SCIENCE AND GOVERNMENT: A MARRIAGE OF INCONVENIENCE

The impact of science and technology on public policy.

AUTHOR'S NOTE

This book is based upon a series of radio programs that I hosted between 1986 and 1988 at Carleton University's radio station, CKCU. The series called 'Science Briefs,' attempted to deal with contemporary policy issues stemming from science and technology. It gave me an opportunity to voice my views and via interviews, those of interested experts. Unfortunately, the interviews and the notes for the programs have been lost. I have tried to ascribe sources for materials used wherever I could. I apologize to all whose work I should have referenced but did not. For what they are worth, what remains is largely a compilation of my opinions and ideas I endorse. They form the basis of this book.

To a large degree, these views reflect my service at the now defunct Science Council of Canada, first as its Secretary and then as a member of its science advisory staff. Insights were also drawn from work done under contract for Health and Welfare Canada, the Canadian Public Health Association and the Canadian Union of Public Employees. The issues dealt with represent a sample of topics often labelled science policy subjects. This book does not presume to be an exhaustive examination of science policy issues. Although I have tried to keep it as non-technical and non-scientific as possible, I found it impossible to completely separate science from science policy.

Essentially, this book is a series of essays dealing with a variety of

science policy issues. However, it is marked by some glaring omissions, such as themes dealing with: communication and transportation technologies which have transformed all societies on this planet; science, technology and the arts; birth control; politics and science, and politics of science; the gender gap in science; education; resource industries such as forestry, agriculture, mining, metallurgy and marine industries; regional disparities; municipal planning; population and demographic shifts; the state of the various sciences; space and astronomy; meteorology; and engineering. My only excuse is that the book is meant to comment upon a number of science policy areas in order to provide a sense of what science policy is. It does not presume to be encyclopedic. Also, justice could not have be done by a short essay dealing with some of the topics mentioned above. Finally the book is based upon subjects dealt with in my radio programs. Very few of those listed above were.

I apologize for the many glaring redundancies. My only excuse is that the book is culled from a series of radio programs where I was bound to repeat myself. More importantly, many of the various topics I attempt to describe under different headings overlap in many of their essential details. Science policy issues cannot be neatly labelled and pigeonholed.

The reader will note that the head of each chapter contains

citations made by famous personages. I have been somewhat presumptuous by including a few of my own as well. My only defense is that the citations I attribute to myself represent thoughts I feel had to be expressed and I could not find an appropriate place for them in the body of the related essay. I am sure that these thoughts and possibly their articulation are not original with me. I have been influenced by many. To underscore this, Appendix A is a list of relevant citations from a variety of sources other than mine, that, hopefully, the reader will find informative, interesting and sometimes amusing.

The views expressed in this book, however bizarre, belong to me. No one else is to blame. This book is certainly neither scholarly nor academic. It is intended to provide the reader with a unique perspective of the science and government scene replete with all its conundrums, incongruities and contradictions. The perspective is based upon more than fifteen years of hands-on experience that I have had in the surreal arena of science policy.

Jack Basuk
July, 1993

CHAPTER 1

SCIENCE, TECHNOLOGY, SCIENCE POLICY & ALL THAT

There are in fact two things, science and opinion; the former begets knowledge, the latter ignorance. Hippocrates

THE PROBLEM

This book is about issues closely related to science and technology, arising from just about anywhere. Collectively, they may be considered as "Science Policy." Science policy can have any number of parameters: social, economic, political, industrial, fiscal, environmental, ethical, educational, bureaucratic. These need to be considered when attempts at policy decisions are under way. It is particularly difficult because there are many such parameters often representing incompatible competing interests. Science policy issues are really no different from most other problem areas that beset us. A certain mystique around science policy has developed because it involves science and technology, two areas understood by relatively few. Perhaps it is time it was demystified.

There is an underlying problematique common to all science policy issues: a mismatch between scientific and common language or thought. This has often led bureaucrats, politicians, the media, and the public at large to misunderstand what is being suggested by scientists. The inability of so called scientific managers from the public or private sectors to appreciate the nature of basic science has frequently led to expectations unreal and damaging both to the scientific and lay communities. These pseudo-scientists too often feel that they know best the direction scientific research under their purview must take. They are akin to those courtesans of old who directed painters on how and what to paint and composers on what to compose. Luckily their ignorance allowed artists to exploit their unique talents and ideas to the full.

Sadly, today's so called managers of science have some relevant knowledge. Usually, they have been co-opted from the scientific

community and quickly corrupted by the bureaucratic and political communities. Armed with "some knowledge that can be dangerous," they cannot be so easily deterred from their inopportune tasks. Scientific bureaucrats are a recent breed.

Adding insult to injury are the political scientific dilettantes whose personal agendas, coupled with an abysmal ignorance of science, frequently lead them to wield power with disastrous results. The costs of contemporary scientific research are often enormous. Science and scientists rely heavily on support from the public and private sectors. As is well known, those who pay the piper, usually call the tune.

Nearly everyone fails to appreciate that supporting scientific research is like cultivating a wild garden. All plants are equally nourished with the hope that at least one, if not several, will prove to bear fruit. Some may produce poisons. Some may be risk free with no benefit. Some may have great benefit but with high risk and others, high risk and low benefit. The very nature of this endeavour precludes predicting useful results. So it is with scientific research. It is a voyage into the unknown and thus of discovery. If we knew the answers, we would have no need for research. The biochemistry of the tissue of a rare exotic insect may lead to a cure for cancer via a variety of routes. It is crucial to realize that all areas within a given science as well as all sciences are linked again in often unpredictable ways.

On the other side of the coin are the academic and government scientists who often fail to comprehend that their support mostly comes from the taxpayer. Thus most scientists are nothing more than glorified public servants. As such, they should be held accountable for how they spend public monies. Yet they have resisted such a direction, forming cliques to procreate their own thinking while resisting new and often disturbing questions and ideas. "Just give us financial support and leave us alone," has frequently been their arrogant stance. Moreover, they mostly lack political savvy and courage as attested to by their kow-towing behaviour when budget cuts are being contemplated by the government of the day.

This difficult relationship between science and government is perplexing and poses a real conundrum. To better appreciate it, some elaboration about the terms science, technology and science policy might be useful, particularly since there are probably as many differing definitions of these terms as there are interested parties. Most would be hard pressed to come up with general definitions that cover the subject areas comprehensively, although, instinctively, most people know what these terms mean, the same way they understand concepts such as time, temperature, life, death. Hopefully, the reader will be in a better position to accept, reject or debate arguments that attempt to assess decisions of a political, socio-economic, ethical, funding or even scientific and technological nature if there is a consistent definition of these terms. The following comments are offered with the forlorn hope that many find them acceptable.

SCIENCE

Fundamentally, science is a way of viewing the world. Without context, this is too narrow a definition unless it also includes the immediate and major results of this world view, such as the general knowledge, laws, theories, hypotheses and facts that science has

and will generate, as well as some description of its underlying methodology and philosophy. Without going into detail as to what comprises the scientific world view, here are some brief comments about science, relevant to any discussion of science policy.

Science does not try to answer the primordial question of 'why.' Why do we exist? Why does anything exist? Why is the diameter of a Euclidean circle divided into its circumference a constant and why is that constant equal to 3.1417....? The number of such whys is enormous. Up to now, they have been, are and probably will continue to be, for a very long time, beyond the ken of science. Science tries to describe what occurs and how. It then endeavours to predict what will happen under various sets of conditions. (For a more profound and contemporary discussion of "science," the reader is referred to the works of Kuhn, Popper, Bohm & Peat.)

While science is by far, the most objective way humans have of viewing their world and themselves, the merits of that so-called objectivity are becoming more and more questionable. Such a view of science is based on the notion that 'truth' exists outside of humankind, just waiting to be discovered. This view has fallen into disrepute in some quarters. Is 'truth' discovered or invented? That question is currently the nub of a philosophical and metaphysical quandary. An old Russian adage states that in all lies there is some truth and in all truth there is some falsehood. This view is further supported by some aspects of quantum mechanics.

The view that science is the most objective way of viewing the world is buttressed by the fact that most scientific activity consists of measurements that can be verified by others, with results that can be formulated mathematically and/or statistically. In other words, up to now, science has pretty well dealt with quantifiable variables. In the contemporary world this has led some to raise questions about science's limitations and validity. Can science deal with non-quantifiable variables such as emotions, aesthetics, beliefs, values? Is science the only valid way to view the world? Has science created more problems than it has resolved? Have expectations about science been unrealistic? As the frontiers of science are being more and more extended, is a merging of science and theology a possibility?

Science is supposed to be a value-free search for truth. This is impossible for two reasons. One, some value, -positive or negative- is associated with any human activity, like science. It is impossible to separate the scientist from science. When a scientist chooses a line of investigation or of thought, this choice is based on personal values which in turn may be influenced by a wide variety of subjective criteria. Two, the term "value-free search for truth" is often said to mean that the results of the search are completely independent of the researcher and will not be affected by the researcher's desires or biases vis-…-vis the outcome of the work. Experience has shown that while this is an ideal to be striven for, it is very seldom if ever achieved.

A further comment. Science has utility. However, a utilitarian approach to science may rob it of the characteristic that makes it most valuable. The scientific journey is one of discovery. We do not know in which direction we are headed or where we will end up. The free spirit, endemic to true science, may easily disappear, should the shackles of utilitarianism be allowed to strangle it.

