studied extrinsic to the materials themselves. The information gained from these studies provides a very limited appreciation of STS designs as they are confined to the narrow scope of the question they are posing. A description of STS designs that focuses on determining intrinsic characteristics of the units has far greater potential for providing rich and meaningful accounts of the designs.

There appears to be no adequate descriptions of STS units, so this study will endeavour to develop its own conceptual system by describing existing STS units. The development of conceptual systems is established in the areas of classroom research. Meaningful descriptions rest on conceptual frameworks which are defined in terms of the categories and subcategories. Research on classrooms carried out by Bellack, Kliebard, Hyman, and Smith (1966) used transcripts of audiotape recordings of teachers' classrooms to develop categories of pedagogic moves and content of communication. Through the categories of the conceptual framework they were able to give meaning to the evidence that was gathered in the study. A similar conceptual system was developed for describing teacher beliefs by Bussis, Chittenden, and Amarel (cited in Anderson and Burns, 1989). This was based on the analysis of audiotape recordings of open-ended interviews conducted with teachers and provided categories based on teacher beliefs about curriculum and children. Conceptual categories emerge out of studies on children an school as well. Gustafson (1991) identified categories of children's ideas about a science topic mainly through interviews and observation.

The present study begins with an attempt to find out about the characteristic content of STS units and seeks to develop a conceptual system to guide this process. Although the above studies were interested in a different subject, the nature of the studies is similar to the nature of this one. Soltis (1990) claims that descriptive qualitative research needs a 'face to face' element with the source in that it is usually necessary for the researcher to encounter the source. Anderson and Burns (1989) advise as to the strength of multiple data sources, some of which may include the examination of physical objects such as textbooks and asking the individuals involved. As already mentioned, the three sources of evidence that appear to be of most use in determining the content features of STS textbook units: (a) the textbook unit itself, (b) the accompanying teacher's guide, and (c) the author's conception of the unit.

As these features are determined, the researcher's own perspective is likely to influence what is found. In order to ensure that the qualities observed are indicative of what actually exists in the units, two methods of verifying evidence can be included in the study (Eisner, 1991). The first is what Eisner calls structural corroboration. This method is similar to triangulation in that it relies on multiple data sources to support an interpretation if it is to be accepted. A second method is that of referential adequacy. The use of this method of evidence is seen in the features being clearly connected to the object of study. The source of evidence must be made clear so that the reader can locate the features in the subject matter.

A study that attempted to identify reasons for instructional decisions of mathematics teachers was carried out by Glidden (1991). He used a questionnaire to ask teachers about whether they used particular teaching methods. He then followed the positive answers with a question as to the reason why they did, and the negative answers with a question as to the reason why they did not. The use of a questionnaire limited the potential reasons offered by the teachers to those that were included in the choices. Other studies performed in order to gain access to teacher's thinking used interviews (Clark and Elmore, 1979; Morine-Dershimer, 1977) and analysis of written documents (Carnahan, 1980; Morine-Dershimer, 1977).

In this study, the reasons for author decisions in the design of STS units are not anticipated due to prior research. A semi-structured interview method using the previously identified features as a basis provides an effective way to collect the reasons while not limiting the authors' answers. The selected sources of these reasons are the authors. They are the ones who are both familiar with the content, and the reasons why it became so. Because the unit was written in the past, an actual observation of the process is not possible therefore simply asking the author why the unit turned out as it did becomes the best course of action.

4.2 - Materials

In order to carry out this study six textbook units were selected and analyzed. Each of the units were found in the SciencePlus textbook series. This particular series was chosen because of its national and international popularity. The authors of the units were available and willing to participate in the study.

This textbook is intended for use in science classes at the grade seven, eight, and nine levels. It was originally developed by the Atlantic Science Curriculum Project, or ASCP, and is considered to be atypical of commercially published curriculum materials at this level in two respects: (1) the nature of its development and (2) the nature of materials that emerged. The development of SciencePlus was not initiated by a publishing company, but rather was the result of the ASCP being founded at a meeting of science teacher educators in 1977 (McFadden, 1992). The ASCP evolved into a project involving hundreds of science teachers throughout Atlantic Canada. It became a "field-based, research-driven curriculum and professional development project" (McFadden, 1992, p. 72). The group attempted to be responsive to local curriculum needs but at the same time was using much of the international literature on topics related to their endeavour. After a seven-year writing period and field development stage, an agreement was negotiated with a publisher and the original versions of SciencePlus 1, 2, and 3 were published between 1986 and 1988. The original units emphasized science concepts and made other science-related goals subordinate to these (McFadden, 1991). Nevertheless, these early versions of

SciencePlus were considered by some to be STS materials (Yager, 1990).

Between 1986 and 1990, further writing and field development was done to prepare the Ontario, Alberta, and French versions of SciencePlus (McFadden, 1992). When the Ontario and Alberta versions were being developed it became necessary to amend or replace several of the units to develop a greater focus on technology and science-related social issues (McFadden, 1991). This explicit shift to an STS orientation is of particular interest in this study. SciencePlus is now used in six Canadian provinces and new versions are being created for use in the United States where it has been rated as the number one middle school curricula (Middle School Curriculum Review Panel, 1991).

The materials that were studied are SciencePlus units that have an STS emphasis according to the project team. Whether or not the units were believed to have an STS emphasis was be determined by reference to claims of the authors of the unit in question, reference to the teacher's guide, and reference to the literature (i.e. McFadden, 1991). These units provided an excellent opportunity for study as each have an identifiable author who was available for interview. The six STS units and the abbreviations that will sometimes be used to refer to them in this paper are:

(1) Energy and You (E&Y)

- by John Haysom (1988)

(2) Micro-organisms and Food Supplies (MFS)

- by M. Muriel Smyth (1989)

(3) Environmental Quality (EQ)

- by Alan Moore (1990)

(4) Structures and Design (S&D)

- by Charles P. McFadden (1989)

(5) Growing Plants (GP)

- by M. Muriel Smyth and Charles P. McFadden (1990)

(6) Fluids (Fl)

- by Alan Moore (1990)

4.3 - Procedure

Determination of features.

The initial stage of this study was an attempt to seek out and identify design features of various STS units. The first step was to examine each unit individually at which time the unit was outlined to produce a more compact view of the unit as a whole. After becoming familiar with the unit, I went back through it and identified several features that appeared to relate to its STS character. For the purposes of this study, a feature shall consist of a characteristic or quality that was noticed as being present in the particular unit. Because this initial identification was dependent on my own perception, I suggest neither that this examination yielded an exhaustive list of features nor that the list of features generated is the only possible way to perceive the unit. The goal, in this case, was to try to accumulate features that will provide the basis for meaningful discourse about and insight into STS units. My focus was on the determination of some qualities of the unit designs for the purpose of understanding what the author has attempted to do in the unit through the particular design that has resulted.

The initial examination of the text was followed by conducting an interview with the author of each unit as well as an examination of the teachers guide that accompanies the unit. In keeping with the formative nature of this part of the study, these interviews were structured only to the extent that the initial features I had identified were presented to the authors so as to get their reactions. The rest of the interview was very open and unstructured. It was more of a general discussion of the unit to elicit the authors' conception of their units. These steps were used to provide evidence for the features that I had determined and to modify them in light of the authors' comments. It was also an opportunity to identify some new features. In order to provide a more comprehensive list of features, any other features that were discovered through the author interviews or examination of the teacher's guide that were included in the unit were added to the list. In a case where a feature was mentioned in an interview that was not found in any of the units, it was added to the list if it appeared to be tenable as a unit feature. Such a feature would represent what Eisner (1979) referred to as the null curriculum. The null curriculum is that which is left out and not represented. The primary reason for including features that describe the null curriculum is to find out why it was left out in the final stage of this study.

The teacher's guide was primarily used for the purpose of corroborating the evidence gained from the initial unit examinations and the interviews. If features were to arise in the examination that had not already considered they would added to the list.

When a list of features was accumulated for each of the units, all of the features were combined. Many of the features that were found in one unit also appeared in other units as well. In this case, the feature was recorded in the final list only once along with the supporting evidence. The features that were recorded in the aggregate list formed the basis for the final list of features.

Each feature from the aggregate list was re-written in generic language so that the feature would not refer to one particular unit but rather could be considered with respect to any given unit. The features were determined as a positive instance of a particular quality. Each of the features become a bipolar construct (see Kelly, 1969a). Not only can a unit be considered on the basis or whether it contains a given feature, two units can also be compared as to the relative inclusion of a given feature. Each feature becomes a dimension of appraisal for STS units and all of the features considered together form the appreciative system.

Unit organizations and orientations.

The second part of this study is concerned with providing a more in depth analysis of the units in light of the features and their relation to the unit as a whole. Once the features were clarified, they were considered in the context of the units in which they are found. To do this a chart was constructed in which each unit was evaluated as to whether it includes each feature on the aggregate list. This compilation exposed which features are in a particular unit but also which features are not present in a particular unit. The chart contributed to the analysis by clearly displaying the prevalence of a given feature in the units.

The analysis proceeded on the basis of perceptions made about the units using the features as a heuristic tool to guide perception. The perceptions where based on similiarities and differences that emerged within particular aspects of the units. Each of these perceptions was described in order to provide another level of unit appreciation that went beyond that offered by the features.

Using the different elements of STS established as a result of the features, the general organizational structure of the STS units was established. An organizational chart was constructed in order to communicate the possible content areas for STS units as well as the relationship between these areas. This organizational chart was used later in the analysis as a tool for describing the six units that were studied and for developing a conception of the feature interrelationships between the elements of STS that shaped the unit as a whole.

The relationships between the unit features and the overall unit orientation were also considered. The unit orientation was taken to be the fundamental organizing principle used to create the unit and usually related to the overall appearance of the unit. The selection of an orientation has implications on the other components of the unit. The discussion of the orientations consisted of the interpretative identification of the orientations used in each of the units. Each orientation was described with reference to the general context it establishes for the unit and the features that appear to typify it. Each orientation is also related back to the units themselves and their particular content structure.

Reasons for design decisions.

The third part of this study is an attempt to investigate the thinking of the authors with respect to each feature found in the final list. Of particular interest are the authors' reasons for developing certain features in their unit and not others. The individual features are not necessarily intended to be a description of what the author consciously considered as the major decisions of the actual design process. They are qualities of STS units that may be present in their work as a result of conscious choice or they may be present without having been consciously considered (i.e. as a result of tacit or incidental inclusion). They are also qualities which may not have been included in a given unit as a result of conscious choice or as a result of never having been considered for inclusion.

In order to examine the authors' thinking in relation to the features, the features were made into questions. Interviews were conducted with the unit authors and they were asked about the importance of each of the features within the unit. This interview was more directed than the first interview in that specific questions were asked of the authors but the authors were permitted to form their own responses to the questions. It was explained to each author before the interview that when the question inquired as to the importance of a feature, it did not necessarily refer to the space devoted to it. The question could be interpreted as such but it could also be taken to refer to the relative importance of the feature when compared with the other aspects of the unit. If, when asked about a feature, the author said they had included it to a large extent, they where then asked why they had done so. If they said they had not included the feature, they were asked why they had not.

If they said that they had to a limited extent, they were asked why they had included it and why they had not included it to a greater extent.

When the reasons given in the interviews were all collected they were put into categories that were created on the bases of their similarities and differences. Reasons that were similar were grouped together. The reasons were examined on the basis of: (a) the different types of reasons that emerged, (b) the frequency with which each type was quoted, and (c) the types of reasons that were associated with particular features.

Chapter 5 - Analysis 1

The Features, Organizations, and Orientations

The analysis of the six SciencePlus units will be performed in this section and will be followed by the discussion of this part of the study. In the next section another analysis will be performed on the reasons given by the authors for their design decisions. The second analysis will also be followed by a discussion. This section will proceed by, first, providing a description and explanation of the features developed from the units and, second, describing several organizational characteristics that were perceived by examining the units in light of the features.

5.1 - The Features

The features will be developed in this part of the present study using evidence that was collected to ground them. For each unit, a list of features was constructed that was based on evidence collected from the examination of the unit, the examination of the teacher's guide, and the interview with the unit author. From the list of features compiled from each unit, an aggregate list was constructed which includes all the distinct features found in the six units. In many cases a feature found in one unit was the same quality that had been already discovered in another unit. In such a case the feature was recorded on the final list only once, on the first occasion it was encountered.

"Energy and You" was the first unit to be considered in the formation of the aggregate list of features. As a result, "Energy and You" appears to make the greatest contribution to the aggregate list. Units that were considered after "Energy and You" contribute less to the identification of new features to be included on the aggregate list because the features that were found in these units were often already in the final list as features of another unit.

In the course of the interviews, the authors suggested potential features that were not found in any of the units. In these cases, it was clear that the authors who brought up these features considered it to be an element that was worth considering in the design of STS units even though all of the authors either chose not to include it or overlooked it as an element of their unit. If it did appear to be a tenable inclusion in an STS unit, it was added to the feature list.

The aggregate list of features is presented in the Appendix. Each is categorized to indicate where it was first encountered and any evidence that supports the feature is also included. In the discussion to follow parts of the evidence for the features will be referred to but a more detailed account is provided in the Appendix. This information was added as an appendix because once each feature is combined with its supporting evidence, the list becomes quite long. It would be rather cumbersome if it was included in the body of this paper.

A more general and streamlined version of the aggregate list was created from the version found in Appendix. This list may be referred to as generic because the features were re-written as to avoid any references to a specific unit so that any one feature could be considered with respect to any given unit. The final list of generic features represent dimensions of appraisal for the STS units and will provide the basis of discussion for the remainder of this study. These features are presented below, organized into groups of related features.

Science understanding

1. An understanding of science concepts is developed.

2. The science concepts that are developed are used to help provide an understanding of another nonscience topic (e.g. technology or an issue) that is included in the unit.

Technology understanding

3. An understanding of one or more technologies is developed.

4. The understanding of technology that is developed is used to help provide an understanding of another topic (e.g. science or issue) that is included in the unit.

Social understanding

5. An understanding of personal lifestyles is developed to

help provide an understanding of another topic (e.g. an issue or technology) that is included in the unit.

6. An understanding of society is developed to help provide an understanding of another topic (e.g. an issue or technology) that is included in the unit.

7. A global appreciation (e.g. sustainability of resources, disparity between nations and peoples) is developed of a topic (e.g. an issue or technology) that is included in the unit.

Inquiry process development

8. The process through which scientific (experimental) investigation is carried out is developed.

9. The process through which technological testing is carried out is developed.

10. The processes through which social research is carried out are developed.

Appreciation of technological or issue decision making

11. Technological decision making is presented (i.e. decisions that take into account various factors such as science, technology aesthetics, and values).

12. Technological products are created as a result of technological decision making.

13. The unit remains value neutral when presenting an issue or dealing with decision making on an issue.

14. An appreciation of the viewpoints of others is developed when examining and/or deciding on an issue.

15. Personal decision making on an issue is developed (i.e. ones that could actually or hypothetically involve students acting as individuals).

16. Collective or group decision making on an issue is developed (i.e. ones that are made by a group and could actually or hypothetically involve students acting as a part of a group).

17. Decisions are actually made by the students.

18. An awareness of the effectiveness of possible actions that may be taken on an issue at the personal, group, and/or political levels is developed.

19. Real action is included as a follow-up of decision making on issues.

Now that the features have been identified, the specific meaning of each feature must be clarified. This will be accomplished with specific reference to one or more units that included the feature. The features provide a basis upon which the units can be examined both individually and in comparison to each other. By doing so, an awareness of the design possibilities begins to emerge.

Each group of features identified above will be discussed. Within each group, individual features will be elaborated in an effort to better communicate their meaning. Each feature will be supported by evidence from one or sometimes two units which employed that particular feature.

Throughout the text of this paper reference will be made to the evidence collected from the textbook units and the interviews with the authors. When a textbook unit is being referred to, the name of the unit will be given within in quotation marks (e.g. "Structures and Design") without any other information. The unit authors are identified at the beginning of the method section and the unit reference is found in the main reference list. Interviews are referenced normally with the term "int." added along with the month and year the interview took place (e.g. (Moore, int., August, 1992)). All interviews were recorded on audio tape and each separate interview is referenced in the main reference list.

Science Understanding

The two features relating directly to science both deal with the science concepts that were developed in the unit. The character of the science content varied from one unit to the next. All of the units included science concept development yet the context in which it was done varied.

Feature 1 - An understanding of science concepts is developed.

All of the units developed science concepts to some extent. For "Fluids" there is a clear emphasis on this as can be seen in Moore's (int., July, 1992) description of the unit structure.

> It brings forth the main physical science concepts that are going to be developed through the unit such as density, buoyancy, pressure, and fluid flow and so on

> and so forth. All of these things emerge in these opening lessons and then the second part of the unit is looking at density and buoyancy and its impact on fluids; and then the third part tends to concentrate more on pressure effects, and how fluids, both gases and liquids, exert pressure.

"Fluids" is structured around science concepts that relate to fluids, such as buoyancy and flow. In such units the science content was organized in a manner that tends to reflect the structure of scientific knowledge.

The main criteria upon which to judge a unit with respect to this feature are based upon the ability of the science concepts to stand alone as an outcome of the unit regardless of what use they were put to in the overall structure of the unit. A unit that was almost entirely devoted to presenting a given concept or set of related concepts to students would be an example of a unit that would be very concerned with promoting a conceptual understanding of science topics.

Feature 2 - The science concepts that are developed are used to help provide an understanding of another nonscience topic (e.g. technology or an issue) that is included in the unit.

"Energy and You" cevelops science concepts, but does so with the intention of using them to lead to a better appreciation of the energy issue upon which the students were to make decisions.

> [Science comes first because] I needed to establish an

> information base--a scientific information base. . . . If I build this solid scientific information base first, then I thought there was a chance that I could casually refer to it so as to bring the decision into full focus. . . . There are all sorts of ideas--if you like, scientific ideas--[that needed to be established] before the issue could be addressed. (Haysom, int., March, 1992)

This feature deals with the degree to which the science is related or applied to another topic in the unit. Regardless of how conceptual the science concept development is, the purpose to which the science is put is of concern with this feature. Most of the STS units considered in this study relate the science to another topic such as the building structures or the avoidance of food poisoning and spoilage. Effectively, the other topic determines what science is relevant and shapes the science content selection. The interactions that are formed between the science and other topics strengthen the presentation of both. The main differences in science presentation seem to revolve around the purposes to which it was put and its relative priority in a given unit.

Technology Understanding

Technology will be considered in much the same way the science was. The main considerations relate to the importance of the technology, in itself, and the purposes behind the technology development.

Feature 3 - An understanding of one or more technologies is developed.

"Fluids" deals with several fluid related technologies in an effort to see how they work.

> I think I was really left with doing it to explain everyday kind of technologies that they [the students] may be familiar with or that they may encounter whether it's a bicycle pump, to pumps in their cars, to whatever it may be. (Moore, int., July, 1992)

Part of the unit was devoted to the explanation of specific technologies and an outcome of the unit would have been students becoming familiar with these.

This feature simply refers to the extent to which the technologies act as the subject of instruction. Some units deal with a technology, in itself, so that students may gain an understanding of how it functions. The students would be expected to finish the unit with an understanding of specific technologies.

Feature 4 - The understanding of technology that is developed is used to help provide an understanding of another topic (e.g. science or issue) that is included in the unit.

In "Energy and You" technologies are used to help the students understand where electricity comes from. The use of electricity is the issue developed in this unit and the eventual purpose of the technology.

> The hydrodam--that was there so that children could gain an understanding of how a water wheel could be

> harnessed so as to provide the electricity that comes out of the socket in the wall. (Haysom, int., November, 1992)

Moore uses technology to help provide a context for using the science in "Fluids".

> I think that's one reason why we do incorporate technology--examples of technologies, especially from the students everyday experience--to give them a reason for using the science. (Moore, int., July, 1992)

Technologies can be used to strengthen the presentation of something else. The degree to which the technology that is developed is related or applied to another topic in the same unit is the concern of this feature. This did appear to be true to some extent of all the units that presented technology. When technology was developed, the specific choice of which technology to include was a function of another topic. The understanding of the other topic was the main goal, and having the students understand a particular technology would contribute to it. The drawing of the relationship between the two topics, however, strengthened the presentation of each.

Social Understanding

The features that deal with social understanding are the society element of STS. The society element seemed to center on individuals, larger social groups, or a global view of the world. Three levels at which a social understanding was developed were distinguished and each appeared to inform another topic.

Feature 5 - An understanding of personal lifestyles is developed to help provide an understanding of another topic (e.g. an issue or technology) that is included in the unit.

"Micro-organisms and Food Supplies" connects the students lifestyles with the prevention of food poisoning and does examine students personal food habits. After discussing the development of personal lifestyles Smyth comments,

> I thought it [safe handling of food] really is not something remote. It is something that should really affect their lifestyle. . . . Everybody, boys and girls, are all going to deal with food and all are going to work with it and it's a basic thing of everybody's everyday existence. (Smyth, int., August, 1992)

The concern was to have the students relate their personal lifestyle to what the learned in the unit.

