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ABSTRACT

"Perspectives on Transportation" is one of the "Preparing for Tomorrow's World" (PTW) program modules. PTW is an interdisciplinary, future-oriented program which incorporates information from the sciences and social sciences and addresses societal concerns which interface science/technology/society. The program promotes responsible citizenry with increased abilities in critical thinking, problem-solving, social/ethical reasoning, and decision-making. This module examines land, sea, and air transportation and also briefly considers future prospects. Provided in the teaching guide are discussions of the socio-scientific reasoning model (theoretical basis of PTW), purpose of the module, strategies employed (focusing on the dilemma/debate discussion technique), module structure and objectives, and its use in the school curriculum. Also provided are a suggested teaching schedule, guidelines for conducting dilemma discussions (including basic steps in the process), a chart indicating moral issues (as defined by Kohlberg) contained in the dilemmas presented in the student material, suggested teaching strategies for the filmstrip used to introduce the module and for activities related to each form of transportation, bibliography, and appendices containing teacher background information. The module may be used as a separate unit of study, as a mini-course, or incorporated into such subject areas as social science, language arts, or science. (JN)

PREPARING FOR TOMORROW'S WORLD

Perspectives on Transportation

Teacher's Guide

[illegible]

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Preparing for Tomorrow's World
An Interdisciplinary Curriculum Program

Coastal Decisions: Difficult Choices
Energy: Decisions for Today and Tomorrow
Future Scenarios in Communications
Space Encounters
Technology and Changing Life-Styles
Food: A Necessary Resource
Perspectives on Transportation
Future New Jersey: Public Issues and the Quality of Life
People and Environmental Changes
Environmental Dilemmas: Critical Decisions for Society
Of Animals, Nature and Humans
Beacon City: An Urban Land-Use Simulation
Dilemmas in Bioethics
Technology and Society: A Futuristic Perspective

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PREPARING FOR TOMORROW'S WORLD

Perspectives on Transportation

Teacher's Guide

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PREFACE

We live in an exciting, rapidly changing, and challenging world — a world highly dependent upon science and technology. Our world is changing so rapidly that we sometimes fail to recognize that much of what we today take for granted as common, everyday occurrences existed only in the imaginations of people just a few short years ago. Advances in science and technology have brought many dreams to fruition. Long before today's school children become senior citizens, much of today's "science fiction" will, in fact, become reality. Recall just a few accomplishments which not long ago were viewed as idle dreams.

- *New biomedical advances have made it possible to replace defective hearts, kidneys and other organs.*
- *The first air flight at Kitty Hawk lasted only a few seconds. Now, a little over half a century later space ships travel thousands of miles an hour to explore distant planets.*
- *Nuclear technology — of interest a few short years ago because of its destructive potential — could provide humankind with almost limitless supplies of energy for peace-time needs.*
- *Computer technology has made it possible to solve in seconds problems which only a decade ago would require many human lifetimes.*
- *Science and technology have brought us to the brink of controlling weather, earthquakes and other natural phenomena.*

Moreover, the changes which we have been experiencing and to which we have become accustomed are occurring at an increasingly rapid rate. Changes, most futurists forecast, will continue and, in fact, even accelerate as we move into the 21st Century and beyond. But, as Barry Commoner has stated, "There is no such thing as a free lunch." These great advances will not be achieved without a high price. We are now beginning to experience the adverse effects of our great achievements.

- *The world's natural resources are being rapidly depleted.*
- *Our planet's water and air are no longer pure and clean.*
- *Thousands of plant and animal species are threatened with extinction.*
- *Nearly half the world's population suffers from malnutrition.*

While science and technology have given us tremendous power, we are also confronted with an awesome responsibility, to use the power and ability wisely, to make equitable decision tradeoffs, and to make valid and just choices when there is no absolute "right" alternative. Whether we have used our new powers wisely is highly questionable.

Today's youth will soon become society's decision-makers. Will they be capable of improving upon the decision-making of the past? Will they possess the skills and abilities to make effective, equitable, long-range decisions to create a better world?

To the student:

This module has been prepared to help you — the student and future decision maker — function more effectively in a rapidly changing world. Other modules in the *Preparing for Tomorrow's World* program focus on additional issues of current and future importance.

To the teacher:

It is our belief that this module — and indeed the entire *Preparing for Tomorrow's World* program — will help you the teacher prepare the future decision-maker to deal effectively with issues and challenges at the interfaces of science, technology, society. It is our belief that the contents and activities in this program will begin to prepare today's youth to live life to the fullest, in balance with Earth's resources and environmental limits, and to meet the challenges of tomorrow's world.

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INTRODUCTION

Transportation today reflects some of our most exciting advances in science and technology of the past hundred years. What Jules Verne wrote as science fiction in the 1800's are now realities — we can jet across continents in a few short hours, stay submerged in the depths of the ocean for weeks, or explore outer reaches of space. With developments in transporation our world has changed in many ways. Our man-made landscape has been shaped by our various forms of transportation. Our very lifestyles can be said to be a product of our mobility — moving people and goods quickly, efficiently and economically. From a once rural population, we are now essentially an urban population. Modern travel has opened for us new horizons of which our grandparents never dreamed.

Yet with these new developments have come a new and different set of issues. Traffic accidents have become a major cause of death. Automobile exhaust fumes are the major contributors of air pollution. The quality of our environment is threatened by oil spills; waste from chemicals that are used in the manufacture of our vehicles and keep them running; road de-icer salts that contaminate farmlands and water supplies; and off-road vehicles that trample fragile plant and animal communities, to cite a few. While there is no turning back to the horse and buggy, there is a need to examine the consequences of our modern mobility and try to avert serious dislocations in the future.

The issues surrounding transportation are many. Just a brief scan of a daily newspaper reveals a plethora of news items related to transportation concerns, problems and controversies. These issues impact upon our lives at all levels and pose difficult to resolve dilemmas. That there is a need for wise and responsible decision making and creative and effective problem solving is clearly evident.

Perspectives on Transportation is intended to create an awareness about some of the questions and concerns regarding transportation now and in the future. Helping students develop decision making skills is an integral component because they will be our future decision makers living in an increasingly complex world. The materials and activities have been selected to challenge students to more critically analyze and evaluate the implications and consequences of different decisions on transportation. They will discover that decisions are value laden and that the moral, ethical elements are inextricably intertwined in all aspects of human affairs. These value considerations produce conflict. By addressing some of these conflicts, it is hoped that students will begin to question their own ideas and ideas of others and gain new insights into our transportation needs and concerns.

The Theoretical Basis of *Preparing for Tomorrow's World:* The Socio-Scientific Reasoning Model

As pointed out in the Introduction to this guide, developments in science and technology are not without societal issues and problems. New developments and applications will inevitably bring about new issues as well as increase their complexity. Unlike scientific problems, socio-scientific problems often have no "correct" answer because they involve human choices and decisions. Such choices and decisions are value ladened. The particular decisions made today and tomorrow will determine the course of the future. Hence, we are faced with the profound challenge to make just and wise decisions in order to create a better future world. To help prepare our students to become more effective problem solvers and decision makers, education will need to focus on the simultaneous development of the following skills.

- Ability to deal with problems containing multiple interacting variables
- Decision making that incorporates a wider social perspective
- Critical thinking in the evaluation of consequences and implications

Components of the Socio-Scientific Reasoning Model

In response to the above concern and recognizing the importance of this mode of development, we developed the "socio-scientific reasoning" model to serve as a framework in the production of our curriculum materials. This model combines our own philosophy, ideas and research with the theories and philosophies of Piaget, Dewey, Kohlberg and Selman. Basic to these theories is the idea of education as helping an individual grow both intellectually and morally. Therefore, this socio-scientific reasoning model approaches education from a developmental perspective. This model incorporates the ideas of stage development from the perspective of cognition, moral, ethical reasoning and social role taking. The basic tenets of these theories are briefly summarized below

Logical Reasoning

Jean Piaget, the noted Swiss psychologist, has made important contributions in the area of cognitive development which are pertinent to our efforts[1,2]. Piaget views the development of logical reasoning as progression through the series of stepwise stages indicated in Table 1 (sensori-motor preoperational, concrete operational and formal operational) At each successive stage the logical reasoning ability of individuals takes on a broader perspective and incorporates the ability to deal with greater numbers of interacting variables of increasing intellectual complexity. Each stage of thinking builds upon the previous one, but takes on a new structural form Growth in cognition, it seems, can be facilitated and nurtured through appropriate educational experiences.

In explaining growth in logical reasoning capability, Piaget refers to the processes of assimilation, accommodation, and equilibration. Assimilation occurs when the child incorporates new ideas and situations into his or her existing thought structures. On the other hand, the child also encounters objects and events that do not fit into his or her existing thought structures. In these contradictory situations, the child has essentially two options he/she must either enlarge his/her existing structures or create a new category or structure. Piaget defines this as the process of accommodation.

Intellectual growth, Piaget postulates, occurs when the individual attempts to resolve the tension between the interactive processes of assimilation and accommodation by developing new thoughts and responses that are more suitable or adequate. Equilibrium is re-established when thought structures are altered, producing new accommodations that enable the individual to assimilate the new situations. Intellectual growth, then, occurs through internal self-regulation processes that lead to new, higher levels of equilibration.

Moral/Ethical Reasoning

While there are several approaches to values education, the more encompassing one is the cognitive developmental approach offered by Lawrence Kohlberg[3,4]. Kohlberg's ideas are derived from the philosophic positions of Dewey and and Piaget. The emphasis here is to help individuals grow intellectually and morally. This is, we feel, a more functional approach than arbitrary indoctrination of values as used in "character" or "socialization" education or taking a "values relativity" stance, typically employed in the more common values clarification approach.

Kohlberg's moral/ethical development theory is an extension of Piaget's cognitive development theory. Similarly to Piaget, Kohlberg views moral development from childhood to adulthood as progression through a series of stages (Table 2). Each stage is characterized by a very different way of perceiving and interpreting one's experiences. At Kohlberg's Stage 2, for example, "right" and "wrong" are judged in terms of satisfying one's own needs and sometimes the needs of others if it is convenient to do so. Stage 3 type of reasoning centers around maintenance of approval in one's own social group. The orientation is towards conformity to group expectation. At the higher principled stages, reasoning takes into account concerns for the welfare of others in a broader context, and includes concerns for human dignity, liberty, justice, and equality—those very same principles upon which our Constitution is based.

Following Piaget, Kolhberg views development not as mere accumulation of information, but changes in thinking capabilities—the structures of thought processes. In the course of development, higher-level thought structures are attained and result in the extension of an individual's social perspective and reasoning capabilities. Applying higher levels of thinking to problems results in problem solutions that have greater consistency and are more generalizable. See Appendix detailing the stages of development.

Social Role-Taking Stages

The research of Robert Selman[5] indicates that social role taking ability is a developed capacity which also progresses in a series of stages from early childhood through adolescence. Role taking is viewed by Selman in terms of qualitative changes in the manner a child structures his, her understanding of the relationship between the perspectives of self and others.

Using the open-ended clinical method of inquiry first applied by Piaget and then later by Kohlberg, Selman has identified and defined Stages 0 through 4 (age range is approximately 3 years to 15+ years). These stages are referred to as, Ego-centric Viewpoint (Stage 0), Social-Informational Role Taking (Stage 1), Self Reflection Role Taking (Stage 2), Mutual Role Taking (Stage 3), and Social and Conventional System Role Taking (Stage 4). Descriptions of the role taking stages appear in Table 3. Each of Selman's role taking stages relates closely to and parallels Kohlberg's moral reasoning stages.

Selman views the social role taking stages as a link between Piaget's logical reasoning stages and Kohlberg's moral reasoning stages. Just as Piaget's logical reasoning stages are necessary but not sufficient for attaining the parallel moral reasoning stages, a similarly necessary but not sufficient relationship appears to exist between the social role taking stages and parallel moral reasoning stages.

As Selman has pointed out, "...the child's cognitive stage indicates his level of understanding of physical and logical problems, while his role taking stage indicates his level of understanding of the nature of social relations, and his moral judgment stage indicates the manner in which he decides how to resolve social conflicts between people with different points of view".

The Socio-Scientific Reasoning Model

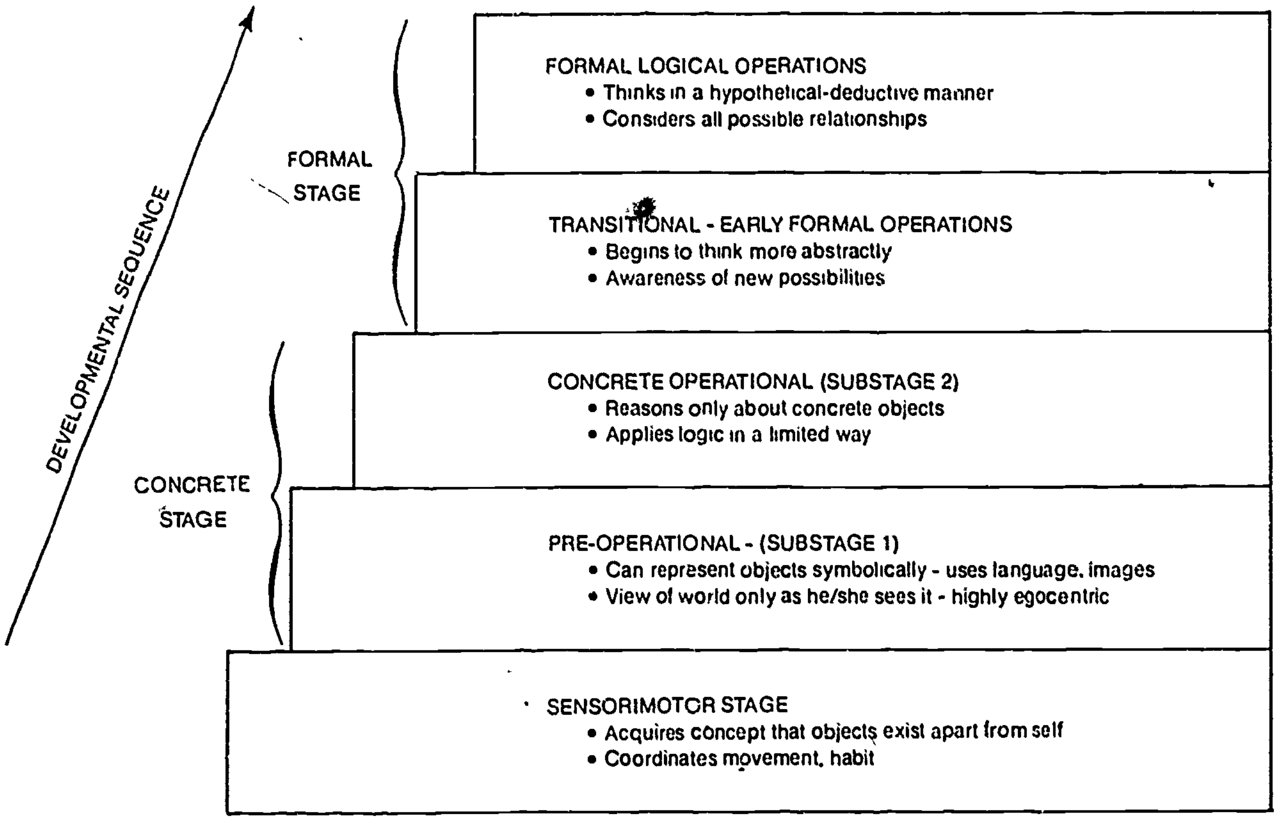
Combining our own philosophy, ideas, and research with the theories of Piaget, Kohlberg and Selman, the socio-scientific reasoning model has been developed. Socio-scientific reasoning, as defined here, is the incorporation of the hypothetico-deductive mode of problem solving with the social and moral, ethical concerns of decision making. This model has served as a guide in the development of educational materials to help students advance to higher levels of thinking and reasoning capabilities. Moreover, it is highly flexible and readily adaptable to other classroom activities.

The basic assumption of this model is that effective problem solving requires simultaneous development in the realms of logical reasoning, social role taking, and moral, ethical reasoning. Purely objective scientific thinking cannot be applied in the resolution of most of the probable future conflicts without regard to the impact of those decisions on human needs and human goals. A technological solution, for example, may be, after critical analysis, feasible and logically consistent. From a societal perspective, however, one must question whether or not it should be applied. How to best prioritize our needs and evaluate trade-offs with a concern for the needs of future generations involves logical reasoning and critical thinking, but now with an added dimension . . . a social moral, ethical reasoning dimension.

Hence, the Socio-Scientific model consists of four interacting components (see Figure 1): (1) logical reasoning develop-

TABLE 1

PIAGET'S STAGES OF COGNITIVE DEVELOPMENT



ment is based on the theories of Piaget, while (2) moral, ethical reasoning relies strongly on Kohlberg's ideas. Selman's research provides the basis for the third component, the social role taking aspects of our model. Since the content or information component of the problem (component four) will vary, so too will the concepts vary accordingly. For example, in our applications of this model we have concentrated on issues at the interfaces of science, technology, and society. Of course, problem issues could also deal with or focus on any other topic one chooses to investigate

The content component also consists of three interacting subunits. These subunits science, technology, and society-- rely on each other for their very existence While each of the subunits is dependent upon the others, their individual underlying value structures create a high potential for discord since the concerns of one subunit often conflict with those of the

TABLE 2

KOHLBERG'S STAGES OF MORAL DEVELOPMENT

DEVELOPMENTAL SEQUENCE

STAGE 5 SOCIAL CONTRACT
- Emphasis on democratic ethic, reaching social consciousness
- Respect for self and other

STAGE 4 LAW AND ORDER
- Do your duty, set good example
- Respect authority and follow the rules

STAGE 3: CONFORMITY
- What is right is what others expect of me
- Be kind and considerate of others - good intentions

STAGE 2 BACK SCRATCHING
- What's right is what's good for me
- Eye for eye, tooth for tooth concept of justice

STAGE 1 OBEDIENCE AND PUNISHMENT
- Right is what authorities command
- Be good and avoid punishment

TABLE 3

SELMAN'S ROLE-TAKING STAGES

DEVELOPMENTAL SEQUENCE

STAGE 4. SOCIAL AND CONVENTIONAL SYSTEM ROLE TAKING
- Realizes mutual perspective taking does not always lead to complete understanding
- Each self considers the shared point of view of the generalized other (social system)

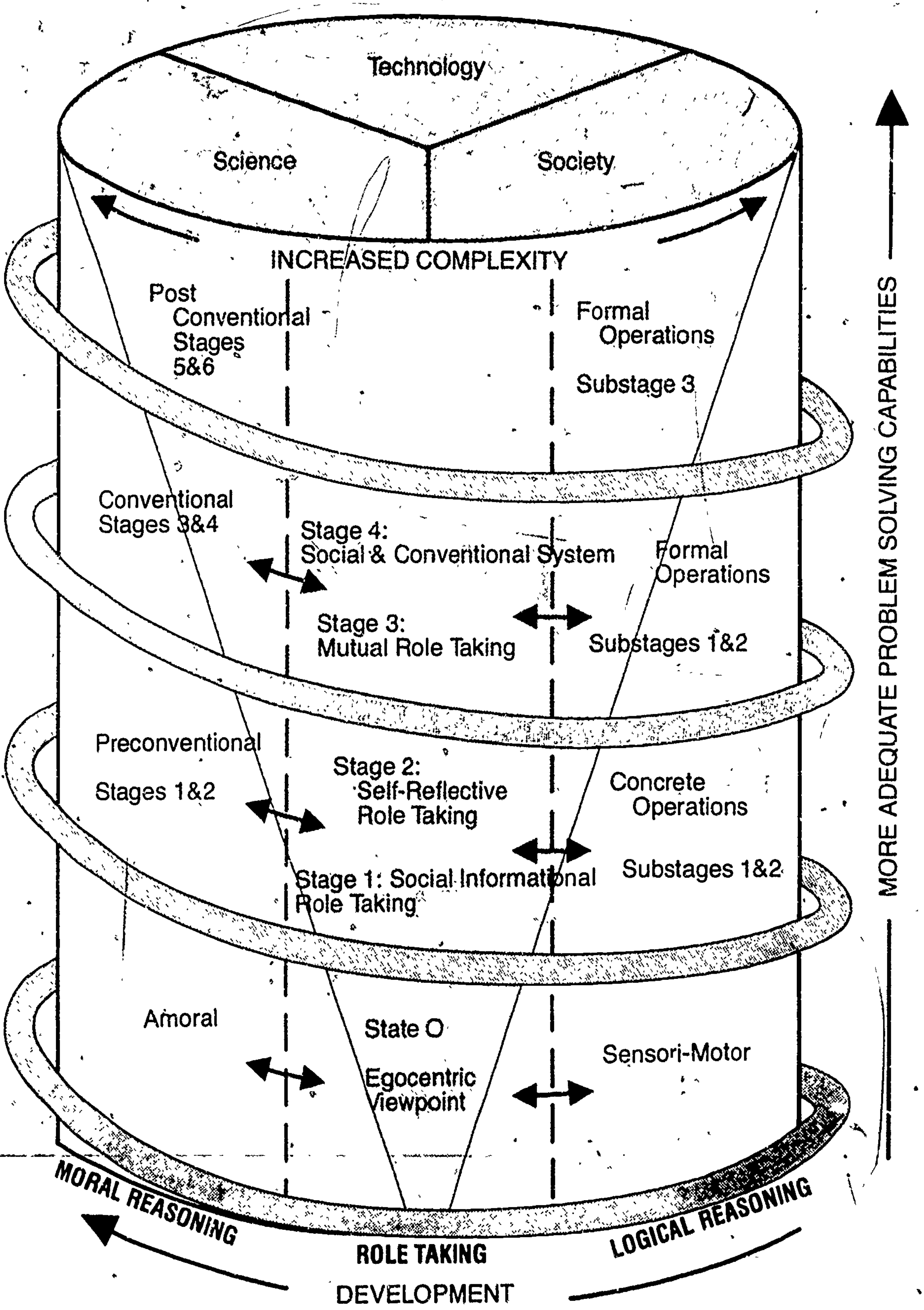
STAGE 3 MUTUAL ROLE TAKING
- Realizes self and other can consider each party's point of view simultaneously and mutually
- Can step outside dyad and view action from third person perspective

STAGE 2 SELF-REFLECTIVE ROLE TAKING
- Relativistic belief that no person's perspective is absolutely valid
- Reflects on the self's behavior as seen from other's point of view

STAGE 1 SOCIAL-INFORMATION ROLE TAKING
- Aware that self and others may have different social perspectives
- Focuses on one perspective, not on coordinating viewpoints of self and others

FIGURE 1

THE SOCIO-SCIENTIFIC REASONING MODEL



others. This paradox – dependence and simultaneous conflict among the subunits – presents a unique opportunity and context for curriculum developers employing the Socio-Scientific Reasoning model to prepare educational materials.

Each component of this model is not seen as a totally separate and distinct entity. Rather, each of the four components interacts with and has an effect on all other components. Thus, logical reasoning has an effect on, and in turn is affected by, social role taking development. In a similar manner, social role taking has an effect on, and is affected by, developments in the moral/ethical realm. Of course, logical reasoning and moral ethical reasoning also interact. Each of these major components—logical reasoning, social role taking, and moral/ethical reasoning – interact not only with each other but with the fourth component, content or information.

Referring to Figure 1 again, the content cone is small at the low end because at earlier stages of development the number of concepts entertained are smaller and the concepts are simple in nature. Hence, as the cone broadens so too does the complexity of content or information included. Individuals at stages of development intersecting the lower end of the cone can deal with issues and concepts of a simpler form while, on the other hand, individuals at the upper end with higher levels of maturity have the capacity for dealing with more issues and issues of greater complexity. Development, then, is both vertical and horizontal. vertical development is from lower to higher stages. horizontal development relates to the "necessary but not sufficient" requirements which must be satisfied as one moves from logical reasoning, through social role taking, to moral reasoning capabilities.