TECHNOLOGY

Science is relatively new. From a conceptual point of view technology is easier to handle. If science is a way humans view the world, technology is how they manipulate it for their own purposes. Technology is value-laden.

Technology has always been with us. It can be argued that technology is intrinsic to humankind. Some bothersome questions that immediately arise are: To what extent do we really shape technology? Does it take on a life of its own and end up by shaping us? Incredible powers of destruction are now available. The tremendous range and speed of communication are leading to the spread of somewhat dubious ideas and trashy forms of art. Fabulous means of transportation have played a prominent role in revolutionizing our cities, not necessarily for the better. A plethora of consumer goods has led to a consumer oriented society, with a host of attendant problems. Improvements in medicine in turn have caused a host of social and ethical problems and dilemmas. In the workplace, great changes in technologies have initiated much employment dislocation. Our vaunted technologies have been unable to help us overcome the very evident inequities that plague us world-wide. Has the human condition really improved with the very rapid introduction of all these technologies, despite their obvious benefits? No answer to this all consuming question is attempted here. Let the reader decide.

At one time, technology was easy to identify with, e.g., wood or coal burning stoves, horse and buggies, typewriters. Today, we are confronted with mysterious black boxes, or massive technologies that do wondrous things, whose workings are understood by very few.

SCIENCE POLICY

Science and technology have become inseparable and mutually interdependent. There is a symbiotic relationship between the two. Technology really took off only after the scientific revolution had occurred. Now both science and technology are replete with value, and those who control them can control the world, shape societies and manipulate people. This underscores the seeming importance of science policy: under its rubric, all governmental actions concerning science and technology come under scrutiny.

First of all let us ask, "What is science policy?" and, at least in Canada, "How did the notion arise and how did the federal, and provincial governments respond?" The origins of the notion go back to Confederation or even to the inception of the National Research Council, the Defence Research Board, the Canada Council (which until recently, also dealt with the social sciences) and the Medical Research Council. The history of this notion will not be revisited here, since for the most part, the notion of science policy per se had not arisen when these instruments of government involvement with science were created. Like the leading character in a play by MoliŠre who, to his astonishment and delight, discovers that all his life he had spoken in prose but did not know it (Le Bourgeois Gentilhomme), one way or another, our government has always been involved with science policy but no one knew it.

In the late 1950s, the Canadian government of the day created a Royal Commission to study the public service and make recommendations on how to increase its effectiveness and efficiency. That commission became known as the Glassco Commission. It was not unlike the recent Neilson Task Force that twenty-five years later

was given a similar mandate. They both had different but strong impacts on government involvement with science.

The Glassco Commission undertook its work at a time when Canadians were becoming aware of and sensitive to the importance of major scientific and technological projects such as the Soviet breakthroughs in space and the peaceful uses of nuclear power. It was also becoming evident that because of size, costs, and potential socio/economic/environmental impacts, such projects required that government play a leading role.

What Glassco found was that government involvement in science was often incoherent, wasteful and irrelevant. There were principally two aspects to this engagement: support of scientific research through the granting councils, principally the National Research Council; and secondly, scientific work carried out inside various government departments and agencies or elsewhere but paid for by them under contract. Much of the government's efforts appeared to be at cross purposes and redundant.

Clearly, a general policy on science was needed. Thus a new and potentially rewarding policy area was discovered by the bureaucracy, namely science policy. It has cynically been observed that the government has been constantly on the lookout for such new employment opportunities as part of a welfare scheme for university graduates with no place else to go. Better some useless task in the bureaucracy than anarchy in the streets and better still that incomes generated by these positions increase spending power as a boon to the economy. It is generally perceived as an economic truism that the health of any economy is directly related to the frequency and speed with which money is circulated through it.

The creation of mechanisms such as the Science Council, the Senate Committee on Science and Technology, later known as the Lamontagne Committee, the Science Secretariat, a part of the Privy Council which became the Ministry of State for Science and Technology, and the Institute for Research on Public Policy, were advocated and subsequently created. Their role was to develop recommendations on the nature and implementation of a general science policy. As of today no such policy exists and it probably never will. (The Science Council also no longer exists.) Instead, we having to do with science and technology - with hardly any common thread running through them at all. Why is this so?

The most probable answer is because science policy was and is a Science policy can exist as a concept, but not in the real world as an operational tool of government. Let us examine that thought a little closer.

The first approach taken by those involved professionally with science policy was to examine the state of the various sciences in Canada and to make recommendations on how to improve them and fill existing lacunae. These recommendations were based mostly on the views of the scientists involved in the particular area under investigation. After all, who should know better about the state of science in Canada than the scientists active in scientific research in our country? Thus many of those first actively involved in science policy were scientists who brought with them the idea that a scientific, rational, objective approach to the subject was feasible. How naive they were!

Although considered science policy, this approach could be labelled policy for science. It had very little to do with the needs of our

society. It had to do with the needs of science and represented the vested interests of scientists. Had the matter ended there, a coherent science policy could still have been conceived.

The government must be more concerned with the needs of the country than with any particular sector within it. Thus science policy was quickly broadened to include the role science has in Canadian industry, with an eye to enhancing Canada's economy. Even more ingenuous was the notion that a scientific, rational approach could be of immeasurable help in resolving the problems of the nation, be they economic, social or industrial.

One such strategy involved the use of econometric models. These are conceptual constructs that quantify various related parameters for the purpose of predicting economic outcomes when socio-economic variables are altered.

A very sophisticated archetype, named Candide, was developed by the Economic Council of Canada and was still being enhanced when the Council was disbanded. While of some use, the very great expectations it kindled were never realized. Perhaps they were unrealistic. Attempting to deal with real world economies means manipulating a huge number of variables, where each is linked to where these equations are themselves approximations. The parameters of these equations are estimated by statistical means and are subject to stochastic error as are the equations themselves. Thus when attempting to solve these simultaneous equations for the purposes of predictions, these errors may compound in unpredictable ways, making accurate consequential forecasts at best difficult, and in times of structural change and shifting behaviourial responses, impossible. It is like trying to predict how a stew will taste after it is concocted with a thousand different ingredients and a thousand disparate condiments, each with their own taste and each interacting with one, two or all of the others to produce differing flavours. The cooking time, the type of utensils used, the consistency of the ingredients, etc. further complicate this chaotic array. Appropriately, this type of problem now falls under a new concept in physics suitably designated Chaos Theory.

Finally it was and is strongly believed that R & D has become the prime generator of wealth and the key element in the innovative spectrum. This belief has been challenged by some who claim that there is inconclusive evidence for this position. They argue that a high level of R & D is the result of a strong economy and not a very important factor in creating one. Their point is supported by the fact that when cuts are being considered, R & D is usually the first item to go.

In parallel with linking science to industry for the supposed benefit of the nation, came the realization that science and technology themselves had impacts on our society that were not always desirable. Strengthening certain sciences to identify and deal with these negative impacts quickly became another science policy responsibility. In summary, science policy is a three-sided coin consisting of policies concerned with the health, the use and the negative impacts of science and technology.

The lumping of science and technology into one basket further complicates the issue. While interrelated, they are not interchangeable. Yet because of government's predilection towards concrete results, technological development usually gets the lion's share of available resources at the expense of the basic sciences.

The amount of funding given to any project is inversely proportional to the uncertainty of the result. This approach fails to take into account the fundamental nature of science.

The number of interests competing for scarce resources is enormous. Within government, nearly every department, ministry or crown corporation has an important stake, as do all the universities, provincial governments, and private sector
interests. No wonder a national coherent science policy is fiction.

One afterthought. The key word in the term science policy is policy. Any notion that most governmental policy is rational, equitable or designed to meet the country's needs is simplistic. Government policy represents a choice between competing interests. The powerless, the poor, the disenfranchised, non-unionized labour, the fragmented scientific community, are usually ignored when policy decisions are being considered.

CHAPTER 2

HEALTH

We are all ill: but even a universal sickness implies an idea of health. Lionel Trilling

From inability to let well enough alone; from too much zeal for the new and contempt for what is old; from putting knowledge before wisdom, science before art, and cleverness before common sense; from treating patients as cases; and from making the cure of the disease more grievous than the endurance of the same; Good Lord deliver us. Sir Robert Hutchison

GENERAL

Health, a subject obviously dear to the hearts of most of us, is so vast, so complex, and of such major importance and interest that no book can adequately deal with it, let alone one chapter of a book devoted to science policy. However, it exemplifies a near ideal example of a science policy issue, because it encompasses the three major aspects of science policy, namely, those policies designed: (1) to support scientific research and technological development, (2) to use science and technology to achieve certain desirable ends, and (3) to mitigate science and technology's negative impacts.

Thus it is appropriate that issues pertaining to health are the first science policy topic discussed in this book. These are supposed to play a prominent role in any nation's attempts to enhance the health of its citizens.

However, they are frequently at the nub of explosive political debate and deceptive gamesmanship, given the emotional aspects surrounding many if not most health concerns and their related costs. After all, what is of more interest for most persons than the state of their health and their pocket book? For many, the two are directly related. Politicians alternate between alarm and enthusiasm about the future of our health care system, still one of the world's best, leaving most of us in a state of either confusion or depression. This state of affairs is not conducive to good health. We rely heavily on our health care system and have come to take it for granted. We regard it as a right and yet, inevitably, it is fodder for political posturing and bureaucratic manoeuvring. The question of 'health' permeates many policies. It will arise again in

subsequent chapters.