Personal lifestyles are affected by science, technology, and issues but our lifestyles also affect each of these areas. This feature is concerned with the extent to which information about the way students and other individuals live is developed in the unit as a way of showing the relationship between the lifestyles and another topic. Lifestyles can involve the students looking at their own personal ways of life or it can involve them looking at the ways of others. What individuals do is highlighted.

Feature 6 - An understanding of society is developed to help provide an understanding of another topic (e.g. an issue or technology) that is included in the unit.

"Energy and You" connects changes in society to energy use by developing a timeline that compares developments in energy production to changes in society over a 200-year period as well as pie charts that compare the type of energy sources in the past and present. When discussing the reason why he used these in the unit Haysom says,

> To broaden out beyond that personal perspective so as to see thing more generally, in social terms. (Haysom, int., August, 1992)

This feature refers to the unit developing an understanding of society as it relates to other factors such as the development of technology. Information about society refers to the use of descriptors that provide an understanding of groups of people, such as energy use or wealth. It can also refer to things that have been created by the group such as government and laws. The relationship between areas such as these and factors that affect or are affected by them are the concern of this feature.

Feature 7 - A global appreciation (e.g. sustainability of resources, disparity between nations and peoples) is developed of a topic (e.g. an issue or technology) that is included in the unit.

A global appreciation was not developed to any great extent in the units studied. "Energy and You" did briefly discuss the idea of renewable and nonrenewable resources and "Environmental Quality" referred to the global commons but, as in the other units, the use of universal themes that might lead to a global appreciation was very limited when included at all. It was however discussed in the author interviews by Haysom (int., November, 1992).

> I really regret, in retrospect, that I didn't include something with respect to the amount of energy which is used in highly industrialized societies like ours and compare that with the amount of energy which is used in some of the developing societies, like India--a global perspective. (Haysom, November, 1992)

A global appreciation of a topic is related to the degree to which the topic was linked to universal themes that underlie problems. It is related to the appreciation of other perspectives but calls for the consideration of the common good of all the world's people rather than the mere representation of the interests of a few groups that are closest to an issue or those which are most powerful. Such a viewpoint often makes reference to such concerns as sustainable development, global disparities, peace, food, and environment. A global perspective tends to put interests of all people ahead of those of a few and demands that what is best for the planet and the people on it must be considered first.

Inquiry Process Development

The term inquiry is used in reference to methods of inquiry by which the goals of an endeavour are achieved. The goals are different for each endeavour and as a result the processes by which those goals are attained also vary. The representation of each of the processes considered below is considered in the STS units that were examined. Each feature simply explores the importance of each of the processes within a unit.

Feature 8 - The process through which scientific (experimental) investigation is carried out is developed.

"Growing Plants" incorporated science process into the unit and required the students to do a great deal of experimentation related to growing plants.

> In a unit like growing plants, the kids really are given opportunities to do more meaningful experimentation. . . . The goal of a lot of the activity in Growing Plants is not the development of concepts; it's simply that they undertake experimentation to find what is included in science-fair-type activities: what happens if, and let's find out. (McFadden, int., August, 1992)

Scientific investigation is an experimental process that is used in our attempts to find out truths about the world. Although what constitutes "scientific method" is a point of scholarly contention (see Kuhn, 1970), science process is presented in many science textbooks. Scientific process deals with such topics as making a hypothesis, performing experiments, manipulating variables, collecting data, and formulating conclusions is found in several of the units examined. The extent to which it was done has to do with the relative importance placed on it in the unit as compared with other goals.

Feature 9 - The process through which technological testing is carried out is developed.

"Energy and You" examines this process in describing an experiment to determine the best angle and length for windmill blades.

> It [the windmill section] is included to give children an opportunity of developing some of their process skills and really is a sidetrack which teachers might take if they want to encourage the development of those skills. (November, 1992)

The direct use of the information from this experiment would be directed towards creating a better technology.

Technological testing often uses experiments to decide on how to best construct a technological product. The testing is done against a criterion and through this technologies are developed that function as well as possible. Science process is distinct as it deals with developing a better understanding of the world while technological process attempts to create something that we use to control our environment.

Feature 10 - The processes through which social research is carried out are developed.

In "Environmental Quality", the students completed a were assigned a project on a local environmental issue. This issue was considered by Moore to be central to the unit and it required the students to perform some informal social research.

> I think probably they'll learn as much in the projects --going out and asking people, interviewing people, gathering data, doing surveys, making newspaper clippings. . . . I see this as the central part [of the unit]. (Moore, int., April, 1992)

This feature refers to the use the techniques of social research to find information about different levels of society. The information sought in such research could have to do with the past or the present. The extent to which it was included in the unit is a consideration of the importance of the social research compared to the rest of the unit content.

Appreciation of Technological or Issue Decision Making

All of the units involved decision making on issues or technological problems. Technological problems take into account a wide variety of factors and attempt to decide on an optimal design for a technology. Issues are situations that present problems for people. They involve developing an understanding of the problem and, in many cases, a sense of how the problems may potentially be solved. As the unit features that pertain to this area illustrate, there are many possible ways to present issues. The features do much to outline what was done in the units with respect to issues and in doing so provide a good sense of the complexities of issue presentation.

Feature 11 - Technological decision making is presented (i.e. decisions that take into account various factors such as science, technology, aesthetics, and values). "Structures and Design" works almost totally with the development of various design factors, while units such as "Fluids" tend to devote short sections to a consideration of specific design questions. McFadden discusses technological design in "Structures and Design":

> They [the students] develop science and engineering concepts and then they're introduced to historical, and sociological, ethical, environmental, and aesthetic questions. . . . What I did was create the task and the setting that really enabled the kids to put all that together. That's usually the context in which all technological decision making takes place. (McFadden, int., August, 1992)

Technological decision making deals with the more comprehensive process of bringing a technology into use where technological testing takes a very narrow view of the process by simply trying to make a technology function better. Although the larger design process may include technological testing as an aspect of design, it ventures further to include other considerations such as economics, social needs, aesthetics, and social regulation. It expands the view of technological development so that it takes into account the society in which the technology is going to be used.

Feature 12 - Technological products are created as a result of technological decision making.

In these units the students did not create any technologies that would be used in the real world but models of real technology are created in several units. "Fluids" is one of these.

> The fluids section began with a technological design problem. That was the [making of the] oil rig, and so that one started with quite a major type of technological design problem which could be a full-fledged kind of project. . . . With pressure and that aspect of fluids there were a couple of smaller design problems. One was the making of the water tower. (Moore, int., July, 1992)

This feature focuses on whether the students who had made technological decisions actually carry it through and create a technological product as a result. This product is often one that is not really used but it is based upon what the students had decided in the technological decision making part of the unit.

Feature 13 - The unit remains value neutral when presenting an issue or dealing with decision making.

In "Energy and You", Haysom was concerned with trying to maintain a neutral presentation in the presentation of the unit.

> Clearly the focus there was on saving energy, and that was something which certainly influenced me although I wanted to look at it in a more value neutral way. (Haysom, int., August, 1992)

Also when speaking about neutrality he said,

> I'd almost like to keep my hidden values completely hidden. (Haysom, int., March, 1992)

The degree of neutrality found in dealing with an issue relates to the intended purpose of the presentation. The students can either learn about an issue from a certain point of view or they can develop their own point of view. In presenting an issue, the taking of a value position represents a predisposition about what caused or what should be done about a particular problem. While it is difficult to deny that a value position is not taken by simply deciding that a given issue is important enough to discuss in a unit, this feature has more to do with what is done beyond this initial decision. The question remains as to whether the unit takes a position on the issue. A position can be explicit, where the position is stated in some manner, or it can be implicit, where it is not stated but, nonetheless, is communicated. One way implicit communication can be accomplished is by not presenting enough information about the causes or the potential solutions to a problem. This would provide the students with less information and would make them more likely to form certain opinions. The judgement of the extent to which a unit is value neutral will be made by considering whether the students receive a reasonably balanced presentation of the problem and solution choices, and whether they are directed towards taking a particular stance with reference to the issue.

Feature 14 - An appreciation of the viewpoints of others is developed when examining and/or deciding on an issue.

"Environmental Quality" developed the application of other perspectives to the decision making process.

> I wanted them [the students] to examine the issue in terms of both positive and negative consequences in terms of the different perspectives that might have a say in determining a solution to it--how opinions vary. (Moore, int., April, 1992)

Here Moore discusses his intent in the application of this feature.

Issues are often characterized by differing opinions about what the nature of the problem is, how serious it is, and what should be done about it. Viewpoints are often a reflection of the particular interests held by a given individual or group in reference to the issue. A full appreciation of the complexity of an issue or problem is often not possible without being able to see the problem from various perspectives in order to realize that the problem has a different meaning to different people. As a potential feature of an STS unit, an appreciation of the viewpoints of others in the examination of an issue is a reference to the extent to which a unit attempted to help the student recognize the interests of the different affected parties. A unit might accomplish this by first of all acknowledging the different individuals or groups involved and following up so that the students can appreciate the perspective of each party.

Feature 15 - Personal decision making on an issue is developed (i.e. ones that could actually or hypothetically involve students acting as individuals).

Students were involved in personal decision making as part of "Energy and You". Haysom thought this to be very important.

> They had to be decisions that they personally could make and I was looking for examples that they would find sensible--meaningful--and I thought that kids could readily appreciate the pros and cons of black and white TV versus color TV for example. (Haysom. int., August, 1992)

In this case the students were presented with particular decisions as part of the unit.

This feature is concerned with the extent to which the unit deals with decisions about actions that the students can take for themselves. Since an issue presentation necessarily must relate to some kind of problem, it holds the possibility of contemplating possible solutions. Some of the solutions may be ones that the student can consider personally. The consideration of personal action can lead to deciding whether to act or not. The presentation may involve a discussion of personal decision making or it may have the students really making decisions. Either way the measure of this feature is the extent to which the unit incorporates the topic and its relative importance in the unit.

Feature 16 - Collective or group decision making on an issue is developed (i.e. ones that are made by a group and could actually or hypothetically involve students acting as a part of a group).

Collective decision making is developed in "Environmental Quality" in order for the students to understand the process and their role in it.

> It's more looking at, how do we make decisions and what are the different perspectives that come into making a decision. . . . [The students need to understand] their own role in making a group decision. (Moore, int., April, 1992)

Related to the same idea, Haysom comments on the importance of presenting this feature in "Energy and You".

> You're having to accept that your opinion doesn't count all that much in the big picture; it's just one. (Haysom, int., March, 1992)

Group decision making involves decisions that are made with the input of two or more interested parties. The difference between group decision making and individual decision making is that multiple viewpoints must be considered. The process of coming to a decision must reconcile more than one viewpoint into a course of action that is acceptable to all or find a way to decide which of the presented courses of action will be followed. The extent to which a unit includes this feature is determined by considering the relative emphasis placed on group decision making in the unit. A unit can include the feature by describing the process, by having the student somehow participate in the process, or both.

Feature 17 - Decisions are actually made by the students.

When discussing her involving the students in actually making food safety rules for themselves in "Micro-organisms and Food Supplies", Smyth explains why she has done so.

> It is something that should really affect their lifestyle forever, hopefully, and therefore they needed some stage to sit down and make a list of things they really could do which would be part and parcel of their lives. . . . It makes it a reality to everybody's life. (Smyth, int., August, 1992)

Although Smyth refers to the actual making of decisions, this feature was first noticed as a perceived difference between "Energy and You", where decision making is carried out, and "Environmental Quality", where it is not carried out as part of the unit.

This feature simply deals with whether the decisions are actually made by the students when any type of decisions are presented. It does not matter whether the decisions are really be acted upon but only if the students processed the information and came up with a decision.

Feature 18 - An awareness of possible actions that may be taken on an issue at the personal, group, and/or political levels is developed.

The units did not develop this feature in any appreciable way but Haysom identified and discussed the feature during an interview.

> Some form of political activism works and some form of political activism doesn't work . . . and ultimately these kids have to understand the way in which decisions are made within their society so they can be politically effective. There's a difference between political activism and political effectiveness. (Haysom, int., February, 1992)

An example from a SciencePlus unit that was not considered as part of this study may be offered to help illustrate what is meant by the feature. In a unit titled "Heat Travel" (Haysom, 1987), a small section on nuclear winter is included towards the end. After examining the cause, the phenomena, and the effects of nuclear winter, several possible activities are suggested which include writing a letter to the editor of the local newspaper, making a poster about nuclear winter, or inviting a politician to come to class to answer some questions. These actions represent a response that may be taken to the issue by students. Although it is not followed through in this case, students could have examined each of these possibilities to a greater extent in an attempt to discover what each was likely to accomplish. This would make the students more aware of what actions really make a difference.

This feature involves a closer look at the action possibilities that may be used as a means of dealing with an issue. Actions can be taken at the personal, group, and political levels. At each level their are choices of various types of action that can be carried out; each with its strengths and weaknesses. A unit could examine different categories of action that may be taken. Often effective solutions involve knowing what sort of action best achieves the goals of those involved in acting on an issue. An overall awareness of these actions may be considered to be a possible part of a unit dealing with an issue.

Feature 19 - Real action is included as a follow-up of decision making on issues.

None of the units have the students actually act as a result of any decisions that have been made. The feature came from Moore's comments on discussing how action could have been included in "Environmental Quality".

> The final and most important element of it (the decision making process) is where the individual, the student in this case, comes to a personal decision but then there should be one more step beyond that and that is where the decision leads to action and that step, where we have the decision based upon what we know, leads to action and that should have been emphasized a lot more. That action component, I don't think came through very clearly. For example, the action might have been writing to your M.P. or a letter to a newspaper or starting a roadside clean-up but all of these are personal actions. I think that would have been a very important element to emerge from this but we stopped one step short. We are at the decision making process but what action? (Moore, April, 1992)

In some units such as "Energy and You" and "Micro-organisms and Food Supplies" action is possible after decisions are made from the information presented but these units do not include action as a part of the unit itself.

The solutions to issues usually involve taking some sort of action. This feature is an inquiry into whether the unit involved the students taking real action as distinct from a unit that may discuss possible actions or present decision making that may lead to real action. Regardless of how the action came about, this feature is concerned about the extent to which the unit actually carries it out as part of the unit.

Unit characterizations.

Each of the units included some features but not others. In a follow-up interview with the authors, each feature was phrased as a question which asked the author the extent to which each feature was developed in the unit. It was explained to the author before the interview that the question did not necessarily refer to the space devoted to the feature in the unit. It could also be interpreted to refer to the importance of the feature in the unit despite the amount of space it occupied. Based on the answers to these questions, a table (see Table 1) that evaluates each unit with respect to each of the features was developed. Each unit was rated with one of four designations. If the unit did include a particular feature it was given a "y" for "yes". If it did not include the feature it received an "n"

Table 1

Feature Analysis of Six STS Units

features	EY	FSM	EQ	GP	SD	F1
Understanding of science concepts	y	y	y	y	y	y
Science concepts are related to another topic	y	y	y	y	y	y
Understanding of technology	y	y	m	y	y	y
technology is related to another topic	y	y	m	y	y	y
Information on personal lifestyles is related to another topic	y	y	n	n	y	n
Information about society is related to another topic	y	y	m	m	y	n
a global appreciation of a topic is developed	m	n	m	n	n	n
scientific investigation is developed	n	y	n	y	n	n
technological testing is developed	y	n	n	y	y	n
social research techniques are developed	y	y	y	y	y	n

(Table 1 continued)

Features	EY	FSM	EQ	GP	SD	F1
Technological decision making is presented	n	n	n	y	y	y
Technological products are created as a follow-up of technological decisions	na	na	na	m	y	y
unit remains value neutral when presenting issues or decision making	y	y	m	m	na	na
An appreciation of the view points of others is developed on issues	m	m	y	m	na	na
Personal decision making on an issue is presented	y	y	n	n	na	na
Collective decision making on an issue is presented	y	m	y	m	na	na
Decisions are actually made on issues	m	y	n	m	na	na
An awareness of the effectiveness of possible actions that may taken on an issue is developed	m	m	m	m	na	na
Real action is included as a follow-up of decisions on issues	n	n	n	n	na	na

for "no". If the unit only included the feature to a limited extent it received an "m" for "minor". Lastly, if a certain feature does not apply to a particular unit, it is given an "na" for "not applicable". An example of such a case would be if a unit that did not develop issues in any way was being considered with reference to whether action is taken on issues. Because the unit does not include issues it would not be appropriate to inquire as to how the issue development was handled.

5.2 - STS Organizational Characteristics

Using the features as a basis, several perceptions were made about the organization of the STS in the units examined. This section will review these perceptions starting with ones that attend to parts of the units and moving to ones that attempt to comment on the unit as a whole. The three categories of perceptions considered will be (1) stylistic perceptions which relate to the way particular aspects of the unit were presented; (2) the organizational framework which accounts for the arrangement of the parts of the units in relation to each other; and (3) the orientations of the units which focuses on the fundamental organizing principles around which the units were written.

Stylistic perceptions.

The stylistic perceptions are a result of looking for similarities and differences between the units. Whereas the features were grounded in evidence from the three sources, the styles are a result of re-examining the units in light of the features. Neither the authors nor the teacher's guides were central to this task because they focused on the individual unit. The focus for this section was on inter-unit relationships rather than specific qualities of any single unit. The interviews with the authors are referenced to support statements made about particular units but undue elaboration of these sources at this point would distract from the area of focus. The perceptions of similarities and differences are mine and they resulted from using the features as a template for re-examination of the units.

Science: First, Mainline, or Dispersed

Because SciencePlus is a science textbook, all units use science as a basis for development of the topic. The common focus of each of the units is to help the students acquire an understanding of science concepts. By referring to an issue, technology, or activity that the students all recognize, a unit gains by making the science relevant to the students. A familiar context in which to develop the science provides "conceptual hooks" (Moore, int., April, 1992) that links the students world to the science. On the other hand, this leaves the author of the unit having to decide how and where the science should fit in.

"Environmental Quality" referred to many science concepts throughout the unit but let the flow of the unit, which was not based on developing science concepts, dictate where and what science concepts would be used. The science appeared to be in support of the other aspects of the unit rather than being the focus itself. I will call this a **"science dispersed"** style.

The other units sectioned off the science concepts and developed it apart from the nonscience parts of the unit. This allowed the author to concentrate on conceptual development separate from the rest of the unit. Units such as "Energy and You" and "Micro-organisms and Food Supplies" put the science first and emphasized a development of science concepts before the rest of the unit, which was nonscience in nature, was developed. The concept development was influenced by what it was going to be used for, but the unit laid down a solid foundation of science concepts as a first step. I will call this a "**science first**" style.

The last method also developed the science concepts together but put in bits of the nonscience subject matter during the science concept development. "Fluids" concentrated from start to finish on the science concepts but included some applications in several places. The science concepts set the direction for the unit and were emphasized throughout. The other nonscience content was used in support of the science. The nonscience topics were in the form of short excursions taken within the development of the science concepts. I will call this a **"science mainline"** style. The style of science development used by each unit are developed in table 2.

Table 2

Style of Science Presentation Found in the Units

	EY	FSM	EQ	GP	SD	Fl
Style of science presentation used	ScF	ScF	ScD	ScD	ScF	ScM

ScD = science dispersed style   ScF = science first style
ScM = science mainline style

Technology: Explanation, Appreciation, or Function

On the whole, the development of technology was much less emphasized than the science and often was only dealt with in short sections of a unit. When it was developed it was viewed in different ways. In the case of "Fluids" the technology was used, at least in part, to help the students come to better understand the science concepts through application (Moore, int., July, 1992) but the presentation of the technology itself emphasized explanation. The students were expected to explain how it works. This emphasizes understanding the technology itself. This may be considered the **"technology explanation"** style.

In "Structures and Design" technology was presented in order to allow the students to appreciate how it comes to be by centering attention on the decisions behind its creation. Students do develop an understanding of the building of structures but it moves beyond that to take into account other aspects of the design process such as sociological, aesthetic, and ethical concerns (McFadden, int., August, 1992). This helps students to appreciate the process and will be referred to as the "**technology appreciation**" style.

"Energy and You" as well as "Micro-organisms and Food Supplies" were trying to develop issues in which technologies played a role. The development of the technology was not considered that important in itself (Haysom, int., March, 1992) but its function in a larger subject made its development necessary. I will refer to this as the "**technology function**" style. Table 3 describes how each of the units presented technology.