Thus, while each stage reflects a distinctly unique capability for problem solving in a science, technology, society context, we view development or progress as a continuously spiraling process. In this process, however, there are leaps and quiesence, and fixation at any stage is possible. Levels of logical reasoning, moral reasoning, and role taking maturity also seem to vary, we find, depending on the issues addressed. These apparent inconsistencies in reasoning – even when dealing with the same or similar mental and moral constructs—seem to be related to the degree of emotionality, familiarity with, interest in, and/or knowledge about the issues under consideration[7].

The goal then is to help each individual "spiral" upwards through the Socio-Scientific Reasoning cone and synchronously achieve "more adequate" problem solving capability. "More adequate" as used here refers to the idea that when applied to problem solving, the higher stages of reasoning result in solutions that are more encompassing and generalizable, they enable students to deal with greater complexity.

Application of the Socio-Scientific Reasoning Model in the Classroom

The Socio-Scientific Reasoning model therefore serves as the basis for identifying the types of learning experience and the sophistication level of those experiences important to help students develop. It recognizes that learning capabilities differ with age, grade level, interest and learning needs. Implicit in the model and in accord with stage theory is the idea that at each stage there is a characteristic form of thinking capability which determines how experiences and information are interpreted and acted upon

The main strategy underlying all of these activities is based on Piaget's concept of equilibration It is only when disequilibrium is created that active restructuring of thought takes place. This active restructuring leads to growth in logical reasoning, in social role taking, and in moral ethical reasoning capabilities as well.

Restructuring of existing cognitive structures occurs when internal disequilibrium is felt by the individual New experiences and inputs which are not readily comprehensible to the individual challenge his/her existing mode of thought by revealing inadequacies or inconsistencies in that problem solving strategy[8]. Arrestment at a given stage is partially explained by the developmental theorists as the lack of opportunities that create conflict or dissonance which place the individual in a position where he/she needs to assess his/her particular mode of thinking. Perhaps, as Clive Beck points out, the reason why people do not develop morally is because they have not had the opportunity to entertain alternatives – their imaginations have not been extended[9]. We, in addition, contend that the reason people do not advance in logical reasoning can also be attributed, to a large degree, to a similar lack of opportunities.

We have identified some of the basic elements needed to provide experiential opportunities that promote development of problem solving and decision making skills. A partial listing includes providing opportunities for students to:

- Encounter a variety of viewpoints
- Experience higher level reasoning
- Take the perspective of others
- Examine and clarify one's own ideas
- Examine the consequences and implications of one's decisions
- Defend one's position
- Evaluate possible alternatives
- Consider and recognize the role of the self to society
- Reflect on one's own value system
- Test own ideas and those of others

One educational activity which incorporates some of these elements is the classroom dilemma discussion, an activity most commonly associated with Lawrence Kohlberg and his colleagues. We have, however, modified and extended this approach to more systematically encompass critical analysis and evaluation of information and data. We have also employed such other formats as role taking, simulations, and futures forecasting and analysis methodologies.

For example, reasoning at a particular stage is not a value judgment of whether an act is good or bad, but is the pattern of the concepts entertained in judging the "ought" of rights, duties and obligations of human relationships. Younger children at lower stages reason about duties in terms of reciprocal benefits from the party – "If you do me a favor, I will do you a favor." Whereas in principled reasoning, duty is what an individual has become morally committed to do and is self-chosen. Higher stage reasoning is therefore the ability to apply value concerns (Kohlberg's major concerns include self welfare, welfare of others, sense of duty and of motives, conscience, rules, punitive justice, role taking) in a more internalized, complex, autonomous, critical, consistent and generalized manner.

Effective discussion, however, cannot take place in a vacuum. Needed also is an information base or context from which students can begin to analyze and evaluate information. With information which they have extracted and synthesized, additional ideas and rational arguments can be developed for discussion. For curriculum activities, we have created problem situations in a variety of contexts which, according to scholars in a variety of fields, will be prominent in the next quarter century and beyond[10]. This adds another perspective to the dilemma problem—that which elicits scientific logical reasoning in addition to moral/ethical reasoning—but in a futuristic context.

These serve as mechanisms for students to put some of the ideas and judgments that have emanated from the discussion into larger structural frameworks. They also provide students with opportunities to project into the future, to think beyond their own immediate experiences, and to consider the impact of different decisions on future society.

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[3] Lawrence Kohlberg. Moral stages and moralization: the cognitive-developmental approach. In Thomas Lickona (Ed.) *Moral development and behavior theory, research, and social issues*. New York: Holt, Rinehardt and Winston, 1976.

[4] John Gibbs, L. Kohlberg, A Colby and B. Speicher-Duban. The domain and development of moral judgment. In John R. Meyer (Ed.) *Reflections on values education:* Waterloo, Ontairo, Canada, Wilfred Lawrier University Press, 1976.

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[6] Ibid, pg. 307

[7] Louis A. Iozzi. *Moral judgment, verbal ability, logical resoning ability and environmental issues.* Doctoral Dissertation, Rutgers the State University of New Jersey, 1976

[8] Carol Tomlinson-Keasey and Clark B Keasey. The mediating role of cognitive development in moral judgment *Child Development*. 1974, *45*, 291 298.

[9] Clive M. Beck. *Ethics* Toronto McGraw-Hill, 1972

[10] Harold G Shane *Curriculum change toward the 21st century* Washington, D.C National Education Association, 1977.

Overview Of *Perspectives On Transportation*

Purpose

Diminishing petroleum supplies, increase in population, industrialization in lesser developed nations, air pollution, greater global interdependence — all pose critical questions regarding future developments in transportation. Most obvious is the question "Can we continue to drive with impunity our private automobile?" Problems of fuel shortages, skyrocketing fuel costs and pollution will bring about changes in our current lifestyles and mobility. It is, therefore, the purpose of this module to engage students to examine some of the many issues related to transportation and have them consider how these different problems impact upon their lives and on the lives of others. In most cases, students will need to deal with the concept of trade-offs. What are our needs and desires, and what are acceptable consequences?

The problems and controversies that we encounter today, experts predict, will not abate in the future. Our students, citizens of the future, will be confronted with these problems, and more. The activities in this module hopefully, will help students anticipate future changes and recognize that problem solving and decision making in modern society are complex processes where a multiplicity of factors interact. They must, therefore, become cognizant of the need to develop their knowledge and reasoning abilities in order to become informed and wise decision-makers.

Strategy

In order to become aware and understand problems/issues, students need a knowledge base and must develop a sense of involvement in the controversy. Societal questions, for the most part, have no meaning or interest for younger students because they do not see how such questions relate to their lives now and particularly in the future. Their concerns tend to revolve around the very narrow confines of their immediate environment.

Hence, it is necessary to present opposing/alternative arguments and provide students opportunities to challenge their own ideas and the ideas of others. In this module background information is provided through a series of short readings, commentaries and student activities. Additional knowledge is developed as students begin to think about and discuss the material in the several types of activities and decision making opportunities. To involve students to actively examine issues and controversies, we have employed the dilemma discussions which focus on and heighten a given situation. The heightened situation of a dilemma is intended to elicit a higher level of student to student interaction so that students can begin to express their own ideas, testing them against the ideas of others. Through active involvement with the issue ideas will emerge that students can use to relate to their own lives to develop new awareness.

The dilemma debate/discussions, and simulation and role play exercises (variations of the dilemma format) thus serve as the focal point of student activity in this module. Many of the dilemmas and simulations are adapted from actual case histories, while others, although hypothetical, reflect critical choices being made today or require resolution in the near future. This approach requires students to take an active role in the dialogue, examining alternative positions and experiencing value or ethical conflict. Taking a position and defending it offers new challenges to students. They must learn to hear the arguments and opinions of others as well as examine the implications and consequences of their own stance. Also, the level of relevancy becomes elevated when students hear arguments from their peers rather than from adult authority or the printed word. Although the discussion process may seem to move more slowly than imparting information through lectures or readings, it places a personal demand on the students to organize, coordinate and interrelate information and concepts. In this manner, they will begin to understand the dynamic interrelationship of issues and the difficulty of decision making.

Although the dilemmas involve individuals, we have constructed the different dilemmas to reflect decisions having effects at the personal, community, national and international levels. Hence, students can begin to expand their scope of thinking and consider impacts from a variety of perspectives. In view of Piaget's model that places secondary school students at the transitional stage of formal development, many of the dilemmas consider social implications beyond one's own social sphere to those on a more global level. The intention is to move students from their egocentric orientation to that which encompasses a broader world view.

The dilemmas as presented are simple in form but can be further developed by the teacher with increasing complexity, depending on the intellectual and conceptual level of the students, as well as their interest and curiosity. The subject area or course in which this module is taught may determine ways in which many of the concepts might be further developed — such as concepts from sociology, economics, ecology, government, philosophy, history, etc. Drawing relationships from what is learned in the course will inevitably make students' learning more meaningful and effective.

Perspectives on Transportation in the School Curriculum

This module, designed for the secondary school level (grades 7 through 9), can serve to complement or supplement courses in a number of subject areas: social science, language arts, science, etc. Classes in different subject areas will, of course, emphasize or develop the concepts/issues presented from somewhat different perspectives. For example, in social science classes greater emphasis may be placed on how changes in transportation affect lifestyle changes or cultural developments. In science classes, more emphasis may be placed on examining the feasibility of alternative fuel sources or new types of engines. Whatever the case may be, the module is intended to provide a structure to extend and interrelate concepts presented in the courses.

Since flexibility is inherent in its design, one can use this module in a number of ways. The activities may be presented sequentially in the order given and serve as a single unit of study. Alternatively, the activities may be selectively interspersed in the teaching schedule where they best relate to ongoing classroom studies. Thus, the module can provide another dimension to the existing course or "stand alone" as a mini course.

The dilemmas can also serve as a "springboard" for teachers to develop additional dilemmas for their classes. So often it is the case that many of the best dilemmas are developed spontaneously from the materials that are part of the ongoing coursework. Having used these dilemmas, teachers can better understand the intent and value of dilemma discussions and begin to recognize other problematic situations that confront society. The question of relevancy and meaning can be bridged when specific information is related to its impact on our lives.

All important in the dilemma discussion strategy is to engage students in the consideration of problems and new concerns that arise from applications of new technologies and use of resources. It is, in essence, applying information learned to concrete examples and examining possible effects.

Objectives of the Module

- To increase the student's knowledge of transportation issues.
- To increase the student's ability to critically analyze issues and conflicting viewpoints.
- To increase the ethical/moral reasoning ability of the students.
- To increase the decision-making skills of students regarding transportation issues.
- To increase students' ability to recognize future problems which might impact on society.
- To help students recognize the different aspects of transportation and their effects on our daily lives.
- To engage students to examine their own and other students' value considerations.
- To increase students' self-esteem and ability to communicate and function more effectively in classroom discussions.
- To increase students' ability to logically and comprehensively present arguments in support of a selected viewpoint.
- To help students understand alternative viewpoints and respect opinions of others.

Components of Perspectives on Transportation

- Student's Guide
- Teacher's Guide
- Filmstrip and Audiotape Cassette
- Student Handouts - 7

Perspectives on Transportation is comprised of three major sections, each examining a different form of transportation — land, sea and air. An introductory filmstrip provides a general overview of transportation and poses some questions that will be addressed in the module. Within each section are a variety of activities and dilemmas stories which lead students to explore various aspects of that form of transportation — social, political, economic, etc. In most cases, each activity and dilemma is accompanied by background readings which highlight some of the critical issues, create problem awareness and provide ideas for discussion and further study. Included after each dilemma is a series of probe questions which students should consider and discuss when determining the course of action to be taken by the central role character. The questions also serve to help encourage and extend discussions by bringing out additional aspects of the issue.

Underlying societal problems and controversies are moral/ethical questions. The dilemma stories examine these questions. Each dilemma, thus, raises two or more moral issues. Table 4 identifies the issues emphasized in each of the dilemmas. Become familiar with the moral/ethical issues entertained in the dilemmas so that you can guide the students to address these issues in their discussion. As previously mentioned, wise and responsible decision-making must take into account the moral and ethical implication of alternative actions.

Table 4

Issues Contained in Each Dilemma

Dilemma	*Issues**								
	punishment/blame	property	affiliation role	law	life	truth	governance	civil rights/ social justice	morality/mores
1 On a Clear Day					X		X	X	
2 One Less for the Road		X		X			X		
3 How Safe is Safe?			X			X			X
4 Fuel for Our Cars — The Synfuel Battle		X						X	
5 Oil in the Sea	X		X						
6 Stranded at Sea		X			X			X	
7 Space Litter					X				X

*These basic moral issues as identified by Kohlberg comprise the underlying elements of a conflict situation involving a moral decision. Our dilemmas were constructed to incorporate two or more of these issues. Dilemma resolution requires a choice or action to be made between conflicting issues. For instance, in a dilemma dealing with the issue of governance and social justice, the questions surrounding the issue of governance include: 1) Should one accept or reject the authority of the governing body? 2) What are the characteristics and responsibilities of good government? The social justice issue raises the questions: 1) Should one defend or violate the political, social and economic rights of another person? 2) What are the bases of these rights?

Suggested Teaching Schedule

Class Period	Activity
1	Showing of filmstrip and class discussion
2	Reading 1* Discussion of Dilemma 1
3	Reading 2 Discussion of Dilemma 2
4	Activity 1, Handout 1 Small group discussion
5	Reading 3 Discussion of Dilemma 3
6	Activity 2, Handout 2
7	Group presentations of Activity 2 findings
8	Activity 3, Group meetings to develop a future car design
9	Group presentations of ads or commercials
10	Reading 4 Discussion of Dilemma 4
11 (or homework assignment)	Activity 4, Handout 3
12	Analysis of survey results
13	Presentation and discussion of survey results
14	Reading 5 Activity 5, Handout 4
15	Presentation of mass transit plans
16	Reading 6 or 7 Class discussion
17	Discussion of Dilemma 5
18	Discussion of Dilemma 6
19	Reading 8 Activity 8, Handout 5 Preparation for Senate Hearing
20	Conduct Senate Hearing, Handout 6
21	Continuation of hearing
22	Reading 9 Handout 7
23	Discussion of Dilemma 7
24	Activity 7, Scenario writing
25	Presentation of scenarios

*Readings might be assigned for homework, thereby allowing more class time for discussion.

Conducting Dilemma Discussions In The Classroom

Since dilemma discussion may be a new classroom technique, its major characteristics, the basic guidelines, and some helpful suggestions will be described. There are no hard, fast rules for leading dilemma discussions. Most important is that both teacher and students feel comfortable participating in the activity. The following guidelines are merely recommendations drawn from experiences of persons who have conducted moral dilemma discussions in the classroom. These may or may not meet the entire requirements of your particular situation and needs. Adjustments and changes may be necessary so that the dilemmas and discussion format correspond to the intellectual level and interests of your students.

Basic Steps in the Process

The five basic steps in conducting a dilemma discussion as outlined by Kohlberg and his associates are as follows:

Presentation of the dilemma
Selection of alternative positions
Small group discussions
Class discussion
Summary and closing of discussion

Background Information—In our materials we have included an additional component—an information base. See Diagram 1, *Schema for Dilemma Discussion*. This background information will provide students with at least a basic understanding of the issues contained in the dilemma and therefore the substantive content which can be used to develop the discussion. Moreover, the background materials serve to bridge the gap between the real world and the hypothetical dilemma situation. Hence, the dilemma will be construed not simply as a story, but as a reflection of real societal concerns and value moral conflicts that arise from our scientific technological activities. Readings or other activities should therefore stimulate thinking and assist students in the formulation of their personal views regarding the action that the main character(s) in the dilemma should take.

The background information provided is by no means extensive, and you may find it desirable to include additional materials as the need arises. If you have readings or exercises which you feel are more suitable for your students, do not hesitate to substitute or supplement what has been included here. In addition, it may be necessary to discuss in class some of the more sophisticated concepts and technical terminology to insure that students have an understanding of the basic issues.

Our desire is to avoid encumbering students with too much technical detail and information. Nonetheless, some classes may wish to pursue certain topics in greater depth and should be encouraged to do so. From our experience, additional research on the part of the students helps to generate a livelier discussion that includes a wide diversity of perspectives.

Following each dilemma are a series of questions. These questions can serve to probe further into the issue or provide the basis for developing other dilemmas. The dilemmas, as presented, focus on a limited instance but, as educators are well aware, issues have many more ramifications and can be built upon to encompass a much more complex situation. Therefore, by proceeding from a simple situation, it is possible to increase the levels of complexity in a step-wise fashion with appropriate questions.

Provocative questions can also help students reflect on how they might be affected by certain decisions or policies and their roles as future decision-making citizens.

Presentation of the Dilemma—After the students have read the introductory material as a classroom or homework assignment, the dilemma can be presented. The dilemma may be read to the class as a whole, or else, each student can read the dilemma for himself, herself. At this point you may wish to determine if the students fully understand the dilemma. This can be identified by asking:

- Do you feel that this is a hard question to answer?
- Will someone please summarize the situation?
- What things might the main character have to consider in making a choice?
- What are the main points in the conflict?
- Who would be primarily affected by the decision?

Small Group Discussion—It is usually recommended that dilemma discussions be first conducted in small groups followed by discussion with the entire class. Students often are more willing to speak out in small rather than large groups. It offers individuals greater opportunity to speak out as well as places more responsibility on each person to contribute to the group's activities. The sense of informality in a small group allows for entertaining unique or unusual ideas that students may hesitate to bring up in a larger grouping for fear of ridicule or "put-downs."

Homogeneous Grouping—The small discussion groups (four to six students) may be formed in a number of ways. From a show of hands or written answers students who vote "yes" or "no" on the question can be identified and grouped according to their position. There should be enough heterogeneity among class members to create division the question and formation of the small discussion groups.

Small groups where members hold similar positions would provide a more congenial atmosphere for initiating discussion. Here the students will feel less threatened if their peers share the same action decision and be more willing to contribute to the conversation. The membership would be more supportive, and individuals would not sense a fear of attack or failure.

Heterogeneous Grouping—In another format, students may be arbitrarily grouped. Here they have the additional task of evaluating, analyzing, criticizing and challenging the reasons given in the alternative choices. In this approach the degree of controversy is heightened, creating the potential of generating a livelier exchange. In defending a particular choice, the student will need to come up with more convincing reasons in order to persuade the others to support his/her side. Or the group might begin by using a "brainstorm" session and generate a series of supporting reasons for the different positions. These responses can then be examined and compared with one another. Through an elimination process, the group can select the more compelling arguments for each position.

DIAGRAM 1

SCHEMA FOR DILEMMA DISCUSSION

Teacher Activities		Student Activities
assign readings, exercises, etc	BACKGROUND INFORMATION	readings, films, exercises
check students' understanding	PRESENTATION OF DILEMMA	identify situation, clarify terms
set up small groups	SELECT ALTERNATIVE POSITIONS	indicate preliminary action choice
help stimulate discussion (probe questions)	SMALL GROUP DISCUSSION	examine individual reasons react to probe questions
coordinate class focus (probe questions)	CLASS DISCUSSIONS	examine different reasons - group reports discuss issues, consequences, implications
bring discussion to close, summarize main reasons	SUMMARIES	present main ideas, reasons - review discussion
determine types of relevant activities	EXTENSION ACTIVITIES (optional)	further research, essays, analogous dilemmas, etc.

Whatever grouping strategy you decide to employ, all the groups should focus on the moral issues of the dilemma. To more personally involve students in the group discussion have them first express their feelings about the dilemma. Some preliminary questions for consideration might include.

• What issues in the dilemma are hard to talk about? What makes them difficult to discuss?

• Can you foresee yourself having to make such a decision?

• Do you know anyone who has had to make a similar decision?

• Have you recently read any news articles about similar dilemmas?

• How do you think you would feel if you had to make such a decision?

• When you have a problem, how do you think it through?

Once the students become comfortable with the discussion format, they can then begin to critically discuss the position taken and the supporting reasons. They should consider the adequacy of the reasons given as well as the adequacy of their own reasons. After stating comparing and evaluating each of the reasons, they might select two or three of those that they believe best support the position taken on the dilemma issues. Each of the dilemmas contains two or more major moral issues. It is important that the students recognize the issues within a dilemma and direct their attention to the issues and not to the irrelevant aspects of the dilemma (i.e., speculating on the reality of such a situation).

If a group has difficulty in getting started or if discussion begins to lag, the teacher can interject a probe question or two to activate conversation. (See the discussion below on the different types and uses of probe questions.) Sample probe questions are listed at the end of each dilemma and may be used selectively as needed. It is often useful to have students answer a few of probe questions as a written assignment prior to the group discussion. In this way, students have time and opportunity to reflect on the issues and become more constructive contributors to the dialogue.

A recorder should be selected to list the group's conclusion to be presented in a written or verbal form for the entire class discussion.

Class Discussion—The entire class reconvenes to hear the comments made in the various groups. The discussion results of each of the groups are presented for the entire class to examine. They might be best displayed on the chalkboard or overhead projector. This procedure presents the opportunity for students taking opposing views to ask questions and challenge the different viewpoints. Again, the adequacy of the reasons are critically analyzed and merits of each discussed. Students reasoning at lower levels will be exposed to higher level reasoning and discover that their reasons may not have taken wider implications into consideration and hence be less appropriate for resolving the conflict.

The class as a whole can then choose the best reasons for each position. You will find that although students may not be able to generate higher level reasons they will tend to prefer reasons one stage higher than their own.

The class discussion is most fruitful if the discussion guides students to explore ideas they have not considered and to think about those higher level reasons. This can be accomplished through the use of probe questions. There are basically seven types of probe questions:[11]

1 *Clarifying probe.* Asking student to explain what he/she means in his/her statement. "What do you mean when you say that concealing evidence is immoral? What is the meaning of *immoral?*"

2 *Perception checking probe.* Determining whether student understands a statement made by another individual. "Please explain to me what Joe has just said."

3 *Issue specific probe.* Examining student's thinking on the major issues (Kohlberg has identified ten that underlie moral reasoning—see Table 4). "Why should the government establish standards for air quality? What should good guidelines take into account?" (Issues, governance and law)

4 *Inter-issue probe:* Resolving conflict when two or more issues appear to be at odds. "Should a richer country be allowed to use a greater share of the earth's resources?" (Issues: social justice, life, property)

5 *Role switch probe.* Placing student in the position of someone involved in the dilemma. "What would you do if you had to make that decision?"

6 *Universal consequences probe.* Considering the implication of the judgment made when applied to everyone. "What might happen if every household were required to reduce its use of electricity by 30%? Is it fair to place such demands on everyone?"

7 *Reason seeking probe.* "How did you come to this conclusion?" or "Why?"

Questioning along these lines will lead students to broaden their scope of thinking and to evaluate effects and consequences of different solutions. It offers them an opportunity to see how others might think about the same issue and challenges them to consider the many sides of an issue.

Probe questions can also be used to develop alternative dilemmas or introduce more abstract ideas by increasing the complexity of the dilemma. For instance, a dilemma involving personal sacrifices in a gasoline rationing situation might be extended to consider social and life-style changes in our highly mobile society. How should transportation fuel be best allocated? Does private and public interest conflict if gasoline were rationed? Dilemmas of an inter-personal nature can thus be presented from a community, national or even inter-global perspective to stimulate thinking about future implications for human society.

Skillful questioning becomes the tool to aid students to think critically—analyzing the positions they take and the values inherent in their position. They should begin to discover the significance of their principles by relating those principles to specific decisions and situations. Is government severely limiting our freedom of choice when it enacts safety regulations? What should freedom mean? What is the relationship between freedom and responsibility? What should be the role of government in protecting the health and welfare of future society? The constant interplay between the abstract principles/concepts and specific instances is pertinent in making the dialogue a thoughtful, meaningful exercise. Students need to understand concepts on their own terms before they can integrate new concepts and ideas into their thought structure. The process of development is one where students actively experience (or think about) new ideas which in turn interact in restructuring the form of thinking.