What do we mean by health or more importantly what do we mean by good health? According to the Oxford dictionary, health refers to the general condition of the body and mind of an individual. Good health refers to their soundness. Well then, how do we know when we are of sound mind and body? Are there appropriate measurements? Perhaps, but at best, to a circumscribed degree. The absence of disease is one such possible measurement. However it presupposes that we are cognizant of all human diseases, which is doubtful. Furthermore, no one is without some affliction: an absolutely healthy person just does not exist. "Good health" is relative, not only between individuals but also between differing societies and is largely determined by social, economic and cultural parameters. In other words, what is regarded as the norm of good health in certain parts of the third world would be regarded with horror in other parts of the world.

Are there other measurements? Well, after a fashion, yes! We can measure heart rate and function, basal metabolic rate, muscle tone, kidney output, to some extent brain function, and a wide range of blood characteristics. We very seldom use the results of these tests as a measure of good health, but rather as an indicator of the presence or absence of disease. Evidently we are much more conscious of what ails us than of what makes us feel good. Good health is more than the absence of disease. According to the World Health Organization, it should or must include a sense of well being, whatever that is. After all, "one's meat is another's poison." Individuals whose test results indicate an absence of disease may not enjoy a sense of well being and therefore of good health if they fear losing their jobs, their income, and their lives in war or in dangerous occupations. People who cannot procreate for a variety of reasons, whose marital affairs leave something to be desired, who endure difficult economic circumstances, who are chronic worriers and who suffer poor self images because of disfigurements, probably have good reason to feel poorly.

In a world replete with tension producing scenarios, ranging from traffic jams to reliance on technologies that very few of us understand or control, perhaps such a sense of well being is a Utopian dream. In any case, with dogged optimism, we must make the best of a difficult situation and proceed, using all the tools and knowledge available to us, right up to the inevitable end.

A HEALTH INDEX

The next question is whether it is possible to jump from measurements of the individual's health to estimating the health of the populace. The Dow Jones Index, together with measures of the gross national product, the rate of inflation, the value of our currency on the international scene, and the unemployment rate, indicate the state of our economy. Might it be possible to create a health index that tells us something about the general state of health of our citizens? By providing valuable information such an index could oblige the creation and elaboration of rational health policy decisions. It would also enable monitoring the effectiveness of such policies.

Is such an index possible? The answer, within limits of common sense, is yes. Death rates at birth, the incidence of a range of particular diseases such as cancer, heart disease, AIDS, other venereal diseases, malnutrition, the average age of the population,

and the general physical condition of various age groups in our population, can all be measured, given some weighting factor, then integrated to provide a facsimile of a health index of sorts. It would be an improvement over not having one. It would be an expensive tool and therefore would be subject to all sorts of politico-bureaucratic machiavellian schemes. Pressure from various lobby groups would come into play. The required epidemiological measurements would be costly. However, we must be prepared to make such long term investments since the ultimate savings could be substantial in decreased health care delivery costs.

HEALTH CARE DELIVERY

Having gone from measuring the health of the individual to that of the group, the next question is, "who is responsible for delivering health care and what should such care consist of?" The health care system in Canada, as compared to those of most other countries in the developed world, has done and is doing an estimable job within the limitations of its mandate, its resources and its traditions. The author's criticisms of the system are not meant to denigrate the people that actually provide medical services

within it. For the most part they merit our esteem. However, instinctively, we feel - no, we know - that the optimum health care for our citizenry, available to all must be a prime social goal. Every means possible must be sought to enable our health care system to achieve this goal.

It is ironic that by far, the largest share of the costs of health care delivered to an individual during his or her lifetime is incurred in the last year of the person's life. These costs are assumed by all. Yet as soon as a person dies, to the financial benefit of lawyers, undertakers, et al, the inordinate costs associated with death, especially the funeral are assumed by the estate or the family. Perhaps we also need "death care."

For good historical, humane and compassionate reasons, health care delivery and related research are still mostly disease oriented. There is no quarrel with that emphasis. The strides made in treating disease are truly amazing. If anything, we need more research into conquering disease, not less. However, while it has become a truism to state that prevention is a much more desirable way to combat disease, very little in terms of resources have been allocated to this end. Why?

The practice of medicine and some related professions have become highly technological. In fact, the diagnosis and treatment of disease

rely totally on high tech. As with other areas of our society, the technological fix has taken over the practice of medicine. To some extent, the doctor has become a sort of hospital mechanic. If something is wrong, replace it. If something else is wrong, take a pill. Presumably, there is a therapy to match every known curable disfunction. Were it that simple! One person's therapy may mean death for another. Therapies are frequently incursive and may have unforeseen traumatic or chronic effects on sick people whose genetic make-ups differ widely.

Moreover, since most current therapies are either surgical or pharmacological, they require a costly technological approach. They are expensive for a number of reasons, not the least of which is

that commercial and industrial interests can make a great deal of money in the field of health care with a high tech approach. If the costs are high, probably little money is left to pursue and promote prevention. Also, prevention may not be to the liking of certain powerful vested interests. Treatment and prevention are now competing for scarce resources. So far treatment has won hands down. Perhaps it is asking too much of the Health Care Industry to strive to fulfil what its prime purpose ought to be - the elimination of the need for such an industry.

Regulation is one policy area where the government has a key role in preventing disease. Using the regulatory apparatus, (prior to the 26Health

restructuring of 1993) located within departments and agencies such as the Department of Health Canada, Environment Canada, Agriculture Canada, Corporate and Consumer Affairs, Labour Canada, the Atomic Energy Control Board, the government attempts to lessen exposures to dangerous materials and energy forms and to assuage their effects. In some cases, exposures are instantly lethal and the risks easy to identify and regulate. When the exposures are too small, doses over long terms and the effects difficult to detect because of long gestation periods, such as is often the case with carcinogens, regulation becomes far more complicated because of the difficulty in proving a causal relationship. This has and continues to open the door to all sorts of controversy frequently resulting in the dissatisfaction of everyone concerned. Then regulatory agencies are seen to be more preoccupied with their survival and the welfare of the economy than with the health of citizens.

SPECIFIC CONCERNS

Let us return to who should be responsible for 'health' and what that responsibility should consist of. It is clear that far more resources must be allocated to all aspects of prevention.

- Information for both treatment and prevention should be made more readily available to the public.

- There are a number of potential ethical issues stemming from biomedical technology and research that will have to be faced squarely in the near future. One such example is the question of "informed consent." Another is, "when to turn the life sustaining machine off?" Another still has to do with transplants. At a time when transplantable organs are scarce and the costs of the associated surgery are very high the question of who should benefit from these procedures will become paramount. Should it be those who can afford the costs because our health care system probably cannot? Should criteria for selection include the recipient's age, his/her sex, his/her parental status, his/her chances of success, the seriousness of his/her medical condition, the perceived importance of his/her profession, his/her social, economic and political status? Hopefully this dilemma will be resolved either by learning how to prevent the conditions that now require transplant surgery, or by a drastic reduction in the costs of the procedure. While now in the realm of science fiction, it is possible that sometime in the future we will have a technology that will allow us to clone our vital organs so that each of us will have a bank of "spare parts."'

- The role of the private sector in health research, should be

circumscribed. Publicly funded research mostly carried out in universities and private sector research ought to join forces. This body of private and public medical research should then make

every effort to fill outstanding lacunae.

The private sector, being motivated mostly by market forces, often fails to investigate diseases that are relatively rare or prevalent in underdeveloped countries. In both instances, sick people are simply being abandoned because either there are not enough of them to make seeking a cure profitable, or some are so poor they cannot afford the cure if research costs turn out to be high. Failure to recognize the possibility that these diseases may be latent in our part of the world may yet come to haunt us.

- Next is an area that bears special mention. Relative lack of attention has been paid to women's diseases. There has been a dearth of research into the various ailments affecting female organs, into afflictions related to the women's differing physiognomy and psychology, into the difficulties associated with post menopausal syndrome, into the possibilities of gender differences associated with the incidence and causes of various diseases and into gender parity of most epidemiological studies. While the reason for this disparity was most likely due to the male domination of bio-medical research, the time has come to redress this imbalance by considering the gender factor in all new and many old areas of medical research.

- Every effort has to be made to ensure that a disease has really

been conquered, before research into that disease is abandoned. The recent recurrence of tuberculosis in both the underdeveloped world and North America has clearly indicated the emergence of new bacterial strains that are resistant to current antibiotics. The decision to stop this line of research was a short sighted, economic/bureaucratic/political one. It is like a patient not taking the full dose of antibiotics because she/he is feeling better and then being surprised when the disease crops up again. A more farsighted, scientific approach is required.

- A conservative regulatory approach vis-…-vis exposures to new chemical and physical phenomena should be the order of the day. It is better to be safe than sorry, in spite of economic temptations and pressures.

- Innovative approaches that deal with the health problems of the elderly are urgently required. It is assumed that everyone aspires to live to a healthy old age. Living to an old age is no longer just a possibility. It has become a probability. What has this to do with science? A great deal.

First, demographic studies have shown that, at least in North America, the average age of everyone alive and the percentage of older people are rapidly increasing.

Why has this occurred? There appears to be two principal reasons. First, the baby boom that followed WW2. Those babies are now in their forties and doing well. Second, people are not dying off as fast as they used to. This is due to better and healthier life

styles, the fantastic advances in the practice of medicine, the regulation of exposure to dangerous things and practices, a better educated public and a variety of hygienic public health measures. In other words, nearly every reason for a longer life expectancy can, somehow or other, be traced back to a scientific or technological breakthrough.