Table 3

Style of Technology Presentation Found in the Units

	EY	FSM	EQ	GP	SD	F1
Style of technology presentation used	TF	TF	TF	TA	TA	TE

TE = technology explanation   TA = technology appreciation
TF = technology function

Process: An Option

The development of any of the processes of enquiry appeared to be an option in the units. As Table 1 indicated all but one of the units developed at least one process of inquiry. The processes themselves, however, did not appear to be essential as a part of the unit. This is most obvious in a unit like "Energy and You" where technological process is included but very much as an aside. It could have been left out with out by the teacher without altering the character of the unit (Haysom, int., March, 1992). In other units the processes played a larger role. "Growing Plants" used a great deal of science process (McFadden, int., August, 1992) and "Environmental Quality" used social research process (Moore, int., April, 1992). Despite the space devoted to the processes in these units it can be argued that an understanding of environmental problems does not necessarily require an ability to conduct social research and an understanding of growing plants does not necessarily require an understanding of how to conduct a science experiment. These topics enrich the presentation but appear to be goals that are separate from the main topic of the unit. All of the units that use process incorporate them as a design option.

Decisions: Technological or Issue

Each of the units involved the students in decision making in some way. It is clear from the features that there are two main types: technological decision making and issue based decision making. Technological decision making was included in three of the units (i.e. "Structures and Design", "Growing Plants", and "Fluids") and issue based decision making was included in the other three (i.e. "Energy and You", "Micro-organisms and Food Supplies", and "Environmental Quality"). The difference is very simply the type of decision being made. Technological decision making is concerned with creating a product of some sort while issue decision making involves decisions that are made by individuals and/or groups of people in response to a problematic situation. The units presented either one type of decision making or the other.

Issue Decisions: Action Focus

There were three units that used decision making in relation to issues. They were "Energy and You", "Micro-organisms and Food Supplies", and "Environmental Quality". Each of the units took a different approach to the presentation of decision making. For example, the decision making encountered in "Environmental Quality" is substantially different from that encountered in "Energy and You" and "Micro-organisms and Food Supplies" because "Environmental Quality" develops the general topic of decision making but, unlike the other two, does not have the students actually making specific decisions. None of the units actually followed the decisions with actions that were taken in response to the issue as part of the unit leaving the decision making somewhat contrived. Each did, however, leave the possibility open that the students could decide to take action on their own as a result of being sensitized to the issue.

The units, in dealing with decisions, may have described decision making, actually had the students make some decisions, or had the students acting on their decisions. These different areas have to do with the action focus of each unit in that the decisions that were made in the units were decisions about actions that could be taken. The closer a unit gets to action the greater the action focus. Table 4 provides a summary about what was done in the three units with respect to decision making.

Table 4

Summary of the Action Focus of Decision Making in the Units

	E&Y	MFS	EQ
decision making is described	n	y	y
decisions are made	y	y	n
action is taken	n	n	n

Issue Decisions: Locus of Decisions

The locus of decision making refers to who is making the decision. A distinction is made between local, regional, and global issues in "Environmental Quality". The reason for this distinction was to point out the different type of decision making and action required to resolve each issue (Moore, int., April, 1992). This points to the possibility of global decisions which none of the units dealt with. The locus of decision making was developed at the personal level where the student decides on their own action. This is seen in "Micro-organisms and Food Supplies". It was also developed at the collective or social level, where the student participates in making a decision regarding an action or position of a group. This is done in "Energy and

Table 5

Locus of Issue Decision Making Found in the Units

	E&Y	MFS	EQ
Personal decision making is developed	y	y	n
Group decision making is developed	y	y	y
Global decision making is developed	n	n	n

You" and discussed in "Environmental Quality. The group canbe anything from the family of the student to a social group of some form to a government decision. Table 5 summarizes the locus of decision making found in the units.

Issue: Mainline, Culmination, or Aside

In much the same way the science developed varied, issues appeared to dealt with in different ways in the units. As already discussed, three of the units dealt with issues. In addition, "Growing Plants", which did not deal with issues in the main flow of the unit, did include an issue as a sidetrack. A few pages towards the end of the unit were used to develop an issue dealing with pesticides. After this excursion was completed the focus returned to the main flow of the unit which dealt with the technological activity. Such a unit develops an issue but does not emphasize the issue and does not use the other elements of the unit in support of it. The issue appears more for enrichment purposes as an add-on and may be referred to as an "issue aside" style of development.

"Energy and You" and "Micro-organisms and Food Supplies" dealt with issues but, although some reference may have been made to them during the unit, did so at the end of the unit. The science understanding, technological understanding, and social understanding are developed before this point to provide the information base and bring the issue into full focus at the end. Both units finish with the consideration of the issue and will be referred to as using an "**issue culmination**" style.

"Environmental Quality" develops the whole unit in terms of the issue and all other content is in support of it. The issues being dealt with are always in full focus and the science is used to illuminate various aspects of it. This may be referred to as an "**issue mainline**" style of development.

5.3 - An Organizational Framework for STS

Although the STS units were very diverse in the subject matter covered, they did have a coherence with respect to the types of elements included. In an ecological manner the individual elements of the unit seemed to relate to the other elements. From the units that were examined, it was possible to construct an organizational scheme that describes the domains of STS elements and the relationships between these areas. As a basis for this scheme, there were four separate domains of STS elements used: (a) those which dealt with processes of inquiry; (b) those which dealt with developing an understanding of the subject matter; (c) those which involved decision making; and (d) those which involve the students in acting on their decisions.

The Processes Domain

There are three processes of inquiry that directly reflect the features established earlier. They are processes of science, technology, and social research. These are alike in that each of them is a way to go about finding information. Because the information sought by each process varies, so does the basic character each of the process.

The Understanding Domain

An understanding of the subject matter can be carried out by providing students with understanding in three distinct areas: science concepts; technological concepts; and social concepts. The social concepts may be further divided into three levels: personal lifestyles; societal; and global. Each area of understanding as well as the division of the social concepts into three sublevels is also a direct reflection of the information given in the features. These areas of understanding were used in aid of each other in the units. The most prominent relationship between these areas of understanding was between the science and technological concepts. Both of these areas assisted in the development and understanding of the other. Science often provided understanding that was pre-requisite to understanding the technology, while at the same time the technology may have provided a concrete application of the science that would provide a framework within which to understand the science. The ecological character of the unit becomes evident in these relationships.

The Decisions Domain

As described in the previous section, there are two types of decision making depending upon whether the decisions have to do with technological design or issues. In either case, the decision is both an appreciative and integrative process. The students must be informed so that they have enough information to properly appreciate the nature of the decision, but they are also required to take all of the information provided and integrate it so as to produce the decision.

Technological decision making is quite straight forward but issue decision making is somewhat more complex. The features account for personal and collective or social decision making. For the purposes of providing a comprehensive sense of the levels of decision making, Moore's (int., April, 1992) distinction between levels of issues for the purpose of realizing levels of decisions and actions will be utilized at this point. In "Environmental Quality", issues were considered at the local, regional, and global levels. This allows the creation of a third level of decision making, the global decision.

The Action Domain

The final type of STS elements are those which involve the students acting on their decisions. An awareness of how students could act is not what is being looked at but rather if they actually did act or not. For technological decision making the action would consist of creating a product and corresponds directly with the feature that deals with the creation of a product.

In issue decision making the action would consist of following through with what was decided. Action is possible at each of the three levels developed for decision making. Such a consideration involves expanding the conception of action represented in the features to correspond to Moore's (int., April, 1992) distinction of levels described above. Action may be considered to be at the personal, social, or global levels.

The action dimension of STS.

The distinction between the four domains of STS elements is one way of perceiving the difference between the types of elements that can be used in the design of STS units. Considering the relationship between the four domains provides a view of the scope of STS. This may be done by taking into account different human interests and how they represent a movement from a means to an ends.

Each domain represents a distinct type of activity: processes of inquiry relate to finding information; understanding of different types of subject matter relates to using information to formulate an understanding of the world; decision making uses the understanding to decide on a course of action to attempt to accomplish a desired outcome; and action involves following through to attempt to affect the outcome we desire. If a goal of enabling students to exercise intelligent control over their environment and participate in democratic society is adopted as an end in education, then an STS program that educates students in each domain takes them all the way to this end. STS may be considered a move closer to an action based conception of education. The action dimension simply accounts for the relationship between each domain and the action outcome of the educative experience. As action is approached, what had been a discipline based knowledge system begins to undergo integration into knowledge for action.

The world perspective dimension of STS.

Another way of considering the scope of STS is by considering perspective changes within each of the domains of STS elements. Using the understanding domain as an example, as one moves from content that deals with science, which is relatively esoteric in its goals, to technology, which is more directly related to people, to society, which is directly related to people and their diverse interests, the perspective increases and brings together more aspects of the world. In society itself, this same increasing perspective is seen in a move from personal lifestyles to societal concerns to global concerns. Each step involves assuming a wider perspective on the world and accounting for a greater amount of relevant knowledge and understanding. This idea perspective change can be superimposed on each of

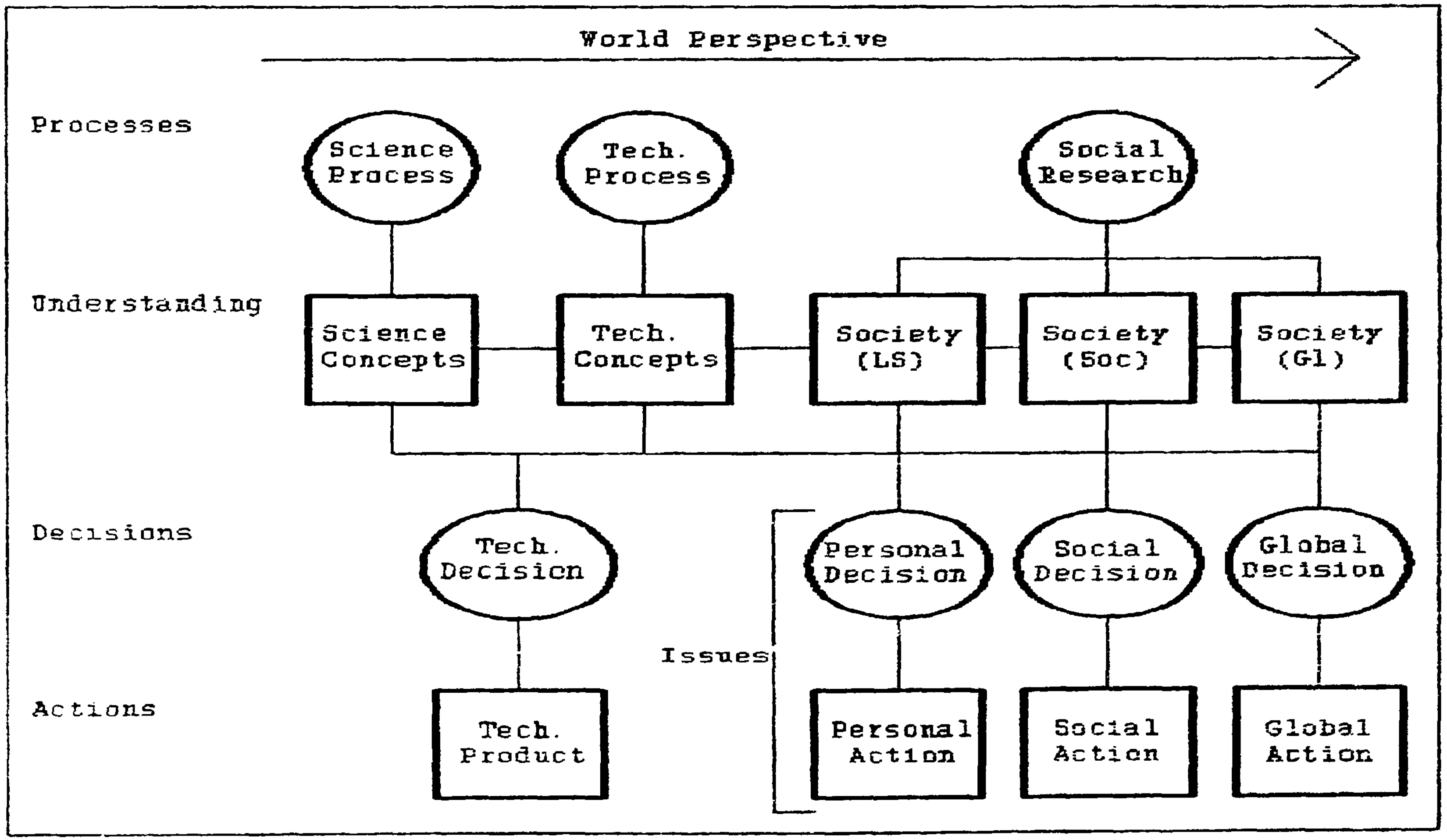

Figure 1. STS organizational chart.

the domains delineated above.

<u>The organization of STS.</u>

The organizational scheme developed in this section can be represented in chart form and this is done in Figure 1. The potential content areas are represented by the boxes and ovals. The lines connecting these content areas represent the potential relationships that could be drawn between the content areas. Most organizational charts, like this, have their limitations in being unable to communicate the richness and unique character of the individual unit, but this chart is helpful in gaining an organizational overview of the STS units studied.

5.4 - The Orientations

The orientation of an STS unit will, for the purposes of this study, be taken to represent the end to which the unit seems to be working. By distinguishing between orientations, some of the fundamental differences between the units examined in this study will become apparent. Science, technology, and society are areas of understanding that make up the main components of STS. The science-technology-society movement puts two or all three of the component areas together to provide a deeper understanding of a one or more subjects. The unit orientation is a description of the end or ends achieved by putting these areas of knowledge together.

Any given unit is normally put together to achieve more than one goal and the identification of an orientation is not meant to deny that the unit attempts to achieve other things. The orientation recognizes that there is usually a common principle that the unit is organized around. This **organizing principle** is what draws all of the different components of the unit together and directs them towards a common goal. Such a goal suggests much about the character of the STS materials and what the students will perceive themselves to be engaged in. It will also provide students with messages about the value of learning about science, technology, and society.

An awareness of unit orientations as well as features sets up an enhanced appreciation of STS units that explicitly connect the parts to the whole unit. The features provide a view of many of the possibilities that exist in STS while the orientation provides the package into which the features will be placed. Each identifiable orientation holds unique potential with respect to which features are likely to be included and which are likely to be left out.

The orientations of the units examined will be developed below. The means of identifying the orientation was through recognizing the organizing principle of the unit (i.e. the common aim of the unit parts). The organizing principle, in effect, determines what content is appropriate in a unit by defining the use to which it will be put. In doing so, the organizing principle defines the orientation of the unit. The orientation appears to establish content boundaries and priorities but within the boundaries but there is still much left to be decided by the author.

In the units examined, three definite orientations were evident: (1) the conceptual science orientation; (2) the technological activities orientation; and (3) the issue orientation. In order to both illustrate the framework provided by each orientation and the options that exist within it, each of these orientations will be described and related to the features that appeared to be associated with them in the units that were studied.

The conceptual science orientation.

"Fluids" is the one unit of those studied that deals primarily with science concepts. At various places during the development of the fluid related science concepts, technologies that apply those concepts are described. These technologies are examined in some detail so as to make it very clear how it illustrates the fluid concept. The same unit includes technological decision making activities in which designs are created that make use of the fluid concepts. The designs demonstrate how an understanding of fluids is important when trying to meet society's needs through designing technology such as a watertower or oil rig. Although the connection between technology and society is touched upon, it was only followed to a very limited extent.

Using the STS organizational chart developed in the previous section, the content areas and relationships between those areas found in the "Fluids" unit are identified in Figure 2. In the chart, the boxes and ovals are drawn using three different types of lines: (a) broken lines represent areas which are covered minimally or not at all in the unit; (b) regular solid lines represent component elements of the unit; and (c) thick solid lines represent the focal elements of the unit into which the others are integrated. The content areas that the unit concentrated on are represented by shaded ovals or boxes. STS units are ecological in character and most of the content areas are supported by other areas giving the content of the unit a high degree of interrelatedness. The relationships between STS elements are represented by arrows. The regular arrows represent normal relationships between the elements while the thick arrows represent the main relationships moving toward the focal elements of the unit. The thick lines and areas highlight and the main direction of content flow in the units and, in effect, define the orientation.

The structure of "Fluids" is based on the structure of scientific knowledge and, in keeping with this, its main goal is the transmission of scientific knowledge. The addition of the STS theme has provided some options to

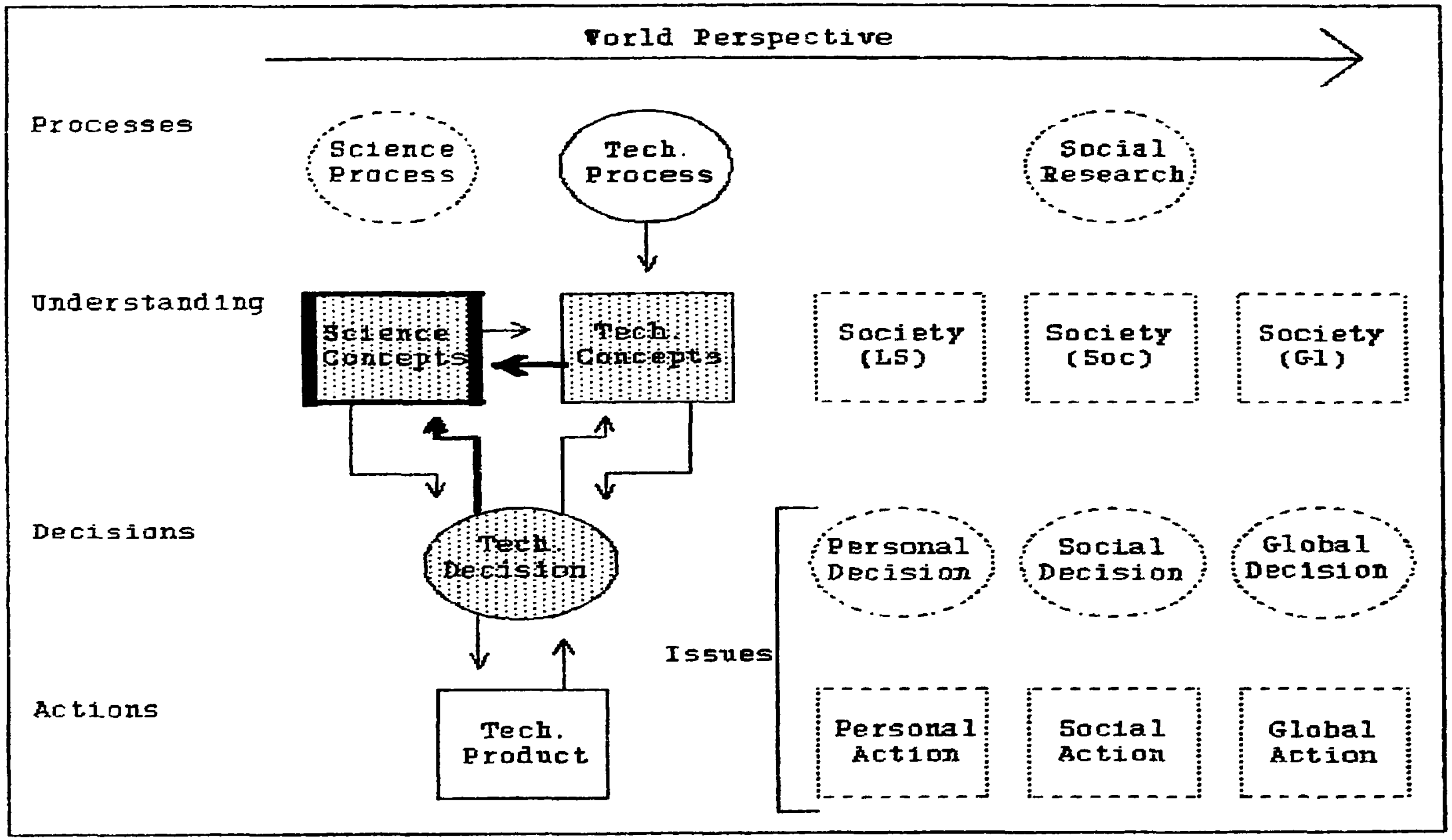

Figure 2. STS organizational chart for "Fluids".

enrich the presentation. Units dealing with science concepts have gained more freedom to apply the concepts that are being developed through excursions into other areas.

Within science, the area of emphasis is on concept development but it is directed to a modest extent towards providing an understanding of the technologies that were covered. Because so much of the unit was preoccupied with science, it was able to cover the fluid related concepts quite thoroughly. The technologies were developed to be known in themselves but, because the science determined the unit structure, the technology appeared to be directed towards helping with science concept development by providing familiar applications.

Modes of inquiry were only implicitly represented as a part of the design activities that were included. The approach to creating technologies did not explicitly involve technological testing but it would be part of the design process.

The conceptual science orientation clearly puts the science up front and adds the elements that give it an STS flavor. The STS elements could be removed because, although they provide character for the unit as a whole, they are not essential to the structure of the unit and the unit could be taught without including these elements. "Fluids" provides evidence of this point in the way it was created. This unit was not written from scratch. It was the result of combining two existing science units that dealt with fluid related science concepts. In the process of combining the units, STS elements were added to the material that had focused nearly exclusively on science concept development (Moore, July, 1992). The STS sidetracks tend to be short and to the point otherwise the conceptual flow would be lost. If a long investigation had been carried out on the design of oil rigs that went into their cost, the types of materials used, legislation concerning them, and such topics, it would interrupt the science to a great extent and alter the character of the unit very much.