Discussion should also include analysis of the information and facts given. How does the information influence the decision? What is inferred from the information presented? Were the facts provided sufficient for informed decision making? What additional information is desirable? How might one go about acquiring additional knowledge? On what basis does one sort out and analyze the facts given? To what degree does the information influence the decision towards one position or another?

Finally, the consequences and implications must be appraised. This is the test of the effects of the position taken; again values are weighed. What values are held? What makes them desirable? What are the priorities? How is the nature of human society perceived?

Closing the Discussion—The discussion can be closed with a simple summary statement of the major points made. This summation will help the student bring together the ideas entertained during the discussion into sharper focus. One approach is to write down the list of the major reasons/arguments "pro" and "con". The reasons most preferred by the students can be indicated, or the reasons can be rank ordered.

The different positions on the dilemmas should not be judged for that would imply a correct answer. A "right" answer would also defeat the purpose of future discussions; students will try to "second guess" the optimum position response. However, at this time the students should have another opportunity to choose reasons they personally prefer or find most persuasive. This decision need not be openly declared. Suggest that the students examine their original reasons after hearing the other comments. What might they wish to change or add?

It may be appropriate at this time to point out some actual situations that resemble the hypothetical dilemma. How were they resolved and what were some of the results? Students may begin to notice analogous dilemmas that are currently making the news headlines. It is a good idea to take every opportunity to relate concepts discussed in class to the students' personal experiences and levels of interest.

Some General Guidelines for Dilemma Discussion

Dilemma discussions should flow naturally and comfortably. However, when students have had little exposure to open-ended types of discussions, it is often difficult to engage them in in-depth exploration of an issue. The following are some pointers that might be useful in stimulating discussion.

Goals of Moral Discussion—Barry Beyer, who has written extensively on moral discussion techniques, has pointed out that the goals of moral discussion should contribute to the overall objectives of the course and general educational goals, in addition to introducing new ones. Hence these goals are general rather than narrow in nature. Among these are: 1) improving learning skills, 2) improving self-esteem, 3) improving attitudes toward school, 4) improving knowledge of key concepts, and 5) facilitating stage change.[12]

An important teaching strategy is to encourage students to think about and reflect on alternatives and consider different ideas. The process of development includes extending one's imagination and exploring one's thinking.[13]

Classroom Atmosphere—Every effort should be taken to create an atmosphere conducive to an open, free exchange of ideas. Students should feel at ease when expressing their thoughts and, when confronted with challenge, not feel that they are being attacked personally. The emphasis is on analyzing the reasoning process by considering divergent viewpoints and alternative choices. It would be stressed that no one answer is correct or absolute: each position has merits and invites investigation.

Classroom furniture should be arranged in such a way that students can speak directly with one another and can be easily heard. For small group discussions the chairs might be arranged in a number of small circles so that attention can be given to all members of the group with-out delineating an authority focal point. The seating should also offer some degree of flexibility so that students might be able to shift groups or share their thoughts with members of other groups. A student who is uncomfortable with one group or who wished to take the opposing position may want to move to another group.

Role of Teacher—The teacher's crucial role in dilemma discussions is that of a creative process facilitator whose function is to stimulate students' searching and "stretching," and help students embark on their own personal search. A key skill lies in sensitive listening. By listening with care and delaying action the teacher can begin to:

- Identify problems that students may have in coming to grips with the issues—do the questions need further clarification?
- Identify students who monopolize or dominate the conversations;
- Find students who are hesitant in expressing their ideas;
- Prevent the discussion from becoming a clash of personalities;
- Find when the discussion begins to lag or focuses on irrelevant details, etc.

By posing questions to the group or certain group members, the teacher can then provide helpful guidance or gently direct the course of the discussion.

At all times it is important that the teacher be supportive and reinforce in a positive manner. Students should not be singled out as having given particularly "good" or "bad" answers. Each response should be taken as a point of departure for further discussion. The question "why" should be the dominant concern.

Some degree of structure in a discussion is necessary but structure should never hinder the flow of ideas. Probe questions can serve as the guiding structure, but they need not be taken in any order or progress in a stepwise fashion. For a given group of students some questions may stimulate more interest or controversy than others; the less fruitful questions, therefore, need not be pursued.

Promoting student to student interaction is another major role of the teacher, requiring insight and patience. The discussion process is an evolutionary one, often requiring much time before a definitive direction can be perceived. At times it may even appear that the discussion is circuitous, but it is imperative that each student has the opportunity to air his/her views and partake as an active member of the group. The student, when he/she becomes confident in himself/herself and recognizes the worth of his/her ideas, will then accept the responsibility of his/her role in the group as well as become more receptive to the ideas of others.

Characteristics of Dilemma Discussion

- *Open-ended approach:* There is no single "right" answer. The goal is not to reach agreement but to critically discuss the reasons used to justify a recommended action. The emphasis is on *why* some reasons may be more appropriate than others.
- *Free exchange of ideas:* Students should feel comfortable in expressing their thoughts. Each student should have an opportunity to contribute to the discussion within a non-judgmental atmosphere.
- *Student to student interaction:* The conversation is primarily between student and student, not teacher and student. The teacher uses questions to guide the discussion and to encourage students at adjacent stages of moral reasoning to challenge one another. Lecture or recitation should be avoided.
- *Development of listening and verbal skills:* Each student should be intimately engaged in the discussion activity, building and expanding on one another's ideas as well as examining each response critically.
- *Focus on reasoning:* Reasons are to emphasize the prescriptive "should" rather than the "would" arguments.
- *Dilemmas produce conflict:* Conflict heightens student involvement and interest and should have a personalized meaning for the student. Resolution of internal conflict is a precondition for advancement to higher stage reasoning.

Helpful Hints

- Review carefully the dilemma to be discussed in class and try to anticipate any problems that students might encounter when dealing with the dilemma.
- Identify the main issues and list a few questions that might help clarify the issues for the students (particularly, how these issues might relate to the students' lives).
- Determine if there are words or concepts that may be unfamiliar to your students. These should be defined and

discussed so that the students do not become overwhelmed by the terminology and can more easily grasp the essence of the problem.

- If you have readings which you feel are more pertinent or appropriate, use them in place of those included here.
- Consider whether or not the dilemma poses conflict for your students. It is often possible that the dilemma as written is either too sophisticated or too simplistic, and the students cannot appreciate the implicit conflict. The dilemma question might be reworded or altered in order to elicit a division of opinion among the students.
- When presenting the dilemma story make sure the students understand the problem and the goal of the discussion activity. This can be accomplished by having a student summarize the story and list some of the possible alternatives available to the main character(s).
- If a class is not accustomed to discussion-type activities, it might be wise to group the students in such a way that those who are more vocal and aggressive do not dominate or monopolize the discourse. Try to balance each group with different personality characteristics.
- When the discussion has difficulty getting started or gets bogged down, have the students role-play the main character. The shift in focus can assist them in gaining additional perspective into the situation.
- Try not to be too impatient if the discussion does not seem to go anywhere. As in any other type of group interaction, some warm-up time is necessary so that students can relax and reflect on their own thoughts.
- Students may continually look to you as teacher for direction and "correct" answers. When asked a question you can shift the attention by posing that question to another student and seek his/her opinion. In this way the dynamics of student interaction can be maintained.
- Tape recording some of the student dialogue may be useful as an evaluation tool to help organize future discussions and suggest additional probe questions.
- It is important that the discussion does not drift aimlessly or become a clash of personalities. Skillful interjection of probe questions will provide direction to the group discussion, therefore, become familiar with the different types of probe questions so that you can use them with fluency.

Questions Commonly Asked

- *In order to lead dilemma questions, do teachers need to identify the stage at which a student reasons?*

No, there is usually enough heterogeneity within a classroom so that several stages of reasoning are represented. Most important is to encourage different students to engage in the dialogue and to bring out the many different ways to resolve a problem.

- *What if everyone in the class takes the same position?*

This does not present any difficulty. The particular position taken is not important; what is important is the argument used to support the position. The different levels of reasoning on the dilemma should provide sufficiently lively debate. Students can also be asked to put themselves in the other position and develop arguments to support that position.

- *Should students be required to give reasons for their decisions?*

No, if reasons are not volunteered, you can simply ask another student to comment. The debate should not be forced but evolve naturally.

- *How does one detect student growth?*

Development is a slow process and a limited number of classroom dilemma discussions is not expected to advance students from one stage to the next overnight. However, students having experienced a diversity of alternative ideas should begin to develop an increasingly more global orientation and consider the different aspects of a problem.

- *Will a student reasoning at higher levels regress and accept the reasons of a more forceful lower stage argument?*

No, regression is not consistent with the stage theory. Persons reasoning at higher stages will see their argument reinforced as the discussion continues. Their reasons can deal more effectively with the question over a broader variety of situations, lower stage reasons begin to fall short. Studies have demonstrated that higher reasons are preferred over lower reasons.

- *How long does one continue the discussion?*

Discussion should continue for as long as it is fruitful and students continue to display a level of interest and involvement.

- *Is the object of the discussion to convince the class to accept higher level reasons?*

No. Simply "parroting" higher stage reasons does not effect or indicate growth. A stage reflects one's dominant mode of thinking on moral issues, one that is utilized. The purpose of the discussion is to provide new exposures and create a state of disequilibrium so that individuals begin to rethink and restructure. Discussion facilitates the course of development; it does not dictate it.

[11] Edwin Fenton, Ann Colby and Betsy Speicher-Dubin. *Developing moral dilemmas for social studies classes*. Cambridge: Harvard University, Moral Education Research Foundation, 1974.

[12] Barry Beyer. Conducting moral discussions in the classroom. *Social Education*, April, 1976, 195-292.

[13] Clive Beck. *Ethics*. Toronto: McGraw-Hill, 1972.

Suggested Teaching Strategies

Introduction

Filmstrip and Audiotape Cassette: "Perspectives on Transportation"

This filmstrip serves to introduce the module. The general overview provided and issues raised will help to establish the underlying theme of the module — the changes brought about by modern transportation and critical concerns to be addressed now and in the future.

Following the showing of the filmstrip, a short discussion of the ideas presented will be useful. Questions might include:

- What types of new problems do we now face because of advances in transportation?
- How does life today compare with life one hundred years ago? What changes have been brought about by new forms of transportation?
- In many countries the automobile is considered a luxury that only a few can afford. How do people in those countries travel?
- In what ways do we depend on transportation by car? By railroads? By boats? By airplanes? By space craft?
- How might we be affected if trains suddenly ceased to run? Airplanes? Trucks? Ships?
- How important are fast forms of transportation? To whom are they most important?

Filmstrip Script

Film Strip Frame	Title Credits
1	**SPACE SHUTTLE ORBITER ENTERPRISE** It is hard to think of any activity that does not involve transportation in one form or another, directly or indirectly. Our work and leisure all revolve around getting from one place to another.
2	**COMMUTERS WAITING FOR TRAIN** We all depend on transportation, the moving of people, goods or anything for that matter. Transportation systems and vehicles come in various shapes and sizes.
3	**MAP OF AIRLINE ROUTES** Our modern world can be described as a vast system of transportation networks. These networks have made it possible for us to reach any corner of the earth.
4	**MAZE OF INTERSECTING HIGHWAYS** However, to keep the network operating, such as the millions of automobiles in America on the move, a system of support services and structures is required. Included in this network are the millions of miles of roads, bridges, parking lots, tunnels, service stations and people needed to keep them functioning.
5	**VIEW OF EARTH FROM SPACE** Our immense earth has seemingly shrunk in size because of air craft developed in the last hundred years. Trips that once took months or even years now take hours and, in the future, might only require minutes.
6	**COVERED WAGON** A coast to coast covered wagon trip in 1849 took 166 days.

7	**JET AIRPLANE** The same trip today by jet airplane takes approximately 5 hours.
8	**SPACE SHUTTLE** In the future, the space shuttle will make this same trip in only 8 minutes.
9	**PORT CITY: SHIPS UNLOADING** How our world looks today has been shaped by the various forms of transportation. Cities have grown because of good transportation networks.
10	**EARLY TRAIN** People have continued to improve upon travel from the time the wheel was first invented. Change often occurs rapidly. What was once a common sight, just a few years ago, can now be seen only in museums.
11	**MODERN MASS TRANSIT CARRIER** Improvements, for the most part, are related to speed, convenience and comfort.
12	**CONTEMPORARY CAR** In today's society, especially in the United States, we also have a greater variety of choices. In addition to buses, trains, boats and airplanes, our private automobiles allow us to go where we want to go, and when we want to go.
13	**A SEA OF PARKED CARS** We, Americans, carry on a great love affair with our personal automobile. For both work and play, we are never without our cars. People have been known to drive one block to visit neighbors.
14	**A JEEP LOADED FOR CAMPING** Yet, without a car it would be difficult to vacation in wilderness country.
15	**TRAFFIC JAM** We have gladly accepted the conveniences of modern travel. At the same time, we have forced to adjust to some unpleasantries of increased mobility, such as: traffic.
16	**A FLAT TIRE** frustration,
17	**OUT OF GAS** fuel shortages,
18	**POLLUTED SKY** dirty air,
19	**JUNKED CARS** other environmental hazards,
20	**DAMAGED AUTOMOBILE** accidents, injuries, and sometimes even death.

21	**OIL REFINERY** The widespread use of the private automobile has thus created new concerns. Building and maintaining a car requires many resources, some of which can never be replaced. In addition to steel, rubber and glass, our cars use 5 million barrels of oil a day, more than any form of transportation, and produce 80% of all air pollution.
22	**CAR EXHAUST** The automobile exhaust spews over 80 million tons of poisonous gases a year into the air. These poisons are responsible for heart, lung and eye disease as well as contribute to mental stress. In addition, 57,000 people die in automobile accidents each year.
23	**CITY SCENE AT RUSH HOUR** Although thousands upon thousands of miles of roads crisscross our country, we are continually plagued with traffic jams. Everyone seems to want to be at the same place at the same time.
24	**NARROW CITY STREET** With the automobile, people can work in the city and live in the suburbs. However, many cities have not been able to keep up with the rapid increase in traffic. We still find city streets which have not been widened or changed since the early horse and buggy days.
25.	**EMPTY BUS** The least expensive form of land transportation is also one of the most under-utilized — the bus.
26	**FULLY LOADED BUS** Obviously, buses can hold many more passengers than the private car and therefore operate less expensively. Despite the economy and energy savings of buses, people still choose the convenience of the personal automobile.
27	**CARGO TRAIN** Railroads continue to be an important part of our transportation networks, especially for the delivery of heavy cargo and supplies.
28	**EMPTY TRAIN** Trains, however, have been for the most part rejected by passengers.
29	**AIRLINE PASSENGERS** Once again, speed wins out. For the traveler who once used railroads for long distance travel, the airplane is now the carrier of choice.
30	**PLANES AT AIRPORT** For those who can afford it, plane travel today is fast, easy and comfortable. The airplane has been particularly important to the business traveler. As a result, one can conduct business almost anywhere in the world. Most places are only one day's air time away.
31	**PLANE IN FLIGHT** Much freight is moved by air. We now find our supermarkets stocked with exotic tropical fruits, fresh vegetables in the dead of winter, breads from Parisian bakeries — all brought in by air cargo planes. We can sample foods from all over the world without ever leaving our home town.

32	**PLANE REFUELING** Airplanes, also, have their drawbacks. They consume tremendous amounts of energy. A jumbo jet can use 47,000 gallons of fuel in just one flight.
33	**S.S.T.** Our newest development in air travel is the supersonic plane which flies at speeds of 1,400 miles an hour, nearly twice the speed of sound. This plane, however, uses more fuel and carries fewer passengers than the 747 or DC-10.
34	**HOUSES NEAR AIRPORT** Another problem with airplanes is the tremendous noise. People living near airports must endure the constant sounds of roaring engines, especially those located in the landing patterns of airports.
35	**AIRPORT RUNWAYS** Another issue is the need to expand runways to handle the larger planes and the increased traffic. More land is needed, but who wants an airstrip in one's backyard? So, planes must often circle for hours before they can land, increasing the chances of mid-air collisions.
36	**A FUTURISTIC PLANE** Problems accompany each type of transportation. How might we solve some of our transportation problems? Future air vehicles may need to meet the requirements of quieter engines, more fuel economy, and shorter runways. Who knows, we may even see the return of the dirigible!
37	**SPACE SHUTTLE** Products of the space shuttle program might possibly be modified for commercial air travel.
38	**A FUTURISTIC CAR** The automobile, as known to us today, may look completely different in the future. Fuel shortage and rising fuel cost will force these changes.
39	**FUTURISTIC MASS TRANSIT CARRIER** Mass transit systems may need to play a greater role in the future. Transport systems that look like something out of science fiction today, may become a reality tomorrow.
40	**GAS PUMPS** The hard reality of decreasing supplies of oil and pollution raises some difficult questions. Will we be able to afford the luxury of the personal automobile in the future?
41	**LARGE RECREATION VEHICLE** Will we be able to continue traveling at high speeds and in comfort?
42	**TRAIN YARD** Installing new mass transit systems is expensive. Will we be able to afford them?
43	**TRANSPORTATION IN A FUTURISTIC CITY** What choices in transportation will be open to us in the future?
44	**SPACE COLONY** What is your perspective on transportation?

SECTION I:
LAND TRANSPORTATION

In this section greatest emphasis is placed on travel by automobile, the most common form of transportation in this country. It is also the form to which students can most easily relate. Yet, the problems created by the excessive use of the private automobile have at times reached crisis proportions. We have highlighted in particular the problems of air pollution, safety, and fuel supplies.

Reading 1: The Car - Friend and Foe

This reading briefly summarizes the variety of problems created by automobile travel, particularly pollution. Some ideas may be new to the student and require further elucidation. Among these might include the toxic effect of nitrogen oxide, hydrocarbons and carbon monoxide and the "green house" effect produced by carbon dioxide. Questions that follow the reading provide additional ideas for discussion.

Student Activity: Dilemma Discussion

Dilemma 1: *"On a Clear Day . . ."*

Air pollution and traffic congestion are major problems in most large metropolitan cities. Various solutions have been offered, some which many people find difficult to accept. This dilemma exemplifies a proposal which will create economic hardships for one section of the community, yet will quickly improve air quality. The mayor must resolve the conflict between the need for healthy air and the viability of the business community.

Please follow the basic procedures for conducting dilemma discussions as outlined in this Teacher's Guide.

Reading 2: Problem for Cities: Where to Put 36 Million More Cars

The reading focuses on the problem of limited space and increased numbers of automobiles. This situation is one that cities are finding to be increasingly more difficult to manage. While this reading cites examples from the nation's larger cities, our own communities (save for sparsely populated areas) share similar difficulties.

After the students have completed the reading, they might examine the existing local traffic pattern of their community and try to predict the effects of doubling the number of cars currently on the road. How might they adjust to such a situation? How might they have to change their daily activities or travel habits?

Student Activity: Dilemma Discussion

Dilemma 2: *"One Less for the Road"*

In this dilemma a congresswoman must decide between her responsibility to her constituency and responsibility to the general public.

While this dilemma deals with a difficult decision to be made by a lawmaker, several other questions also surface. They are questions concerning the limits of government authority and personal property rights. To what extent might our freedom of choice be limited in order to protect public health and safety and our economy? Although the situation may today, seem farfetched, the hard reality of limited oil supplies, increased population and our growing trade deficit created by oil imports may all someday force our government to enact drastic conservation policies. As unpleasant as it may be, students need to confront such a possibility as well as consider alternative measures that might be taken in order to prevent a crisis situation.

Please follow the suggested procedures for conducting dilemma discussions.

Activity 1: Road Maps and Their Uses

Handout 1: *Road Maps and Their Uses*

Description

This map reading exercise has been included to help further develop students' map reading skills. They will use information found on a map to answer the questions on the worksheet.

Student Objectives

- To learn about the different types of information one can extract from a typical road map.
- To interpret information found in maps and apply it to trip planning.

Student Activity

- Prior to this activity, have students bring in a map of the mid-Atlantic states. Maps produced by the oil companies are most satisfactory.
- Have the students complete the handout individually or as a small group exercise.
- If the exercise is completed individually, have the students meet in small groups to share one another's finding. What are the similarities? Differences?

Comments and Suggestions

- Typically we consult road maps for directions from one place to another. However, a wealth of information is compacted in the graphic representation. Many inferences can be drawn about an area by examining its surroundings, the type of roads leading to it, landmarks, etc. Learning to interpret maps and making inferences from the given information will enhance one's appreciation of a seemingly mundane road map.
- If students have not had much experience in map reading, it may be useful to review the legend so that they understand the symbols used.

Reading 3: The Nation's Tragedy

Our young students, for the most part, tend to take a cavalier attitude when it comes to driving, or for that

QUESTIONS

1. Name three cities with a population over 50,000:

   ______________________, ______________________, ______________________

2. What roads might one take to get from Boston to Philadelphia?

3. Which road would you select to make such a trip? What factors would you have to consider in making the decision?

4. What is the approximate distance between Boston and Philadelphia? In miles? In kilometers? By which route?

5. If a car averages 15 miles to a gallon of gasoline, how many gallons would it use on a trip from Baltimore to Atlantic City?

6. How much would it cost to drive from Scranton, Pa. to Allentown, Pa.? (Assume that the cost of gasoline is $1.50 per gallon, and your car averages 15 miles to a gallon of gasoline.)

7. What are the interstate highways which run from New York to Boston?

8. Which route might you take if you wanted to do a great deal of sightseeing from New York to Boston? Why?

9. At the present speed limit of 55 mph, how long would it take to travel from Baltimore to Wilmington? (Assume no traffic jams, just continuous driving) Using which route?

10. What are some of the major benefits of such a road map? What other things do you learn from a road map?

11. On what type of road might one find the greatest number of facilities (e.g., rest stops, service stations, restaurants)? Interstate highway or state highway?

matter, any activity with associated risks. The case history of an accident presented in the beginning of this reading offer some sobering thoughts and may make the statistics presented in the latter section more meaningful. The reading also discusses the conflict between government regulations and personal freedom and privacy. This issue will be further explored in the following dilemma.

Student Activity: Dilemma Discussion

Dilemma 3: *"How Safe is Safe?"*

In conflict in this dilemma are filial obedience, conformity to peer pressures and personal rights. Additionally, this dilemma is intended to point out a typical human foible. Logically, we know that seat belts, a simple, painless safety precaution, can reduce the severity of injuries in automobile accidents. Yet, more than 75% of motorists foolishly refuse to heed the procedure of "buckling up" when they drive.

Examples of this type of action or inaction are readily found in many other human behaviors such as smoking, the use of drugs, obeying traffic regulations and so on.

Activity 2: The Selling of the Car

Handout 2: *The Car Maker's Selling Technique*

Description

In this activity students will examine advertising strategies and persuasive techniques. The auto makers are perhaps one of the nation's largest advertisers. Examples drawn from their advertising will be used to illustrate the types of persuasive techniques employed to influence buying habits. In the exercise students will try to identify the "message," "theme," or "hidden agenda" in the different ads. A critical examination of the underlying assumptions, value perspectives and how people view the role of the car in their lives, will thus provide students an opportunity to examine their own values. Moreover, students will learn some of the characteristics of different selling techniques.

Student Objectives

- To examine some techniques of persuasion used in advertising.
- To identify one's own values and values of others as related to the ownership of the automobile.

Student Activity

- Have students bring in examples of auto advertisements from newspapers, magazines or brochures. Remind them to select several examples so that they can make comparisons between several approaches.
- Students, individually, will complete Handout 2, *The Car Maker's Selling Technique*, using the ads they selected. The chart serves to help organize and summarize their findings.
- After the students have individually completed the exercise, they will meet in small groups of 3 to 5 members. In the small group meeting they will compare and contrast their findings. Discussion of the questions will help them summarize their findings and develop a report to present to the entire class.
- Upon completion of the presentations the entire class will discuss the questions that focus on the interactions between consumers and advertising.