Today, the growing number of elderly people places increasing demands on our social fabric and health care systems. Slow economic growth, limited tax revenues, increasing strains on old age security payments and pensions, and growing budget deficits have led to a renewed concern among governments about the costs of health care programs.

The provinces, who are mainly responsible for the delivery of health care in Canada, are being forced to decide whether to transfer new resources into health care, reduce services or identify and implement more efficient delivery systems. For example: in every hospital in Canada, about 10% of all beds are blocked by chronically ill elderly people. These are very costly beds. It may be that what the elderly need, for the most part, is not expensive

hospital care, but modified housing facilities with an infra-structure of needed services built in. In any case the elderly should never be sacrificed on the altar of economic efficiency.

All elderly persons, if they survive, become frail and chronically ill. While this deterioration is usually slow and over a long period of time, overtly it often appears that the onset of these symptoms has been rapid. Thus, immediate radical measures to provide them with relief and help become necessary.

One of the major means we have used to deal with the frail elderly has been to place them in institutions. In some instances this is truly the only realistic solution, especially for those requiring constant care because of mental infirmities. However, an institution is no place for human beings. We place criminals in institutions. They, at least, know that they will someday be released into this world. The elderly have no such expectation. In other words we treat some of our elderly worse than we treat criminals and yet the elderly often have to pay for this privilege, while convicted criminals get free room and board. As much as possible, the elderly to the often patronizing attitude of the medical, paramedical, bureaucratic and social worker syndrome of knowing what is good for them.

(For a synoptic portrait of the health and related factors of Canada's senior citizens, the reader is referred to Appendix B.)

AIDS

AIDS is a modern day fatal plague that has created profound problems. AIDS, an acronym for Acquired Immuno-Deficiency Syndrome, is known to be caused by a virus, although scientists are not sure whether that virus is the only factor in the cause of AIDS. When one contracts AIDS, one's ability to resist infection is eliminated. While there are some potential cures that hold some promise, at the present time there is no known cure for AIDS.

Not everyone who is infected with the virus reacts the same way.

Some react immediately and others may remain without symptoms for several years. The syndrome of severe infections and symptoms that categorizes AIDS consists of lung disease, skin tumours called Kaposi's sarcoma, severe fungal infections of the stomach, severe diarrhea, neurological problems such as memory loss, irrational thinking and behaviour, and death.

There are three main ways in which the virus that causes AIDS can pass from one person to another. One is by sexual contact with an infected person. Another is by blood and other fluids from an infected person getting into someone else's blood stream. This

explains why homosexuals who practice anal sex are in one of the highest risk groups. Rips in the rectum provide a quick route for infected semen to enter the blood stream. Finally, an infected woman can pass the virus onto her baby. In the absence of any effective treatment for AIDS, the only way to halt the spread of the disease is to reduce the transmission of the virus, by persuading people to change their sexual habits.

It is of equal importance to know which activities and conditions do not represent a risk of catching AIDS. For example, there is no evidence that social or casual contact with an infected person presents any risk.

At the moment the only way to test large numbers of people is to look for indirect signs of infection that a person's immune system provides. However, to be identified as positive in this way does not mean that a person has AIDS. It only means that a person has been infected. Unfortunately, it is also sometimes true that a negative blood test result is not conclusive proof that one is free from infection.

The preceding represents the most salient facts about AIDS. Facts, in and of themselves, cannot convey the tragedy of the disease. They also do not tell much about attitudes which were and are often based on ignorance and irrational fear and which have led to

much controversy.

What are the non medical issues that have aroused debate?

First, there have been assertions that governments dragged their heels when it came to allocating resources to combat the disease from research, monitoring and medical points of view. Since the disease was initially more prevalent among homosexuals and blacks, the implicit reasons appear to have been related to a bias against them. To be fair, governments are nearly always slow to react, although there is reason to believe that the reaction would have been much faster had the disease had affected only white heterosexuals. Today, lots more is being devoted to finding a cure for AIDS, mainly because the so called gay connection has been overshadowed by the rapid spread of the disease into the heterosexual world.

Secondly, one way or another, the victims of AIDS often appear to be blamed for their affliction. One extreme of this are the biblical moralists who invoke their religious fanaticism to suggest that AIDS is nothing more than God's retribution for sinful behaviour. Blaming the victim is an old way of allocating guilt. It relieves the rest of us from the burden of doing something.

Sometimes it appears to creep into the subconscious thinking of otherwise reasonable people. How else can one account for the

overreaction of those who would deprive those with the disease and those testing positively, of their basic civil rights and in some instances of medical care?

Third is the moral dilemma faced by the parents of children going to a school where one or more of the students or teachers have tested positive for the virus. It is hoped they would behave responsibly. Children are more at risk when their parents smoke, drink, eat junk food, exercise too little or neglect them.

Fourth are the problems associated with mandatory testing for AIDS. If such an approach is used, it should be in place only as long as a crisis situation exists, because civil rights must remain protected, especially the right to privacy. The World Health Organization has drawn up a list of criteria for programmes to screen for infection. Jonathan Mann of that organization feels that, "If all these criteria are explicitly and carefully addressed .... both the interests of public health and respect for human rights will be favoured and the temptation to see screening as a simple or reflex solution to a complex problem will be tempered."

CONCLUDING REMARK

Finally, after all is said and done, we, as informed and reasonably intelligent individuals, must take responsibility for our health. It is

not enough to learn about what constitutes good health practices. We must all undertake such practices. The costs of health care delivery are escalating. The day may soon arrive when those afflicted with diseases that they could have prevented, will have to pay the costs of treatment because society will refuse to so do. While this is a rather contentious possibility, we all know the consequences of indulging in excessive eating of unhealthy foods, of imbibing too much alcohol, of smoking, of not exercising enough, and of not putting on seat belts. We may well be held accountable for these transgressions.

With the amount of information available to all in the developed part of the world, it is perturbing that so many seem to be imbued by a death wish as witnessed by their very unhealthy practices. With tongue in cheek, it seems that since the world is overpopulated, such individuals are actually engaged in an activity of great social benefit for future generations.

Medical decisions should very rarely, if ever, be left solely to the attending doctor. The final decision belongs to the patient. It should be an informed one, based upon reasoned discussion with one or more experts. Admittedly, this can be quite confusing since experts often disagree from too narrow points of view. The patient should also consult a close family member or friend. Someone well known to the author, without asking for a second opinion, foolishly

allowed a knife happy surgeon to perform unnecessary surgery on him. He developed an infection in the incision. The condition persisted and got much worse before it got better. That foolish fellow certainly learnt his lesson and went on to write this book.

38CHAPTER 3

ENVIRONMENTAL HEALTH

The tepee is much better to live in: always clean, warm in winter, cool in summer, easy to move....Indians and animals know better how to live than white man; nobody can be in good health if he does not have all the time fresh air, sunshine, and good water. Flying Hawk, Oglala Sioux Chief.

As crude a weapon as the cave man's club, the chemical barrage has been hurled against the fabric of life. Rachel Carson

The following parable illustrates in a somewhat dramatic and gloomy fashion many of the issues, both overt and covert, that relate to environmental health.

Two individuals were stranded on a small desert island. The island had a supply of fresh water and one tree. The only tool each of the individuals had was a knife. The only food available was fish from the ocean which they caught with their hands. It took each individual two days to catch one fish. They soon agreed that they had to increase their fish catch.

They then decided, using their knives, to fashion nets with the tree's branches to more efficiently snare the fish. It took them two days to accomplish this. The nets were quite productive. They

were now each able top catch two fish a day, which was two more than they could consume per day. Thus they were able to create a stock of fish that they preserved in the fresh water and which permitted them to have some leisure time.

On the surface the development of this productive technology appeared quite successful. Their costs had been two days labour and the foregoing of the two fish they normally caught during that period. What they had not calculated as part of their costs was the loss of shade and a certain aesthetic quality, that had been provided by the tree's branches and that was now irrevocably gone. Also, unknown to them, in time the tree would have provided them with further nourishment in the form of fruit.

Finally, this sorry tale ends somewhat tragically. The two individuals disputed as to who was responsible for the apparent environmental degradation. They fought, with their knives, over the narrow strip of shade the tree provided and over who really owned the stock of fish they had successfully acquired. Perhaps their anger was due to frustration leading to stress created by living under such barren circumstances. Only one survived. When finally rescued, the survivor was a raving maniac.

GENERAL REMARKS

Ever since we became aware that there are certain subtle entities in our environment that cause deleterious human health effects which are not immediately discernible, the environment and the notion of environmental health has become one of the major policy issues of our time. Cynically, it can be observed that this issue has created and drawn a host of so called interested parties to it as bees to honey. It has engendered a great deal of activity and interest. Included are all levels of government, a rash of public interest groups and individuals, many of whom are always looking for a way to attack the establishment, the media who are ever on the lookout for a way to alarm the public, and of course those who are perceived to be the villains and thus are obliged to spend a good deal of time defending themselves, often by means that are suspect. Despite the effusive heat generated, environmental health remains an important question that needs addressing.