The bottom line on recognizing this STS orientation is in the identifying the organizing principle of the unit as a whole as being based on science concepts. There exists the potential of including many of the STS features identified in this study but only to a limited extent as they cannot take over the control of the unit content; that must remain with the science. As described above, "Fluids" was able to include several STS features but they were not essential to the unit. It is entirely conceivable that an STS feature that was put in could be removed and replaced by another one. For example, in "Fluids" the technological decision making activities could have been removed and replaced with a short section dealing with an issue on a topic such as oil spills without much of an effect on the flow of the unit. The STS additions that are placed in this sort of unit relate strongly to the science that is being developed. They are often put in the unit to help strengthen the science concept development as supporting applications.

<u>The technological activity orientation.</u>

Two of the units that were studied adopted this orientation. "Structures and Design" examined many considerations taken into account in the design and creation of structures such as bridges and buildings. These considerations ranged from the science concepts that provides a basis for the understanding of the technology that is applied, the technology itself, the aesthetic considerations, and the meeting of public needs and standards. "Growing Plants" centered on the science and technology behind the growing of plants. It covered various things that could be done to improve plant growth as well as the science behind many of the methods. It does little concerning making a connection with society or lifestyles but concentrates on the technology and science. Both of these units focus on the technological decision making required for the activity and integrate the rest of the content around it. Using the same representative scheme already described for Figure 2, an organizational chart has been constructed for "Structures and Design" and for "Growing Plants" in Figures 3 and 4, respectively.

The technological activity orientation refers to a unit that chooses a technological activity as an organizing

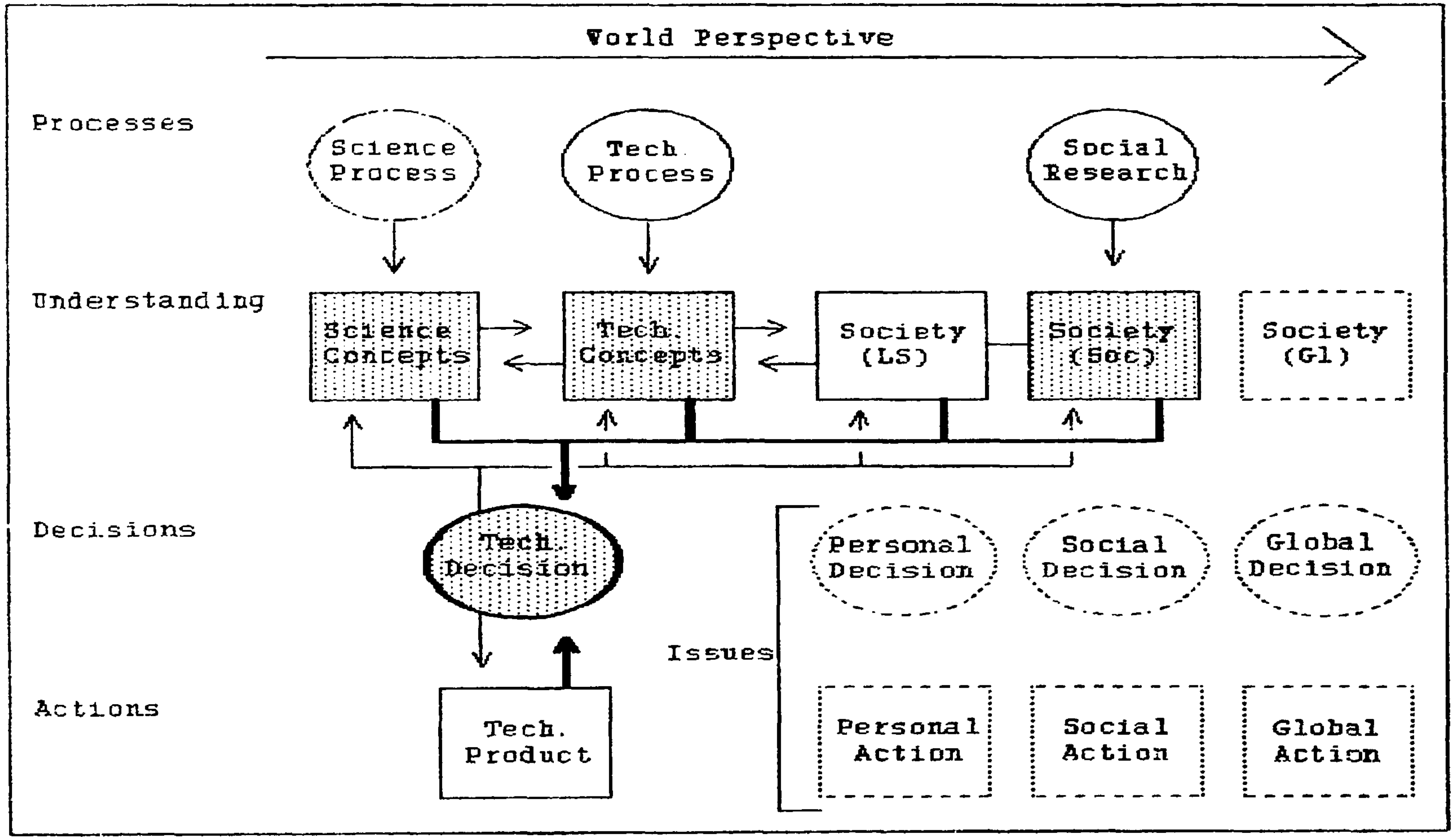

Figure 3. STS organizational chart for "Structures and Design".

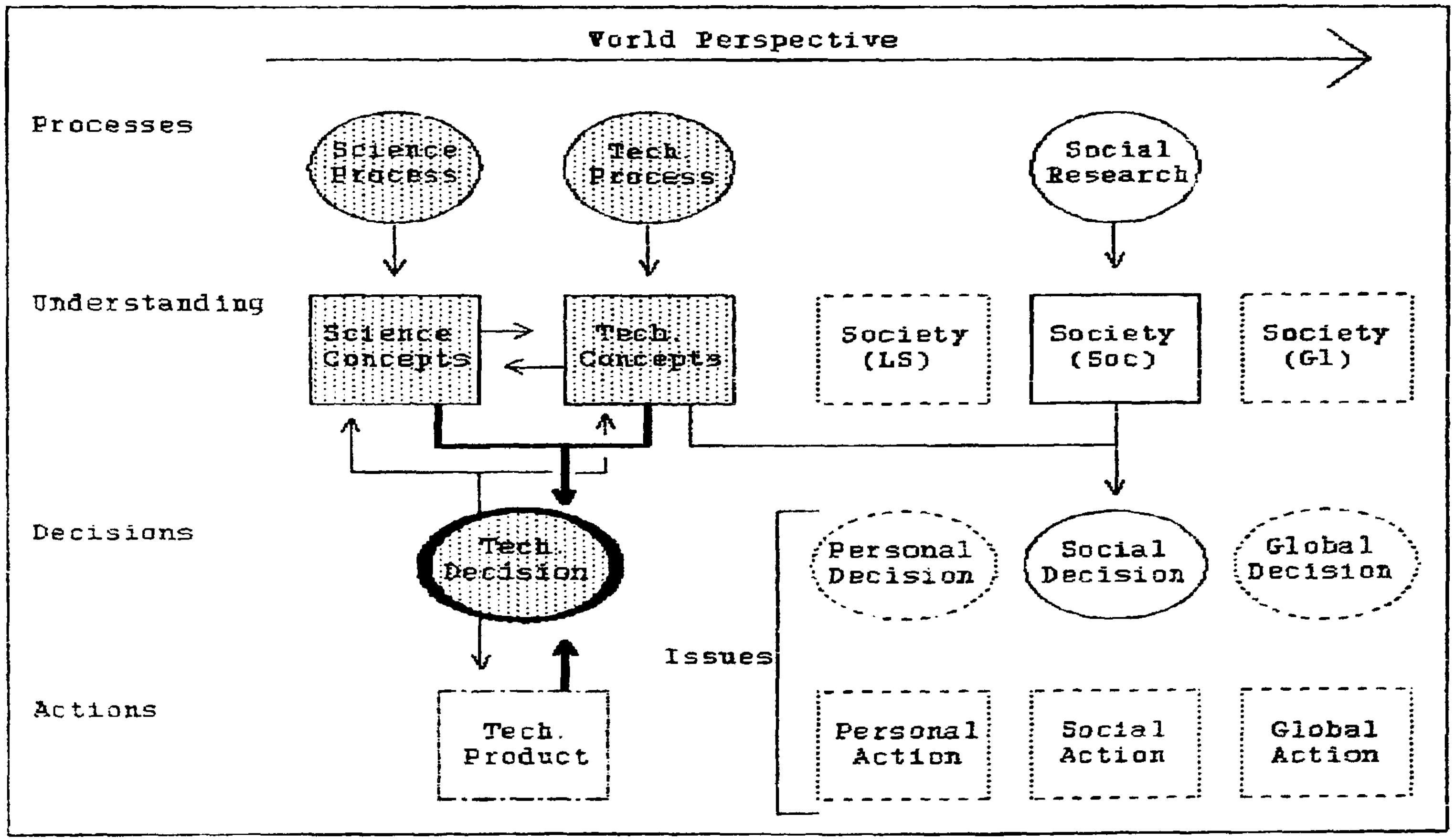

Figure 4. STS organizational chart for "Growing Plants".

principle for the presentation of science, technology, and/or society. A technological activity is one that is carried out by people in order to accomplish some sort of useful purpose using technological means. The activity may be considered as a career or group of related careers but neither of the units adopting this orientation approached the activity as a specific career although each made some reference to careers. The focus is on providing the students with an understanding of how something is done by examining a number of the main characteristics of the activity.

What these two units have in common is the technological context that they present the material in. The organizing principle in each is a technological activity and the content of each unit has the common purpose of working to provide the students with an appreciation of the activity. In other words, the units integrate information from science, technology, and, to some extent, society in order to allow the student to develop an understanding of the particular activities that are focused upon. The students will see this as the purpose to which the information in the unit was put and consequently will receive a message about what the value of the unit content is.

The science, technology, and society information is shaped by the particular activity being described. The information is roughly limited to that which is seen as being relevant to the activity, giving the activity a great deal of control over what can be included in the units. The units establish a strong relationship between the content areas and the activity in order to illuminate the technological decision required. The technological activity being developed in a unit sets the boundaries on what content can be included in the unit but within those boundaries there are options available to the unit author.

A unit with a technological activity orientation will tend to develop the science so that it helps with an appreciation of the activity. This does not deny the possibility of the science concepts being important themselves but an emphasis on concept development does not appear to be essential when developing a technological activity. The science that is presented in "Growing Plants" is directed at providing the student with a deeper understanding of important aspects of plant growth. The concepts are limited to the framework of growing plants and the science is mixed in with the technology in a "science dispersed" style. "Structures and Design" is similar in that the science is clearly directed towards a knowledge of engineering structures. It is different from "Growing Plants" in that it develops the science early in the unit as a base for the remainder of the information to be developed. The concepts are put in place before the unit attempts to develop the other areas. This is a "science first" style.

The technology is used in much the same way as the science. It represents the means by which the activity can be accomplished and in that sense the development is aimed at helping with the understanding of the activity. At the same time, the development of an understanding of particular technologies for their own sake can be pursued to varying extents. The technology developed in "Growing Plants" is that which is used in order to carry out the activity such as fertilizers and hydroponics. None of the technologies are covered in much detail but are important in that they can be used to carry out the activity. "Structures and Design" also develop an understanding of technology but it too was presenting as an aspect of the building structures. The technology developed was the engineering materials and methods used in building bridges or other structures. Most of this information was developed in a section that followed the science.

The same idea applies to lifestyles and social information. Both are developed to inform the students' understanding of the activity and are thus directed towards a greater understanding of the activity. The degree to which other features involving lifestyles or society will be followed varies. "Growing Plants" did very little in this area but "Structures and Designs" considered people's wants and values as an aspect of designing structures. This can include which styles are most appreciated, what type of structure can go in certain areas, or how the law is used to ensure that structures are safe. This unit also tries to show how the types of structures a society has reflect the characteristics and values of that society. This is done in a research project. Again, such a development is aimed at understanding structures more than lifestyles or society themselves.

A summary of the understandings that were integrated into the decision making process related to a technological activity is found in Table 6.

Table 6

<u>Concept Summary of Technological Activity Orientation Units</u>

	S&D	GP
Science content	y	y
Technological content	y	y
Social content	y	n

The technological activity orientation also provides a first look at a unit that is presented in a problem solving or decision making framework. Both of these units start with a design problem for which the information in the unit provides a better understanding of what must be considered in a solution. At the end of the unit the information is used to solve the problem. This provides a framework within which to present the information and an immediate use for it when the unit is completed and the students are asked to complete the task that the problem presented. In using this sort of presentation option, "Structures and Design" asked students to re-design a waterfront of a small fictional town and "Growing Plants" had them design an area to grow plants in as well as choose the plants that should be put there. "Growing Plants" also attempted to engage the students in deciding what is necessary to grow plants in an artificial environment on Mars. Although these problems are contrived they do provide an integration thread for the information in the unit.

The issue orientation.

Three of the units involved issues as an integrating theme. They were "Energy and You", "Micro-organisms and Food Supplies", and "Environmental Quality". An issue presents a situation that is problematic in that there are steps that can be taken to solve or help solve the problem that is presented, but coming to a the decision about what should be done is one that presents a special difficulty. These are social problems that are often ones that concern great numbers of people and must be dealt with by those involved. The issue acts as an integrating thread for the other elements of the unit. Using the same presentation scheme as was described for Figure 2, the STS organizational charts for "Energy and You", "Micro-organisms and Food Supplies", and "Environmental Quality" are presented in Figures 5, 6, and 7, respectively.

The science, technology, and society content is aimed at providing an understanding of the issue. For example, the issue in "Micro-organisms and Food Supplies" was what precautions should be taken to avoid food poisoning. The understandings developed in the unit were to be used by the students to make an informed decision about actions that could be taken in response to the issue. Much like the role played by the unit content already seen in the technological activity orientation, the unit content of the issue orientation is directed at providing the student with an appreciation of a problem so that a decision can be made on it. These two orientations are separated by the fact that this orientation is specifically concerned with an issue whereas the technological activity concentrates on one or more technological tasks.

The issue orientation is similar to a technological activity because it is a means of integration for the science, technological, lifestyle, and societal content presented in a unit that deals with issues. All of these areas are directed towards an understanding of the issue and, sometimes, some of the actions that can be taken to help resolve the issue. For example, "Energy and You"

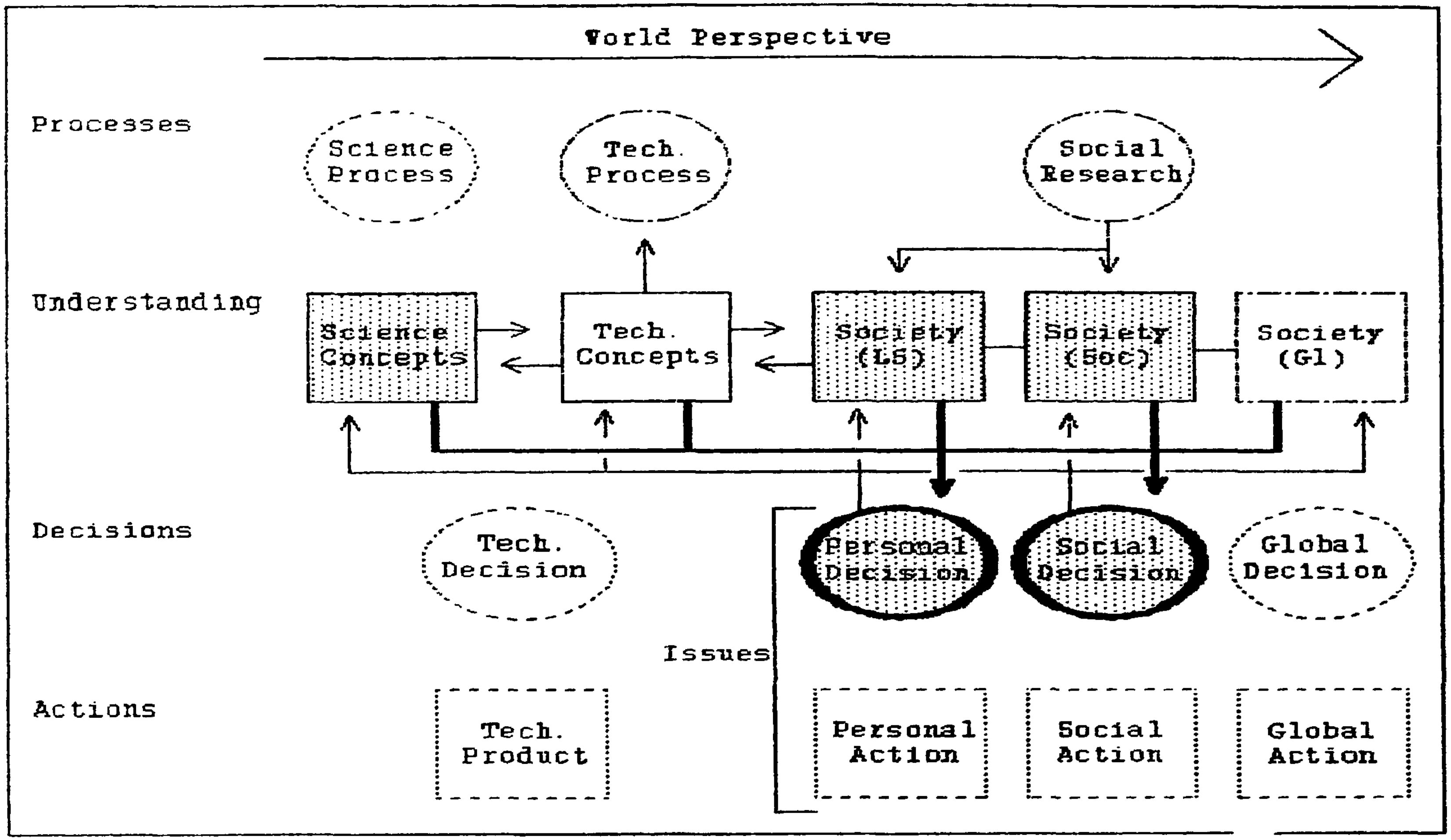

Figure 5. STS organixational chart for 'Energy and You".

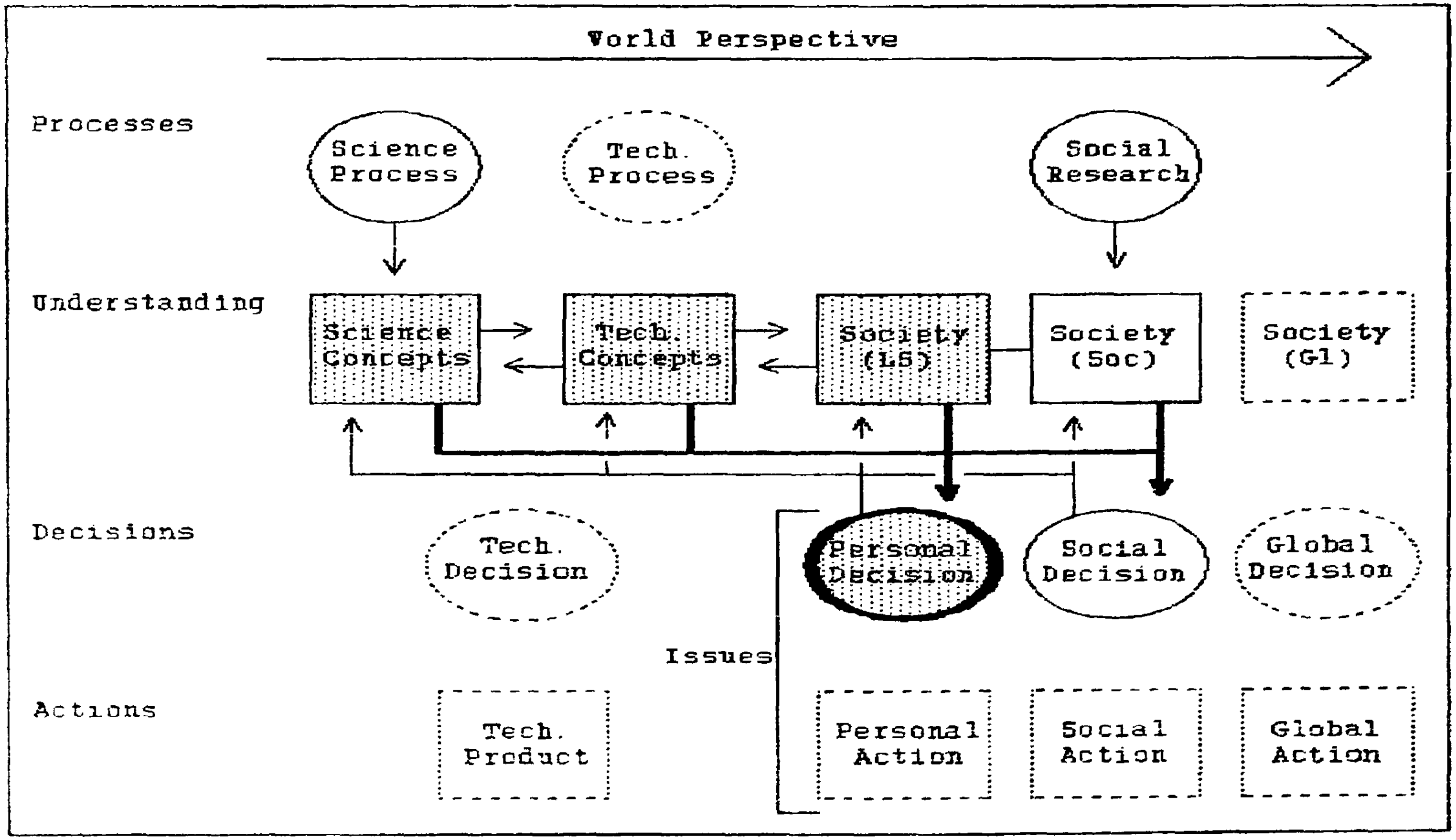

Figure 6. STS organizational chart for "Micro-organisms and Food Supplies".