Comments and Suggestions

- To insure that students understand how they are to complete the handout, review the terms used for each of the columns. It is possible that there may be overlap among some of the terms. Therefore, students will have to use their own judgment in assigning to categories the "words and phrases" found in the ad. It is possible for the same words and phrases to appear in more than one category. You may wish to examine one ad with the entire class and list the findings on the board for the students to use as an example.
- This activity serves to illustrate the idea that the personal automobile is not only a utilitarian piece of machinery but is a reflection of many of our societal values.

THE CAR MAKER'S SELLING TECHNIQUE

Name of Car (and where ad was found)	Styling	Economy	Special Features	Safety	Image	What impressions do you get from the picture?
1)						
2)						
3)						
4)						
5)						
6)						

Activity 3: Reinventing the Car

Description

In the previous activity students examined the values we, Americans, place on the personal automobile. Increasing fuel costs and diminishing supplies will force many different changes in the future. In this activity students will project possible future changes by designing their own car of the future. Students will need to consider the concerns and limitations that are being addressed today and will become even more critical in the future. Possible ways to alleviate or help reduce these problems are to be incorporated into the automobile they design.

Student Objectives

- To become aware that environmental, economic and political factors will affect automobile transportation.
- To project into the future and design a car that will offer solutions to energy, pollution and other environmental problems.

Student Activity

- Students, in small groups of 3 to 5, will create a design for a car of the future. This design need not be detailed or elaborate but should incorporate ideas that address current and future imperatives.
- They will then prepare an ad or commercial for the car that they have designed.
- Each group will present its ad or commercial to the entire class.

Comments and Suggestions

- A primary purpose of this activity is to demonstrate how changes in automobile transportation will effect lifestyle changes. Some changes may be more difficult to accept than others. As the students present their proposals, it would be instructive to pose questions regarding the acceptability of the car from an environmental perspective and from the perspective of lifestyle adjustments.

Reading 4: Excerpts from Prospects for the Automobile: Sputtering Towards the 21st Century

This reading briefly describes the types of synfuels that are currently being considered to meet our future fuel needs. The resources and technology required to produce synfuels raise a new set of environmental issues and problems. Depending upon the interest of the students, you may wish to have them do additional research on this subject. The information from the reading, however, should provide some background for the discussion of the dilemma which follows.

Student Activity: Dilemma Discussion

Dilemma 4: *"Fuel for Our Cars – The Synfuel Battle"*

This dilemma is adapted from the article, "Plan to Build A Coal Liquifaction Plant on Montana Rangeland Stirs Up a Battle Over Using Land for Synfuel Production," by Michael Parfit, which appeared in the March 1980 issue of the *Smithsonian*. Students may enjoy reading this article to gain further insights into the situation.

The critical nature of this dilemma can be better appreciated if students have an understanding of the ravaging effects of strip mining and fuel conversion. In addition to the destruction of topsoil, there are problems of acid runoff, reduction of the water table, erosion, increased air pollution, acid rain and other secondary long-term effects. These issues should be raised during the course of the class discussion or students may be assigned to present reports on the topic.

As an alternative to the dilemma discussion format, you may wish to use this dilemma as the topic for a more structured student debate.

Activity 4: Class Survey: Your Views on Mass Transit

Handout 3: *Mass Transit Survey Form*

Description

Students will conduct a survey on mass transit usage and analyze the results. In this exercise students will gain experience in conducting a survey, tabulating responses and gain insight into the public's attitudes towards mass transportation. Results of this survey will provide data for Activity 5.

Student Objectives

- To investigate mass transit usage by conducting a survey.
- To learn to tabulate and analyze the responses on a questionnaire.
- To gain an understanding of public attitudes towards mass transportation

Student Activities

- The survey may be completed as an in-class exercise by having each student complete the survey questionnaire, Handout 3. Or, students may conduct the survey outside of class and interview people in the community. A survey of a cross section of the community, of course, would be the more interesting. *(If a large population is surveyed, students may wish to identify the respondents in terms of age, sex, occupation, etc. In this way they can develop a profile of mass transit riders as part of their findings. "What groups are the most frequent riders?" "For what purposes do they use the transit system?" "In what section of the community is mass transit most widely used?" Answers to questions of this nature can be obtained if the students indicate the additional personal data somewhere on the form and incorporate this information in their analysis.*
- When all the questionnaires have been completed, the responses will be tallied and analyzed by the entire class. Detailed instructions for tabulating the results are given in the Student's Guide. It is recommended that the students work in small groups with each group responsible for a section of the questionnaire.
- When the class has finished the task of compiling the responses, each group will present its findings and describe how it has interpreted the results. They should consider the inferences that can be drawn from the information obtained. That is, what do they think are the problems and assets of the mass transit system? Do they think that ridership can increase? In general, how do they think about the community's attitude towards mass transit? Is it a feasible alternative to the private automobile?

Comments and Suggestions

- If the students are mathematically inclined, they may wish to perform some simple statistical analysis on the data and/or display the data in a graphic form. This might include "average distance traveled," "average distance to a transit stop," "frequency of ridership in different sections of town."
- Some of the data might also be displayed in a demographic form where the information is plotted on a map. For example, students can take a map of the community, draw in one or two transit routes and then locate where the people reside. Riders and nonriders can be indicated using different colored symbols. From such a display, one can readily see where the majority of riders cluster and determine the relationship between proximity to the service and use of the system. This information will also be useful for the next activity.
- Results showing little or no mass transit ridership can be equally useful. Class discussion might then focus on why mass transit is not feasible or impractical in that situation.

Reading 5: Mass Transit

Mass transit is an alternative to the private automobile, and several types of mass transit systems are discussed in this article. Also, some of the problems associated with mass transit are highlighted — cost, maintenance, service, fuel consumption and consumer appeal. Students should begin to examine the number of possible types of mass transit and consider how each might best suit the needs of different communities (urban, suburban, rural). The idea of "trade-offs" is an important concept to explore at this time.

Activity 5: Plans for a Mass Transit System

Handout 4: *Mass Transportation*

Description

In this activity students will examine methods to either improve or develop mass transportation in their own community. The purpose of this exercise is to demonstrate the many needs and conflicting interests that must be taken into account in the planning process. It is also important for students to recognize the fact that economics (many times only from a short-range perspective) play an influential role in the decisions made.

Mass Transit Survey Form

1. How many times a month do you use mass transit? ________
2. What type of mass transit do you use? (subway, bus, trolley, train, cable car, monorail) ________
3. Approximately how far do you go? ________
4. What is the furthest distance you travel on mass transit? ________
5. For what reason do you use mass transit? (work, school, shopping, pleasure, etc.) ________
6. How far from your home is the nearest mass transit stop or station? ________
7. Do your parents use mass transit regularly? (circle one) Yes No

   Why or why not? ________________________________

   ____

8. Do you think that the mass transit system in your community is adequate and convenient to use? (circle one) Yes No

   Why or why not? ________________________________

   ____

9. If the mass transit system in your community provided more services, do you think that you will use it more often? (circle one) Yes No

   Why or why not? ________________________________

   ____

10. If you do not use mass transit in your community, please explain the reason.

    ____

    ____

11. Do you think that the mass transit system in your community is used to capacity? Explain.

    ____

    ____

12. How can the mass transit system attract more riders? ________________________________

    ____

MASS TRANSPORTATION

Current Systems	Sections of City Serviced	Proposed New Types	Sections of City Serviced	List Benefits of New Proposed System — compared to current system

In many cases, mass transit has not proved to be an attractive alternative for a number of reasons. Students should try to address these criticisms when they develop their plan.

Student Objectives

- To learn about existing and new types of mass transit systems.
- To develop a proposal for a system that will meet the needs of the community.

Student Activities

- Students will work together in small groups to develop a proposal for mass transit in their community.
- They will first examine the data from their survey as well as other information about the existing system, if any. Information about existing systems should be recorded on the first two columns of the student handout to help them organize their thoughts. A map of the community will also be useful in developing their plans.
- Each group will develop a plan to improve existing service or provide new types of service.
- The proposals are presented to the entire class which will then select the plan best suited for the community. In some cases, a combination of several plans may prove to be the best solution.

Comments and Suggestions

- In sparsely populated areas or sprawling suburbia, the typical forms of mass transit found in cities are not feasible. In this case, students should consider alternative ways to use the private car or small intracommunity conveyances. These alternatives might include minibus pools, dial-a-ride systems, or a community fleet of energy efficient vehicles that are shared on a coin operated system and located at strategic stations.
- Perhaps, a major reason that mass transit has not become important in many areas is because people are so ingrained in their habit of driving their own car. A focus of the class discussion should be directed at techniques for attracting riders and increasing customer appeal.

40

SECTION II: Water Transportation

Transportation by water craft may very well be one of the earliest forms of long distance travel. And, until recently, boating has not caused any serious environmental dislocations. (Boats have, however, facilitated the over-fishing of many waters.) With our increasing dependence on imported oil, a new concern has developed — oil spills. This section mainly addresses both the need for and dangers associated with the superships.

Reading 6: Superships, Superhazards

Reading 7: Supertankers and the Law of the Sea

These two articles highlight the problems and hazards that shipping oil has created. The problems can be addressed at several levels. From a more personal perspective, we can focus on the question of fuel conservation. More difficult to resolve are questions concerning responsibility for oil spill clean-ups, the protection of the ocean environment, restitution payments to aggrieved parties and shipping regulations. All these questions need to be resolved at the international level and solutions do not come easily. We, at the same time, want to protect our ocean environment and need the oil to satisfy our enormous energy appetite.

From these readings and subsequent discussion students will, hopefully, gain a broader perspective on the nature and complexity of shipping a toxic cargo across waters. Politics, economics, lifestyle, international relationships, moral responsibility — all are related to supertanker shipments.

Student Activity: Dilemma Discussion

Dilemma 5: *"Oil in the Sea"*

This dilemma addresses a ship captain's conflict of responsibilities. As captain, he is responsible for the safety of the crew, ship and cargo. At the same time, should he be responsible for the effects of oil released into the water? Oil spilled into the ocean will result in fish kills, polluted beaches, injury or death to other animal life as well as severe detrimental effects on the fishing industry of the nearby community. In this situation, does Miguel have the right to disobey orders? The dilemma also illustrates a predicament of advanced technologies. Our machines have increased our physical capabilities by many fold, and as a result we are capable of inflicting damages with widespread and extensive consequences never before encountered in history. It is important to help students recognize the enormity of repercussions associated with our various activities and our need to develop a sense of responsibility and vigilance.

Please follow the basic procedure for conducting dilemma discussions as suggested in this Teacher's Guide.

Student Activity: Dilemma Discussion

Dilemma 6: *"Stranded at Sea"*

The law or traditions of the sea, rescuing the shipwrecked, and immigration laws of nations becomes issues in conflict in this dilemma. The moral exigencies are readily evident, but the difficult question is, to what extent can we be responsible for helping others without jeopardizing our own welfare and safety. It is a basic question of humanitarianism, our obligations and responsibilities.

Please follow the basic procedure for conducting dilemma discussions as suggested in this Teacher's Guide.

SECTION III: Air Transportation

In this last section, dealing with air transportation, we will examine questions regarding the supersonic transport and the space shuttle. While travel and transport by conventional airplanes have become a commonplace scene, air travel by the aforementioned opens new frontiers and horizons in space. Human endeavors now can extend far beyond the limits of earth, and we are confronted with different issues and uncertainties. We want to test our limits and quench our insatiable curiosity, but can the investment in capital, resources and research be justified? Students will explore the arguments surrounding this issue in a role play simulation and discussion activities.

INTEREST GROUP: FACT SHEET TO DEVELOP ARGUMENTS

Argument	Reasons and Benefits	Supporting Facts	Possible Opposing Arguments	Response to Arguments

1) List your arguments logically and precisely; 2) Make sure Reasons & Benefits justify your arguments; 3) Be sure to include supporting facts and materials to support your argument; 4) Anticipate possible objection or opposing statement to your argument and be prepared to defend your position.

SENATOR'S WORKSHEET

Interest Group Name	Argument	Facts Presented	Benefits to My State	Disadvantages to My State	Questions to Ask

1) Fill in the columns as the arguments are presented by the various interest groups; 2) Write down any question you may wish to ask the spokesperson; do not interrupt his/her presentation. Ask your questions at the end of the presentation.

Reading 8: The Concorde: Who Will Let It Fly?

This reading provides the background information for the simulation that follows. It includes the divergent viewpoints that have surfaced in the SST controversy. These arguments will be further developed and expanded by the students in their presentations.

You may first wish to have the students read the article and then identify and discuss the relevant issues prior to assignment of the simulation activity. In this way you can determine whether or not the students grasp the essence of the situation. Or, the reading may be assigned when the students meet in their interest groups to develop their presentation. In either case, the article presents the basic elements of the controversy and highlights concerns which students can investigate in greater depth by doing some additional research.

Activity 6: The SST Hearing — A Role Play Simulation

Handout 5: *Interest Group -- Fact Sheet*

Handout 6: *Senator's Worksheet*

Overview

The students will simulate a Senate committee conducting a hearing on the SST landing rights. Seven students will represent Senators while the remaining students will represent one of the six special interest groups. Each group will make a formal presentation to the Senators; when the presentations are completed the Senators will cast their votes and announce the results.

Student Objectives

- To learn about the debate over the question of the SST landing rights.
- To take a role perspective and develop arguments in support of that position.
- To present a well developed and convincing argument.

Student Activities

- Assign or have the students select their rôles. A well balanced grouping inevitably produces the more dynamic interchange; and as the teacher, you can best determine the optimum assignment of student groups.
- Have the students study their role position and use the reading to identify their major arguments.
- Students should have at least one class period or more to identify the major issues and develop their presentation. Additional research by the students will enhance their learning experience and provide other ideas for debate.
- Handout 5 is to be used by the members of the interest group to aid in the development of their presentation. The Senators will use Handout 6 at the hearing to help them organize their notes and comments on each group.
- Upon completion of the hearing, the Senators will meet to determine the outcome. Each vote is to be accompanied by a short statement giving the rationale for that vote. The chairman announces the decision and explains the Senator's reasons.

The SST Simulation

Step 1	Students Read Article
Step 2	Formation of Interest Groups
Step 3	Groups Develop Presentation
Step 4	Presentations to Senate Committee
Step 5	Senate Committee Votes

Comments and Suggestions

- When the interest groups prepare their presentations, the Senators will be learning about the state he/she represents and its position on the SST. Since this is a somewhat demanding task, some guidance on your part will be helpful. If possible, the "Senators" might obtain summaries of the House's or Senate's debate on the issue or news reports by the popular press in the winter of 1975.

• Although the groups may select a spokesperson to present the arguments, the groups should be encouraged to involve all its members in the presentation. This is most easily accomplished by identifying one aspect of the argument for each person to further develop and present at the hearing.

Reading 9: The Shuttle Era

Handout 7: *The Space Program – Advantages and Disadvantages*

This article summarizes some basic facts about the Space Shuttle system. However, it does not discuss some possible ramifications and concerns associated with this complex and sophisticated system. Some of these possibilities are raised in the questions which follow the reading.

Following the reading, students will complete the Space Shuttle Worksheet by listing what they believe are the advantages and disadvantages of the shuttle system and space colonies. They will need to develop their ideas based on the reading and perhaps on other outside readings. You may wish to provide them with an example to help them get started, such as:

Advantage of Space Colony	**Disadvantages**
If people lived in space colonies, there will be more room on earth.	People may not be able to adjust to life in space.

Two readings in the Appendix of this guide further elaborate on ideas about Space Colonies. The positive and negative aspects are explored in greater detail. Some of the ideas entertained will provide additional topics for class discussion.

Student Activity: Dilemma Discussion

Dilemma 7: *"Space Litter"*

This dilemma deals with the difficult task of choosing between danger to oneself and endangering the lives of others. This dilemma is somewhat analogous to our current situation with crippled orbiting satellites and the possibility of debris falling on populated areas. With the application of many new technologies, we frequently encounter the age-old questions: "How much risk are we willing to accept?" "How can we best prevent unforeseen risks?"

In addition, we may need to raise questions about our responsibilities in space. Will our activities bring about irreparable changes in space? Do humans have a right to pollute and exploit space as they have planet Earth? Will we race to gain control of valuable resources in space, and what might be the consequences? Do humans have a right to stake claims in space?

Please follow the basic procedures for conducting dilemma discussions as suggested in this Teacher's Guide.

THE SPACE SHUTTLE: Advantages And Disadvantages

Instructions: In the spaces below, list some possible benefits and disadvantages of the Space Shuttle System and Space Colonies. Some have been identified in the reading; others you will have to predict.

SPACE SHUTTLE SYSTEM	
BENEFITS	PROBLEMS OR DISADVANTAGES
SPACE COLONIES	
BENEFITS	PROBLEMS OR DISADVANTAGES

(Save this completed worksheet which will help you answer the questions on pg. 65)

SECTION 4:

Future Perspectives

Activity 7: Transportation in the Future: A Scenario Writing Exercise

Overview

In this activity students are to write a scenario based on one of the topics suggested in the student's guide. Or alternatively, they may wish to develop a transportation topic related to their own particular area of interest. The main purpose of this activity is to engage students to examine potential changes or effects created by a given decision or situation. Using the scenario format, students can incorporate some of the ideas and concepts learned from this module and their own ideas and visions. All important is that the students begin to take into account the many complex and intricate issues surrounding the different modes of transportation — i.e., the enormous demand cars and trucks place on a nonrenewable resource and their detrimental effects on environmental quality.

Student Objectives

- To synthesize some of the ideas and concepts learned and incorporate them in a scenario.
- To make some projections about transportation in the future.

Student Activities

- Individually or in small groups, students will select one of the suggested topics or another choice and develop it into a scenario.
- The completed scenarios are presented to the class.

Scenario Writing

The scenario is a technique which provides students a wide degree of latitude as well as an opportunity to project into future possibilities. In fact, this is a tool frequently employed by future forecasters or decision makers to evaluate or explain a possible future. It is basically a story or narrative that is developed around a series of events or desired goal, and examines the complex interaction of factors and variables of that situation. Typically, a scenario begins with a "what if. . ." situation. Thus, a scenario allows the writer a flexible way to consider alternatives, possible changes, consequences and interrelationships from a broader perspective. Oftentimes, a scenario is used as a planning guide to detail those steps necessary to achieve a particular goal and to investigate effects of particular decisions.

The two articles on space colonies (see Appendix), exemplify one type of scenario writing — a description of a future event. However, each writer starts with a different set of basic assumptions and consequently foresees different futures for space colonies. In both cases, the writers have raised important issues which policy and decision makers should take into consideration.

Science fiction is another form of scenario writing. Since most students are familiar with science fiction in books and films, examples from this format may prove useful in assisting students in the development of their own scenarios.

The scenarios which the students will write for this activity will be in a simpler, more abbreviated form. It may be presented in a number of different ways: a story, a poem, cartoon drawings, a dialogue or a short skit. Encourage students to stretch their imagination and speculate about certain kinds of changes and try to identify the kinds of effects those changes might bring about. They should begin to recognize that a single change brings about other changes. As they relate one event with another a larger picture emerges and the scenario unfolds.

Some helpful hints to guide the students include:

- What changes do you predict might occur?
- In what ways might people respond or adjust to the change?
- What other alternatives are possible?
- Are your arguments or reasons well presented?
- How well does the story hold together?
- Is it interesting to the reader?

Thinking hypothetically such as in scenario writing is often difficult because our thinking is so influenced by what we know and what we have experienced. If the scenario is written as a group activity, the possibility of exploring a number of different ideas is increased. One technique often used for generating different and unusual ideas is *brainstorming*.

Brainstorming is a useful technique to help a group develop its scenario. The purpose of this technique is examined, possibly by first posing a question. Each person in turn contributes an idea and this continues around the group until all possible ideas seem to be exhausted. One person's idea often leads to other ideas. Or ideas may result from combining several ideas. *The important rule for brainstorming is to reserve judgment.* No one critically comments on another person's idea. Each and every idea is treated equally, no matter how far-fetched it may seem. Have one person record the ideas, and at the end of the session the list will be read. Then the group can decide which ideas are more interesting, practical or feasible to incorporate in the scenario.

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APPENDIX 1

Stages of Moral Development

PRECONVENTIONAL LEVEL

At this level the child is responsive to cultural rules and labels of good and bad, right and wrong, but interprets the labels in terms of either the physical or the hedonistic consequences of action (punishment, reward, exchange of favors) or in terms of the physical power of those who enunciate the rules and labels. The level is divided into the following two stages:

STAGE 1

The punishment and obedience orientation. The physical consequences of action determine its goodness or badness regardless of the human meaning or value of these consequences. Avoidance of punishment and unquestioning deference to power are valued in their own right, not in terms of respect for an underlying moral order supported by punishment and authority (the latter being stage 4).

STAGE 2

The instrumental relativist orientation. Right action consists of that which instumentally satisifies one's own needs and occasionally the needs of others. Human relations are viewed in terms as those of the market place. Elements of fairness, of reciprocity, and of equal sharing are present, but they are always interpreted in a physical, pragmatic way. Reciprocity is a matter of "you scratch my back and I'll scratch yours," not of loyalty, gratitude, or justice.

CONVENTIONAL LEVEL

At this level, maintaining the expectations of the individual's family, group or nation is perceived as valuable in its own right, regardless of immediate and obvious consequences. The attitude is not only one of conformity to personal expectations and social order but of loyalty to it, of actively maintaining, supporting, and justifying the order, and of identifying with the persons or group involved in it. At this level, there are the following two stages.

STAGE 3

The interpersonal concordance of "good boy - nice girl" orientation. Good behavior is that which pleases or helps others and is approved by them. There is much conformity to stereotypical images of what is majority or "natural" behavior. Behavior is frequently judged by intention — "he means well" becomes important for the first time. One earns approval by being "nice."

STAGE 4

The law and order orientation. There is orientation toward authority, fixed rules, and the maintenance of social order. Right behavior consists of doing one's duty, showing respect for authority, and maintaining the given social order for its own sake.[1]

POSTCONVENTIONAL OR PRINCIPLED LEVEL

At this level, there is a clear effort to define moral values and principles which have validity and application apart from the authority of the groups or persons holding these principles and apart from the individual's own identification with these groups. This level again has two stages, which are as follows:

STAGE 5

The social-contract legalistic orientation, generally with utilitarian overtones. Right action tends to be defined in terms of general individual rights and standards which have been critically examined and agreed upon by the whole society. There is a clear awareness of the relativism of personal values and opinions and a corresponding emphasis upon procedural rules for reaching consensus. Aside from what is constitutionally and democratically agreed upon, the right is a matter of personal "values" and "opinion." The result is an emphasis upon the possibility of changing law in terms of rational considerations of social utility (rather than freezing it in terms of stage 4 "law and order"). Outside the legal realm, free agreement and contract is the binding element of obligations.

STAGE 6

The universal ethical principle orientation. Right is defined by the decision of conscience in accord with self-chosen ethical principles appealing to logical comprehensiveness, universality, and consistency. These principles are abstract and ethical (the Golden Rule, the categorical imperative); they are not concrete moral rules like the Ten Commandments. Instead, these are universal principles of justice, of the reciprocity and equality of human rights, and of respect for the dignity of human beings as individual persons.

[1] Lawrence Kohlberg. Stages of moral development as a basis for moral education. In C.M. Beck, B.S. Crittendon, and E V Sullivan (Eds.) *Moral education*. New York: Newman Press, 1971, 86-88.