Notwithstanding the plethora of critical environmental health issues such as global warming due to the greenhouse effect, increased exposure to harmful ultra-violet light due to depletion of ozone in the stratosphere, acid rain, air, water and land pollution, and radioactivity, it is necessary to understand and agree on what is meant by the term, "environmental health." This is easier said than done because the term and the corresponding issues are really much

more complex than appears on the surface.
The term, 'environmental health' usually refers to the way human health is affected by environmental factors, that is, factors outside the human organism itself. This appears to suggest a dichotomy between the human organism and its surroundings, meaning that the well being of the human organism is causally related to those factors in the surroundings that impact on it. The spectre of the old 'nature versus nurture' argument is once again raised by this scenario.

Today that argument has become a cliche of the past. Separating any living organism from its surroundings is perhaps a useful semantic device, as is much of the language of science. It has very little to do with reality. No living organism exists in a vacuum. Every living organism is inextricably linked with its surroundings. Every living organism affects and is affected by its environment so that any separation of the two is somewhat arbitrary. Every local set of surroundings is also affected by its neighbouring surroundings. In other words, no living organism lives in complete isolation from any or all other living organisms and from any of the myriad environments on the face of the planet or, for that matter, in the universe. In light of all this, perhaps it would be better to define environmental health as the viability of the functional relationship between an organism and its environment

and conceivably deal with the two as if they were one.

Much additional research is needed to establish more concretely the connection between 'environmental health and health of the environment.' It has been suggested that any identifiable and controllable factor shown to impair the flora and fauna in our environment should be removed or exposure to it radically reduced, because, in all likelihood, it will turn out to be harmful to humans. In any case, whether one takes an extreme or more moderate position, this approach can be viewed as an ecological approach to environmental health.

The term, 'environmental health,' usually refers to all factors responsible for the impairment of human health, that is, those factors responsible for chronic and traumatic diseases and disorders. By the preceding definition of environmental health, it can be argued that all disease is environmentally induced. It matters not whether the factors are microbiological, chemical, physical (e.g., energy), genetic, psychological, social, economic, industrial, and natural as opposed to artificial. If involved, either individually or collectively in shaping the health of humans, or if in any manner whatsoever, they represent a risk to human health, such factors must become the subject of inquiry. Resources to that end should be made available and appropriately allocated.

As stated in the previous chapter, according to the World Health Organization the term 'health' does not only mean the absence of disease but also includes a sense of 'well being' of both a physical and psychological nature. Thus, 'environmental health' should not only refer to those factors that impair health but also to those that improve or promote that sense of 'well being'.

There are many approaches to Environmental Health, with related While too numerous to cite, they can be categorized under three headings, namely, Social Science Issues, Natural Science Issues, and Specific Problem Areas. Any suggestion that all the related issues can neatly be categorized under one of these headings is very misleading. They are all interconnected. Listing them into one of these categories is only useful for linguistic expediency. Some issues more readily transcend all of the preceding categories. It is recommended that some of these transcendental issues should constitute areas of investigation for universities that are endowed with Institutes of Research On the Environment and the Economy in their work on Environmental Health. Again, it should be emphasized that although they are listed separately, they should not be thought of as being distinct from each other. Examples of such issues are:

Stress

While the term stress, in a human context, is widely used and probably tacitly understood by most people, clearly defining and measuring it is quite another manner. The identification of those factors that produce stress is sometimes complicated because people react differently to various 'stressors'. Determining the effects of stress is also difficult because some perceived effects

may be caused by other more direct factors such as micro-organisms or chemicals.

No matter, stress must be investigated from a myriad of approaches since it is probably the most important reason for the diminution of a sense of well being in any individual. It stems from may sources. It may very well be the leading cause of nearly all diseases. According to Drs. Jeanne M. Stellman and Susan M. Daum, when the body is subjected to stress, biological changes occur, leading in some cases to symptoms such as reduced appetite, loss of weight, inability to make decisions, irregular bowel movements, headaches, skin rashes, insomnia, backache, nervousness, tremors, poor memory and irritability. In other instances, these symptoms may not appear but chronic stress can lead directly to actual diseases, such as ulcers, migraine, asthma, ulcerative colitis, high blood pressure and most deadly of all, coronary heart disease.

The sources of stress vary. Poor personal or marital relations, poor working conditions, emotional and psychological pressures due to fear, to job and financial insecurity and to constant pressure to succeed, contribute greatly to stress reactions. Fatigue is closely related to stress. The various feelings associated with fatigue, such as boredom, weariness, depression, anger, exhaustion, etc., can cause changes in the heart rate and brain waves. Causes of fatigue include monotony, unpleasant surroundings, intensity and length of manual and mental work, and mental and emotional causes such as conflicts, responsibilities, fear and worry. One unfortunate side effect that often occurs as a result of stressful situations is the use of alcohol and drugs as escape.

Summarily, it is imperative to further research into all factors that produce stress, into the biochemical and physiological route by which the effects of stress are manifest in humans and into the ways of coping and lessening both stress itself and its negative effects. However, while stress is a key factor in many disorders, it is also an inescapable part of life.

Education

The problems associated with educating the citizenry about environmental health are a matter of major concern. Some pertinent questions are:

- How can the public acquire a truer picture of the risks it faces from potential or illusory exposures to proven harmful or nontoxic substances?

- How can the media be convinced to avoid sensationalism and provide more accurate representation and a new understanding of the field of environmental health, a field that is easily exploitable because it can readily prey on everyone's fears?

- How can the "not in my backyard" syndrome be overcome?

- How do we convince individuals to engage in environmentally sound and healthy personal practices? (e.g., avoiding cigarette smoking, the single greatest cause of disease extant.)

- How can chief executive officers be trained to be occupationally and environmentally health responsible? They often set the tone for

the health practices of their companies. It would be interesting to study factors such as the incidence of disease and the rates of absenteeism in various industries and correlate the results with the attitudes of senior management.

- How can workers be educated to overcome their often repressed feelings of "shame" when they have become the victims of an occupational disorder?

- How can the interaction of scientists be promoted, to overcome sometimes restrictive local and regional points of view while providing for a more national and global perspective?

- How can young people be encouraged to enter relevant sciences, such as the medical and environmental sciences?

- What can be done in colleges and universities, to pull together and integrate various disciplines such as engineering, urban planning and design, so that more graduates are realistically involved with matters affecting environmental health?

- Is there not a need to upgrade the material taught in medical schools with respect to environmental health and its relationship with human health?

Social Issues:

The following research projects into the impacts on environmental health by unacceptable societal situations are recommended: poor housing; inadequate transportation and communication; the pressures brought on by consumer orientation; the economic anxieties that each of us feels because of lessening job security and the dwindling value of our assets; increasing concern about our health care system, its inadequacy and escalating costs; the issue of equity;

urban growth and its impact on the environment; the way our plastic society has distanced us from our natural roots; effects of community ethics and of the groups within it, with particular emphasis on the inconsistency of value systems; the tensions brought on by debates over such issues as abortion, euthanasia, language; the need for a set of environmental ethics that recognize that non-human flora and fauna should have rights somewhat analogous to those that protect human life; our ever growing reliance, indeed fixation, on technology to satisfy our wants and needs and solve our problems; and finally the need to find ways to transcend the scientific and technological paradigms that seem to beset us.

We need to realize that our health care delivery system provides treatment and hopefully, cure for disease, but does very little to improve the general state of health. Past public health measures that provided our society with microbiologically clean water and efficacious waste disposal probably prevented more diseases than all medical practices combined, with the possible exception of vaccination and inoculation.

Most of the problems listed above are apparently related to unplanned, uncontrolled and untrammelled economic growth. "Sustainable Development" has been touted as the answer, notwithstanding the view that the term has become distorted. While

there are a number of approaches to this concept, such as economic and ethical, it usually means that it is not appropriate to defer payment for environmental cleanup to our progeny. We must learn to lessen the negative impact of irreversible phenomena. Nowhere, however, is there any mention of environmental health in the description of this concept. A careful examination of all aspects of "Sustainable Development" is in order.

Regulation

Everyone agrees on the need for government regulation in the arena of environmental health. However, regulation raises a plethora of questions that need answers. Some of these require natural science research, some social science research, and others, an integration of both. The following is an illustrative list of such questions.

1. How best to provide public input into the regulatory process; after all, environmental health is mostly an inter-actional problem. How can those affected be empowered with some authority and responsibility? Do public interest groups adequately represent those affected? If so, how should they be recognized and funded?
2. How to provide in "law" a "right" to a clean environment;
3. How to provide strong national, coherent and consistent laws, given the jurisdictional make-up of Canada;

4. Is the Canadian Environmental Protection Act adequate?
5. Should the regulatory approach to a new potential hazard be: "guilty until proven innocent?"
6. The two federal regulatory government departments primarily concerned with regulating environmental health are the Department of Health Canada and Environment Canada. To many, their roles are unclear. What is their mandate? Do they work well enough together to give the Canadian public adequate protection?
7. How good is compliance to regulation in Canada? No such data exists. A study of such compliance would be very useful in making the regulatory process more realistic. Further, while the probable range of compliance is quite wide, there is a long time lag before any example of non-compliance reaches the public. By then it is usually too late.
8. How to cope with contaminants. Who pays for the cleanups and damages, since those responsible often claim they acted in good faith and within the confines of the law?
9. What is the best way to establish regulatory standards, while recognizing that they are not necessarily a reflection of scientific values but of socio/political ones? Should risk benefit analyses be used when contemplating standards? If so, should risk managers use public perceptions about risks and benefits rather than measured range levels of the two? How can public perceptions be aggregated?
10. To what extent should or can the ethics of "equity" be incorporated into regulation?