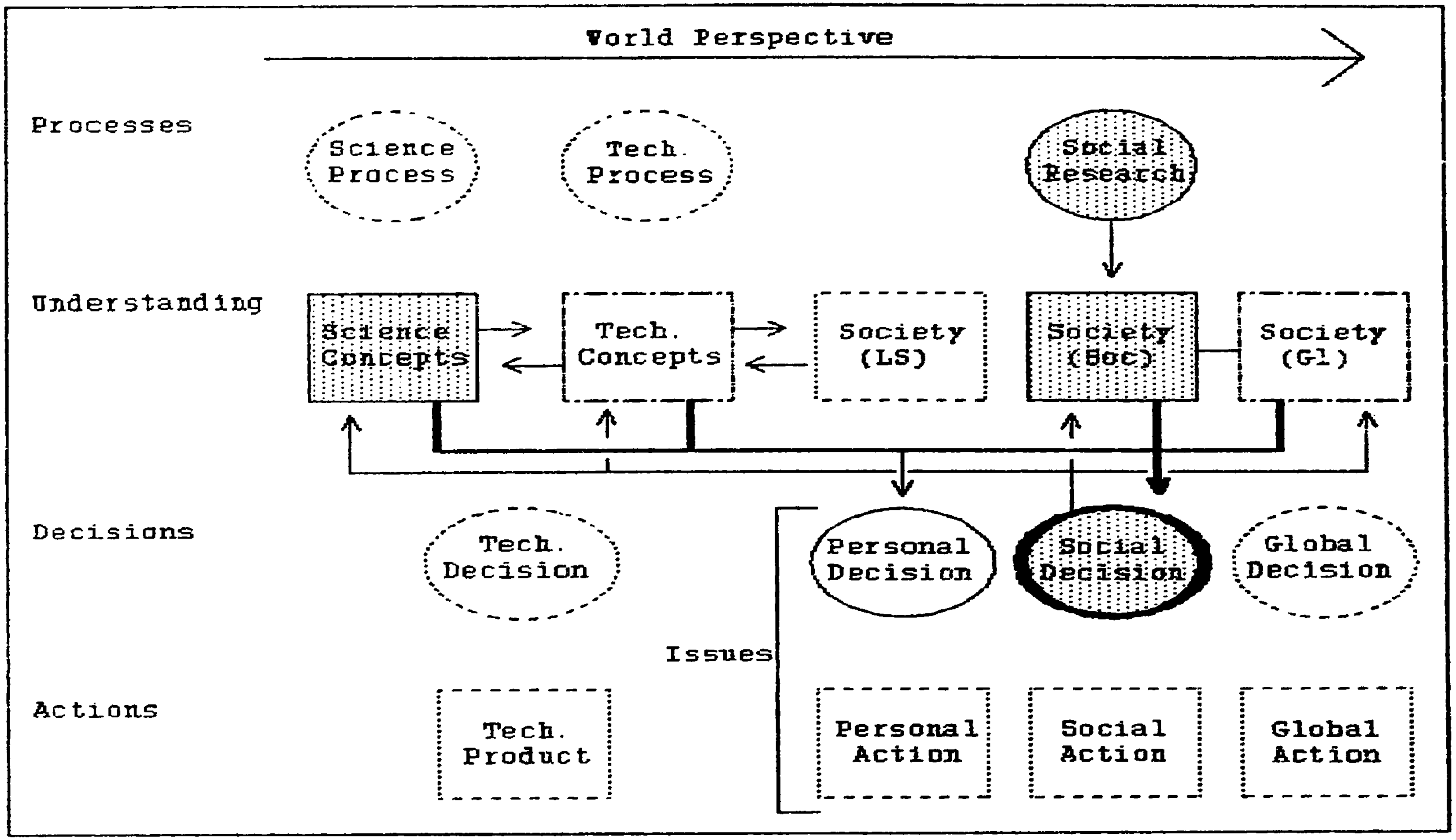

Figure 7. STS organizational charts for "Environmental Quality".

develops students understanding of the problem that we face as we deplete our oil resources. This unit also helps students to see some of the actions that may be taken to help respond to the problem. An understanding of the problem that necessitates decision making on an issue is essential in a unit that is to possess an issue orientation. As was the case in the technological activity orientation, the concepts developed in the unit may be considered important in themselves, but they tend to be subservient to the issue which serves as the integration theme. The issue is the higher order principle that defines what concepts are relevant. Table 7 summarizes the type of concepts used to build the knowledge base of the units with an issue orientation.

Table 7

Concept Summary of Issue Orientation Units

	E&Y	MFS	EQ
Science content	y	y	y
Technological content	y	y	n
Social content	y	y	n

The issue orientation had the special characteristic of carrying with it some special elements that were unique to issues. These elements generally dealt with decisions required to respond to an issue. The units that did adopt this orientation differed mainly in the distance they went with the issue. The issue presentation can be broken down to three components: (1) the problem presented by the issue; (2) the process of deciding on what to do about the problem; and (3) following through on the decision with action. Taking these categories as the basis for determining how an issue is covered, the issue units examined in this study developed issues to varying extents. The understanding of the issue problem can also serve as prerequisite for decision making and action. Without understanding of the problem, there would be no decision to be made and therefore

Table 8

<u>Issue Components Covered in the Units</u>

	E&Y	MFS	EQ
issue problem	Y	Y	Y
decision making process	Y	Y	Y
action taken on decisions	N	N	N

no action to be taken. These two resultant areas represent the potential of units with the issue orientation to develop unique content that other units would lack. Table 8 provides a description of what the three units did with respect to these categories.

The choice of what issue or set of issues to develop plays a major role in determining the unit content but there is also the question of unit scope. "Environmental Quality" develops issues in the framework of various representative qualities or aspects of the environment such as the hydrosphere, the atmosphere, the lithosphere, and the biosphere. The unit development does not focus on one issue but points out examples of how problems can be seen in the different areas of the environment. The scope of the issues considered is quite extensive. Units like "Energy and You" and "Micro-organisms and Food Supplies" tend to choose only one or two related issues and develop the entire unit around these. The scope of the unit can be narrow or wide and this choice would clearly have implications on what could be done in the unit.

The issue orientation offers content that other units are unable to. Although none of the units go the full distance towards action, they do provide an appreciation of what the issue orientation holds. When an issue involves decision making, it provides a very natural problem solving or decision making framework for the unit.

Chapter 6 - Discussion 1

STS Unit Descriptions

The unique offering of the first part of this study was a list of features that provide a comprehensive conception of what STS science units are. The features were found in real units so they are grounded in the practice of STS rather than a theoretical or intended version. In short, the list of features represents a ready-made tool that was derived from actual materials and can be used to appraise other materials. Such a tool has heuristic value to many groups of people who need to be aware of STS for many different purposes.

The description of the units provided information on various levels of perception. The first level dealt with features while the later levels dealt with larger organizational characteristics of the units. The STS organization scheme developed from the study of these units provides an excellent basis for examining STS units are it demonstrates how the different elements of a unit may be related to the whole unit. The domains of processes, the understanding, decisions, and action put together similar elements of the units and provided a strong basis upon which to examine them. The consideration of the main orientations of units provides another level of awareness as it has implications on the elements that are found within the unit.

6.1 - The Processes Domain

All three of the processes of inquiry seemed to be an option in unit design in the sense that they are not directly related to what the orientation or organizing principle. When the processes in inquiry are used they tend to enrich the unit but they were not essential to the structure of the unit. This is not to question the value of including processes of inquiry in units, but they seem to represent a secondary goal of the units. This is consistent with the discussion provided by Hickman et al. (1987) as they do refer to processes of enquiry but put it under the general heading of information processing. It does not appear to be a central focus in STS.

6.2 - The Understanding Domain

The elements of the understanding domain refer to the unit attempting to develop an understanding of science, technology, and/or society. These understandings appear to form the foundation of STS units. They are normally developed to be understood in themselves but are usually used to help provide an understanding of another topic as well. When these disciplines are used to help provide an understanding of other areas interrelationships are established. Relating each of these areas to each other and to the new content areas that emerge out of the relationships may be referred to as creating a context and may increase learning. These interrelationships are commonly used to conceptualize STS (see Bybee, 1986; Hickman et al., 1987). It is in these relationships that much of the character of STS seems to emerge.

Science was included in all of the units. This is not really surprising as SciencePlus is, after all, a science textbook. The science was incorporated into the unit using different styles. Two of these are similar to what Holman (1987) described as the "science first" and the "applications first" models. The findings of this study focus on the relative location of the science. Holman's "science first" referred to beginning with the science. In this study, there were two ways of starting with the science distinguished: (a) "science mainline" where the science concepts begin the unit and remain the focus throughout the unit and (b) "science first" (not to be confused with that of Holman) where science concepts begin the unit but the unit turns to other related topics later on such as technology or an issue. Holman's "applications first" model is essentially the same as this study's "science dispersed" where an issue or application is dealt with throughout the unit and the science is brought in where needed in a support role.

The extent to which technology and society is included varied from unit to unit. Technology was central to some units (i.e. those with a technological activity orientation) and very lightly treated in others. When included, the different styles of presentation identified in this study, provide a scope of possibilities (i.e. explanation, appreciation, or function of technology). Technology seemed to either very important in units or not very; there was little in between. Units that lack technology may be missing something as technology is often the means by which science most impacts society (Kranzberg, 1991).

The societal content, when included, was put there to contribute to the organizing principle and seems to carry a relatively low emphasis. When the units did use societal content, it was almost entirely confined to the personal and societal levels. Within the understanding domain there was a drop in emphasis as one moved from science towards social and, within the social area, towards a global appreciation. There are reasons suggested for such uneven treatment of the areas of understanding. Hickman et al. (1987) and McFadden (1991) point out the difficulty of adding content to the already overcrowded science curriculum, and Bybee (1991) and May (1992) suggest that there could be difficulties when specialists from one discipline are asked to deal with another. The many proponents of areas such as technology (i.e De Vore, 1992), social (i.e. Marker, 1992), and global (i.e. Merryfield, 1991) education point to the need to pay attention to these elements of STS. This evidence in this study strongly supports their concerns.

The social understanding that was developed in several of the units had a personal lifestyle level. This appears to be an area of understanding which is underplayed in the literature and an aspect of STS which is worth more attention. As well as providing a distinct possibility for content interaction, personal lifestyles may improve instruction by making the learning more meaningful as a constructivist approach to learning would emphasize (Novak and Gown, 1984).

6.3 - The Decisions Domain

The determination that decision making is central to STS is supported in most of the literature concerning STS (e.g. Aikenhead, 1985; Bybee, 1986; Hurd, 1986; Waks, 1992). All of the units studied included decision making in some form. The two main types are decision making are technological and issue decision making. Technological decision making is discussed by Zuga (1991) and De Vore (1992) but seems to lack a great deal of attention from those who are not in the technological field. There are many advocates of issue decision making (e.g. Aikenhead, 1985; Waks, 1992) and most see this as that which is done in response to a problem faced by individuals or groups in society to which there is often no one solution.

The three loci of decision making distinguished in the features as well as in the STS organizational chart (i.e.

Figure 1) are mirrored in literature with each being distinct from the other due to the unique purposes and inputs required. Aikenhead (1985) distinguished the personal and global levels of decision making but also dealt with what this study called decision making at the societal level. Bybee (1986) also refers to decision making at the personal, public, and global levels. The units in this study did include personal and social decision making but did not approach global in any significant way.

Decisions are ideal points at which the science, technological, and social concepts can be integrated. They also reflect some of the intended outcomes of education in that the students are often put into the role of citizens making decisions. Other more discipline-centered forms of curricula are differentiated from STS curricula by the decision making component making it a fundamental feature of STS. Most traditional curricula provide students with what are thought to be important knowledge and concepts within a given discipline. The bearing this knowledge had on the lives and the world around them was often unclear. Through decision making the knowledge is applied to tangible situations. Such applications provide grounding and purpose for knowledge and understanding. Barnes (1976) distinguishes between school and action knowledge. School subjects are separated by artificial boundaries. Within each discipline, knowledge is constructed and learned for its own sake, but when it is being integrated into making decisions that relate to the real world, the subject boundaries are lowered. This lowering of the boundaries is leads to action knowledge where the students move from being world-receivers to world-makers. This also represents a move towards an action orientation as the students move closer to making real decisions in the real world. The units studied often had the students making decisions about action but they did not follow this up by carrying out the action as part of the unit.

The way in which an issue is brought into a unit may vary. The styles used have implications on how the rest of the unit will be arranged because the issue can sometimes act as an integration area for the rest of the unit content. The issue may be the central focus of the unit (i.e. "issue mainline" or "issue culmination" style) or it may be a spin off of other content that is being covered ("issue aside" style) in which case it provides enrichment rather than the central focus for the unit. Although examples of articles can be found that describe aspects or components of issue development (i.e. Hickman et al., 1987, Waks, 1991), few can be said to actually provide concrete models to identify the issue development.

Using science and technology to inform decisions is what is frequently described under the heading of scientific and technological literacy. Despite the general terms of reference associated with each of these terms (Roberts, 1983), it seems that if students are able to understand scientific information and use that information as a basis for decision making, then they are scientifically literate (AAAS, 1989b). Technological literacy is similar but refers specifically to using technological understanding, as distinct from scientific, to make decisions (De Vore, 1992). The integrative use of the information presented in STS units allows the students to demonstrate understanding through application.

Although it appears to be the case, the conception of STS as vehicle to promote scientific or technological literacy encourages a narrow view of what STS really seems to be. The STS units examined in this study were often able to pull the focus away from the science, the technology, and the society content of the unit. The students' attention was often placed on a decision that had relevance to the real world. Effective decision making requires that several different knowledge domains be taken into account and not considering all pertinent knowledge contributions leads to mediocre decisions (Aikenhead, 1985). These decisions are ones that reflect the real world more than any one domain of knowledge. Making the decision relates more to the real democratic responsibilities of citizens then it does to any one discipline. In effect much of STS is more devoted to democratic participation than any other single goal as most

STS proponents claim it should be (e.g. Rubba, 1991; Waks, 1992). The fact that there is frequent discussion about promoting discipline-specific goals such as scientific and technological literacy seems to over-emphasize secondary goals of STS that merely represent elements of its total development.

6.4 - The Action Domain

The action focus was not found in the units dealing with issues but was seen to some extent in the units that contained technological decision making. These involved the creation of models of a technological product that had been designed. This sort of action was a follow-through of a decision making activity.

Action as a follow-up of issue decision making was absent which meant that the units lacked a complete action focus. Much of the literature that forms the theoretical basis for STS makes reference to creating citizens who are able to participate in society by taking responsible action on STS issues (e.g. Aikenhead, 1986; Hickman et al., 1987; Ruba, 1991). The lack of an action focus at levels where decisions might have been made prevents the students from gaining action experience unless they do it on their own or the classroom teacher includes it. Further, the units did little to even make students aware of the effectiveness of various actions. This may well represent an important deficiency in most STS curricula.

6.5 - The Orientations

STS unit character is determined by the orientation of the unit, which is central in any discussion of STS materials. STS units have an interactive or ecological nature (Hurd, 1986) in that all parts seem to provide support for the others but there is usually one part of the unit that provides the framework into which the others are placed. The most explicit relationships between the elements of units usually have a focal point towards which they all move. This is the unit orientation. A "conceptual science" orientation, for example, emphasizes the science concepts and the other parts of the unit assist in this task by providing relationships between the science and other areas.

It is in looking at STS from the perspective of the orientations that the conceptualization of STS as mere interactions between science, technology, and society sometimes become superficial. While there is no doubt that the interactions do provide a basis for all STS curricula, they do not provide a basis for the appreciation of the new topic that is understood as a result of merging the content areas. In STS units the individual areas of content are combined towards an end. The interrelationships are actually a result of the integration of the individual elements and the unit is able to move beyond these elements. This appreciative venture creates new knowledge that the individual areas are unable to provide. In the units studied this was mainly seen in the "technological activity" and "issue" orientations. Both of these focused the unit content on bringing about a decision and thus, the new knowledge. Creating a technology or model of one is a follow-up of technological decision making and it represents another form of new knowledge. If action had been included in the issue units, it would have provided yet another type of knowledge. STS curriculum frameworks, such as that offered by Waks (1992), that take into account these synthesized areas of learning appear to provide a more meaningful description than ones that fail to move beyond the interactions to show the type of knowledge is created by them. The different types of knowledge and learning are clearly shown as one moves down the STS organization chart that was created in the analysis.

6.6 - Conclusion

The descriptions of STS developed from the units have been provided and discussed. The value of such a description is in its ability to illuminate these and other STS curriculum materials. They can be used to help people involved with STS become connoisseurs of the materials they encounter. It will make them aware of them in terms of what is included but also in terms of what is left out. Further descriptive research on this topic will only serve to improve the description given here and allow it to account for features that were absent or unnoticed in these units.

This description has also brought forth questions about the units that were studied. A complete understanding of the materials cannot be provided without going beyond describing what is present and attempting to determine why it ended up this way. The question of the general influences on the creation of the units is of interest but there are also two more specific questions that have emerged:

(1) Why were elements that involved technology and society (i.e. increasing world perspective) treated less thoroughly or not at all in the units?

(2) Why did the units that dealt with issues lack an action focus?

The next section of this study will attempt to determine the reasons why the authors created the units as they did and by doing so, answer the questions posed above.

Chapter 7 - Analysis 2

Reasons for STS Decisions

In order to gain a greater understanding of the design process, the authors were once again interviewed, but in this case the reasons why they included or did not include each of the features was the focus. Each feature was phrased as a question which asked the author the extent to which each feature was developed in the unit. After the authors gave their answer, they were asked why they had or had not included the feature. If the feature was included and very important to the unit they were asked why they had used it. If it was not included they were asked why they had not used it. If the feature was included to a limited extent they were asked both why and why not.

The reasons the authors gave for including or not including the features were collected and from these and categorized. The categories are given below along with some examples from the interviews of a reasons that fell into each of the categories. Each category represents a type of constraint that plays a role in determining the final form of an STS unit.

7.1 - Author Contemplated Factors

Unit scope reasons.

An example of a reason that was judged to account for the scope of a unit in justifying the use of a feature was illustrated when Moore (Moore, int., February, 1993) briefly indicated how technology fit into "Fluids" better than "Environmental Quality" when he states that,

> It was much easier to bring technology into a unit of this sort than it was for a unit such as "Environmental Quality.

Some reasons that refer to the scope of the unit allude to the author including a feature because it was considered an element of STS. In discussing his use of decision making in a unit Haysom (int., January, 1993) makes reference to STS when he states,

> I think the major thing that distinguishes an STS unit from a science unit is the decision making aspect.

A reason that relates to unit scope that explains why a feature might be left out is provided in the reason,

> This unit was not a great vehicle for doing that. In addition, there were so many other things I wanted to do, it didn't have a priority. (Haysom, int., January, 1993)

Reasons given by the authors that were judged to be ones concerned with unit scope seemed to be consider the appropriateness of the particular feature being discussed within the framework established by the unit. Such reasons could be given as an explanation of why a feature was included or an explanation of why a feature was not included. Two related sorts of answers emerged. Some referred to whether the feature fit with the rest of the unit content, while others referred to the priority choices that had to be made regarding the features due to the limited length of the unit.