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Mass Transit and Appropriate Technology

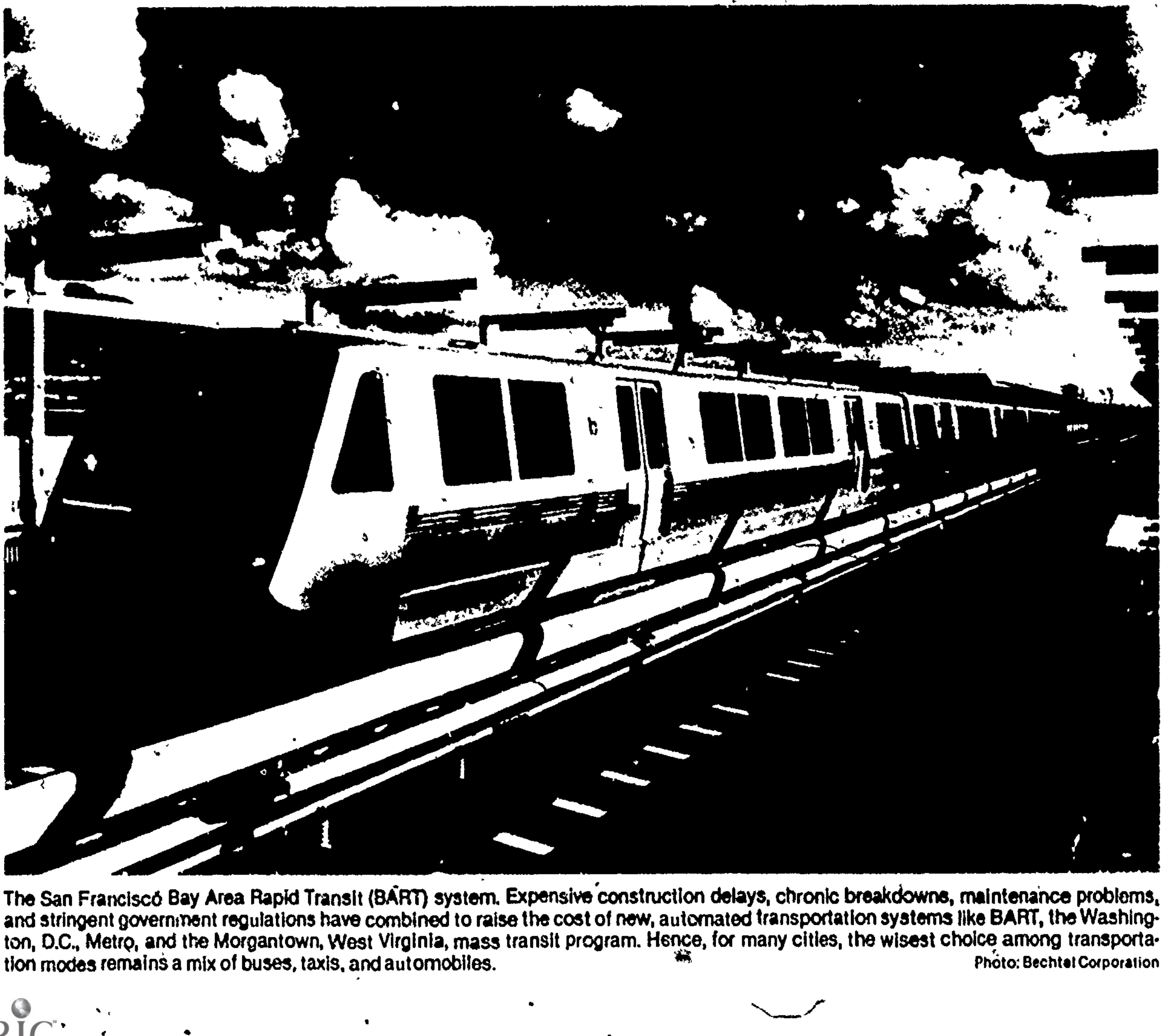
by Larry Bell

Population pressures, dwindling fossil fuel reserves, and new technological developments will make mass transit more and more competitive with private automobiles in the future. But future transit systems require a combination of "high" and "low" technologies—automated subways and conventional sidewalks. In many cities, buses and taxicabs are still the best public transit alternatives, and newer, more sophisticated technologies often cause more problems than they solve.

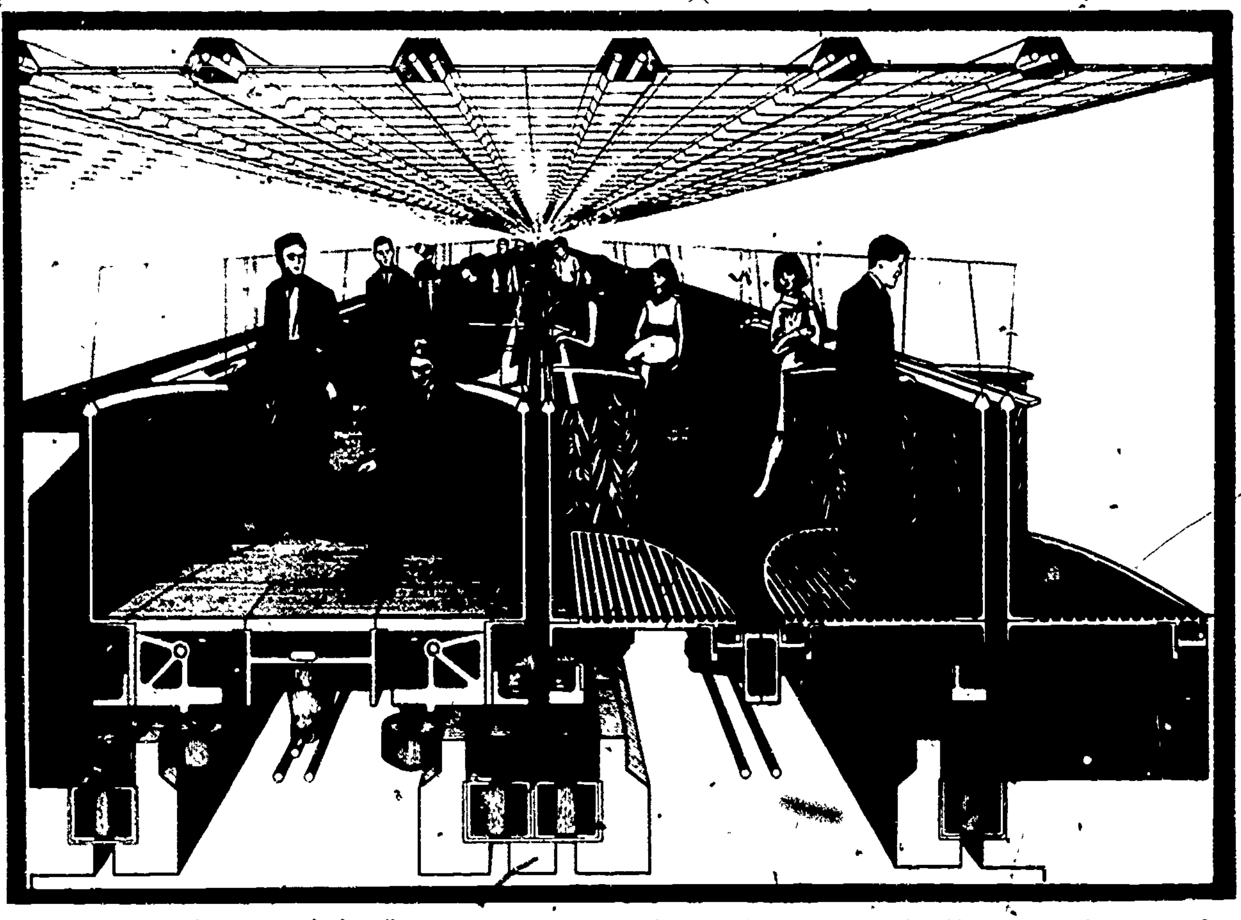
Recent advances in transit systems show that modern technology can provide solutions to difficult mechanical problems. Yet despite dazzling technical achievements, very few of the new systems have actually been implemented to serve American cities, and none has captured a significant share of the public transit market.

The apparent lack of public support for new "advanced" transit systems does not reflect unqualified satisfaction with more conventional road and rail transportation. Rather, it reflects the fact that technical priorities have often been off-target. they have focused too much upon finding sexy answers to technical challenges and not enough on exploring needs and underlying issues. For example, some planners advocate completely automated systems with numerous small stations and no human operators, but experience has shown that crime is a major problem even in systems with many attendants and relatively few stations to defend.

Public sentiment can eventually be expected to shift in support of major improvements in public transit systems, if only because the rape of urban space to provide more and more roadways cannot continue indefinitely. (Los Angeles has already devoted two-thirds of its land area to streets and parking lots.) And while the great American love affair with the automobile will not end soon, fuel shortages are bound to force growing numbers of motorists to seek transportation alternatives. In addition, fuel shortages can be expected to coun-



The San Francisco Bay Area Rapid Transit (BART) system. Expensive construction delays, chronic breakdowns, maintenance problems, and stringent government regulations have combined to raise the cost of new, automated transportation systems like BART, the Washington, D.C., Metro, and the Morgantown, West Virginia, mass transit program. Hence, for many cities, the wisest choice among transportation modes remains a mix of buses, taxis, and automobiles. Photo: Bechtel Corporation



A cutaway illustration of Larry Bell's "synchroveyor" public transportation system. Synchroveyors are essentially "trains" that have no beginning or end but are arranged in continuous loops. These "endless trains" can be several miles long. The two synchroveyors pictured here run in the same direction, but one is an express loop that operates at a constant speed of 30 miles per hour, and the other a local loop that makes regular stops and operates at variable speeds of up to 30 miles per hour. For short trips, passengers would simply board their local loop and get off at their destination. On longer trips, they could switch to the adjacent express loop. They could make the change when the local synchroveyor reached its top speed of 30 miles per hour, and was moving at the same speed as the express.

teract urban sprawl in ways which will make public transit more economical. But to meet the need for improved transit systems, we must shift our emphasis from *advanced* technology to *appropriate* technology.

When the U.S interest in mass transit was awakened in the 1960s, many people believed that the exciting new technological powers that had hurled objects into outer space and put people on the moon could readily be applied to solve the transit problems of modern cities. However, recent experiences with the Bay Area Rapid Transit (BART) system in San Francisco, the personal rapid transit (PRT) system in Morgantown, West Virginia, and other attempts to market new aerospace-inspired systems have shown that technology transfer from outer space to urban space is more difficult than many people had imagined. There are two major differences between public transit systems and space programs.

• New transit systems must compete for funds and acceptance with a well established network of roadways and vehicles that are linked to nearly all aspects of the social and economic life of the nation. No such competition exists in space.

• Space programs need only meet the priorities of a few decision-makers who usually have very specific objectives. Urban systems must satisfy the needs of large, enormously diverse populations, and costs and benefits must bear comparison with other transportation alternatives.

"High" Technology Not Always Best

Advanced transportation developments have typically emphasized automation and labor-saving techniques. This emphasis reflects the priorities of the past, when the U.S. work force was relatively small in comparison to its natural resources—land, water, raw materials, energy, etc.—and arguments for reducing labor requirements through automation were widely accepted by workers as well as employers. Now that natural resources are shrinking and the U.S. is facing unemployment and under-employment, some influential groups are beginning to urge a switch from "high" technology (technology that makes minimal use of human labor) to "low" or "intermediate" technology. The late British economist E.F. Schumacher, who inspired the opponents of high technology, argued that the world needs a technology that will employ lots of people, be gentle in its use of scarce resources, and serve the human person instead of making him the servant of the machine. The ideal technology in a given situation might often be neither high nor low, but intermediate. In his well-known book *Small Is Beautiful*, Schumacher argued that intermediate technology is "vastly superior to the primitive technology of bygone ages but at the same time much simpler, cheaper, and freer than the super technology of the rich."

Many people (myself included) believe appropriate technology can include large-scale and high technologies as long as human and ecological interests are served. But the technologies should present clearly demonstrable advantages over simpler alternatives. In some urban areas, elevated computer-controlled vehicles, for example, may provide clear advantages over more conventional modes that clog city streets, are slower due to congestion, use more fossil fuel, and contribute to air and noise pollution. And they may

The Future of Transit in the U.S.: Some Projections

Immediate Future (present to 1980)

• Leisure time will continue to increase, as will congestion resulting from recreational travel. (H)

• Industries will relocate from large northern cities to sunbelt areas in increasing numbers to avoid high winter energy costs and taxes. (B)

• Unemployment, poverty, and crime rates in large northern cities will increase. (B)

• Public interest in conservation and responsible life-styles will continue to grow. (C)

• The 55-mph speed limit will continue and people will be encouraged to carpool and use mass transit systems through widespread educational programs urging energy conservation. (C)

• All fossil fuels will be deregulated. (C)

• There will be periodic rationing of fuels. (C)

• Tax incentives will be provided to increase research efforts in developing alternative travel methods. (C)

• Taxes will be levied on automobiles by weight and horsepower. (C)

• Introduction of free rapid transit will gain public support and be implemented in many heavily populated urban areas. (Downtown Seattle already has free bus services.) (H)

• All federal rail spending proposals will be closely scrutinized and require strong local financial support, no major new rail transit systems will be initiated. (B)

• The trend toward pollution-free vehicles will continue. (B)

Intermediate Future (1980-1990)

• The environmentalist movement will continue to gain strength in the 1980s, although it will diminish slightly by 1995. (H)

• By 1985, 10% of the activities that now require travel will be done through electronic communication. (H)

• There will be a growing trend toward labor strikes that tie up mass transit systems. By 1985, bus riders will experience a 10% increase in strike disruptions of service. (H)

• Public transit costs will remain fairly steady for the next 10 years (but will then increase by 20% by 1995). (H)

• Energy taxes will be imposed. (C)

• There will be permanent rationing of gas, fuel oil, and gasoline. (C)

• There will be negative incentives for large energy users, the opposite of the present pricing system. (C)

• Driving automobiles will be discouraged and tolls for entering downtown areas will be imposed. In some cities, cars will be banned from downtown areas altogether. (H)

• Lack of adequate highway maintenance will raise insurance rates and cause more accidents. (H)

• There will be rigid enforcement of land use controls to prevent urban sprawl. (H)

• Movement of people and goods will be nationalized by the mid-1980s and legislation will be enacted to correct union abuses of railroads. (H)

• Federal funding of state transportation research will become commonplace and there will be increases in state and federal regulation of transportation. (H)

• There will be a lessening of controls at the city, county, and regional levels. (H)

• Free transit rides will be commonplace by the late 1980s. (H)

• A practical high-density battery or fuel cell will be developed, making electric cars competitive for city use in the early 1980s. (H)

• Small electric vehicles will be mass produced. (C)

• By 1985, 20% of personal vehicles will be largely pollution free. (H)

• All eight-cylinder cars will be phased out. (C)

• Reliable communication systems to improve coordination of multimodal transit systems will be developed early in the 1980s. (H)

• Buses and subways will become increasingly unsafe from an operational standpoint, but transit-related crimes will begin to decline by 1990. (H)

• Large cities will develop and expand urban subway systems, which will become economically feasible due to reduced excavation costs. (B)

Long-Term Future (1990 on)

• The distances people travel to work on buses or rapid transit will nearly double in the next 30 years. (H)

• Major alterations of urban land use patterns will occur, with premium prices for land near city centers and rapid transit lines. (C)

• Structural, economic changes will be based on the development of new technologies and the decline of old technologies. (C)

• There will be a decline of all industries producing products that use non-renewable resources as fuel. (C)

• Per-capita car ownership will be reduced slightly during the next 30 years, but there will be increased use of rental and leased cars. (H)

• Demand for rapid transit will nearly double by 2005. (H)

• Freeways and expressways are losing their popularity and with more people turning to public transportation, opposition to building new freeways will increase three-fold within the next 30 years. (H)

• Free-fare transit will be the rule rather than the exception by the 1990s. (H)

• The powerful transportation lobby will only be one-third as effective by the year 2005. (H)

• Measures will be taken to control air pollution and within 25-30 years it will be viewed as half the problem it is now. (H)

• One out of four trips that people now make will be handled by electronic devices such as home-to-store communications. (H)

• By the mid-1990s, half of all personal vehicles will be pollution-free. Ninety percent will be by 2005. (H)

• Six-cylinder cars will be phased out. (C)

• There will be widespread use of electric cars for intra-city trav[illegible]

• Dial-a-ride systems will [illegible] vogue and city-to-city rail p[illegible] service will measure up to [illegible] standards by the mid-1990s

• There will be widespread [illegible] electric trains for inter-city travel. (C)

• Moving sidewalks will be used widely by the late 1990s. (H)

• After prolonged experimentation, automated highways will be built for regular usage during 199[illegible]-2010. (H)

Most of the projections highlighted in this chart are drawn from two sources:

James Coomer, a memb[illegible] [illegible] Future Studies graduate faculty [illegible] the [illegible]niversity of Houston at Clear Lak[illegible] [illegible] Texas, published some recommended government role projections in the August 1977 issue of *THE FUTURIST*.

Ray Herbert, a staff member on the *Los Angeles Times*, published some results of a congress on transportation and society in the March 1976 issue of *Mass Transit* magazine. The discussions were conducted under the direction of the University of Southern California's Center for Futures Research to identify trends and events which can be expected to have a significant bearing on society, and in turn, its relationship to transportation. The panel experts included businessmen, economists, environmentalists, educators, transportation and oil company executives, jurists, and law enforcement officers. In addition, the author, Larry Bell, has included some forecasts of his own. The sources of the forecasts are indicated by a letter: C = Coomer, H = Herbert, B = Bell.

Larry Bell

Larry Bell is a professor of industrial design at the University of Illinois and a visiting professor of architecture at the University of Houston. He is a licensed architect and has been a senior associate with Barton-Aschman Associates, Inc., a national urban and transportation planning firm. Professor Bell has written many articles about advanced transportation, the environmental impact of transportation, and crime prevention through environmental design. In addition, he is a contributing editor for *Industrial Design* magazine and writes a regular column about design management. Some of his many projects include:

• Synchroveyor Urban Mass Transportation System: The Synchroveyor is a patented system for transporting very large numbers of people, conveniently, in heavily populated areas. The concept utilizes closed loop conveyors or "endless trains" for moving standing and seated passengers at speeds up to 30 miles per hour. Passengers board the loops during stop phases that occur at 40-90 second intervals. Transfer between adjacent loops is possible during regular phases when both "endless trains" are moving at the same speed. All boarding, transfer, and exiting are accomplished automatically by means of transfer decks that revolve in a "lazy Susan" fashion. Continuous safety partitions on board the loops and along adjacent walkways prevent improper transfer when the system is in operation.

Larry received the national ALCOA *Ventures in Design* award in 1970 for his work on Synchroveyor.

• Chicago Tunnel Project: Larry was project director for a study which was jointly undertaken by the University of Illinois and Vought Aeronautics of Dallas, Texas, to investigate potential uses for 50 miles of abandoned freight tunnels located 40 feet below the streets of downtown Chicago. Three decades ago, as many as 90 electric trains operated in the small tunnels, distributing freight and mail, and carrying coal to downtown buildings. After Chicago switched to oil and gas heat, financial losses forced the system to close down in 1958.

The multi-disciplinary study group determined that by implementing a high-capacity automated transportation system, Chicago's tunnels could be returned to productive use and could compete for freight contracts with the 13,000 trucks that clog downtown streets every day. Besides reducing traffic congestion, the tunnels would make it profitable to recycle huge quantities of paper generated in the central business district and valued at millions of dollars each year. Quite possibly, the network could also be used to move people.

• Dragonfly Car: Larry Bell and an associate have designed an inexpensive ($4,000), energy-efficient (40 miles per gallon estimated) automobile that is versatile, safe, and fun to drive. Engineering for the Dragonfly applies sophisticated racing technology to provide outstanding sports car handling. And by sliding or removing elements of the two-piece canopy, the car can easily be changed from a hatchback sedan to a touring landau, sports convertible, open roadster, or a utility pickup. The cars are being manufactured by a small company in Mayview, Illinois.

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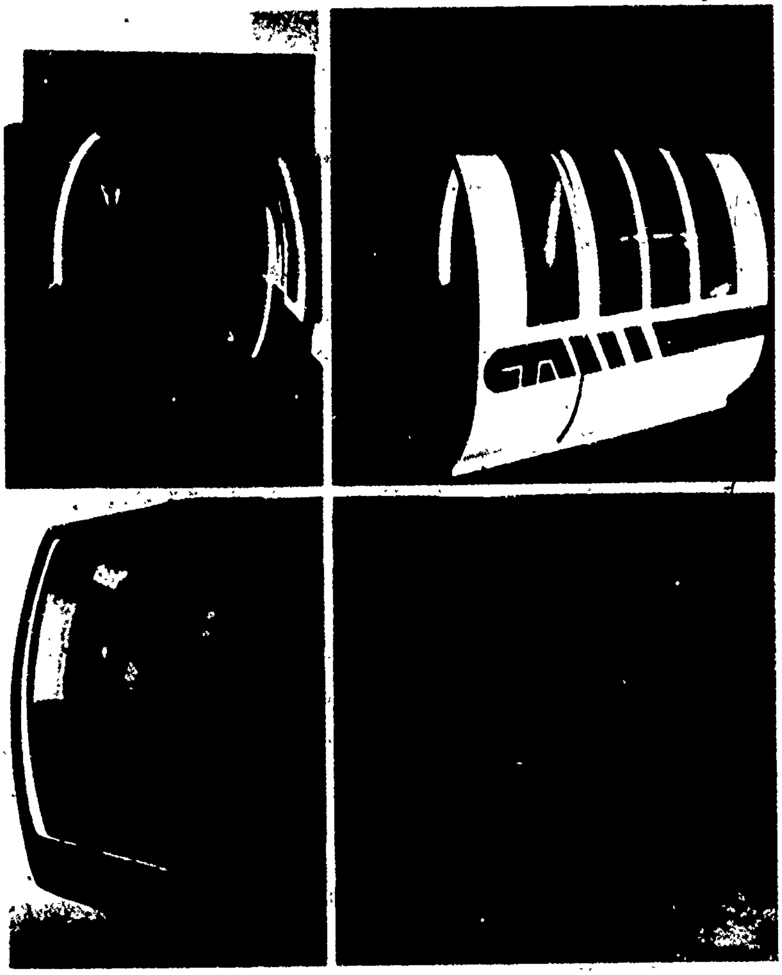
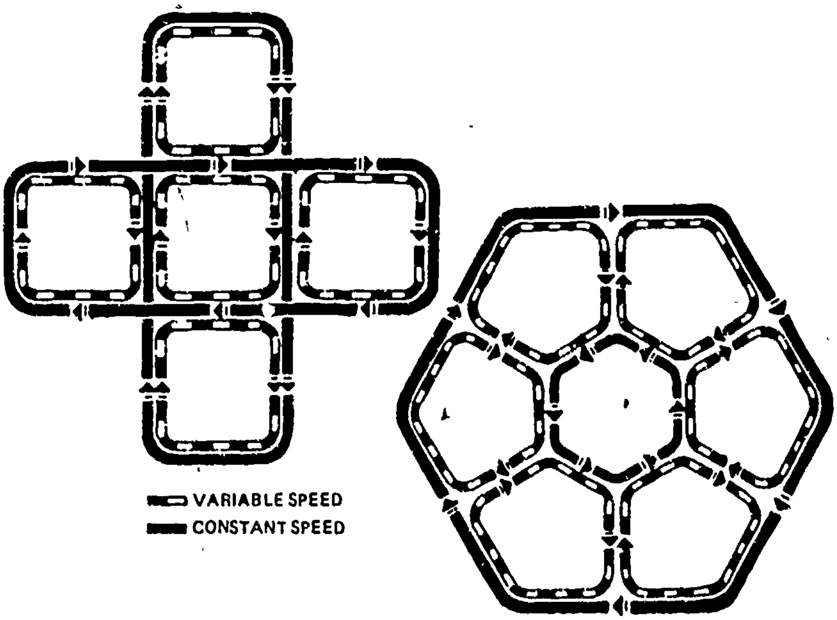


Cutaway model of a proposed automated "subway" developed for the Chicago Tunnel Project. Author Larry Bell directed a study of the potential uses of 50 miles of abandoned tunnels beneath the streets of downtown Chicago. The study showed that a carefully designed automated transportation system would allow the tunnels to be profitably used to transport freight and perhaps even people.