11. How well does the regulatory process incorporate scientific results into regulatory decisions?
12. How can ecological, cross-media, and more holistic concerns be incorporated into the regulatory process?
13. How is and how should bio-technology be regulated? Most work in that arena still comes under the heading of research. Thus regulating biotechnology means regulating research, a practice with very few precedents.

14. Finally, what effects does the gamut of government policies have on environmental health, either singly or en masse, from the point of view of the individual or the collective? An examination of all government policies currently de rigueur is probably in order.

52CHAPTER 4

THE ENVIRONMENT

The poet... may be used as the barometer, but let us not forget that he is also part of the weather. Lionel Trilling

La nature est … droite; L'homme est … gauche. Quoted by Jacques Delors

We shall never understand the natural environment until we see it as a living organism. Land can be healthy or sick, fertile or barren, rich or poor, lovingly nurtured or bled white. Our present attitudes and laws governing the ownership and use of land represent an abuse of the concept of private property... In leave the corpse for all to see, and nobody calls the cops. Paul Brooks

The forest at night is an experience in sensory deprivation most of the time, black and silent as the midnight zone of a cave. Life is out there in expected abundance. The jungle teems, but in a manner mostly beyond the reach of human senses. Ninety-nine percent of the animals find their way by chemical trails laid over the surface, puffs of odour released into the air or water, and scents diffused out of little hidden glands and into the air downwind. Animals are masters of this chemical channel, where we The Environment53

are idiots. But we are geniuses of the audiovisual channel, equalled in this modality only by a few odd groups (whales, monkeys, birds). So we wait for the dawn, while they wait for the fall of darkness; and because sight and sound are the evolutionary prerequisites of intelligence, we alone have come to reflect on such matters as Amazon nights and sensory modalities. Edward O. Wilson

We destroy the things we need, love and create, just like the madman who destroys a great work of art that he cannot appreciate nor understand. Jack Basuk.

GENERAL

In recent times a mystique has developed around the concept of the "environment," It has become a sort of "holy grail," largely coloured by both rhetoric and polemic. If meaningful and useful policies regarding the environment are to be developed, much, if not all of the cosmetic layers of idealism that mask the

fundamental nature of this important concept must be stripped away to get at some semblance of reality. What follows is a meagre and probable contentious attempt to do just that.

Chapter 3 of this book, which dealt with some of the policy problems associated with the impact of certain environmental traits on human health, emphasizes and to a great extent characterizes

the anthropocentric aspects of the environmental movement. We are concerned about the environment because of its potential negative effects on our health, economy, and socio-political fabric. Furthermore, it must be emphasized that we humans are at the centre of that environment. We have invented the concept; we have imbued it with both positive and negative values; and we use artificial scientific and aesthetic approaches to describe it.

Were our sun to go critically supernova at a moment's notice, and dissipate our planet it would have no more importance than the disappearance of a speck of dust. Yet we have placed ourselves at the centre of the cosmos. Our perceptions and related concepts about our universe, ourselves, and our more immediate environment, as well as the language we use to express our ideas, can be viewed as nothing more than extensions of our nervous systems. Thus because we have created our conception of the universe, we must be at its heart, metaphorically speaking.

Of course, there is a reality out there. However, because of the limited nature of our senses and our mind, its essence is barred from us. Any suggestion that we truly know it, represents arrogance at its worst. Yet, it is very difficult for us to accept the notion that, although we are so intimate with the environment, its basic nature is unknown to us. To overcome the fear of the unknown, we have created a wide variety of myths. They enable us

to cope with a barren, and fleeting existence that for many would be without meaning, hope, purpose, and pleasure, as well as replete with despair. Myths are essential to our survival.

Myth making is consistent with our conservative human nature, our fear of and resistance to shifts and changes, especially to those over which we have little or no control, such as environmental fluctuations. Since changes of the short-term catastrophic sort, or of the longer term, usually result in disasters for the affected living organisms, our fears may be explained by the biological imperative to survive. Whether we are or not the initiators or masters of such situations or in some instances whether we are or not aware of them, does not seem to alter our reactions. Like many in the animal world whose behaviour seems to signal a major change (e.g. an earthquake), we either panic or simply resign ourselves to the inevitable.

While many myths abound, there are two worth mentioning because they are situated at the polar extremes of the spectrum of views. The first is the biblical precept stating that we have been granted dominion over nature. This allows humanity to do with the natural environment as it deems fit. Some who hold this position recognize that control over nature must be used wisely, and scarce resources necessary for life carefully husbanded, or we will suffer dire consequences.

However, this position has an ominous extrapolated potential. With the ever increasing rate of technological development, the day may come when we will be able to live in a totally synthetic environment, allowing us to neglect and perhaps even obliterate the natural environment. To some extent this is already occurring: totally enclosed climate controlled malls, office buildings, factories and residences; time spent in front of television sets where virtual reality dominates, influencing our thoughts in a fashion that is unthinkable; communication with disembodied voices or with word symbols on a computer monitor; and the inescapable conclusion that we have become slaves as opposed to masters of technology.

Finally, the day is not that far off when we will be able to genetically select or breed persons for certain occupations because they are resistant to certain environmental factors, thus accelerating the neglect of the environment.

At the other conceptual extreme is the notion that we are biologically natural organic entities, part and parcel of terrestial processes and subject to the same environmental forces and fate as all other living things. We cannot and should not hold ourselves apart from the natural environment and manipulate it solely for our somewhat suspect purposes. Such behaviour may lead to disastrous results for all. Instead, we must develop a better appreciation of nature's rhythms, ebbs and flows. We must learn to synchronize our

behaviour with nature's so that a natural equilibrium can be maintained without the intrusion of environmental disorder.

A logical extension of this approach is that since we are natural beings, everything we do belongs to the natural order of things. Thus the values, the sense of ethics and morality and the notion of rights that we have generated must also be an endemic part of nature. While hardly ever overtly stated, it is implied by those who argue that the environment has rights that must be respected.

Yet, there is no evidence that nature is imbued with any such sense of ethics. On the contrary, the apparent randomness of catastrophic natural disasters seems to indicate that we are at the whim of natural forces, that without any sense of fairness and feeling, - two very human traits, - have wrought untoward misery all over the planet. Furthermore, are we willing to ascribe to nature, human malevolence that has also led to unimaginable horrors? If we are, indeed, part of the natural process, why is it that we and the rest of the natural world do not seem able to avert destructive practices? Perhaps it is because we are part of a process bereft of ethics and morality; whatever such sense we seem to be imbued with may be nothing more than a normal biological survival strategy and not inspired from some higher and divine source.

In this world view there are no natural rights, and no sense of right or wrong. Indeed, there are no human rights as a natural endowment. "Rights," a human invention, had to be fought for. The granting of rights to the environment is a human contrivance. Nature is totally unaware of rights. If the environment is granted certain rights, it is probably because we are guilty of being anthropocentric and wrongly ascribing to it characteristics such as vulnerability and muteness. However we treat the environment, it is nothing more than a reflection of how we view ourselves.

BIODIVERSITY

Edward O. Wilson in his book, "The Diversity of Life," which was reviewed by John Terborgh in the November 5, 1992 issue of the New York Review of Books and from which the following is excerpted, suggests that we are the only species able to reflect on nature. He asks whether it is right that we, a unique species, should commandeer the earth's resources to the detriment of millions of others that represent the biodiversity or the sum total of life on this planet. The immensity of natural biodiversity is beyond one's intuitive grasp. Ten thousand species of microbes may teem in a pinch of European soil; 12,000 species of beetles may dwell in the treetops of a single hectare of Panamanian rain forest. The diversity of life is still so unexplored that biologists cannot say with any certainty whether the entire number of species on our

planet is 10 million, 30 million, or, not impossibly, even 100 million.

Besides the moral questions involved, this diversity should matter to us because its hidden, unglamorous components are intimately engaged in the biological recycling processes that purge the air, soil, and water of toxins and wastes. We would quickly acquire a keen appreciation of their unesteemed roles if they were suddenly to go on strike.

Professor Wilson ranks the task of conserving biodiversity as the greatest challenge of our time. In his estimation, the masterworks of nature deserve at least the same solicitous attention we lavish on the masterworks of man. During the second world war, both sides secured their art treasures in deep underground vaults. No human beings were so well sheltered. Why are we not equally concerned about nature? Perhaps it is because nature has no appointed custodian. If nature is to survive, we must all become its custodians. If we fail, we must bear responsibility for what Professor Wilson has called the one misdeed of this generation which future generations will never forgive.

Another argument can be made for preserving biodiversity. Apparently it is not mentioned in either Professor Wilson's book or its review. Many biologists believe that the strength of any ecosystem is directly related to the number of species it supports.

More natural biodiversity within an ecosystem enhances its capacity to maintain life and resist new and potentially calamitous factors that may destroy it. The arctic is far more fragile than the jungle. The jungle is more resilient because it supports many more life forms. Just as the species within an ecosystem must be preserved, so should the diverse natural ecosystems. After all, the planet earth is one large ecosystem containing many sub ecosystems.

Finally, Professor Wilson prescribes a five-point program for biodiversity.
(1)Survey the world's flora and fauna, so that scientists can base their investigations on a complex inventory of species, rather than on a small sample.
(2)Create wealth out of new biological products, materials, medicines and foods.
(3)Promote sustainable development.
(4)Save what remains of biodiversity. And
(5)Restore wild lands in areas that have been abused, exhausted,

and abandoned.