The scope of the unit refers to the authors' conception of the task. When the authors begin to write a unit, it appears, from the reasons that were given, that they had some conception of what fit into the unit and what did not. The importance of this conception is evidenced by the number of times this reason was used in relation to all the others which are still to be developed. Table 9 is a summary of the number of times a reason was classified in each category. Totals for each category are given as well as for each of the groups that the features were placed in when they were first developed. The reasons preceded by a plus sign are ones given to support including a feature, while those given after a negative sign are reasons for not including a feature. It is important to realize that the numbers are results of interpretations made from author comments in unstructured interviews. They are only meant as approximations of the frequency that each category was referred to and not as valid measurements. It is also noteworthy that the feature groups referred to are not directly comparable as a means of analysis as, for example, there were only two features that led to questions in the science group and nine in the decision making group.

Table 9

Reasons Frequency Summary for each STS Feature Group

	sci	tech	social	inquir	dec	total
+ Unit scope	4	9	8	7	14	42
+ Author values	15	7	6	11	31	70
+ Pedagogic concerns	0	1	0	2	0	3
+ Provincial guidelines	2	2	0	1	1	6
- Unit scope	2	8	10	12	28	60
- Author values	1	1	1	1	3	7
- Pedagogic concerns	1	0	3	1	1	6
- neglected or unaware	0	0	1	0	4	5
- uncertain of approach	0	1	1	0	2	4
- Writing deadlines	1	0	0	0	2	3
- considered controversial	0	0	0	0	2	2
- Edited out	0	0	1	1	1	3

When the reference to total number of reasons involving unit scope is considered in relation to the other reasons, it is clear that the author's initial conception of the scope played a very important role in determining what would go into the unit. This conception played an even larger role in determining what did not fit in to the unit. The units were limited in length and this resulted in the need for certain choices. The scope of the unit appears to be a major factor in making these choices.

Author value reasons.

A reason that represented a design decision made on the basis of an author value was exemplified by Smyth when she decided to do a section on insecticides in "Growing Plants". In explaining why she decided to do so she said,

> It was an important thing to be done, and you have to worry about the indiscriminate use of poisons. (Smyth, int., February, 1993)

In this case the material was included because the author thought it was important. An example of another reason that represented an author value about science would be,

> Students should incorporate a science understanding into any decision made about the energy crisis. (Haysom, int., January, 1993)

These reasons indicated a specific value that was either held by the author or represented by the author. The author's values were reasons that could have been for or against including a feature.

As indicated in Table 9, the influence of author values on what is put into a unit is very evident. In fact, it appears to be the most dominant factor in determining what is placed into a unit. Taken with the author's conception of unit scope that plays a large role in determining what fits into a unit, the author's values seem very important within the framework provided by the scope. The scope seems to set the boundaries for the task (i.e. what belongs and what does not) and within these boundaries the author's values determine what is important. A mediated process of unit writing that considers scope and values begins to emerge.

Pedagogic reasons.

An example of a reason that would be placed in this category is,

> There's a lot of genuine interest in growing plants in the house and in the garden and so on, and kids, I found, were quite interested in it. (Smyth, int., February, 1993)

In this case reference is made to what the students would be interested in as a justification for putting something in a unit.

This category includes reasons given that refer to the students with respect to their conceptual level or interests. This type of reason can be given for using or not using features. Pedagogic concerns seem to play at least some role in determining what is included in a unit. The answers given in this category may be lower than indicated in the chart because the author's values may have tacitly included this as a consideration in determining what was important. Another important point that came to light through this reason relates to the development of a global appreciation. Three of the six reasons as to why the development of a global appreciation was not included in the unit referred to the conceptual level or interests of the students. It was felt that the students were not conceptually prepared and they may not be interested.

7.2 - Author Limitations

Neglect or unaware reasons.

The authors sometimes gave reasons indicating they had never thought of a certain element or had simply neglected to include it in the unit. If this was the case, the reason

Table 10

Features Associated with Author Limitations

	science	tech	social	inquiry	dec
- neglected or unaware	-	-	7	-	17,18 18,19
- uncertain of approach	-	4	6	-	17 19

was counted in this category. The types of features for which authors gave this reason provides some insight into a constraint of science teachers writing a unit that uses a new theme. Table 10 lists the numbers of the features that authors claimed they had neglected or were unaware of.

Feature 7 relates to the development of a global appreciation; feature 17 involves students actually making decisions; feature 18 refers to developing an awareness of types and effectiveness of actions; and feature 19 relates to students acting as a result of their decisions. It is evident that the features associated with this category of reasons that they are ones that are beyond the normal concern of traditional science education. The fact that the authors were not aware of them indicates a problem that is a constraint to the design of STS units.

<u>Uncertainty reasons.</u>

Moore (int., February, 1993) indicates uncertainty about how to incorporate a topic into a unit when he reflects on a feature that he did not include in the unit.

> I'm not sure if I know how, or what the opportunities might be.

He appears to refer to the fact that he was not certain of how to include the feature in the unit and as a result left it out. If the author said a feature was not included because they were uncertain about how to go about doing so, it was counted in this category. This category is related to the previous one with the main difference being one of awareness. In the case of being uncertain of how to put a feature into a unit, an author would imply that they were aware of it but still unable to include it.

Table 10 indicates the numbers of the feature to which this reason applied. Features 17 and 19 appear again as well as feature 4 which refers to relating an understanding of technology to another topic and feature 6 which involves relating an understanding of society to another topic. As was the case when reasons of being unaware were given, reasons of being uncertain of how to include a feature seem to be connected to features that are somewhat different than traditional science content. This suggests that at times the authors are somewhat unsure about how to handle these particular features as compared to when they are dealing with more traditional science areas such as those concerned with science and inquiry. Each of these features are ones that depart considerably from what is the usual experience of science educators. Not many science educators have a great deal of experience with social concepts or decision making and acting on issues and, again, this acts as a constraint on their writing about them in STS units.

7.3 - External Factors

Provincial guidelines reasons.

Haysom (int., January, 1993) indicates the influence of the provincial guidelines as well as the confining role they and the limited length of the unit play when he states,

> It's always difficult to draw the line between the curriculum being a science curriculum and a social studies curriculum and a morals curriculum. It was primarily a science curriculum. I might have wanted to [shift the focus] but there certainly wasn't space for me to have gone much farther. That's really concerning the guidelines I was following, I suppose.

The provinces for which various editions of SciencePlus were being created normally included guidelines that outline the subject, content, and objectives for units. If the author claimed to have included a feature because of these, it was put in this category.

The provincial guidelines seemed to have a great influence on the author's initial conception of what the unit would include. This connects the guidelines to the scope of the unit as a factor that has a substantial influence on determining what the scope may be. The quote from Haysom shows this but it appears that at times the author's values or ideas contribute to the setting down of the scope as well. Moore (int., April, 1992) provides an account of determining the scope of a unit in which there is more flexibility or negotiation in the often rigid framework guidelines provide. He also describes his situation in writing "Environmental Quality" in contrast with the typical circumstances under which units are written.

The Alberta Department of Education takes a very hands-

> on practice in terms of what kind of curriculum they want and so their curriculum--their outline--they had all the units outlined. . . . Their description of this unit ["Environmental Quality] did not look like this [the final unit] at all and, in fact, it created an awful lot of conflict in my own mind. I could not see how I could do what they wanted and have it part of the SciencePlus approach. . . . I went ahead and developed my own criteria and my own sequence . . . and they accepted it. . . . [In] the other materials from Alberta, they set down very strict guidelines in terms of what concepts, what goals in the affective domain, what STS involvement there would have to be within that unit. All of these things were set down in very tight guidelines and often it was a challenge trying to see how you could meet those guidelines.

The units appear to be created through what was a negotiated process that determined what would go into the limited space allowed for the unit. The authors are given, at the very least, a topic and the general content for the unit. At times the authors may have some say in this. The provincial guidelines effectively establish the working boundaries within which the author's values play a large role in determining what final shape the unit will take.

Writing deadline reasons.

The circumstances under which the units are created can often leave little time for consideration of all the relevant material and to think about ways of incorporating material into the unit. Moore (int., April, 1992) told of the very rushed schedule he had faced in preparing materials for the Alberta version of SciencePlus. He later pointed out how this had hampered him in getting some science information ready for the "Environmental Quality" unit.

> Partly, that was due to the rush [to get the unit ready]. I didn't realize and I didn't have at my hands all of the material that has been gathered in terms of temperature change, in terms of temperature change over the past five thousand years, in terms of the carbon dioxide level over five thousand years, and how those changes can be correlated. (Moore, int., February, 1993)

The rush to meet publisher or province imposed deadlines may have resulted in inadequate development time. If this was given as a reason for not including a particular feature, it was counted in this category.

It seems reasonable that the task of writing STS units, which is new to most authors, with only limited time to consider how to do so, might cause problems for the authors. In giving the reasons themselves, several of the authors acknowledged the situation of not having time to consider all of the possibilities STS holds. The circumstances of unit writing, particularly in light of the material being somewhat different from what the authors are most experienced with, acts as a constraint.

Controversy reasons.

In considering the reasons why she chose not to have students write letters about food safety concerns in "Micro-organisms and Food Supplies" Smyth (int., February, 1993) stated,

> Maybe I thought the teacher wouldn't care for that, and the teacher could do that on his or her own, but it was open then for the teacher to do it on the class level--[I would be concerned] that it might get to be very disorganized or cause some sort of administrative commotion. I guess as teachers we don't like to rock the boats without knowing what boats we're rocking. Also, it might not have passed the editorial reviews.

There were times when the authors perceived an element of risk in suggesting that a certain feature be included in the units mainly because they were worried about how schools would react to such curriculum elements. The reservations did not seem to be a result of personal uncertainty about a particular aspect of STS but rather what the author perceived to be a potential conflict when the unit was used in schools. Moore (int., February, 1993) reflects a similar concern in his reservations about introducing the action component in "Environmental Quality".

> I think I was always afraid of how far one should carry this action component. I see it as very desirable but I can imagine that if we had a unit on fisheries, and then we start advocating a certain shaped net within the Maritimes and demanded action by students writing letters to the newspaper, some parents are going to be very, very upset. So it has to be handled carefully.

These concerns reveal the authors' reservations about breaching the traditional limits placed on school activities.

The only feature that was associated with being considered controversial was the one which involved the students acting on their decisions. Society does not appear to value students becoming directly involved in its controversies. The place of students seems to be thought to be in school and school learning should not involve itself with the "real world". This presents a problem to those who write STS units that deal with social issues. There are limits on what can be done. These are constraints placed on the writing of STS units by society and the school system. It relates to the types of activity that society values or perhaps, stated more accurately, what activity society does not value. Because they are aware of these problems with the action component of STS, the authors have reservations about following through with it.

Editing out reasons.

This category emerged out of reasons where it was simply stated that the feature had been included in early drafts of the unit but were taken out by the publisher or the province that was involved. In discussing the editing out of a social research section that dealt with students going into the community for information in "Structures and Design", McFadden (int., February, 1993) stated,

> . . . That was another instance where the Alberta Department of Education stuck in its censors. The censors were teachers who reviewed the materials and they were curriculum consultants for the Department who thought I might be raising too sensitive questions to have the kids go out and look at their own environment. They're dead wrong and the sooner we get those

questions back into curriculum, the better.

McFadden clearly refers to the resistance he experienced when trying to include an activity that involved the students in investigating their own community. Smyth (int., February, 1993) provides another example of being "edited", although she is discussing a unit that was not part of this study.

> There are constraints--and there certainly are constraints when you're dealing with social issues in writing. . . . I had very definite problems dealing with the social issues when I was writing the continuity of life section because I was dealing with reproductive technology, and a lot of things, they wouldn't let me write about, and cancelled a whole lesson. "We won't sell any books with this in there"--it was the publisher.

Having a portion of a unit "edited" by the province or publisher on the grounds that they object to the type of activity that it involves the students in is a point of interest if that province has endorsed the STS theme. This situation is similar to that discussed in the consideration of reasons relating to controversy. The noteworthy point in both cases is that the type of activity involved in virtually all cases had the students acting on decisions or going into the community to find information. Again it seems that there is a problem in having students interact with society in a meaningful way.

<u>The structure of schooling.</u>

There seem to be other constraints on the creation of STS units that arise from the way science is taught in schools and more generally how schools are organized. During an interview McFadden (int., February, 1993) discussed "Structures and Design" in relation to the school curriculum:

> [The fact that this unit did not deal with issues was] not necessarily by desire of the authors but was constrained by the framework of the science classroom. What you'd like to see would be a school curriculum, and what's there [in the unit] is the science component of a school curriculum that addresses the social issue, the aesthetic issues, and the ethical issues related to structures and design. Those issues are only really initiated--raised--in that unit but there is, in fact, little activity that relates to those activities--to those directions. . . . The direction it took does not reflect, necessarily, the desire or intention of the authors for curriculum. It reflects the deck we're dealt.

McFadden followed this comment later in the same interview with one that provided his view of an improved curriculum:

> I'd like to see the curriculum improve in the direction of a more holistic curriculum. I'd like to see preferably a school STS curriculum that would link all components of the system. . . . The result of trying to look at the world as a lot of separate pieces is that you never, in fact, deal with the world. You invent something that is unique to schools.

The constraint referred to seems to be that STS is carried out in the science classroon where there is a limited amount of time and many goals that have to be achieved that relate specifically to science. The goals that do not relate specifically to science are not easily achieved in this setting because the science classroom does not allow extra time to do so. In fact, many of these goals relate more to other disciplines. McFadden, in his above statement, suggests that this problem could be solved if a more holistic curriculum was adopted in which the different disciplines would work towards common goals. He further suggests that STS could serve as an organizing center for the entire curriculum.

The existing school science curriculum and general discipline structure does not seem to fully accommodate the doing of STS. This partly related to the problems suggested about the sort of activities society values in students. School, being a social institution, is set up to achieve goals that are valued by society. The last three reasons relating to external factors suggest some potential problems; science education appears to have limitations as a home for STS curriculum and some of the STS goals, particularly the action focus, seem not to be desired as a school activity.

Chapter 8 - Discussion 2

Challenges for STS

The reasons given by the authors for their design decisions have provided some appreciation for the circumstances and constraints under which the units are written. This section was titled "Challenges for STS" because some of the constraints may well determine whether STS will bridge the theory-practice gap and make it to classrooms in a form that is similar to that which is intended. An awareness of the factors that impede this movement must be identified and dealt with if the gap is to be closed. As Bybee (1991) points out,

> Sustaining the STS innovation requires the translation of policies to practices. Development of curriculum materials and changes in teacher education are essential. If we do not attend to the systematic translation of the STS theme from policies to practices, the implementation will be insignificant and STS will be a passing fad. (p. 300)

STS faces a real risk of being unsuccessful if attention is not being paid to the factors that prevent it from getting into classrooms. Because the textbook is a major medium of STS curriculum, the constraints upon its creation are important.

This section will examine some of these constraints that appear to be important as the STS theme is beginning represented in textbooks. These are a result of problems that were perceived from an interpretive analysis of the reasons given for author decisions. The constraints will be followed by a response to two more questions that came out of the discussion of the STS description developed earlier in this study. Finally, several hypotheses that emerged from the constraints will be examined as areas to which special attention needs to be paid if STS is to bridge the theory-practice gap successfully.

8.1 - Constraints to STS Implementation

The awareness of those involved.

Curriculum writers, policy makers, teachers and others involved in the messy business of bring STS into classrooms have to know what it is they are dealing with. It appears, from the results of this study, that authors and provinces have a great deal to say about what goes into a unit by definition of unit scope and determination of the specific content, both of which are accomplished through a mediation of provincial guidelines and author values. Some of the authors admitted to being unaware of some STS elements or unsure how to incorporate some of them into a unit. In each of these cases, the unit elements being referred to were outside traditional science curriculum boundaries. Being asked to create new material in an unfamiliar subject area while a deadline looms over their heads is not what could be considered ideal. The authors are being asked to write STS material without always having a full appreciation of what STS involves or time to find out.

May (1992) recognizes these problems in her concerns about individuals dealing with subject matter outside their disciplines. This problem is very serious and must be addressed if STS is to be brought to practice in a form resembling the theory which stands behind it. Disciplinary boundaries must be overcome through a re-educative process. Bybee (1991) and Heath (1992) also call for more support to be given to those involved in implementing STS. Given the influence of the textbook in schools, textbook authors play a leadersnip role in implementing STS. They certainly require time and support if they are to be expected to show such leadership.

The provincial departments who formulate the guidelines used in the creation of the textbook units must also be aware of what STS involves. Although an examination of the level of their awareness is beyond the scope of this study, they may be suspect in their ability to appreciate the possibilities that STS presents.

Those involved with creating and implementing STS curricula must be aware of the what potential STS holds. As curriculum decision makers they must realize the possible choices and what the implications of the choices are. The use of an appreciative system such as that already developed in the first part of this study would help to put all involved in a better position for reflective curriculum development.

The existing school system.

This factor may be considered on two related levels: the level of the science classroom and the level of the discipline-centered structure of the school's curriculum. Science class is allotted limited time in the school timetable and is expected to accomplish many science-related goals in that time. When nonscience STS content is introduced, it takes away time from the science content. Much of the new content is more appropriate to other subjects but it is still covered in science classes. For the science curriculum, it becomes difficult for it to accomplish its own goals when part of the time and effort is being devoted to STS goals. This diffeculty has also been recognized by Hickman et al. (1987) and Heath (1992).

The writers of STS textbooks are in a similar position in that they feel a need to cover the science. This is compounded by their inexperience with the nonscience side of STS curricula. When an author is asked to do an STS unit they are given a limited length for their unit and several other science goals to meet. It is their job to try to please the province involved and the publisher of the textbook and also get the material they think is important into the unit.

McFadden (1991) points out the problems being encountered by science curriculum that is trying to meet STS goals. McFadden suggests that reform of the entire school curriculum is necessary if both science and STS goals are to be met. He considers STS topics to have the potential to act as an integrating center for the whole curriculum. McFadden's concerns about incorporating STS into the present curriculum are supported by Bragaw (1992). He points out that even though many writers advocate an interdisciplinary issue approach, "they and others were quick to cite studies that throw the disciplines blanket over the use of such issues as a central school focus" (p. 8). The idea that disciplines are necessary to provide specific sorts of information is a "crutch" used by many who discourage innovation in curriculum (Bragaw, 1992).

May (1992) addresses the topic of curriculum reform by pointing out the inadequate measures taken to successfully implement STS.

> Most STS proponents seem to approach curriculum reform naively, modestly, and cautiously. That is, the school curriculum is seen to be an inanimate structural system of interchangeable parts with a few empty spaces available for the installation of additional parts: a little STS here, a little STS there. Few STS educators argue for a radical restructuring of the entire K-12 curriculum to accommodate sustained, integrated study of science, technology, and society. . . . Such a radical overhaul is tempting because we know that if any significant change is to occur in practice much more than tinkering, tune-ups, and mandates will be required. However, stymied by the odds, we choose the

line of least resistance: tinkering. (p. 77)

STS advocates will likely have to do more if it is going to be properly put into practice. The existing school system appears to offer some obstacles to STS and these must be considered if STS is to be implemented in its intended form.

Societal values.

There seems to be some conflict between the intended goals of STS and the what can be put into the schools. It does not appear that having students interact with society by practising some of the skills STS hopes to create for citizenship is always desirable. The schools are conservative places that do not like to stir up the community too much (Bragaw, 1992). Teachers also seem to assume a role in which they do not want to "rock the boats" (Smyth, int., February, 1993). The students are likely to learn these attitudes rather than the ones that STS puts forward.

From the evidence collected, it appears that some of the authors have reservations about action. They consider it to be risky in that teachers, school administrators, and parents might not appreciate such elements in the curriculum. In some cases, the province involved or the publisher did not want students acting on issues. This study found that none of the units that were examined included acting on issues as a part of the unit. This leaves the decision making in a largely contrived context. Hickman et al. (1987) stated,

> Skill involved in civic decision-making process can be acquired and improved upon through practice in secondary school courses in the social studies and the sciences. Indeed, if these skills are not emphasized in school, through formal education, they are not likely to be learned by most people. (p. 22)

This is quite supportive when considered with respect to these units that included some form of decision making but the same message is not so supportive when considered with respect to action. Can we realistically expect students to be capable of responsible action if they have never actually done so in school? Real action would involve the students in going out and interacting with the world. They would act with the intention of accomplishing something. Ruba and Wiesenmayer (1990) consider action experience to be an essential part of STS.

The society and those who have power in society play a large role in determining what happens in schools (Apple and Christian-Smith, 1991). The publishers are responsive to the departments of education because they want to sell the textbooks (Apple, 1986; McFadden, 1991). The provinces and the people who can influence policy are able to determine the limits for acceptable school activities (e.g. McFadden, int. 1993). It appears that there is a problem with the more action oriented activities that involve students interacting with society, particularly in a critical manner. Such activities are prevented by the author's reservations about how such elements would be accepted, the publisher removing them, or the province removing them. The suppression of such activities appears to be in direct conflict with the intended goals and purposes of STS.