Left: Two adjacent synchroveyor loops shown side by side. When these "endless trains" run at the same speed, passengers may transfer between loops simply by stepping onto a transfer deck, which then revolves and lets them off on the adjacent loop. **Right:** Model shows how passengers board and exit the synchroveyor. A local synchroveyor loop makes regular stops at 40- to 90-second intervals. Passengers get on and off by means of revolving transfer decks that connect the synchroveyor to adjacent walkways. Walkways and synchroveyors "share" the divided transfer decks, which separate when the synchroveyor begins to move and are automatically realigned at all stops.



A schematic diagram of two alternate layouts for synchroveyor systems. The solid lines indicate express loops that operate at a constant speed of 30 miles per hour. The broken lines show local loops that make regular stops, but also reach top speeds of 30 miles per hour so passengers can transfer between local and express loops when both are moving at the same speed.

lure some motorists away from cars. However, proponents should be cautious in their expectations and promises of service efficiencies and increased ridership that automated systems will deliver. The Morgantown, BART, and Washington, D.C., Metro systems have not consistently demonstrated travel-time improvements over conventional buses for most trips. Service interruptions caused by failures of sophisticated "fail-safe" devices have been chronic and costly. Automobile use has not significantly declined and air purity improvements have been too small to measure.

While lauding the virtues of automated "personal" service, many advanced transportation advocates have looked down their noses at transit modes that are truly personalized. Buses have been frowned on because they are so primitive as to require drivers. Yet for cities with populations of less than 250,000, buses offer the only practical public transit option. The most personalized of all forms of public transit, the taxicab, is often made less efficient by municipal policies: for example, in New York City, where private automobile ownership is expensive and subways are deteriorating, the number of taxis is limited and fares are kept artificially high by restrictions on group rates. (A taxicab "medallion,"—the right to operate a cab—recently sold for more than a seat on the New York Stock Exchange!) Washington, D.C., uses a zone system that makes no allowances for the time lost due to traffic delays, thereby discouraging taxi drivers from operating during rush-hours when the need is greatest. Los Angeles is divided into four separate franchise areas and a cab driver who drops off passengers outside his area is not allowed to pick up new passengers there but must return empty.

Some of the enormous problems within the commuter rail industry can be traced to the current fascination with sophisticated technology. In 1974, the St. Louis Car Company folded after losing heavily on 352 cars built for New York and 130 built for the Illinois Gulf Railroad. The Pullman-Standard and Rohr car companies together lost over $61 million on contracts with the New York and Washington, D.C., transit systems. Frequently changing technical requirements imposed by the government are one reason for increasingly complex transit systems and expensive construction delays. The lack of standardized rail system dimensions and equipment specifications also adds heavily to costs since often not enough cars of one type are ordered to support efficient production. Ironically, in spite of the emphasis on technical improvements, the advanced trains often operate at a fraction of their potential speed and experience frequent breakdowns due to antiquated and poorly maintained tracks.

Future Opportunities

Looking now on the brighter side for technology buffs, it appears likely that advanced transit is not only here to stay, but will gain support and popularity in the future. Fuel shortages and municipal restrictions on urban automobile use can be expected to cause large numbers of people to switch to public transportation in the short-term future, expanding available revenues for technical and service improvements. Recent advances in deep tunneling approaches can quite possibly make the construction of new underground transit systems feasible for urban areas which cannot presently afford them. And longer-term land-use trends will result in tighter clustering of urban residents, thus making more efficient public transit services possible and offering increased revenues for ambitious new transit developments.

Based upon observed trends, professional intuition and projections offered by James Coomer and Ray Herbert which are highlighted in the accompanying chart, I will venture some personal predictions about transit-related developments and priorities that will become evident by the turn of the century:

Travel Will Remain Popular: In the future, people will travel as much, if not more, than they do now, despite electronic communication systems that will make many business and domestic trips unnecessary and also despite increasing restrictions on energy consumption. Important factors in maintaining or enlarging the amount of travel will be an increase in leisure time and the significantly greater distances that many people will travel to work.

Importance of Public Transit: Public transportation will play a much more important role for all income groups as private automobiles come to be banned in many cities, energy is rationed, and highway maintenance deteriorates. Public transit may eventually be free of charge. People will accept both intra-city and inter-city public transit as a normal "free" service provided by the government (similar to maintenance of streets and the operation of schools). The public will expect and demand clean, comfortable, and efficient service.

Economic Viability of Public Transit: Legislation to reduce the trend towards urban sprawl will further encourage people to move closer to public transit lines, which will improve the financial viability of transit operations in two important ways: (1) As residential land use becomes denser, increasing numbers of people will switch from private automobiles to public transit. (2) The gradual curtailment of urban sprawl will reduce situations where large vehicles carry only a few passengers to remote locations, thereby enabling transit operators to provide more frequent and profitable service.

Growth of Commuter Rail Systems: Surface rail commuter systems will come to play increasingly important roles in connecting suburbs and satellite cities to industry and business centers. (Only seven U.S. cities have them now.) Many of the new trains will operate efficiently at speeds that reach 130 miles per hour (as do the famous and popular bullet trains used by the Japanese National Railways). Tracks will be welded to reduce noise and maintenance.

Inner-City Rail Subway Developments: Commuter rail subway systems will be built to connect inner-city areas with transportation lines leading to the suburbs. A current University of Illinois study indicates that deep tunneling approaches may often be able to reduce subway excavation and construction costs by 300% or more over conventional methods, making subway systems feasible for cities which so far have not been able to afford them. Rail car equipment costs will be reduced through the establishment of national design standards which will make it unnecessary for manufacturers to develop different lines of vehicles tailored to each city's specifications.

Light Rail Transit: Light rail transit "street car trains" will become extremely popular in many large and intermediate-sized cities. Light trains are cleaner, quieter, and use less than a fifth as much manpower as buses. They can be lengthened and strengthened to meet fluctuating service demands and networks can be expanded in stages as community needs increase.

Automated Fixed Guideway Transit: In the central business districts of many cities, computer-controlled vehicles will provide "on-call" service (like horizontal elevators) and will be linked together to operate as scheduled trains during rush periods. They will interconnect second and third-story activity centers, following the paths of city streets and even passing silently through buildings if necessary. However, crime and fear will be major obstacles blocking public acceptance of these driverless systems—particularly those utilizing small two to four-passenger vehicles—in declining cities and in deteriorating sections of vital cities. Violent crimes will probably be less frequent during daytime hours due to heavy ridership, which will provide safety in numbers. But operation during late evening hours may be risky because passengers will not be able to shield themselves (as can motorists driving private cars) from night-time threats that occur when stations and streets are relatively empty.

Buses: Buses will lose ground to light rail streetcars for transporting passengers in large and moderate-sized cities but will continue to be primary modes for small communities. Buses will also remain important to provide charter services and will be essential for areas that are too remote, sparsely populated, or seasonally used to warrant fixed-track or guideway shuttles. Dial-a-bus programs will be common in most cities to provide special transportation for elderly and handicapped people, offering low-cost or free rides subsidized by federal, state, and city taxes, and the buses will also be sponsored by civic groups, churches, and municipal organizations. In addition, dial-a-bus programs will become common to provide general transportation in rural areas.

Private and Rental Vehicles: Many small business firms will begin to manufacture automobiles and other public and personal vehicles with an increased emphasis upon battery and fuel-cell power sources. These new vehicles, appearing in a wide variety of models and styles, will capture the public imaginations and force major changes upon large manufacturers. System alternatives will include:

- Small, electric rental cars for urban use. (This has already happened in Amsterdam.)
- Passive carriers that can be pulled in trains behind small, electrically-powered vehicles for low-speed transportation in pedestrian activity centers.
- Two-and three-passenger electric cars with trailers that can be attached to transport additional passengers and merchandise.
- Easily removable battery trays that can be quickly slipped out and recharged while an alternate tray is used.
- Rental battery packs provided by stations along highways and in cities.

Moving Ways: New types of moving-way systems will carry people at 20-30 miles per hour in areas of high population density. One type of system will consist of one or more trains, each arranged in a continuous closed loop (without any first or last vehicle). These "endless trains" may be a mile or more in circumference, or may be set into "dumbbell" shaped configurations. In some multiple-loop networks, passengers will transfer from one "endless train" to another—often while the trains are still moving at the same speed—to make trips outside their area of origin. Conventional conveyor-belt "moving sidewalks" will be used for short-distance, low-speed convenience at airports and other active pedestrian centers.

All Levels of Technology Have a Future

The transportation industry includes many rival interest groups, each zealously claiming to have the technology that "holds the key to the future." And while this contest for scarce development dollars and public support continues, the country as a whole is becoming more and more divided in attitudes towards technology in general. Some people seem to think that high technology will save them from having to modify life-styles that are comfortable and internationally enviable. Others view high technology as a threat to the environment, to human values, and to mankind's future. The only hope for a livable future, they argue, lies in low and intermediate technology.

Is there a single type or level of technology that will save us from doom and damnation? I believe not. The most appropriate technology for each problem will be found by aiming at balanced, integrated solutions that consider all reasonable options. These options include high, intermediate, and low technology alternatives ranging from exotic walkways that move to conventional walkways that don't.

APPENDIX 3

Space Colonies: The High Frontier

by Gerard K. O'Neill

An earth-like space colony could be orbiting our world by 1990, says a Princeton University physicist. The colony's 10,000 inhabitants would enjoy green plants, animals, plains, valleys, hills, and streams. The colonists would pay off the cost of building their extraterrestrial home by manufacturing satellite solar power stations, which would supply cheap, virtually inexhaustible power to the earth.

During the past decade, a number of premises about the basic problems of the world have become very widely accepted. The more important of these accepted ideas are

1. For the foreseeable future, every significant human activity must be confined to the surface of the earth
2. The material and energy resources of the human race are just those of our planet.
3. Any realistic solutions to our problems of food, population, energy, and materials must be based on a kind of zero-sum game, in which no resources can be obtained by one nation or group without being taken from another.

Given those premises, logic has driven most observers to the conclusion that long-term peace and stability can only be reached by some kind of systematic global arrangement, with tight constraints to insure the sharing—equable or otherwise—of the limited resources available. I find it personally shocking that many such observers, even those who profess a deep concern for humankind, accept with equanimity the need for massive starvation, war, or disease as necessary precursors to the achievement of such a systematic global arrangement.

In my opinion, based on studies carried out at Princeton University, these three basic premises on which most discussions of the future have been based are simply wrong. The human race stands now on the threshold of a new frontier whose richness is a thousand times greater than that of the new western world of 500 years ago.

That frontier can be exploited for all humanity, and its ultimate extent is a land area many thousands of times that of the entire earth. As little as 10 years ago we lacked the technical capability to exploit that frontier. Now we have that capability, and if we have the willpower to use it, we can not only benefit all humanity, but also spare our threatened planet and permit its recovery from the ravages of the industrial revolution.

The high frontier which I will describe is space, but not in the sense of the Apollo program, a massive effort whose main *lasting* results were scientific. Nor is it space in the sense of the communications and observation satellites, useful as they are. Least of all is it space in the sense of science-fiction, in which harsh planetary surfaces were tamed by space-suited daredevils. Rather, it is a frontier of new lands, located only a few days travel time away from the earth, and built from materials and energy available in space.

The wheel-like design shown above (and also on the cover) might be used for the first space colony. The mirror floating above the colony reflects sunlight into the ring mirrors below, which reflect it through 100-foot strip windows into the colony's interior for light and agriculture. Above the core sphere are communications and spacecraft docking facilities. Long rectangle in foreground is a heat radiator. The facility below the colony is the manufacturing area where lunar ore is melted with solar power. Lower central sphere is the original "construction shack" for the colony.

Drawing NASA

Space Colonies: The Basic Plan

The central ideas of space colonization are:

1. To establish a highly-industrialized, self-maintaining human community in free space, at a location along the orbit of the moon called L5, where free solar energy is available full time.
2. To construct that community on a short time scale, without depending on rocket engines any more advanced than those of the space shuttle.
3. To reduce the costs greatly by obtaining nearly all of the construction materials from the surface of the moon.
4. At the space community, to process lunar surface raw materials into metals, ceramics, glass, and oxygen for the construction of additional communities and of products such as satellite solar power stations. The power stations would be relocated in synchronous orbit about the earth, to supply the earth with electrical energy by low-density microwave beams.
5. Throughout the program, to rely only on those technologies which are available at the time, while recognizing and supporting the development of more advanced technologies if their benefits are clear.

The two key factors that make space colonization an economically sound idea are solar energy and lunar

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materials. As everyone knows, the sun is a virtually inexhaustible source of clean energy. On earth, solar energy use is hampered by nighttime, by seasonal variation in the day-length, and by clouds; in space, solar energy is always available, and also much more intense. The amount of solar energy which flows unused, in a year, through each square meter of free space is 10 times as much as falls on an equal area in even the most cloud-free portions of Arizona or New Mexico. A solar-energy installation in space, therefore, is potentially able to operate at a tenth the cost at which it could operate on earth.

The cost of space colonization could be reduced further by obtaining construction materials from the moon. On earth, we are the "gravitationally disadvantaged." We are at the bottom of a gravitational well 4000 miles deep, from which materials can be lifted into space only at great cost. The energy required to bring materials from the moon to free space is only one twentieth as much as from the earth, and Apollo samples indicate that the moon is a rich source of metals, glass, oxygen, and soil. The moon's lack of an atmosphere reduces further the cost of transporting lunar materials to orbiting space colonies.

Lunar surface raw materials would be transported by a launching device called a mass driver; it exists now only on paper, but it can be designed and built with complete assurance of success because it requires no high-strength materials, no high accelerations or temperatures, and its principles are fully understood. The mass driver would be a linear electric motor, forming a thin line several miles long, which would accelerate small 10-pound vehicles called buckets to lunar escape velocity, at which time they would release their payloads and then return on a side track for reuse. The mass driver would be an efficient machine, driven by a solar-powered or nuclear electric plant.

Building the First Colony

If we were to start now, with determination and drive, I believe that the first space colony (Island One) could be in place, with its productive capacity benefiting the earth, before 1990. This is possible, I must emphasize, within the limits of present-day, conventional materials and technology.

A modified space shuttle and a chemical space tug would be used to transport basic construction equipment, supplies, and 2,000 workmen to a point in space called L5. (L5 is a point in the moon's orbit equidistant from the earth and the moon at which objects will remain in a stable orbit, stationary with respect to the moon.) A smaller work force of about 200 people would establish a lunar outpost which would provide 98% of the raw materials needed for the construction of Island One.

The mass driver, operating only 25% of the time, could lift 500,000 tons of material to L5 in the six-year construction time of Island One. An identical machine, located in space, could be a very effective reaction motor for the shifting of heavy payloads in the 100,000-ton range.

Lunar soil is 40% oxygen, 19.2% silicon, 14.3% iron, 8% calcium, 5.9% titanium, 5.6% aluminum, and 4.5% magnesium. The aluminum would be the primary building material and the oxygen would be used as atmosphere and to fuel rocket engines. Lunar surface materials are poor in carbon, nitrogen, and hydrogen, which would have to be brought from earth. For every ton of hydrogen brought from earth, nine tons of water could be made at the colony site, using oxygen from the processing of lunar oxides.

The removal of half a million tons of material from the surface of the moon sounds like a large-scale mining operation, but it is not. The excavation left on the moon would be only five meters deep and 200 meters long and wide, not even enough to keep one small bulldozer occupied for a five-year period.

In the long run, we can use the fact that the asteroids are also a source of materials. The three largest asteroids alone contain enough materials for the construction of new lands with a total area many thousands of times as large as that of the earth. Once the asteroidal resources are tapped, we should have not only metals, glass, and ceramics, but also carbon, nitrogen, and hydrogen. These three elements, scarce on the moon, are believed to be abundant in the type of asteroid known as carbonaceous chondritic.

Island One

Within the materials limits of ordinary civil engineering practice and within an overall mass budget of 500,000 tons (about the same as the mass of a super-tanker), several designs for the first "island in space" have evolved. All are pressure

Below is an artist's conception of a segment of the wheel-shaped space colony during final stages of construction. Shown is an agricultural area with a lake and a river. These farming sections are interspersed with three more-populated areas, all protected by a shield of lunar slag attached to the outside of the colony shell.

Drawing: NASA

vessels—spherical, cylindrical, or toroidal—containing atmospheres with the same oxygen content as at sea level on earth and rotating slowly to provide a gravity as strong as that of the earth. The axis of the structure would always point toward the sun, the source of all the energy used by the colony.

The first space community would house 10,000 people, 4,000 would be employed building additional colonies, while 6,000 would be producing satellite solar power stations. The interior of the colony will be as earth-like as possible—rich in green plants, trees, animals, birds, and the other desirable features of attractive regions on earth. The design would allow a line of sight of at least a half mile, giving the residents a feeling of spaciousness. The landscape would feature plains, valleys, hills, streams, and lakes. The residential areas might consist of small apartment buildings with big rooms and wide terraces overlooking fields and groves. Near the axis of the structure, gravity would be much reduced and, consequently, human-powered flight would be easy, sports and ballet could take on a new dimension, and weight would almost disappear. It seems almost a certainty that at such a level a person with a serious heart condition could live far longer than on earth, and that low gravity could greatly ease many of the health problems of advancing age.

The space colony would have separate residential, agricultural, and industrial areas, each with its optimal gravity, temperature, climate, sunlight, and atmosphere. Intensive agriculture would be possible, since the day-length and seasonal cycle would be controllable independently for each crop and care would be taken not to introduce into the agricultural areas the insect pests which hamper earth agriculture. Agriculture could be efficient and predictable, free of the extremes of crop failure and glut which the terrestrial environment forces on our farmers. Only 111 acres would be needed to feed all 10,000 residents.

Energy Without Guilt

Energy for agriculture would be used directly in the form of sunlight, interrupted at will by large, aluminum shades located in zero gravity in space near the farming areas. An advanced sewage system would quickly and efficiently turn wastes into pure water and agricultural chemicals. The air, constantly filtered, would be cleaner than in any city on earth.

Non-polluting light industry would probably be carried on within the living-habitat, convenient to homes and shops. Heavy industry, though, could be located in nearby external non-rotating factories because of the advantages of zero gravity. The combination of zero gravity and breathable atmospheres would permit the easy assembly—without cranes, lift-trucks, or other handling equipment—of very large, massive products. These products could be the components of new colonies, radio and optical telescopes, large ships for the further exploration of the solar system, and power plants to supply energy for the earth. Within a century, other industries might be shifted to space colonies because of the abundant, free, pollutionless energy supply and the greater efficiency made possible by zero gravity and the vacuum of space.

Process heat for industry, at temperatures of up to several thousand degrees, would be obtainable at low cost, simply by the use of aluminum-foil mirrors to concentrate the ever-present sunlight. In space, a passive aluminum mirror with a mass of less than a ton and a dimension of about 100 meters, could collect and concentrate, in the course of a year, an amount of solar energy which on earth would cost over a million dollars at standard electricity rates.

Electrical energy for a space community could be obtained at low cost, within the limits of present technology, by a system consisting of a concentrating mirror, a boiler, a conventional turbogenerator, and a radiator, discarding waste heat to the cold of outer space. It appears that, in the environment of a space community, residents could enjoy a per capita usage of energy many times larger even than what is now common in the United States, but could do so with none of the guilt which is now connected with the depletion of an exhaustible resource.

Shape of Future Colonies

While the first space colony will probably be a torus (a wheel-shaped structure), later colonies will be cylinder-shaped. The main reason for the change is that the first colony will be by far the most expensive to produce and the torus will cost less to construct. Once the first colony is in place, the initial investment in equipment and materials from earth will not need to be repeated; consequently, the cost of colony construction will drop drastically. The cylindrical design, considered the most efficient,

Why Not a Moon Colony?

Gerard O'Neill offers the following reasons why a colony in space is more practical than one on the surface of the moon:

1. The availability of energy. The moon has a 14-day night; therefore, there is a serious problem of obtaining energy. Convenient, low-cost solar power is cut off because of the fact that energy storage over a 14-day period is extremely difficult. On the moon one is probably forced to rely on nuclear power, so one loses one of the principal advantages of working in space.

2. The moon is more expensive to get to. To reach the moon, you first have to go into free space, and then go down again.

The analogy that I use is that in our old-fashioned talk about colonizing planetary surfaces, we were rather like a small animal which was deep down in a hole in the ground. The animal climbs at great cost up to the top of the hole and looks out and sees all the grass and flowers and sunshine, and walks across the grass. Then he finds another hole and climbs down to the bottom of that hole again. And in gravitational terms that is exactly what we are doing if we go into free space and then climb down again to the surface of the moon.

The transport costs to get to the moon are about twice as high as they are to go out into free space; that means that the capitalization for productive equipment is up by the same factor of 2.

3. Control over gravity. The moon has one-sixth the earth's gravity, you have to take it as it comes, and you can never cut it off. Even to get higher gravity than that is a lot more complicated and expensive on the surface of the moon than it is in free space, where you can simply rotate a vessel to get any gravity that you want. □

will then be as easy to build as the torus.

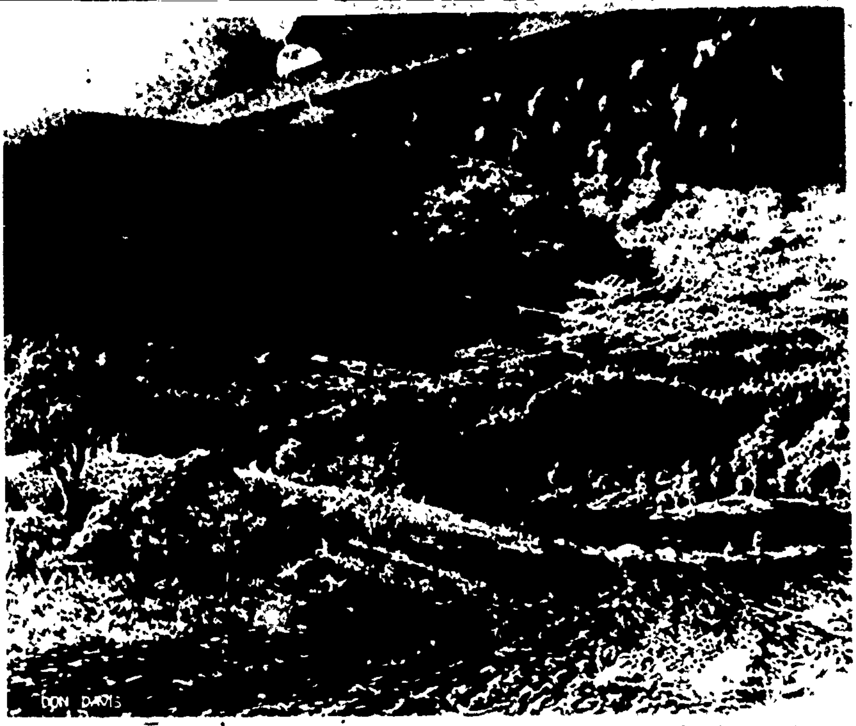
Each colony would consist of a pair of cylinders, connected by cables and spinning in opposite directions so that the total system would have almost no spin. Alternating stripes of land and window areas would run the length of the cylinders; the cylinder walls would be made of aluminum and glass. Agriculture would be housed in auxiliary capsules connected to the cylinders.