CHAPTER 561

ISSUES AT THE INTERFACE BETWEEN SCIENCE/TECHNOLOGY
AND THE LAW

The law is a sort of hocus-pocus science. 1759. Charles Macklin

The law, in its majestic equality, forbids the rich as well as the poor, to sleep under bridges, to beg in the streets, and to steal bread. Anatole France

Science and Law: One seeks the truth. The other seeks to distort it. Which is which? Jack Basuk

GENERAL - THE PROBLEMATIQUE

As long as humans have lived together in communities of one sort or another, there has been "LAW." If by law, we mean a code by which behaviour is governed, it can be argued that law predates humanity if the definition of the term includes all natural phenomena. Indeed, some equate law as the word of God. Others hold that the law is synonymous with so called natural law. The distinction between natural law and man-made law is valid and should be drawn. (It is ironic that the contemporary study of natural law is usually what we refer to as 'science,' and that this chapter deals with the interface problems between the study of natural laws and law.) The former is presumably beyond our powers

to alter, is consistent and arguably exists independently of humans. The latter deals with the human attempt to prescribe human behaviour and for the purposes of this book, is what is meant by the term, 'law.' In any society, law is based upon is perceptions of truth and values. The latter frequently has a strong bearing upon the former.

On a less ethereal plane, many believe that laws have been concocted to protect society, while others posit that it is the best way of resolving disputes. Some strongly favour the punitive and penal aspects of the law, while others hold that law by its coercive power, prevents undesirable behaviour. There is some validity to the various points of view, in that collectively, laws serve to keep society running on a more or less even keel and in a somewhat and sometimes harmonious fashion. It does this by providing society with a code of behaviour which is coercively enforced and consists mostly of a list of "do nots."

Technology has also been around for a long time. It predates humans, as witnessed by the workings of ants, bees, spiders, beavers, chimpanzees, etc. The next chapter will be devoted to a wider and deeper discussion of contemporary technology.

Science and Technology are too often lumped together as if they are synonymous, despite the fact that science is relatively recent.

While it is true that they have become closely linked and interdependent, there exists substantial differences between them that are often not recognized. In this chapter and again for the sake of linguistic expediency they will be used jointly. However, nothing could be further than the truth.

The relationship (and distinction) between science and technology has changed dramatically over time. Unlike science, which strives towards value-free examinations of natural and social phenomena to obtain "truth," technology, is nothing more than what is used and how, to produce marketable products and desirable services. Originally the links between the two were rather weak. However, with the tremendous growth of scientific knowledge and understanding, technology took off.

Science and technology have revolutionized the standard, quality, and style of living of most people. But many of the attendant costs were either hidden, ignored or not foreseen when a scientific advance was realized or a new technology was introduced. Along with the tremendous benefits we have enjoyed, we have also experienced environmental deterioration, depletion of non-renewable resources, stresses on the moral and ethical fabric of our society and totally unforeseen and questionable social impacts.

Never before has science and technology made such inroads and

impacts into all of our lives. Never has there been such a need for the law to respond to the challenges and potential harm of these endeavours. Traditionally the law has dealt with human behaviour. There are very few precedents that enable it to cope with artificial contrivances that are extraordinarily complex, beyond its ken, and whose effects can range from the most subtle to the most direct, with aspects that are quite paradoxical and ethically perplexing. Never has there been such a need for an innovative process in which science and law harmoniously interact to resolve problems never before thought of.

The Science Council of Canada's report titled Regulating The Regulators - Science, Values and Decisions, refers to two leading American thinkers who have highlighted such a contemporary necessity. Judge David Bazelon of the United States Court of Appeal has written: "The astounding explosion of scientific knowledge and the increasing sophistication of the public have radically transformed our attitude toward risk regulations. As government health and safety regulations become pervasive, there is a pressing need to redefine the relation between science and law. This is one of the greatest challenges now facing the government and indeed society as a whole."

Dorothy Nelkin, Professor of Political Science at Cornell University added: "Until recently, the risks of technology have

mainly been perceived as a technical problem, not a political issue; a problem to be relegated to expertise, not to public debate. But controversies have politicized the issue of risk, called attention to the interests and the question of power that are involved. Several features of the disputes over risk have contributed to this politicization and to the difficulties of conflict resolution."

What is at the core of the science/law problem? As stated in the introductory chapter, there is a common problematique with all

science policy issues. In this case, it is the inability of science and law to interact because of fundamental differences in the language and thought employed by both.

The differences between legal and scientific concepts of fact, knowledge, probability and proof, present problems as science enters more and more into regulatory matters and as members of the public expect greater participation in technological decisions that affect their lives. Scientists discover what is. The law, whose bottom line raison d'ˆtre is ensuring the harmonious functioning of society, can no longer ignore science and must adapt to its discoveries. But scientists are often frustrated by the apparent inability of the legal process to act on what they consider clear and compelling evidence. The same frustration is frequently felt by the agents of the law because of science's inability to provide an unambiguous answer. The binary reply of the "law" is rather terse:

something is so or it is not. Science's approach is that the probability of something being so is dependent on a host of parameters which are often very difficult to measure. It is difficult to find a scientist whose answer to a direct question does not contain a host of caveats.

Furthermore, the interaction between law and science at present is insufficient to allow anything other than a crisis-to-crisis response. Technology is advancing too fast, not allowing the social and legal processes to adapt. Many of the critical problems which our society today must resolve are different in degree and sometimes in kind, from those that were handled by our existing dispute resolution mechanisms.

SCIENCE\LAW INTERACTIONS

There is a history of two sorts of science\law interactions. The first is the use of science by law and the best historical example of this is criminal forensics. It worked because, more often than not, science was and is able to provide unambiguous truths based on such things as fingerprints, DNA, straightforward chemical

identification of various substances, blood types and ballistics.

surprisingly, scientific certainty is reduced somewhat when the evidence is of a psychiatric or psychological nature. It becomes highly speculative when so called psychological profiles of unknown

criminals are used by the police.

The main area where science is still being used by the law, other than criminal forensics, can be called environmental forensics, and is principally in the area of risk analysis and assessment, especially with environmental and occupational health problems. This is a contentious area because of the attendant scientific uncertainties and because the sensitivity of scientific measuring devices has become so great that the presence of any substance in another, no matter how infinitesimal, can be detected. Other areas where science is being utilized include the potential social impacts of television violence, rethinking and redefining such things as death and viable life, and opening the judicial process to the public at large by the use of new communication technologies.

The second type of interaction between science and law has to do with the impact on law by science. The issues that arise are often quite subtle. They have been labelled by Milton Wessel, 'socio-scientific disputes.' Others refer to them as value scientific disputes.

Wessel describes socio-scientific disputes as having three principal characteristics: first, the public has an interest in the problem and its resolution; second, the information needed to make a rational judgement is complex and difficult to evaluate; and third, a sound

final judgement requires the fine tuning and balancing of a number of 'quality-of-life' value concerns, about which different people may have widely varying attitudes and feelings. When all three characteristics are present, they seem to synergize and complicate resolution of the dispute.

VALUE SCIENTIFIC CONTROVERSIES

Value scientific controversies consist of a mixture of facts and values, with varying weights given to each component. Sometimes values are explicit, but more often they are not. It appears that the explicitness and the overt manifestation of values varies directly with the degree of uncertainty associated with the facts. This further complicates the interaction of the two aspects, a process already quite complex, which contributes to the difficulty in resolving these disputes.

One must also distinguish between scientific and value-scientific controversy. Scientific controversy is dispute over the validity of scientific findings or the completeness of a relevant database. Value-scientific controversy is dispute over the social, ethical and political implications of scientific findings and their uses. Dispute over the interpretation of scientific findings bridges the two. Overlaps of these two categories are sometimes inevitable. In nearly every value scientific controversy, the science involved is also

disputed, often because of its hypothetical and trans-scientific nature. Trans-scientific describes hypotheses that cannot be verified experimentally for ethical or practical reasons, e.g., human experimentation to test whether certain compounds are cancer

producing. It must be emphasized that the resolution of a scientific controversy will probably not resolve the corresponding value-scientific dispute.

To clarify the preceding, here are some examples of value scientific issues. They are listed under two headings. The first is "biotechnology" and the second is "others." Issues related to the first are listed separately because they are often closer to all the built-in contradictions of humankind. The list is far from exhaustive.

BIOTECHNOLOGY ISSUES

Even though current usage is much narrower, for the purposes of this book, biotechnology is defined as all technologies that use living entities or those that directly modify them for beneficial purposes. Under this rubric, there are and have been over human history, many examples of value scientific issues. Perhaps the oldest is agriculture, one which has implanted in humans a particular set of firm values, because it sustains life.

Yet the practice of agriculture and the gathering of food has led to environmental deterioration and health problems via deforestation, soil erosion, monocultures resulting in fragile ecosystems, pollution, extinction of a wide variety of living species because of overfishing and over-hunting and finally excessive use of harmful chemicals such as pesticides, herbicides and fungicides.

Many anthropologists suggest that agricultural practices have impacted in a far profounder way, by laying the foundation for future societies in eliminating nomadic hunter gatherers. Agriculture gave rise to stable communities, then to cities and then again to nation states, with all their attendant benefits and evils. If we had known then what we do today, would we have gone ahead so uncritically?