8.2 - Questions from the Unit Descriptions

Why were elements that involved technology and society (i.e. increasing world perspective) treated less thoroughly or not at all in the units?

This question has, for the most part, been already answered above. STS elements such as the development of an understanding of society, for example, are somewhat distant from the traditional goals of science education and if a unit was being planned that considered science goals first, they may not be included. The scope of units appear to be a result of author values and provincial guidelines. The unit must also be put in a limited space inside a textbook. Considering the priorities that are likely to be dominant in science curriculum planning, social content may well be neglected. It also appears that the authors are less comfortable developing elements of units that are do not involve science. If one considers the development of a global appreciation, for example, few of these authors have much experience in such areas so they are less likely to include it due to neglect or not being certain about how to develop it.

The way to counter this omission on the part of STS is to provide a better appreciation of what STS is and what can be included. If the people involved, by becoming more aware of STS, decide to use a more balanced approach with respect to the types of elements included, the next question involves how they can do so. The answer to this question is complex but may involve providing more support for those involved in implementing STS and providing a better school structure to fit it into.

Why did the units that dealt with issues lack an action focus?

The action focus may be left out of STS as a result of its being a new initiative in science, much the same as was the case in the previous question. An additional concern would be the resistance to the inclusion of action knowledge in STS. As already indicated, society appears to discourage students interacting with society in an effort to find out about how it is and, sometimes, play a role in changing it. Barnes (1976) equates adopting an action knowledge view in education to "making the ethical decision to prepare students for choice and responsibility" (p. 149). If we do not have students acting in responsible ways as part of their education, it becomes doubtful as to whether they have been prepared to be responsible citizens.

Student action is not valued in schools but action is valued in citizens. Part of STS implementation may well involve a critical assessment of schools and what is done there. Failure to address the issue of the suppression of activities involving action allows a system that may be not acting in the best interests of education to stay in place.

8.3 - Emergent Hypotheses

When the potential and intended goals of STS are considered as it is represented in both the literature and the findings of this study, several specific areas of concern emerge as obstacles that appear as factors that influence the shape of STS designs. Many of these stand in the way of bringing STS into practice. These obstacles are tentative in that they have not been examined individually to any great extent. Their identification, however, marks a starting point for such examination. These obstacles will be presented in the form of emergent hypotheses that point to possible problems in the implementation of STS. These hypotheses are stated as reasons why STS may not be successfully implemented and are organized into groups depending on who it is that they refer to. They are intended as statements to direct attention to possible areas of concern rather than as a type of pessimistic prediction. The hypotheses result from an interpretive account of the reasons suggested for design decisions as they relate back to the implementation process.

Science educators.

The term "science educators" is a general reference that takes into account those who teach science, those who help determine science curriculum, and those responsible for the creation of curriculum materials. The hypotheses are based on interviews with authors but these are ones that appeared to refer to more encompassing concerns that are likely to relate to science educators in general.

(1) Many science educators will be unaware of STS elements that are outside their areas of expertise. This simply suggests that many in science simply do not know about some of the nonscience STS elements (i.e. personal lifestyles, global perspectives, decision making).

(2) Many science educators will be uncertain of how to develop STS elements that are outside their area of expertise. Science educators may be aware of a nonscience topic but not be confident in their ability to develop it in a lesson. They may avoid it for this reason.

(3) Many science educators will resist including nonscience STS elements because they consider the science content to have priority. It may be the case that science educators consider the nonscience content to be inappropriate for science class. They may feel that this sort of content is best dealt with elsewhere.

(4) Many science educators will be prevented from including nonscience STS elements because there is too much science

content which they are required to include. Even if science educators are supportive of STS they may find that there is little room for it in the time or space allotted to them if they hope to also achieve the science goals.

(5) Many science educators will use science as the main organizer or foundation of their lessons rather than nonscience themes because science is their area of expertise. There are models of lessons that are based on putting issues or technology first. Science educators may not be comfortable with this sort of organization and elect to develop the science before anything else as a foundation, or to base the unit structure on science and include a few applications.

(6) Many science educators will use science as the main organizer or foundation of their lesson in order to keep the science together. Again, there are models of lessons that are based on putting issues or technology first. In these cases the science that is relevant is determined by the organizer and often becomes somewhat broken apart and disjointed. Science educators may not be comfortable letting this happen to the science and it also may create problems in meeting science goals.

(7) Many science educators will avoid an action focus if the school is not supportive of such activities. Most teachers do not want to stir up disputes with the school. If the school is not supportive of any particular activity, the teachers are likely to avoid it.

<u>Textbook authors.</u>

This section focuses specifically on the constraints faced by textbook authors and makes reference to the writing process.

(8) Textbook authors cannot effectively include nonscience STS elements in the limited number of pages provided and still develop the science that is needed. The unit length is set in advance. This provides limitations on how much content can be included and forces authors to set priorities. In a science textbook the science is unlikely to be affected but the nonscience STS elements may have to be left out.

(9)Textbook authors cannot effectively represent the STS theme if they are not provided with sufficient writing time to explore the possibilities it presents. Because STS is new the authors need time to explore the possibilities and think about how best to approach the writing of an STS unit. If a tight deadline is imposed on them this cannot be adequately done. The authors require "gel time".

(10) Textbook authors will not be able to include an action focus in units unless the provinces and publishers begin to support such activities. When a textbook unit is being written specifically for a particular province, they gain some control over the content. The publisher, who is most interested in selling the textbooks, tends to be receptive to the provinces' wishes. The provinces do not appear to value the action focus of STS and are able to eliminate it from the units.

Publishers and provinces.

(11) Many STS elements will be left out because textbook publishers will not support STS elements that the provinces do not support as well. Related to the previous point, the publishers do not support the authors against the province. They tend to pressure the authors to produce a sellable product rather than to take a leadership role in implementing STS.

(12) Many STS elements will not be included because the provincial departments of education are not aware of them. The provincial departments that formulate guidelines may be unaware of some STS elements or take a very piecemeal approach to adding STS "extras".

School and society.

(13) STS implementation will be unsuccessful because the subject structure of the school is not set up to accommodate STS. The fact that STS, which takes into account understanding gained in many disciplines, becomes the responsibility of one, limits its potential in terms of time provided for its development and also in the neglect of other resources the school has to offer.

(14) An action focus will be avoided because society does not want students becoming involved in problems that lie

outside the school. Society does not appear to support students involved in real action. This makes it difficult to gain support for an action focus and also makes those who decide whether to include it uncertain about whether they should do so.

<u>Students.</u>

(15) STS elements such as the development of a global appreciation will not be developed at the junior high level because the students are not conceptually prepared or interested. If the authors or anyone involved feels that elements of STS are not appropriate for the students then they are not likely to include them.

8.4 - Conclusion

Bringing STS from theory to practice is a complex task. The reasons given by the authors for design decisions in their units provide an important indication of some of the difficulties they are having in creating STS units. These reasons are represented in the list of emergent hypotheses which are apparent constraints on the implementation of STS. Although it is naive to think that there are any simple solutions to the implementation problems faced by STS, it seems that any effort to eliminate these problems will begin with seeing the problems. If the form of STS is compromised at different stages of the implementation process it will become, as Bybee (1991) warns, a passing fad.

This study has produced an appreciative system with which to become aware of STS materials in terms of what is there and what has been left out. Using such a system will provide those involved in creating STS materials with a means of reflection on their task--what Schon (1983) would call "back talk". Those who examine and use STS materials are provided with a heightened awareness that enables them to become educational critics (Eisner, 1991) thus opening STS curriculum proposals to critical scrutiny (Stenhouse, 1975).

References

Abrams, I. (1986). The sustainable society. In R.W. Bybee (Ed.), NSTA yearbook: Science-technology-society (pp. 46-59). Washington D.C.: National Science Teachers Association.

Aikenhead, G.S. (1985). Collective decision making in the social context of science. Science Education, 69(4), 453-475.

Aikenhead, G.S. (1986). Science curricula and preparation for social responsibility. In R.W. Bybee (Ed.), NSTA yearbook: Science-technology-society (pp. 129-143). Washington D.C.: National Science Teachers Association.

Aikenhead, G.S. (1991). Logical reasoning in science and technology. Toronto: John Wiley of Canada.

Aikenhead, G.S. (1992). The integration of STS into science education. Theory into Practice, 31(1), 27-35.

Alberta Education (1990). STS science education: Unifying the goals of science education. Edmonton: Alberta Education.

American Association for the Advancement of Science (1989a). Project 2061: Science for all Americans. Washington, D.C.: AAAS.

American Association for the Advancement of Science (1989b). Project 2061: Science for all Americans (summary). Washington, D.C.: AAAS.

Anderson, L.W. & Burns, R.B. (1989). Research in classrooms: The study of teachers, teaching, and instruction. New York: Pergamon Press.

Apple, M.W. (1986). Teachers and texts: A political economy of class and gender relations in education. New York: Routledge.

Apple. M.W. (1991a). The culture and commerce of the textbook. In M.W. Apple & L.K. Christian-Smith (Eds.), The politics of the textbook (pp. 22-40). New York: Routledge.

Apple, M.W. (1991b). Regulating the text: The socio-historical roots of state control. In P.G. Altbach, G.P. Kelly, H.G. Petrie, & L. Weis (Eds.), Textbooks in American Society: Politics, policy, pedagogy (pp. 7-26). New York: State University of New York Press.

Apple, M.W. & Christian-Smith, L.K. (1991). The politics of the textbook. In M.W. Apple & L.K. Christian-Smith (Eds.), The politics of the textbook (pp. 1-21). New York: Routledge.

Armbruster, B.B. & Anderson, T.H. (1985). Textbook analysis. In T. Husen and P.N. Postlethwaite (Eds.), International encyclopedia of education (pp. 5219-5223). Oxford: Pergamon.

Atlantic Science Curriculum Project. (1986, 1987, 1988). SciencePlus 1, 2, & 3, and accompanying Teachers Resource Books. Toronto: Harcourt Brace Jovanovich, Canada. (The Atlantic Edition).

Atlantic Science Curriculum Project. (1988). SciencePlus 7 & 8, and accompanying Teachers Resource Books. Toronto: Harcourt Brace Jovanovich, Canada. (The Ontario Edition).

Atlantic Science Curriculum Project. (1989, 1990). SciencePlus Technology and Society 7, 8, & 9, and accompanying Teachers Resource Books. Toronto: Harcourt Brace Jovanovich, Canada. (The Alberta Edition).

Barnes, D. (1976). From communication to curriculum. Harmondsworth: Penguin Books.

Barrow, R. (1984). Giving teaching back to teachers: A critical introduction to curriculum theory. London, Ontario: The Althouse Press.

Bellack, A., Kliebard, H., Hyman, R., & Smith, F., Jr. (1966). The language of the classroom. New York: Teachers College Press.

Ben-Peretz, M. (1975). The concept of curriculum potential. Curriculum Theory Network, 5(2), 151-159.

Ben-Peretz, M., Katz, S., & Silberstein, M. (1982). Curriculum interpretation and its place in teacher education programs. Interchange, 13(4), 47-55.

Boyer, E.L. (1983). High school: A report on secondary education in America. New York: Harper and Row.

Bragaw, D.H. (1992). Society, technology, and science: Is there room for another imperative? Theory into Practice, 31(1), 4-12.

Brunkhorst, H.K. & Yager, R.E. (1986). A new rationale for science education - 1985. School Science and Mathematics, 86(5), 364-374.

Brusic, S.A. (1992). Achieving STS goals through experiential learning. Theory into Practice, 31(1), 44-51.

Bybee, R.W. (Ed.). (1986). NSTA Yearbook: Science-technology-society. Washington, D.C.: National Science Teachers Association.

Bybee, R.W. (1986). The Sisyphean question in science education: What should the scientifically and technologically literate person know, value, and do--as a citizen? In R.W. Bybee (Ed.), NSTA yearbook: Science-technology-society (pp. 79-93). Washington D.C.: National Science Teachers Association.

Bybee, R.W. (1991). Science-technology-society in science curriculum: The policy-practice gap. Theory into Practice, 30(4), 294-302.

Carnahan, R.S. (1980). The effects of teacher planning on classroom processes (Tech. Rep. No. 541). Madison: Wisconsin R&D Center for Individualized Schooling.

Carr, W. & Kemmis, S. (1986). Becoming critical: Education, knowledge, and action research. Philadelphia, PA: The Falmer Press.

Clark, C.M. & Elmore, J.L. (1979). Teacher planning in the first weeks of school (Research Series No. 56). East Lansing: Michigan State University, Institute for Research on Teaching.

Finegold, M. & MacKeracher, D. (1985). The Canadian science curriculum. In F.M. Connelly, R. Crocker & H. Kass (Eds.), Science education in Canada (Vol. 1, pp. 150-172). Toronto: OSIE Press.

De Vore, P. (1992). Technological literacy and social purpose. Theory into Practice, 31(1), 59-63.

Dewey, J. (1916). Democracy and Education. New York: The Free Press.

Dewey, J. (1900). The school and society. Chicago: The University of Chicago Press.

Eisner, E.W. (1979). The educational imagination: On the design and evaluation of school programs. New York: Macmillan Publishing Company.

Eisner, E.W. (1991). The enlightened eye: Qualitative inquiry and the enhancement of educational practice. New York: Macmillan Publishing Company.

Ewert, G.D. (1991). Habermas and education: A comprehensive overview of the influence of Habermas in educational literature. Review of Educational Research, 61(3), 345-378.

Gadamer, H-G. (1975). Truth and method. Garrett Barden and John Cumming (Eds.). New York: Seabury Press.

Gay, G. (1985). Curriculum development. In T. Husen and P.N. Postlethwaite (Eds.), International encyclopedia of education (pp. 1170-1179). Oxford: Pergamon.

Glidden, P. (1991). Teachers' reasons for instructional decisions. Mathematics Teacher, 84(8), 610-614.

Goodlad, J. (1984). A place called school: Prospects for the future. New York: McGraw-Hill Book Company.

Gustafson, B.J. (1991). Thinking about sound: Children's changing conceptions. Qualitative Studies in Education, 4(3), 203-214.

Habermas, J. (1972). Knowledge and human interests (2nd ed.). London: Heinemann.

Haysom, J. (1985). Inquiring into the teaching process:

Towards self-evaluation and professional development. Toronto: OSIE Press.

Haysom, J. (1987). Heat Travel. In Atlantic Science Curriculum Project, SciencePlus 2 and accompanying Teacher Resource Book, Toronto: Harcourt Brace Jovanovich.

Haysom, J. (1988). Energy and you. In Atlantic Science Curriculum Project, SciencePlus 7 and accompanying Teacher Resource Book, Toronto: Harcourt Brace Jovanovich.

Haysom, J. (1992, February). Interview: Unit design of "Energy and You" (on audiotape). Halifax, N.S.

Haysom, J. (1992, March). Interview: Unit design of "Energy and You" (on audiotape). Halifax, N.S.

Haysom, J. (1992, August). Interview: Unit design of "Energy and You" (on audiotape). Halifax, N.S.

Haysom, J. (1992, November). Interview: Unit design of "Energy and You" (on audiotape). Halifax, N.S.

Haysom, J. (1993, January). Interview: Reasons for STS design decisions in "Energy and You" (on audiotape). Halifax, N.S.

Haysom, J. (1993, February). Interview: Reasons for STS design decisions in "Energy and You" (on audiotape). Halifax, N.S.

Haysom, J. (1988). Energy and You. In Atlantic Science Curriculum Project, SciencePlus 7 and accompanying Teacher Resource Book, Toronto: Harcourt Brace Jovanovich.

Heath, P.A. (1992). Organizing for STS teaching and learning: The doing of STS. Theory into Practice, 31(1), 52-58.

Hickman, F.M., Patrick, J.J & Bybee, R.W. (1987). Science/technology/society: A framework for curriculum reform in secondary school science and social studies. Boulder, CO: Social Science Education Consortium, Inc. (ERIC Document Reproduction Service No. ED 288 783)

Holman, J.S. (1987). Resources or courses? Contrasting approaches to the introduction of industry and technology to the secondary curriculum. School Science Review, 68, 432-438.

Hurd, P.D. (1986). A rationale for a science, technology, and society theme in science education. In R.W. Bybee (Ed.), NSTA yearbook: Science-technology-society (pp. 94-101). Washington D.C.: National Science Teachers Association.

Joyce, B. & Weil, M. (1986). Models of teaching (3rd ed.). Englewood Cliffs, NJ: Prentice-Hall.

Kahl, S. & Harms, N. (1981). Project synthesis: Purpose, organization and procedures. In N.C. Harms & R.E. Yager (Eds.), What research has to say to the science teacher (Vol. 3, pp. 5-11). Washington, DC: National Science Teachers Association.

Kelly, G. (1969a). Ontological acceleration. In B. Maher (Ed.), Clinical psychology and personality (pp. 7-45). Huntington NY: Robert E. Krieger Publishing Company.

Kelly, G. (1969b). On whom confide: On whom depend for what? In B. Maher (Ed.), Clinical psychology and personality (pp. 189-206). Huntington NY: Robert E. Krieger Publishing Company.

Klein, M.F. (1985). Curriculum design. In T. Husen and P.N. Postlethwaite (Eds.), International encyclopedia of education (pp. 1163-1170). Oxford: Pergamon.

Kranzberg, M. (1991). Science-technology-society: It's as curriculum theory and practice. Theory into Practice, 31(3), 191-197.

Klein, M.F. (1992). A perspective on the gap between easy as XYZ. Theory into Practice. 30(4), 234-241.

Kuhn, T.S. (1970). The structure of scientific revolutions (2nd ed.). Chicago: The University of Chicago Press.

Lux, D., Gilliom, E., Helgeson, S., & Zuga, K. (Eds.). (1991). Science, technology, society: Challenges [Special issue]. Theory into Practice, 30(4).

Lux, D., Gilliom, E., Helgeson, S., & Zuga, K. (Eds.). (1991). Science, technology, society: Opportunities [Special issue]. Theory into Practice, 31(1).

Marker, G.W. (1992). Integrating science-technology-society into social studies education. Theory into Practice, 31(1), 20-26.

May, W.T. (1992). What are the subjects of STS--really? Theory into Practice, [illegible].

McCutcheon, G. (1985). Curriculum theory/curriculum practice: A gap or the Grand Canyon? In A. Molnar (Ed.), ASCD Yearbook: Current thought on curriculum, (pp. 45-52). Alexandria, VA: Association for Supervision and Curriculum Development.

McFadden, C.P. (1991). Towards an STS school curriculum. Science Education, 75(4), 457-469.

McFadden, C.P. (1992). Author-publisher-educator relationships and curriculum reform. Journal of Curriculum Studies, 24(1), 71-87.

McFadden, C. (1989). Structures and design. In Atlantic Science Curriculum Project, SciencePlus Technology and Society 7 and accompanying Teacher Resource Book, Toronto: Harcourt Brace Jovanovich.

McFadden, C. (1992, August). Interview: Unit design of "Structures and Design" and "Growing Plants" (on audiotape). Truro, N.S.

McFadden, C. (1993, February). Interview: Reasons for STS design decisions in "Structures and Design" (on audiotape). Fredericton, N.B.

Merryfield, M. (1991). Science-technology-society and global perspectives. Theory into Practice, 30(4), 288-293.

Middle School Curriculum Review Panel (1991). Report of the Middle School Curriculum Review Panel. Middle School Review, March, 1991.

Miller, J.P. (1983). The educational spectrum: Orientations to curriculum. New York: Longman.

Moore, A. (1990). Environmental quality. In Atlantic Science Curriculum Project, SciencePlus Technology and Society 9 and accompanying Teacher Resource Book, Toronto: Harcourt Brace Jovanovich.

Moore, A. (1992, April). Interview: Unit design of "Environmental Quality" (on audiotape). Truro, N.S.

Moore, A. (1993, February 8). Interview: Reasons for STS design decisions in "Environmental Quality" (on audiotape). Truro, N.S.

Moore, A. (1990). Fluids. In Atlantic Science Curriculum Project, SciencePlus Technology and Society 9 and accompanying Teacher Resource Book, Toronto: Harcourt Brace Jovanovich.

Moore, A. (1992, July). Interview: Unit design of "Fluids" (on audiotape). Truro, N.S.

Moore, A. (1993, February 11). Interview: Reasons for STS design decisions in "Fluids" (on audiotape). Truro, N.S.

Morine-Dershimer, G. (April, 1977). What's in a plan? Stated and unstated plans for lessons. Paper presented at the annual meeting of the American Educational Research Association, New York.

National Science Teachers Association. (1985, July). Science-technology-society: Science education for the 1980s, an NSTA position statement. Washington: National Science Teachers Association.

Nicholson, G. (1984). Seeing and reading. New Jersey: Humanities Press.

Novak, J.D. & Gowin, D.B. (1984) Learning how to learn. New York: Cambridge University Press.