The smallest cylindrical colony, like the torus, would support 10,000 people. Each cylinder would be 3,280 feet long and 328 feet wide. A Model II colony would have three times more area and as many as 100,000 people, and would be less dependent on earth for resources. Model III, which might be built early in the next century, would be so large that a portion of the island of Bermuda or a section of the California coast like Carmel could fit easily within one of its "valleys." Model III residents would begin mining the asteroid belt for resources and would no longer need to import any materials from earth.

A Model IV colony consisting of two cylinders, each 19 miles long and four miles in diameter, could house several million people comfortably. Its atmosphere would be deep enough to include blue skies and clouds. The endcaps of the cylinders could be modeled into duplicates of a mountain range such as the Grand Tetons, with 8,000-foot peaks. A reflected image of the ordinary disc of the sun would be visible in the sky, and the sun's image would move across the sky from dawn to dusk as it does on earth. The land area of one cylinder could be as large as 100 square miles.

Eventually, it may be possible to build even larger spherical structures with diameters of up to 12 miles and a total habitable land area of 250 square miles.

The date of realization of Model IV colonies does not depend on materials or engineering—those we have already. Rather, it depends on a balance between productivity, a rising living standard, and the economies possible with automation. Under the space colony conditions of virtually unlimited energy and materials resources, a continually rising real income for all colonists is possible—a continuation rather than the arrest of the industrial revolution. Reasonable estimates of 3% per year for the real income rise, 8% for interest costs, and 10% for automation advances put the crossover date (the date when large

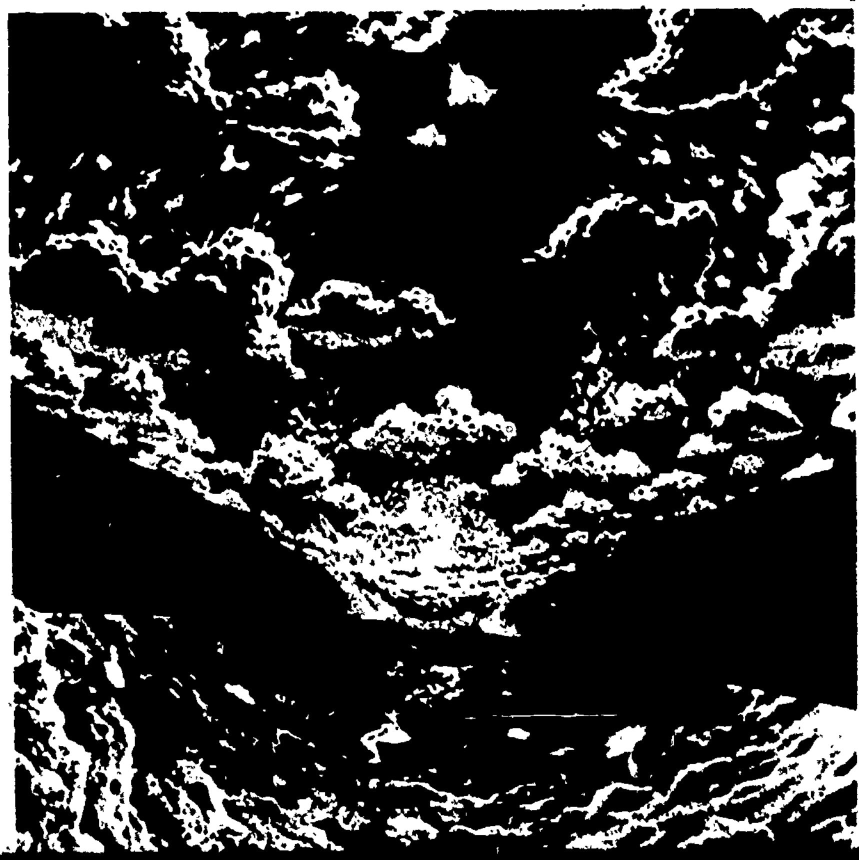


The largest (Model IV) space colonies, which could be functioning by 2025, will probably consist of two connected cylinders, each 19 miles long, four miles in diameter, and containing as much as 100 square miles in total land area. The most beautiful living areas on earth could be duplicated in the colonies. The bridge shown here, to give an idea of the dimensions involved, is similar in size to the San Francisco Bay Bridge. A Model IV colony could hold up to several million people comfortably, but the interior design pictured here is intended for only about 200,000 people.

Drawing: NASA

Night is approaching in this Model IV space colony cylinder, which is 19 miles long and four miles in diameter. The atmosphere in the large colonies is deep enough to include blue skies and clouds. A reflected image of the sun moves across the sky from dawn to dusk. The amount of light entering the cylinder is controlled by mirrors outside the stripes of window areas which alternate with the land areas in the colony. The earth-like atmospheric effects make the colony seem more spacious and natural.

Drawing: NASA



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colonies become economically feasible) about 40 to 50 years from now—well within the lifetimes of most of the people who are now alive.

First Colony Could Cost $100 Billion

The best estimate currently available is that the establishment of Island One would cost $100 billion, with a possible variation of $50 billion in either direction. That figure is 2.5 times the cost of Project Apollo and 5-15% of the estimated cost of Project Independence, the U.S. energy self-sufficiency plan. To put the cost of the first space colony in perspective, a list of approximate costs for other large-scale engineering projects (in 1975 dollars) follows:

a) Panama Canal	$2 billion
b) Space Shuttle Development	$5-8 billion
c) Alaska Pipeline	$6 billion
d) Advanced Lift Vehicle Development	$8-25 billion
e) Apollo	$39 billion
f) Super Shuttle Development	$45 billion
g) Manned Mission to Mars	$100 billion
h) Project Independence	$600-2000 billion

The Apollo project provided trips to the moon for a total of 12 men, at a cost of about three billion dollars per man. In space colonization we are considering, for Island One, a thousand times as many people for a long duration rather than for only a few days. With the cost savings outlined earlier, it appears that we can accomplish this thousand-fold increase at a cost of at most a few times that of the Apollo project.

The eventual cost of building the first colony will be affected significantly by the following variables:

1. Frequency and efficiency of crew rotation between the earth and L5, and between the earth and the moon, during the construction period.

2. Extent of resupply needed during construction. This item can vary over a wide range, depending on the atmospheric composition needed at the construction station, and whether food is shipped in water-loaded or dry form.

3. Atmospheric composition. The structural mass of Island One is proportional to the internal atmospheric pressure, but independent of the strength of artificial gravity produced by rotation. Nitrogen constitutes 79% of earth's atmosphere, but we do not use it in breathing. To provide an earth-normal amount of nitrogen would cost us two ways in space colony construction, because structure masses would have to be increased to contain the higher pressure, and because nitrogen would have to be imported from the earth. A final choice of atmospheric mix would be based on a more complete understanding of fire protection.

With these factors in mind, three different preliminary cost estimates have been made for construction of Island One. My own spartan estimate, $33 billion, would allow for no crew rotation, an oxygen atmosphere, little resupply, and small power plants (10Kg/Kw) on the moon and at L5. The NASA Marshall Space Flight Center made two independent cost estimates for the project last year. The initial estimate, $200 billion, includes chemical and nuclear tugs, super shuttle development, orbital bases, an oxygen/nitrogen atmosphere, extensive crew rotation, resupply at 10 pounds per man/day, and power plants at 100 Kg/Kw. A later re-estimate, carrying a $140 billion price tag, eliminates unnecessary lift systems, but still includes the oxygen/nitrogen atmosphere, crew rotation, resupply at 10 pounds per man/day, and power plants at 100 Kg/Kw. The two NASA estimates also appear to include a contingency factor for problems not yet identified.

Energy for the Earth

Island One will pay for itself mainly by manufacturing satellite solar power stations which would supply the earth with an inexhaustible energy supply. At present, both the industrial nations and the underdeveloped third world nations are vulnerable to the threat of supply cutoff by the Middle East oil-producing nations. The only permanent escape from that threat lies in developing an inexhaustible energy source with a cost low enough to make synthetic fuel production economically feasible.

Nuclear power is moderately expensive (1.5 cents/KWH) and is accompanied by the problems of nuclear proliferation and radioactive waste disposal. Fossil fuels are scarcer now, and intensive strip-mining for coal will almost inevitably further damage the environment. Solar energy on the

Asimov Supports Space Colonization

Noted science writer Isaac Asimov, in a written statement submitted to the House Subcommittee on Space Science and Applications in August 1975, said, "It is my opinion that the important goal for space exploration over the next century is the establishment of an ecologically independent human colony on the Moon, or on artificial space colonies that use the Moon as a quarry for raw materials. The reasons for this follow:

(1) Observatories beyond Earth's atmosphere can lead to a better knowledge of the Universe and the laws of nature governing it—with unpredictable but surely great applications to the human way of life.

(2) The presence of infinite amounts of hard vacuum, of low temperatures, of high solar radiation, should make possible industrial activities of types not practical on Earth, leading to unpredictable but surely great advances in technology.

(3) The establishment of a working colony, ecologically independent, on either the Moon or in an artificial structure in space will require a society fundamentally different from our own—a society that can live in an engineered environment under conditions of strict recycling and mineral waste. Since this is precisely the sort of condition toward which Terrestrial life is tending (barring a catastrophe that destroys our technology altogether), the colonies will serve as schools to Earth, as experiments in living from which we may profit immensely.

(4) The establishment of a colony will be difficult enough and expensive enough to require a global—rather than a national—effort. The effort will be great enough to supply mankind with a common goal and a common sense of pride that may transcend local chauvinisms, and thus encourage the growth of a global political community—and indeed serve as a substitute for the emotional catharsis of war.

(5) Lunar or space colonists, living in engineered worlds, on the inside, would be more psychologically adapted to life in a spaceship undertaking long voyages, so it will be they rather than Earthmen by whom the rest of the Solar system (and eventually the stars perhaps) will be explored.

(6) Colonies in space generally will supply a chance for growth and adventure after Earth itself has, perforce, adopted a no-growth philosophy." □

earth is an unreliable source, suitable for daytime peak loads in the American southwest, but not clearly competitive in most applications at the present time.

For several years, design groups at Boeing Aircraft and at Arthur D. Little, Inc., have studied the concept of locating large solar power stations in geosynchronous orbit—where sunlight is available 99% of the time—to convert solar energy to electricity and beam it by microwaves to earth, where it would be reconverted to ordinary electricity. Already, an overall transmission efficiency of 54% has been demonstrated in tests. The main stumbling block has been the problem of lift costs. Construction of the satellite solar power station (SSPS) units at the space colony, using lunar materials to avoid the high lift costs from earth, would make solar energy competitive with other energy sources even from the start, according to my calculations. Eventually, solar electric power rates would be much lower than those of coal-fired or nuclear power plants. No thermal, chemical, or radioactive pollution would be created, and the microwave intensity would not exceed official exposure limits.

If development of the space colonies proceeds on the fastest possible time-scale (with intensive design beginning this year and major construction of the first colony beginning in 1982), the program could pay back all of the total investment (plus 10% interest) in 24 years. The total investment cost includes the development and construction cost of the first colony; the cost of lifting the materials needed from the earth for subsequent colonies and for non-colony-built SSPS components; a payment in dollars on earth of $10,000 per person/year to every colonist, representing that portion of salaries convertible to goods and services on earth (for subsequent use on visits or, if desired, on retirement); and a carrying charge of 10% interest on the total investment (outstanding principal) in every year of the program. The economic output of the program is measured in the sale of solar power at initial rates of 1.5 cents per Kilowatt-hour, gradually dropping to one cent per Kilowatt-hour.

To produce the necessary number of power satellites within this time-scale, a total work force of 100,000-200,000 people would be required. In our calculations, we assumed that the construction of the first colony would take six years; thereafter, each colony could replicate itself in two years. Each colony would produce two SSPS units per year. The productivity implied, 13-25 tons/person-year, is similar to that of heavy industry on earth. New colony construction would be halted after the 16th colony, due to market saturation. In this scenario, the benefit/cost ratio would be 2.7.

By the 11th year of the program (1993 on the fastest possible time-scale), the energy flowing to the power grids on earth from L5-built SSPS units could exceed the peak flow rate of the Alaska pipeline. By the 13th year, the SSPS plants could fill the entire market for new generator capacity in the U.S. By year 17, the total energy provided could exceed the total estimated capacity of the entire Alaska North Slope oil field. Given the rapid growth of the manufacturing capacity and the possibility of power cost reductions, true "energy independence" for the nations taking part in the L5 project could occur before the year 2000, with a shift to production of synthetic fuels.

Cooperative Multinational Program Is Desirable

There are, in my opinion, at least five or six nations or groups of nations which possess the technical and economic ability to carry out the construction of Island One on their own. In my own view, I would like to see a cooperative multinational program formed, based on participation by all interested nations. It would be in the interest not only of the energy-consuming industrial nations, but also of the oil-producing nations to take part in the program, since it would result in a drastic drop in the market value of Middle Eastern oil before the end of this century. A cooperative international program could have a real stabilizing effect on world tensions.

"The human race stands now on the threshold of a new frontier whose richness is a thousand times greater than that of the new western world of 500 years ago."

Author Gerard O'Neill, Professor of Physics at Princeton University, hopes that space colonization will be a cooperative international program, bringing world peace a step closer.

It would be naive to assume that the benefits of space colonization will be initially shared equitably among all of humanity, but the resources of space are so great that those who are first to exploit them can well afford to provide the initial boost that will allow their less advantaged fellow humans to share the wealth. Suddenly given a new world market of several hundred billion dollars per year, the first group of nations to build space manufacturing facilities could easily divert some fraction of the new profits to providing low-cost energy to nations poor in mineral resources, and to assisting underdeveloped nations by providing them with initial space colonies of their own. The resources of space are so great that even those nations which achieve the ability to use them only after a long delay will still find an abundance remaining. It should also be emphasized that the provision of unlimited low-cost energy to the developing nations will probably be the most effective contribution we could make to solving the world's food problem, because the cost of chemicals for high-yield agriculture is almost entirely the cost of energy for their production.

If we use our intelligence and our concern for our fellow human beings in this way, we can, without any sacrifice on our own part, make the next decades a time not of despair, but of fulfilled hope, of excitement, and of new opportunity.

Public Response Is Favorable

The evidence of the past year indicates that, in terms of public response, space colonization may become a phenomenon at least as powerful as the environmental movement. Since the first small, informal conference in May, 1974, a rapidly increasing number of articles about it have appeared in newspapers and magazines, and all have been quite favorable. Radio and television coverage has also increased rapidly.

A volunteer organization in Tucson, Arizona, recently spent an intensive week trying to get information to people about the space project, and two weeks later carried out a random sampling telephone survey. They report that 45% of the people in that city now know about this project, and of those who know about it, two-thirds of them are already in favor of it.

The mail that I get—from many nations around the world, as well as the United States—runs 100-to-1 in favor of the project. Also, encouragingly, less than 1% of all mail is in any way irrational. Many of the correspondents have offered volunteer help, and are actively working at the present time in support of the space colonization concept. The letters express the following reasons why this concept, in contrast to all other space options now extant, is receiving such broad support:

1. It is a right-now possibility. It could be realized within the immediate future.

2. In contrast to the elitism of the Apollo project or a manned mission to Mars, it offers the possibility of direct personal participation by large numbers of ordinary people. Many of the correspondents, from hard-hat construction workers to highly-educated professional people, see themselves as prospective colonists.

3. In contrast to such technical options as the supersonic transport, nuclear power, or the strip-mining of coal, it is seen as offering the possibility of satisfying real needs while preserving rather than further burdening the environment.

4. It is seen as opening a new frontier, challenging the best that is in us in terms of technical ability, personal motivation and the desire for human freedom. Many correspondents refer to space colonization by analogy to the discovery of the New World or to the settlement a century ago of the American frontier.

"The evidence of the past year indicates that, in terms of public response, space colonization may become a phenomenon at least as powerful as the environmental movement."

Colonies Offer Freedom and Diversity

By about the year 2018, emigration to better land, better living conditions, better job opportunities, greater freedom of choice and opportunity in small-scale, eventually independent communities could become a viable option for more people than the population increase rate. The cultural diversity will be enormous (in exact contrast, I think, to the way things are going on earth at the present time). By 2150, there could be more people living in space than on earth. The reduction of population pressures on earth, left possibly with only a few billion people, would allow the planet to recover from the ravages of the industrial revolution. Earth might serve mainly as a tourist attraction—a carefully preserved monument to man's origin. At the same time, tourism and trade among the colonies would be practical and desirable, insuring the survival and growth of the colonies.

"By 2150, there could be more people living in space than on earth . . . Earth might serve mainly as a tourist attraction—a carefully preserved monument to man's origin."

From the vantage point of several decades in the future, I believe that our children will judge the most important benefits of space colonization to have been not physical or economic, but the opening of new human options, the possibility of a new degree of freedom, not only for the human body, but much more important, for the human spirit and sense of aspiration. □

Gerard O'Neill, Professor of Physics at Princeton University, is noted for his work in high-energy experimental particle physics. He is the leading proponent of the space colonization concept, which he originated in 1969. His address is Physics Department, Box 708, Princeton University, Princeton, New Jersey 08540. The foregoing article is based on the author's presentation to the World Future Society's Second General Assembly in June, 1975, and on his testimony before Congress on July 23, 1975.

Interest in Space Colonies Rises

During the past year, Gerard O'Neill's space colonization concept has captured the imagination of a rapidly increasing number of people. He reports that he gets more mail than he can answer, and 99% of the letters are favorable.

Last July, O'Neill's testimony also impressed the Subcommittee on Space Science and Applications of the U.S. House of Representatives. Near the end of the testimony, Subcommittee Chairman Don Fuqua (a Florida Democrat) said of the space colonization project, "It's something that will happen, and even though it kind of boggles the mind at the present time, it is not beyond the realm of possibility. I hope I live to see it." The Subcommittee concluded, in its official report, that orbital colonies were "potentially feasible" and deserving of close examination. It also stated that "concepts and methods for the space-based generation of electricity, using energy from the sun, should be developed and demonstrated as a significant contribution to solution of the fossil fuel dilemma." Finally, the Subcommittee gave its support to "an expanded space program in FY 1977-1978, at least 25% greater than current funding, to undertake new space initiatives." Fuqua later said that "... bold new space programs, such as the possibility of space colonization, based on realistic appraisals of potential space progress, deserve serious consideration. It is apparent that the imagination, skill, and technology exists to expand the utilization and exploration of space."

Astronomer Carl Sagan, testifying before the subcommittee, declared that "our technology is capable of extraordinary new ventures in space, one of which is the space city idea, which Gerard O'Neill has described to you. That's an extremely expensive undertaking, but it seems to me historically of the greatest significance. The engineering aspects of it as far as I can tell are perfectly well worked out by O'Neill's study group. It is practical." O'Neill says that Wernher von Braun has also expressed interest in his project.

The space colony idea also was examined last year by 28 physical and social scientists participating in the NASA/ASEE/Stanford University 1975 Summer Study at the Ames Research Center in Mountain View, California. The 10-week study was sponsored by NASA's Ames Research Center, Stanford University, and the American Society for Engineering Education (ASEE). The group found no insurmountable problems that would prevent successful space colonization and recommended "that the United States, possibly in cooperation with other nations, take specific steps toward the goal of space-colonization."

A Princeton Conference on Space Manufacturing Facilities was hosted by O'Neill last May. The Proceedings will be published later this year.

A number of technical papers supporting the space colony idea have appeared recently, including "R & D Requirements for Initial Space Colonization" by T. A. Heppenheimer and Mark Hopkins (both of the Summer Study) and "Space Production of Satellite Solar Power Stations," an analysis by William Agosto, a project engineer with the Microwave Semiconductor Corporation, Somerset, New Jersey.

University courses are beginning to be offered dealing with various aspects of space colonization. Magoroh Maruyama of Portland State University is teaching a course on Extraterrestrial Community Systems, which explores new cultural options; possible psychological and social problems; and alternative physical, architectural, environmental, and social designs. Massachusetts Institute of Technology now has an undergraduate course in space systems engineering, emphasizing space colonies. Beginning this May, futurist Dennis Livingston will teach a course at Rensselaer Polytechnic Institute in Troy, New York, called "Space Colonies: A Technology Assessment." The course will cover technical, economic, moral, political, and social aspects of space colonies.

The American Institute of Aeronautics and Astronautics is lobbying for more congressional support for O'Neill's project, and he was a keynote speaker during the Institute's Annual Meeting in Washington, D.C., on January 30.

For those interested in keeping informed about the latest developments in O'Neill's space colonization efforts, several newsletters are now available.

Gerard O'Neill puts out his own *Newsletter on Space Colonization* periodically. The newslettar summarizes recent work, lists the latest magazine articles and books dealing with space colonies, lists lectures scheduled on the subject, reports on the status of the space colony group at Princeton University, and advises of future plans. The newsletter is free. Simply write to Professor Gerard K. O'Neill, Physics Department, Princeton University, P.O. Box 708, Princeton, New Jersey 08540.

L-5 News is a monthly newsletter produced by the L-5 Society, a group formed recently "to educate the public about the benefits of space communities and manufacturing facilities, to serve as a clearing house for information and news in this fast developing area, and to raise funds to support work on these concepts where public money is not available or is inappropriate." *L-5 News* contains news articles; listings of courses, lectures, publications, and conferences; and letters. Membership in the L-5 Society costs $20 (regular) or $10 (student), which should be sent to L-5 Society, 1620 North Park Avenue, Tucson, Arizona 85719.

Another newsletter which reports on O'Neill's ideas occasionally (as well as other space concepts) is the *EARTH/SPACE* Newsletter. EARTH/SPACE describes itself as a commercial space venture dedicated to free space enterprise and "focusing on market development and methods of making space profitable to the commercial user." The *EARTH/SPACE* Newsletter is available for $5 per year from EARTH/SPACE, 2319 Sierra, Palo Alto, California 94303.

O'Neill received a small grant from NASA in 1975, but he believes that additional funding this year of between 0.5 and 1.0 million dollars is needed for basic research if the project is to continue to develop at the fastest possible rate. □

APPENDIX 4

Space Colonization: An Invitation to Disaster?

by Paul L. Csonka

A large-scale space colonization program now would probably lead to widespread oppression, violence, and global disaster, argues a scientist. He believes that only a small, strictly supervised number of space settlements should be permitted until humanity becomes less violent and forms a world government capable of policing space.

The dream of leaving the Earth and reaching the stars is probably as old as the human race. It certainly predates the invention of writing, as attested by ancient legends and mythologies. Through the millennia, the concept of extraterrestrial life and travel has proved to be a rich source of entertainment and inspiration. It also has been quite harmless.

That state of affairs has changed in recent years. Largely as a result of the interesting analysis of Princeton physicist Gerard K. O'Neill and his co-workers in the United States and other scientists abroad, it has become clear that we could now start large-scale colonization of space if we wished to do so. The dream of permanently leaving the Earth could become a reality. And therein lies the danger.

Before presenting my arguments I must emphasize that I am *not* against space colonization. I hope that it is successfully undertaken some day. But mankind should not plunge into such an adventure before conditions are ripe for it, and I believe that at the present time they are not.

It is not our technological maturity which I doubt. In fact, I have high regard for the work of O'Neill and his collaborators, who have presented a convincing argument that our industrial capacity could cope with the task of colonization. Their calculations have proved to be realistic, although occasionally on the optimistic side. My objections are of a social and political nature. Under the conditions prevailing today, immediate large-scale space colonization is likely to have disastrous consequences for the human race.

The Proposed Program for Space Colonization

How could one commence large-scale space colonization today? O'Neill suggests a multi-stage process. In the first stage, a "Model 1" space colony would be constructed, capable of supporting about 10,000 people inside a space cylinder about a mile long and with a radius of several hundred feet. This could then serve as a base to construct a larger "Model 2" space colony with about 100,000-200,000 people and a cylindrical volume about 30 times larger than for the previous model. That, in turn, could be used to construct "Model 3," which would be several miles wide and long and house about a million people. Even larger models might come later.

Various industries would be established in the successive models. The production costs in some of these industries would be less than in similar industries on the Earth; for example, high strength single crystals might be cheaply manufactured in zero gravity high-vacuum environment, and solar energy would be more plentiful. In this way Model 1 could partly pay for itself, starting immediately after it becomes operational, thus reducing the otherwise exorbitant construction costs of Model 2, etc. The technology to accomplish this multi-stage construction project is only partly available today; the rest would have to be developed along the way.

According to O'Neill, Model 1 could be operational by 1988, Model 2 by 1996, Model 3 by 2002, and starting about the year 2014 the work force of a "parent" colony could build a "daughter" colony within 6 years, relying entirely on its own resources plus raw materials found in outer space, with no assistance from the Earth. This doubling time of six years is to be compared with the present doubling time of Earth's population, 35 years. Accordingly, from about the year 2050, the number of places available in the space colonies would increase so fast that they could absorb the population increase not only on the Earth but also in the colonies. Thereafter, population density could be decreased everywhere. The price of implementing this program would be around five billion dollars per year (in 1972 dollars). (For more on space colonies, see "Space Colonies: The High Frontier" by Gerard O'Neill in THE FUTURIST, February 1976, pp. 25-33.)

The first space colony could look like a giant wheel floating in space. The burnished disc that hangs suspended over the wheel is a floating mirror panel that reflects sunlight down onto slanted panels and into shields that screen out cosmic rays.
Photo NASA

Author Paul L. Csonka warns that disaster could result if humanity plunges into large-scale space colonization in the near future.

The Arguments for Colonization

Why should humanity embark on this proposed gigantic expansion project? According to O'Neill and his co-workers, there are several arguments in favor of such a plan. I will try to give a fair summary of these arguments as presented by O'Neill in *Physics Today* (September, 1974). (The ordering is mine.)

1. Cultural diversity will flourish. O'Neill says that "the technical imperatives of this kind of migration of people and industry into space are likely to encourage self sufficiency, small scale governmental units, cultural diversity and a high degree of independence. . . A community of 20,000 people, eager to preserve its own culture and language, can even remain largely isolated. Free diverse social experimentations could thrive in such a protected, self-sufficient environment." (For such reasons many young Maoists are now enthusiastically in favor of space colonization.)

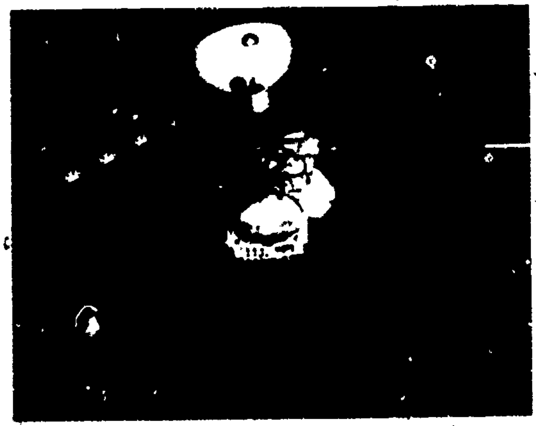
2. Good "land" will be plentiful. "The history of the last 30 years suggests that warfare in the nuclear age is strongly, although not wholly, motivated by territorial conflicts—battles over limited, nonextendable pieces of land." O'Neill maintains. The construction of new living spaces may eliminate the cause of such conflicts.

Furthermore, one may be hopeful that colonization will be peaceful. "We already have a treaty banning nuclear weapons from space, and the colonies can obtain all the energy they could ever need from clean solar power, so that temptations presented by nuclear reactor by-products need not exist in the space communities

3. Population pressures on Earth can be alleviated. After about the year 2050, the number of new space colonies built per year would be high enough to decrease the population density of Earth and the space colonies to predetermined ecologically sound levels even if the growth rate of the population persisted undiminished at its present value of 1.98% per year. This expansion could continue while there is space to be colonized in the Solar System: at least a 20,000-fold increase of the population could be so accommodated without increasing the population density. At the present rate that would take about 500 years during which time we would hopefully learn to slow down population growth or initiate space travel to distant stars. There are enough materials for us to use. If we are so prodigal as to run through the entire material of the asteroid belt in the next 500 years, we can even gain another 500 years by using up the moons of the outer planets.

4. Industrial pollution on Earth could be greatly reduced. If work is begun soon, nearly all our industrial activity could be moved away from the Earth's fragile biosphere within less than a century from now, declares O'Neill. In addition, bird and animal species that are endangered on Earth by agricultural development and industrial chemical residues may find havens for growth in the space colonies, where insecticides are unnecessary . . . and industry has unlimited energy for recycling."

5 The quality of life would be high. The space settlements would offer "new



Model of a space colony's manufacturing facility, where material mined from the lunar surface would be processed into aluminum, glass, and other products. The availability of the low-temperature, high-vacuum, zero-gravity environment of space would also be very favorable for certain types of industries, such as the growth of high-strength single crystals. Photo NASA

A small transportation vehicle waits for lift-off from a mining town on the moon. Lunar materials will be the prime source of metals and oxygen for proposed space colonies. At right are mines and living quarters. The smaller tube bins with glass windows are agriculture sheds where food is grown. At left is magnetic track of accelerator which sends lunar materials hurtling into space Photo: NASA

habitats far more comfortable . . . and attractive than is most of the Earth," O'Neill suggests. In addition, using the matter-and energy available in space to colonize and build, we can achieve great productivity of food and material goods." Examples of this type were cited earlier. favorable environment for large single-crystal growth is difficult to achieve on the Earth, but could be easily accomplished in space colonies, solar collectors, placed in orbit, could gather solar radiation for conversion to electrical energy (which in turn may be radiated to Earth in the form of microwaves).

(During the last year or so, publications dealing with space colonization have tended to stress the fifth item on our list of expected benefits. However, the other four have not been repudiated or retracted, in fact, they are still being quoted, and by now they have been repeatedly enumerated by the news media.)

These arguments suggest that we should undertake space colonization soon, and on a large scale. Indeed, unless we do so, ecological damage to the Earth's biosphere would no longer be reversible, birds and fish which might have found sanctuaries in space habitats would become extinct, the human population density would reach catastrophic levels, and a pathologically overpopulated Earth could not provide the necessary financial resources and supplies to sustain a major colonization effort. Population limitation would then be brought about by other means. Because of the exponential growth rates, even a small delay would mean large deviations from the calculated values. To avoid such a delay, we have to start colonization right now. And if this were the whole story, we would be well advised to do so.

Critique of the Proposed Program

But this is *not* the whole story. Another assumption implicit in the above arguments is that human behavior is mostly rational and generous in the sense that it furthers the best interests of the entire human race. This assumption is unjustified, as any student of history well knows. Those on whose decisions the future of our race depends *must* face the consequences of human irrationality and selfishness; it would be irresponsible to do otherwise At the very least, we must try to foresee all difficulties which we may encounter—and make sure that we know how to avoid them before committing humanity to such an irreversible course of action as space colonization.

Some enthusiasts take the position that space colonization would be a new venture, so we can never know where it will lead us. I reject this argument. It is true that so far humanity has not built large spaceships, colonized outer space, or lived in isolated space communities for any appreciable length of time But mankind *has* built sea-going vessels, colonized distant lands, and lived in more or less isolated communities for centuries. Our ample experience in these undertakings must be considered as an indication of the kinds of obstacles we are likely to encounter.

In this short article my aim is to call attention to some of the social and political problems to be expected on the basis of historical analogy I plan to convince you that we are in no position now to handle the difficulties which would emerge. I intend to demonstrate that in view of the many unsolvable problems, the above listed five benefits expected from space colonization are largely illusory Furthermore, I will argue that not only is the proposed space colonization program unlikely to alleviate our difficulties, but it will inevitably amplify them and move us closer to general disaster.

Let us start our argument by examining one by one the previously listed five expected benefits.

An Invitation to Tyranny

1. Diversity. How realistic is the hope that space colonization would indeed encourage small scale government units, a high degree of independence, and free diverse social experimentation?

If left to themselves, what kind of social structure would the spaceships likely develop? The most reasonable assumption is that they will develop along the same lines as small self-contained social units in the past have tended to do Probably the simplest example of such units is a ship on the high seas. What societies evolved on sea-faring vessels of the past? All of us have heard about pirate ships roaming the high seas, each under the control of its tyrannical captain. But how many ships were inhabited by a democratic community of gentle people who minded their own business, did harm to no one, and made their living happily fishing on the high seas under the bright clear tropical sun? None that I know of. More generally, how many peaceful, democratic, pluralistic communities have evolved since sophisticated weaponry became possible with the discovery of ways to forge copper? The history of Europe shows that whenever central authority has weakened, countries have tended to disintegrate, and smaller, geographically determined units have emerged, each ruled by a strong man reigning over the local population—but also defending it against exploitation by outsiders. With the notable exception of certain Swiss cantons and some cities, essentially all regional governments were autocratic until quite recently. This phenomenon is not limited to Europe: the experience of Asia, North Africa and Central America is similar. Nor is this tendency limited to the past. Hierarchies and ruling cliques crystallizing around dominant personalities still appear when the opportunity arises, children on a playground unattended by adults, or adolescent gangs in and out of school, constitute prime examples of this phenomenon.

These everyday observations are of limited scope, but, in conjunction with our brief historical analysis, they show a general pattern and cause one to wonder if such behavior might be genetically preferred. The formation of hierarchies definitely has survival value for group-animals living in the wild because it insures group formation around the strongest leaders. It seems unlikely that behavior that is common to almost all higher animal societies would be totally absent in human society. Whether the reason is genetic or otherwise, the fact remains that, in the cultures prevailing from ancient times until today, there is a strong tendency toward authoritarian hierarchies.

Nowadays the tendency to form hierarchies seems to have lost much of its primeval value, it is unpleasant for those who are relegated to the lower echelons and it also appears to be harmful to the leaders who occupy the higher levels. Perceiving this change, people in many societies have strived to make the transition to democracy, but only a small minority of countries have succeeded in achieving an acceptable approximation of it. Despite the many setbacks, there are still those who hope that democracy will prove to be viable in the long run and perhaps some day even come to be accepted by many more countries. But even where democratic societies exist, they seem to be in constant danger of sliding toward a more autocratic system The reverse movement happens only as a result of the spectacular social changes usually referred to as revolutions, and more often than not, even these changes merely generate another autocratic system replacing the old one.

In view of the foregoing, we must assume that most isolated space communities will, almost certainly, eventually develop some non-democratic form of

Exterior of a space colony as seen through an astronaut's helmet. At man's present level of development, believes author Csonka, uncontrolled proliferation of independent space colonies probably would produce mostly autocratic space communities, and space pirates would roam the solar system.
Photo NASA

A Dialogue on Space Colonization

In recent issues, THE FUTURIST has published several articles which look favorably upon the idea of large-scale space colonization in the near future "Space Colonies: The High Frontier" by Gerard K. O'Neill appeared in the February 1976 issue and "Designing a Space Community" by Magoroh Maruyama appeared in October 1976.

This article draws attention to some possible drawbacks of large-scale space colonization now. Csonka, a physicist, anticipates that some may tend to dismiss his arguments as "unscientific," because he is "neither a historian nor a political scientist." However, he contends that his presentation is justified because "the choices which will have to be made will affect the future of all of us." In addition, "at present, there is no generally accepted practicable scientific method in the social sciences which could prove wrong" his opinions, he says. In such cases, expertise must be supplemented by other considerations, he concludes. "There is clearly room for opinion."

Csonka believes that the subject of space colonization is such an important one that a dialogue must be started in which all of the possible ramifications for society are brought out into the open before a commitment is made.

About the Author

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government subject to a relatively small ruling group indulging (consciously or subconsciously) their primeval urge to dominate others. Space colonies would offer excellent opportunities for this to happen because of the discipline needed to operate life-support systems and because of the high degree of control that can be maintained over communications and travel. A space colony so operated would resemble an island of prisoners and would not likely become a source of great joy for most of its inmates. At any rate I see no chance for a true diversity of social systems unless local developments are restrained by effective outside control. This, however, implies government on the scale of the solar system and few people would be willing to call that a "small-scale government unit." Thus, in my view, the expectation of small government together with local diversity is unrealistic.

A large-scale, tolerant, concerned government is a necessity if the emergence of autocratic systems is to be avoided. Indeed, in the absence of big government the many local societies would develop essentially independently from each other. On purely statistical grounds, the emergence of many autocratic systems is to be expected.

Colonies Would Fight Each Other

2. Plentiful Lands. Let us turn from the internal social organization of the space colonies to the relationships among them. Still assuming that space colonies are sovereign to the extent that nations are today (i.e. that no large overall government controls them), let us ask the question Is their relationship likely to be always harmonious?

O'Neill argues that these relationships would be peaceful because the habitable space territories, being extendable, would be practically "limitless," and also because the use of atomic weapons in space is forbidden by an international t[illegible]ty

I, however, believe that violent conflicts would soon become likely. Let me enumerate a few of the many reasons for my belief.

Construction of a new space colony would requi[illegible] several years, much work and [illegible] many resources. Occupati[illegible] colony by force would be faste[illegible]per, constituting an economic incentive for aggression. This reasoning is born out by past experience. when the colonists reached the New World, they did not just occupy themselves with peaceful labor or the contemplation of nature. They fought numerous battles. And not only with the Indians who understandably objected to their intrusion, but also with each other—the Spanish with the Portuguese, the French with the English, etc. Many of them also fought within their own communities to such an extent that carrying arms became indispensible? Why did they behave in this manner? Because it was faster and cheaper to take the livestock and occupy the land and houses of others than to raise new animals, clear new land or build new houses. Yet they too had "unlimited" habitable areas at their disposal.

> **"We must assume that most isolated space communities will, almost certainly, eventually develop some non-democratic form of government."**

Furthermore, competition for the most desirable raw materials (best location, highest quality, etc.) would result in raids on each other's installations and in counterraids, retaliations and general violence. Examples of such conflicts—between individuals, labor unions, and industrial companies as well as nations—are so numerous and well known as to render further exposition unnecessary.

Continuing development would be inconceivable without some regulations governing such matters as radioactive and other waste disposal, traffic control, and perhaps even population growth. On the average, there is always a short-term economic advantage in violating such regulations. otherwise there would be no need to invent the regulations in the first place. Hence, the temptation to violate them and try to get away with it. Hence also the need to enforce the regulations through a penal system—yet another source of violence. An illustration of this phenomenon. It is generally agreed that our traffic laws are needed for the common good and are reasonable, yet all of us feel tempted occasionally to circumvent them.

Racial, Cultural Hostilities Will Trigger Aggression

Even more dangerous than the economic motivations just mentioned could be the various psychological ones. Some individuals may try to destroy certain groups of people which they consider to be objectionable. This kind of intolerance is obviously alive and well. Recall, for example, the Nazi rise to power in a "culturally advanced" society like Germany's in the recent past. Or think of certain small East European countries which are notorious for ruthlessly trying to eliminate all national minorities living within their borders; the motive cannot be economic, since the entire economy is state-controlled. The religious wars in Ireland and Lebanon and the intercultural strife in Cyprus also have long outgrown their economic origins.

Let us also remember the simple joy felt by many which comes from conquering others. It would be one of the rewards of aggression. And let us not forget those select few who would consider it their duty to lead the misguided masses of the solar system to greater happiness—against their own will, if need be. Among the many tyrants (whose number, like the total population, can be assumed to double about every 35 years) there will likely be some who will run their space islands on the basis of black magic, voodoo, or various superstitions of their own invention. There will also be those to whom the Lord will reveal that He finds certain types of space colonies offensive and wishes them destroyed. A crazed ruler, acting on "God's orders," may set out to cleanse the solar system of this entire humanity of sinners and repopulate it with the surviving creatures of his own spaceship, a la Noah, but on a grander scale.

Need I go on? There is really no reason to anticipate harmony instead of conflict. On the contrary, the sources of potential conflict will remain plentiful, whether or not habitable areas can be expanded by spaceship construction. Conflict could not be prevented by material abundance, but *only* by a universally-felt deep respect and concern for all human beings. Such a feeling is insufficiently encouraged today. For its acceptance, a long-range cultural reorientation would have to occur, and that may take generations.

Conflicts would not be restricted to conventional warfare. True, we do have a treaty forbidding the use of "weapons of mass destruction" in outer space. However, the treaty does not define "weapons of mass destruction," and although it does require inspection of all installations on celestial bodies, it says nothing about stations or space colonies in orbit. In any case, the moral force of this treaty, all by itself, is hardly likely to deter the greedy ones, the bullies, [illegible] maniacs, the suicidal types, or the [illegible]ious champions of human "progress," "liberation," or "rejuvenation."

Every colony, as well as the Earth itself, would be in danger from outer space at all times. No matter how many problems we may have today, we can still look at the stars with fair assurance that they constitute no immediate threat to us. But with millions of space colonies roaming the solar system, life could degenerate into a series of preparations for and recoveries from attacks—an updated version of the lifestyle of centuries past when raids of the Normans, Berbers and other seafaring people depopulated Europe's coastline—except that this time the weaponry would be a great deal more destructive.

Global Government Must Come First

Surely, if we are to have the slightest chance of survival, a treaty banning powerful weapons from space would have to be further clarified, then policed and enforced by some global government. Enforcement would require armed force, since most colonies would presumably be economically self-sufficient, so that economic pressure alone could not be effective against them. The history of the United States as well as that of other colonies illustrates how economic self-sufficiency leads to political independence unless such aspirations are frustrated by force of arms. Economic pressure would suffice if the colonies were kept in permanent economic dependence, but in that case the entire scenario based on self reproducing colonies becomes invalid. And even then it would be necessary to detect and suppress any attempt toward a self-supporting local economy. Eventually hundreds of millions of space colonies would have to be monitored (remember, we are talking about an increase up to 20,000-fold in the human population) with essentially no margin of error since any undetected local mischief could fast escalate into a solar system-wide disaster. At the moment we are unable to satisfactorily supervise even the handful of major powers right here on our small planet Earth. And we are quite unable to keep track of the doings of even one million people—witness the soaring crime rate in cities—without what we think of as intolerable violations of their right to privacy. How much more difficult it would be to keep watch over just one million space colonies, each one equipped with sophisticated computers designing strategies to outwit observers. Even if we knew how to do it, we would have to agree which of the rival power centers on Earth would have the authority to do it. As things now stand, that is almost inconceivable.

I have now shown that without effective control most colonies could easily turn into space variants of the prison island concept, violence would be frequent and could degenerate into global disaster. I have also shown that at present we have no way to impose effective large-scale control on space communities. Regretfully, we must conclude that large-scale space colonization now would be suicidal. The only alternative which a rational person can permit himself to contemplate at this time is a much more limited program in which at most a very small number of space colonies would be constructed, and each of them would be kept under strict economic and political control by a government on Earth. In practice this would probably mean keeping them in permanent economic dependency to prevent a successful coup d'etat leading to full independence.

3. Population. Turning to the third item on the list of expected benefits from space colonies, we must recognize that space colonization cannot solve the population problem, because that would require a full scale effort starting immediately, to keep up with the pace of population growth. But such an effort is out of the question, as just demonstrated.

4. Sanctuary for Endangered Species. This suggested benefit is more realistic. Although it will not be possible to shift most industrial activity from the Earth's biosphere to the few space colonies envisioned, nevertheless, even a small number of colonies could serve as havens for the bird and animal species endangered on Earth. Of course, if life on Earth ceased for some reason, it would also cease in the colonies which, as we have seen, would have to be kept dependent on the Earth for survival. Since it would be much cheaper to provide havens for those same species here

Cut-away view of interior of a proposed 10,000-person space "habitat." Such space communities are technologically possible, agrees author Csonka, but should not be allowed to proliferate until man has learned to settle conflicts nonviolently and justly.
Photo: NASA

on Earth, this opportunity does not constitute a real incentive to start even a limited colonization program.

5. **Unique Advantages of Space Environment.** Only this final item on the list of benefits constitutes a real incentive. One could derive genuine benefits from research laboratories and certain types of industries located in space colonies, where low temperature, high vacuum, and zero gravity environment would be easily accessible, and sunlight would be plentiful and could be converted into microwave energy to be radiated to Earth. Furthermore, the artificial habitats would have novelty value for visiting tourists.

Outlook for Space Colonies

There is no need to rush into a large-scale colonization program: Its foreseeable benefits would be genuine but limited, nowhere utopian in dimension, and would certainly not solve our most pressing problems, such as overpopulation.

Before large-scale space colonization is undertaken in the far distant future, we need to solve three problems: (1) how to settle conflicts (e.g., concerning the distribution of resources) nonviolently *and* justly, (2) how to safeguard the right of self-determination of various groups (on Earth and in space colonies) without opening the door to perpetual turmoil, and (3) how to limit population growth and waste production to avoid finding ourselves in desperate situations leading to desperate actions.

All three problems are more likely to be solved here and now rather than after large-scale colonization has started. Reaching a consensus is much easier if the number of participants (i.e. independent states or space communities) is small. Increasing the number of participants by even a few greatly increases the number of potential conflicts. Furthermore, experience has shown that assemblies of more than a few hundred participants cannot be grasped by an average human being and are therefore quite ineffective.

If and when these problems have been solved, we may safely commence full-scale space colonization. We would then be expanding an orderly, concerned, nonviolent society into the vast spaces of our solar system. By contrast, premature large-scale space colonization would amount to exportation on a cosmic scale of oppression, suffering, and disorder — the very qualities which characterize most human existence today.

Immediate Tasks

In the meanwhile, we could—and should—explore the possibility of a small colonization program—a program to put into space a few observation posts, manufacturing plants, power stations, etc. But we must insist that none of these space installations become economically self-sufficient, and that all of them permanently remain under firm control from Earth. The space installations must *not* be allowed to become the first step in a self-generating, escalating space colonization program in the near future.

At the present time, both the United States and the Soviet Union have the capability to start a full-scale space colonization program. Once a great power makes the necessary preparations

"Premature large-scale space colonization would amount to exportation on a cosmic scale of oppression, suffering, and disorder — the very qualities which characterize most human behavior today."

and investment to start such a program, it will be almost impossible to prevent its realization short of war.

To forestall such a turn of events, a moratorium on large-scale space colonization should be negotiated with all major powers. The sooner this is done, the better. In a few years, one of the powers may feel that it is in a better position than its rivals to initiate space colonization, and would then be reluctant to agree to a moratorium. Any violation of the agreement should be cause for great concern and should be dealt with accordingly.

Less crucial than such a moratorium, but nevertheless important, would be insuring that all space installations are built under international—or at least multinational—auspices, to prevent them from simply becoming space extensions of the industrially developed nations on Earth. This would decrease the probability of conflict, and may provide experience in how to embark on large projects cooperatively, rather than competitively.

There is no hope to realize either of the above two suggestions until the general public as well as governments understand the destructive potential of a full-scale space colonization program. Unfortunately, it may be too late when that finally happens. The appealing aspects of space colonization are immediately obvious: A growing number of diverse space habitats, flourishing and multiplying in harmony, aiding each other economically and culturally is a very appealing goal. Viewed superficially, space colonization appears to be a noble venture on the road to an expanding, happy human race; by contrast, recognizing the potential for danger requires more careful thinking.

One lesson to be learned from the mistakes of recent decades is that the technical feasibility of something (whether it be babies or nuclear reactors) does not, in itself, prove its desirability. After technical feasibility has been demonstrated, the potential benefits and drawbacks should be carefully evaluated. No agency, no pressure group should be allowed to proceed selfishly, overriding the common good. Foresight and timely dialogue are essential, especially when the project in question is of the size here contemplated.

Exterior view of a possible space habitat. If man undertakes a large-scale space colonization program now, says author Paul Csonka, the result is likely to be "exportation on a cosmic scale of oppression, suffering, and disorder—the very qualities which characterize most human existence today." Photo: NASA

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