Odman P-J. (1988). Hermeneutics. In J.P. Keeves (Ed.), Educational research, methodology, and measurement: An international handbook (pp. 63-70). New York: Pergamon Press.

Polanyi, M. (1969a). Knowing and being. In M. Greene (Ed.), Knowing and being (pp. 123-137). Chicago: The University of Chicago Press.

Polanyi, M. (1969b). The structure of consciousness. In M. Greene (Ed.), Knowing and being (pp. 211-224). Chicago: The University of Chicago Press.

Posner, G.J. (1988). Models of curriculum planning. In L.E. Beyer & M.W. Apple (Eds.), The curriculum: Problems, politics, and possibilities (pp. 77-97). New York: State University Press.

Pratt, D. (1980). Curriculum: Design and development. Toronto: Harcourt Brace Jovanovich.

Pring, R. (1976). Knowledge and schooling. London: Open Books.

Reid, W.A. (1979). Practical reasoning and curriculum theory:

In search of a new paradigm. Curriculum Inquiry, 9(3), 187-207.

Remy, R.C. (1990). The need for science/technology/society in the social studies. Social Education, 54, 203-207.

Roberts, D.A. (1982a). Developing the concept of "curriculum emphases" in science education. Science Education, 66(2), 243-260.

Roberts, D.A. (1982b). Curriculum Emphases - a key area for teacher decision making (the case of school science). In K.A. Leithwood (Ed.), Studies in curriculum decision making, (pp. 211-225). Toronto: OSIE Press.

Roberts, D.A. (1983). Scientific literacy: Towards balance in setting goals for school science programs (Discussion Paper). Ottawa: Science Council of Canada.

Rosenthal, D.B. (1984). Social issues in high school biology textbooks: 1963-1983. Journal of Research in Science Teaching, 21(8), 819-831.

Ruba, P.A. (1991). Integrating STS into school science and teacher education: Beyond awareness. Theory Into Practice, 30, 303-308.

Ruba, P. & Wiesenmayer, R. (1990, April). A study of the qualities teachers recommend in STS issues investigation and action materials. Paper presented at the 1990 meeting of the National Association for Research in Science Teaching, Atlanta, GA. (ERIC Document Reproduction

Service No. ED 340575)

Schon, D.A. (1983). The reflective practitioner: How professionals think in action. New York: Basic Books.

Schwab, J.J. (1970). The practical: A language for curriculum. Washington, DC: National Education Association.

Science Council of Canada (1984). Science for every student: Educating Canadians for tomorrow's world (Report 36). Ottawa: Science Council of Canada.

Shayer, M. & Adey, P. (1981). Towards a science of science teaching. London: Heinemann.

Smyth, M. (1989). Micro-organisms and food supplies. In Atlantic Science Curriculum Project, SciencePlus Technology and Society 7 and accompanying Teacher Resource Book, Toronto: Harcourt Brace Jovanovich.

Smyth, M. (1992, August). Interview: Unit design of "Micro-organisms and Food Supplies" and "Growing Plants" (on audiotape). Halifax, N.S.

Smyth, M. (1993, February). Interview: Reasons for STS design decisions in "Micro-organisms and Food Supplies" and "Growing Plants" (on audiotape). Halifax, N.S.

Smyth, M. & McFadden, C. (1990). Growing Plants. In Atlantic Science Curriculum Project, SciencePlus Technology and Society 8 and accompanying Teacher Resource Book, Toronto: Harcourt Brace Jovanovich.

Soltis J.F. (1990). The ethics of qualitative research. In E.W. Eisner and A. Peshkin, Qualitative inquiry in education, (pp. 247-257). New York: Teachers College Press.

Stake, R.E. & Easley, J.A. (1978). Case studies in science education, Vol. II: Design, overview, and general findings. University of Illinois: Center for Instrucational Research and Curriculum Evaluation. (ERIC Document Reproduction Service No. ED 166 059)

Staver, J.R. & Bay, M. (1987). Analysis of the project synthesis goal cluster orientation and inquiry emphasis of elementary science textbooks. Journal of Research in Science Teaching, 24(7), 629-643.

Stenhouse, L. (1975). An introduction to curriculum research and development. London: Heinemann.

Tanner, D. (1990). The curriculum frontier. Social Education, 54, 196-197.

Tanner, D. & Tanner, L. (1990). History of the school curriculum. New York: Macmillan.

Tyler, R. (1949). Basic principles of curriculum and instruction. Chicago: University of Chicago Press.

Vickers, G. (1965). The art of judgement: A study of policy making. New York: Basic Books.

Waks, L.J. (1992). The responsibility spiral: A curriculum framework for STS education. Theory into Practice, 31(1), 13-19.

Walker, D. (1971). A naturalistic model for curriculum development. School Review, 80(1), 51-65.

Weinsheimer, J.C. (1985). Gadamer's hermeneutics: A reading of truth and method. London: Yale University Press.

Weis, I.R. (1978). Highlights report of the national survey of science, mathematics and social studies education. Research Triangle Park, NC: Center for Educational Research and Evaluation, Research Triangle Institute.

(ERIC Document Reproduction Service No. ED 152 566)

World Commission on Environment and Development (1987). Our common future. New York: Oxford University Press.

Wraga, G.W. & Hlebowitsh, P.S. (1991). STS education and the curriculum field. School Science and Mathematics, 91(2), 54-59.

Yager, R.E. (1986). What is wrong with school science? The Science Teacher. 53(1), 145-147.

Yager, R.E. (1990). The science/technology/society in the United States: Its origin, evolution, and rationale. Social Education, 54, 198-201.

Yager, R.E. & Bonnstetter, R.J. (1984). Student perceptions of science teachers, classes, and course content. School Science and Mathematics, 84(5), 406-414.

Zuga, K. (1991). The technology education experience and what it can contribute to STS. Theory into Practice, 30(4), 260-266.

Appendix

Aggregate Feature List from the Units

The features that were taken directly from the units are given below. They are in their original form and often refer directly to the unit. For each feature evidence is given from at least one of the following sources: (a) the text itself; (b) the interview with the author of the unit; and (c) the teacher's guide. For each feature below, the number of the corresponding feature from the final generic list that can be found in the body of the paper is referred to in parentheses after the feature is stated. If a feature is found in another unit that is similar to one already given in the list below, it is not re-stated in this list.

Energy and You (John Haysom)

The choice of energy concepts to be developed is determined by their necessity in understanding energy production and issues that involve energy consumption. (2)

text

This is seen in the fact the each of the concepts developed are used in some sense later in the unit. They represent a basis for a firm understanding of the concepts to come. In addition to developing a basis for understanding the technology, the science is used to provide a conception of energy and related ideas to serve as a basis for the issue development. At several places in the technology section reference is made to these science concepts. In the case of energy converters, generation systems are classed as to what type of energy they convert.

author

"[Science comes first because] I needed to establish an information base--a scientific information base. . . . If I build this solid scientific information base first, then I thought there was a chance that I could casually refer to it so as to bring the decision into full focus." (March, 1992)

"I wanted them to understand that energy can be changed from one form into another--converted from one form into another--and that was necessary because later on they start using those ideas when you are talking about different sources of energy. They couldn't understand the ideas of wind energy, tidal energy, and nuclear energy unless you understood this notion that energy can come in many forms and all of them can be transformed into electricity." (March, 1992)

"There are all sorts of ideas--if you like, scientific ideas--[that needed to be established] before the issue could be addressed." (March, 1992)

Examples of energy producing (or converting) technology were developed to give students a greater conception of energy production which is later used as a basis for developing the issue. (4)

text

This is done by presenting a section on the electrical generator as well as steam and hydro generation systems. The way each worked was developed in general terms.

author

"I think I always go for meaning for the kids. [They look at] . . . an electrical socket and say, Where does this come from?" (March, 1992)

"The hydrodam--that was there so that children could gain an understanding of how a water wheel could be harnessed so as to provide the electricity that comes out of the socket in the wall." (November, 1992)

An understanding is developed of the role energy has played in society's past and may play in the future to help students see the changes energy has brought about in our lives and the importance of decisions about the future. (6)

text

The past is dealt with in sections using a time line relating societal changes to energy and in the historical story. The future is considered in the two letters describing what the future may be like (one optimistic; the other not) and by presenting headlines describing future energy related developments and having students react. This conception of time and change is important as a context for decision making.

author

"In the beginning, what I was trying to do was to show kids how important energy was in their lives, and so the exercise really involved their comparing life without electricity to life with electricity, and in order to that I chose to do it historically." (August, 1992)

"The second part [dealing with the future] really followed on the thought that oil is running out and therefore, the most ready source of electricity is running out, which creates a problem. So after a series of considerations in which they try to look for alternative energy sources, I said OK lets savour this problem and see if you can understand the impact of different developments." (August, 1992) teacher's guide

"Woven into the unit are three lessons which involve students perceiving how their lives are affected by energy. The lessons follow a time line from life 100 years ago to life today and to life in the future." (p. 217)

A teaching strategy is suggested in which the students are asked to use a number scale to rate the connection between lifestyle and energy at different periods through history. (p. 227)

Technological process is taught by presenting and example of an experiment or test designed to solve a technological problem. (9)

text

The text uses an aside in order to show a write-up of an experiment designed to demonstrate the process that can be used to solve a technological problem. The experiment was conducted to find the best length and angle for windmill wheel blades.

author

"It [the windmill section] was purely an excursion which provided the kids with an opportunity to develop some enquiry skills." (March, 1992)

"It [the windmill section] is included to give children an opportunity of developing some of their process skills and really is a sidetrack which teachers might take if they want to encourage the development of those skills." (November, 1992)

teacher's guide

"Science is a systematic process of investigation. Technology is a device created or improved by science." (p. 240)

In presenting decision making this unit emphasizes understanding the issue but remains neutral with respect to what should be done, if anything. (13)

text

The unit does not at anytime tell the student what to do with respect to deciding on action. It even leaves "do nothing" as an option. The emphasis lies in a fair understanding and assessment of the issue and this is what mos' of the unit is devoted to. It can be argued that because a unit ike this is written it is not neutral and this is true; the unit does recognize energy conservation as an important issue but the neutrality is found in the unit not promoting a certain course of action.

<u>author</u>

Haysom claims that he would like to lead them to the edge of the issue but leave the decision to then as to whether they will act or not. Would like them to "intelligently make a decision." (March, 1992)

"I'd almost like to keep my hidden values completely hidden." (March, 1992)

"Clearly the focus there was on saving energy, and that was something which certainly influenced me although I wanted to look at it in a more value neutral way." (August, 1992)

The students are asked to make personal decisions that forces them to experience the decisions on an opportunity-cost (implicit development) basis. (15) (17)

<u>text</u>

The decisions are made on whether the student will carry out actions to save energy or not. The approach to these decisions is mainly a "why would you" and "why wouldn't you" sort that puts them in a position to consider if any one particular saving is worth the personal sacrifice.

<u>author</u>

"For decisions to be meaningful they've got to be personal decisions." (August, 1992)

"They had to be decisions that they personally could make and I was looking for examples that they would find sensible--meaningful--and I thought that kids could readily appreciate the pros and cons of black and white TV versus color TV for example." (August, 1992)

<u>teacher's guide</u>

"This lesson [the Energy Saving Debate] reinforces the idea that conserving energy has a cost. It involves our deliberately choosing a lifestyle which may be less comfortable." (p. 255)

<u>note</u> - This observation also helped lead to feature 17, involving whether decisions are actually made, when considered in comparison to decision making presented in "Environmental Quality". Where decision making was carried out in "Energy and You", it was not in "Environmental Quality". This lead to the distinction between presenting and actually carrying out decision making.

The students are asked to participate in collective decision making that forces them to experience dealing with the viewpoints of others. (16) (17)

<u>text</u>

This is dealt with in two places. The first, and more informal, is were energy saving decisions are taken up as a family and the second is where decisions regarding the best energy supply for the future is debated in a session held with parents and after the alternative energy source display is viewed. This places other opinions in the decision picture and allows the student to see how decisions can come out of this situation as a vote is suggested to decide the issue.

<u>author</u>

Haysom stated that he is concerned with introducing the political component. (March, 1992)

"You're having to accept that your opinion doesn't count all that much in the big picture; it's just one." (March, 1992)

<u>note</u> - This observation also helped lead to feature 17, involving whether decisions are actually made, when considered in comparison to decision making presented in "Environmental Quality". Where decision making was carried out in "Energy and You", it was not in

"Environmental Quality". This lead to the distinction between presenting and actually carrying out decision making.

Environmental Quality (Allan Moore)

Social research skills are developed in order to complete and present an environmental project. (10)

text

The text devotes quite a bit of space to the preparing the students to research a local environmental problem or situation and report back. There are a wide range of data sources suggested and a research model is presented and explained.

Author

"I think probably they'll learn as much in the projects--going out and asking people, interviewing people, gathering data, doing surveys, making newspaper clippings. . . . I see this as the central part [of the unit]." (April, 1992)

teacher's guide

"In many ways, the students project is the heart of the unit. Students are asked to conduct a case study on an environmental issue. . . . Besides information collected from book resources, they must include information gathered from a non-book source. . . . From this project students will develop research skills and knowledge of the range of issues which will be examined in the classroom." (p. 332)

The different perspectives that must be taken into account in deciding on an action are discussed and examined in the unit. (14)

<u>text</u>

This is discussed very near the end of the unit in a section on issues and actions. The need for considering the opinions of others and finding the reasons behind the opinions is explicitly discussed. The different consequences of a particular action taken with respect to a given issue are examined in relation to this. The students are also asked to select a local issue and design a questionnaire to see what the opinions of other people are.

<u>author</u>

"I wanted them [the students] to examine the issue in terms of both positive and negative consequences in terms of the different perspectives that might have a say in determining a solution to it--how opinions vary." (April, 1992) teacher's guide

"The unit closes by examining the range of opinions the public holds on any issue and its solutions." (p. 318)

"Solutions to environmental problems often come about through consensus with the input of many interest groups: politicians, affected individuals, environmentalists, etc. . . . This section reinforces these ideas by examining a range of possible solutions to a number of problems and the interest groups that may have input into the decision-making process. (p. 351)

Fluids (Allan Moore)

The formation of fluid related science concepts is a priority in the unit. (1)

text

This is evident in the very organization and attention given to the concepts. The unit develops the different conceptual aspects of fluids one at a time. Any non-science content is introduced when the concept development makes it appropriate. The coverage of such sidetracks is brief.

author

In describing the unit it is clear that the science concepts are the central concern. In describing the outline of the unit Allan Moore states, "It [the gathering of student ideas] brings forth the main physical science concepts that are going to be developed through the unit such as density, buoyancy, pressure, and fluid flow and so on and so forth. All of these things emerge in these opening lessons and then the second part of the unit is looking at density and buoyancy and its impact on fluids; and then the third part tends to concentrate more on pressure effects, and how fluids, both gases and liquids, exert pressure, how they differ, and some technological applications of those like pumps and valves." (July, 1992)

teacher's guide

"The major themes of the unit are: the nature of fluids; why things float or sink in fluids; pressure and the effect of pressure on fluids; and technologies that involve fluids." (p. 144)

Specific examples of technologies are developed in the unit to illustrate how they function in general as well as how they apply fluid related concepts. (3)

text

In the text several specific technologies are developed such as pumps, hydraulic lifts, jackhammers, and automobile brake systems. These are done using an "explain how it works" approach.

<u>author</u>

"I think I was really left with doing it to explain everyday kind of technologies that they may be familiar with or that they may encounter whether it's a bicycle pump, to pumps in their cars, to whatever it may be." (July, 1992)

<u>teacher's guide</u>

In the unit description technology was said to be applied by "analyzing systems that use the ideas of buoyancy, pressure, and fluid flow" (p. 144).

The purpose of doing so was "to bring relevance to the science being studied. The science is being applied to systems that are part of the student's everyday world" (p. 144).

Students follow through with their design projects and actually create models of real technologies. (12)

<u>text</u>

Throughout the unit the students are engaged in several actual design projects and in some of these they are actually expected to produce a model based on their design decisions. For example, they are asked to come up with a model oil rig near the beginning of the unit. They plan the creation of the model and then construct it.

author

The fluids section began with a technological design problem. That was the [making of the] oil rig, and so that one started with quite a major type of technological design problem which could be a full-fledged kind of project" (July, 1992).

"With pressure and that aspect of fluids there were a couple of smaller design problems. One was the making of the water tower" (July, 1992).

Micro-organisms and Food Supplies (M. Muriel Smyth)

The personal lifestyle of the student was related to the issue in order to sensitize them to the problem and affect their behavior. (5)

text

This is seen in how the unit relates the issue of preventing food poisoning to situations the students can identify with. The opening of the unit describes a food counter going through an inspection by the health inspector and points out many problems that would be familiar to the students. In much the same way the unit remains in a context that is one that the students live in.

<u>author</u>

"I want to get something that will relate to actual life and something that would be sort of a hook--I suppose sort of a motivator in a way--and the social context would start right there and [I wanted] just a basic, ordinary, down to earth thing the kids would recognize as could happen." (August, 1992)

"I would hope that they would make good life-saving habits in relation to food. That's really the basic thing that we are getting at here and I guess that had to be my goal. Everybody, boys and girls, are all going to deal with food and all are going to work with it and it's a basic thing of everybody's everyday existence. There should be a following of certain rules, not just because somebody has told them but because they know, and I hope that from this they know that these rules matter, and know that certain ways are essential, and therefore they'll just be part of their everyday life. I really would hope that this unit would have a practical effect on every kid that used it." (August, 1992)

Structures and Design (Charles P. McFadden)

The unit developed the content within a technological problem solving shell that utilized the content of the unit. (11)

text

The unit started with a description of a public meeting where a new development was being proposed. Some debate on the issue was carried out that pointed out some of the major concerns people had. The students were assigned the task of proposing a design for the area at the end of the unit. The content of the unit dealt with factors that the students would have to take into account in doing so.

author

"They [the students] develop science and engineering concepts and then they're introduced to historical, and sociological, ethical, environmental, and aesthetic questions. . . . What I did was create the task and the setting that really enabled the kids to put all that together. That's usually the context in which all technological decision making takes place." (August, 1992)

Growing Plants (M. Muriel Smyth and Charles P. McFadden)

Science process was developed through several genuine experiments regarding plant growth. (8)

<u>text</u>

The text posed several questions, had students design experiments, had them collect data, and draw conclusions. The experiments were conducted in a genuine manner in that the results were somewhat unknown until the experiment was completed.

<u>author</u>

"It was an STS unit but it really is involved more in connecting science with what one colleague described for me as real science. . . . In a unit like growing plants, the kids really are given opportunities to do more meaningful experimentation. . . . The goal of a lot of the activity in Growing Plants is not the development of concepts; it's simply that they undertake experimentation to find what is included in science-fair-type activities: what happens if, and let's find out. (McFadden, August, 1992)

<u>Null Curriculum</u>

A global perspective could have been developed on the issue of energy consumption. (7)

<u>author</u>

"I really regret, in retrospect, that I didn't include something with respect to the amount of energy which is used in highly industrialized societies like ours and compare that with the amount of energy which is used in some of the developing societies, like India--a global perspective." (Haysom, November, 1992)

". . . [I]n Canada we consume more oil per capita than anybody else in the world. Now, had we moved into that direction, we'd have gotten into social issues of equality, resource distribution and I think that it's important to recognize that this curriculum doesn't move in that direction as much as, retrospectively, I would have liked it to have done." (Haysom, August, 1992)

Real action follows decision making in the unit. (19)

<u>author</u>

"The final and most important element of it [the decision making process] is where the individual, the student in this case, comes to a personal decision but then there should be one more step beyond that and that is where the decision leads to action and that step, where we have the decision based upon what we know, leads to action and that should have been emphasized a lot more. That action component, I don't think came through very clearly [in Environmental Quality]. For example, the action might have been writing to your

M.P. or a letter to a newspaper or starting a roadside clean-up but all of these are personal actions. I think that would have been a very important element to emerge from this but we stopped one step short. We are at the decision making process but what action? . . . I think that's an emphasis that's missing from almost all STS kind of units. That is, we study the issue and we study the science of an issue, we come to an understanding of it, but we don't ask the question, Well, what are you committed to do and what can you do?" (Moore, April, 1992)

The students are made aware of the effectiveness of several possible modes of action that may be taken in response to an issue at the personal, group, and/or political levels. (18)

<u>author</u>

"What we're really doing here is establishing the information base, we're seeing the nature of the decision and how that's informed by the science information base and then leaving dangling a whole series of loose ends which require two other information bases: one from social studies and the other from civics." (Haysom, March, 1992)

"Some form of political activism works and some form of political activism doesn't work . . . and ultimately these kids have to understand the way in which decisions are made within their society so they can be politically effective. There's a difference between political activism and political effectiveness." (Haysom, February, 1992)

"What's the value of writing a letter to your MLA? What's the value of marching on Province House? How do you inject your opinion and that of your friends--so it's really an invitation to introduce the civics course." (Haysom, March, 1992)