A second example has to do with the use of living things and once living things, for the purposes of research. Historically, the use of cadavers to learn about human anatomy was quite contentious, especially since some found it necessary to rob graves. Today, finding cadavers is no longer a problem. However, human experimentation poses some difficulties as illustrated by the following questions:

- Is there not a moral and ethical predicament posed by clinical epidemiology? Is it not accurate to assert that individuals receiving

a placebo are not receiving the supposed benefits of a new therapy being tested and thus are being short changed?

- What constitutes informed consent, a principle of recent vintage? Does it apply to jailed criminals who are seeking clemency?

- Should the results of human experimentation that took place in concentration camps during the recent Holocaust be used and therefore somehow legitimatized?

- How should, if at all, those women in the third world that were used to test birth control pills be compensated?

- Does the use of fetal tissue from abortions for research purposes encourage that practice? (A fuller discussion of issues related to fetal research is available in a paper published by the Royal Commission on New Reproductive Technologies, titled, "Legal Issues In Embryo and Fetal Tissue Research and Therapy," by Bernard M. Dickens.)

- Should animals have rights somewhat analogous to those humans supposedly have?

A third example, one that is contemporary, contentious and trying

is concerned with reproductive technologies. Rebecca J. Cook, in a paper she wrote for the Royal Commission On New Reproductive Technologies, in 1992 identified a number of substantive "rights" applicable to this area. They include the right; to life to liberty and security of the person; to marry and found a family; to private and family life; to information and education; to reproductive health and health care; to the benefits of scientific progress; and to sexual non-discrimination.

Other than the issues of "rights," the following questions are proposed as pertinent to the issues associated with reproductive technologies.

- Has the "pill" sexually liberated women to their benefit and has its widespread use enhanced certain socially undesirable results as well as diseases such as AIDS?

- When does life really start and should there be foetal rights?

- Who is the mother of a child when, by the use of in-vitro fertilization, a surrogate has been used to carry a foetus to term? What about those instances when artificial insemination is used so that the surrogate is also the genetic mother?

- What are an newborn's lawful rights to an inheritance if it was

born years after the death of its genetic father and by the use of his viable frozen sperm?

- Should prenatal screening be used to determine the sex of the other preferences in certain societies?

- Because there are nearly always hidden costs associated with new technologies, how should we approach the abortion pill that recently developed in France?

- How far should we go when using genetic engineering and cloning, in trying to alter the genetic make-up of future generations? In light of humanity's propensity towards racism, nationalism, tribalism, and its attempts both past and present at racial purification and eugenics, can it be trusted with the potential power of this technology? Is it also possible, indeed probable, that in eliminating certain genes, we also will lose certain desirable traits, something like throwing the baby out with the bath water?

- Perhaps the most volatile issue today is "abortion." To what extent has it become so contentious because of the availability of

technologies that render it simple and safe? Why is it that those who are anti-choice seem to ignore the plight of all the unwanted,

unwashed, starving children in the world? Why do they also oppose planned parenthood?

Finally, under the rubric of biotechnology, the following questions, of a more general nature, are put forward for consideration:

- Are we wise enough to plunge full steam ahead into altering the very basic substance of life itself by attempting to navigate the uncharted waters of Recombinant DNA, Genetic Engineering and Cloning to create new life forms, supposedly beneficial? Whose liability is it if something goes terribly wrong? Should this research be regulated? Dr. Robert Sinsheimer of the University of California characterizes this work as akin to the radio astronomers who are deliberately sending out artificial radio signals into the cosmos with hope that some intelligent life form will respond. Dr. Sinsheimer asks, what will happen if instead of a radio response, we are visited by beings who are light years technologically ahead of us and who intend to deal with us as we did with the natives of newly found lands. He suggested a moratorium on both the radio waves and biotechnology research, at least until the issues have had a public airing.

- Will there be a relaxing of environmental and occupational health regulations if it becomes possible to totally map our chromosomes and predict what sort of maladies each of us is most

likely to incur and under what conditions?

- Is there a right to 'death' as there is a right to 'life?' Are there instances when euthanasia and 'rational suicide' are justified? Is there a possibility that, because of the dire need for transplantable organs, the definition of death will be modified to fill this need, or failing that, will there be instances when death will be pronounced prematurely? How can this monitored and prevented? Is life worth preserving at any cost and no matter the quality of that life? If so, who should make the appropriate decisions and what instruments are the most appropriate? How should the law deal with these very sensitive cases?

- How should decisions be made about who should receive rare and costly therapeutic procedures that may save a life?

- How should the law deal with the sexual legal status of those who have had so-called sex change surgery?

- What legal status should human clones have when that inevitable day arrives? Can a clone be murdered? Can a clone be available for spare parts?

- Should new life forms arrived at by artificial genetic engineering be patentable?

OTHER VALUE SCIENTIFIC ISSUES

What follows is a list of further questions, each related either to a particular technology or to research.

- How effective have the disciplines of penology, criminology, social psychology been in curbing or preventing criminal behaviour?

- The automobile currently kills about 50 thousand people a year in North America and maims countless more. In Israel, far more are killed on the roads than in all her wars and yet there is no public outcry as there is none here, except, occasionally, when the fatality is caused by a drunken driver. Our cities, rural areas and styles of living and working have been shaped by this transformative technology. Does it make any sense to continue with this most inefficient and polluting way of transporting ourselves? Had we known all this when the auto was introduced via mass production back in 1915, would we have proceeded the way we have? The answer is probably, yes. What, if anything, can we do about it now?

- Why do we continue to have copyright laws that are totally ineffective, in light of technologies that enable us to easily copy the written word, videos and computer software?
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- In view of huge computer data bases and elaborate devices that can spy on anyone of us, how can our privacy be protected? Is this threat offset by certain potential benefits such as having our health records available for epidemiological studies and to all qualified medical practitioners who may require them if we fall ill anywhere in the country?

- Should firearms be restricted? Guns, a good example of a "death technology," have made killing lots easier and are widely distributed. Should the individual value of "the right to bear arms" supersede the value of collective protection? If the right to relatively unrestricted possession of firearms is upheld, where does it stop? Should we permit the private ownership of semi-automatic rifles, fully automatic rifles, cannons, rockets, tanks, armed warplanes, nuclear weaponry, poison gas, based solely on one's ability to purchase? Recent curbs on ownership of guns in Canada has been legislated, despite the continued advocacy for private ownership of firearms without limits.
- Are an individual's civil liberties being violated if that person is obliged to undergo tests for substance abuse?

- Are forms of censorship necessary and/or desirable when the fantastic communication technologies available to nearly everyone may facilitate the dissemination of extreme views? Would such

censorship constitute an abridgement of our right to free speech?

- Should there be any restrictions on research because the results might prove to be politically unpalatable? For example, the widespread tenet that we are all born equal, we know to be not true. What is really meant is that all people should be born with equal rights and opportunities. This is an ideal to be striven for. It certainly has not been achieved anywhere. If individuals are not born equal, is it possible that the various ethnic groups and races are born with, other than the obvious, differing characteristics suggesting varying weaknesses and strengths? Would research into this be useful, because it could shed some light on the sources of racism, by highlighting the differences between ethnic and racial groups without conferring 'superiority or inferiority' to any of them? Would results that indicated deep differences be politically

explosive?

Traditionally, many of the problems listed above have been dealt with by the law and the legal process. The former has a strict meaning: the legislation, regulation and case law (judicial precedents) that form the legal system of a society. The law may be established by the legislature or by delegated legislative power (normally the Cabinet). The latter includes all measures taken by government that could eventually result in legislation or regulation, such as commissions of inquiry, and measures leading to guidelines

on regulation prepared by public officers.

Finally, inherent limitations of professional consultancy are revealed by a structural feature of the new global environmental issues. For in these, decisions depend on evaluations of future states of the natural environment, resources, and human society, all of which are unknown and unknowable.

Invaded by such research as reproductive technology and also by research requiring the inflicting of pain on aware beings, the sacred and the private are domains no longer safe from the moral uncertainties that parallel this built-in ignorance.

At the roots of traditional science were images of knowing, leading to control and management. Such "art of the soluble" is no longer appropriate. In circumstances of radical uncertainty, a new scientific inquiry is emerging, focused on issues rather than problems, bent upon the use of special scientific research and professional consultancy for coping and ameliorating. The old excitement of former traditional activities, conducted for so long in innocence of adverse effects, is now history.

The following questions, elicited from the preceding comments on 'science/law,' illustrate some areas of investigation that might prove useful and challenging.

- How is the gap between 'science' and 'law' bridged?

- To what extent should values shape policy decisions as opposed to cold hard facts? One is reminded of the fictional conundrum about a decision a pilot had to make: who amongst his passengers should be sacrificed to save the others because of excess weight and failing engines? The decision is complicated because his passengers included the world's leading artist, political statesperson, scientist, writer, philosopher, sports personage, composer, engineer, soldier, religious leader and musician. If he bases his decision on his values, he will select the person whose profession he esteems least. If his decision is to be objective, he will select the heaviest amongst his passengers.

- What sort of mechanisms and processes, new or already in place, are needed to resolve value-scientific controversies, and involve the public in the formulation of new laws? What sort of experimentation in decision making should be attempted?

- In light of frequent scientific uncertainty over potential risks, should the legal principle, 'innocent until proven guilty' prevail when a new technology, development or chemical is suspected of being hazardous, or should the onus of proof of safety be totally on the proponent of the innovation?

- In light of the statistical nature of risk, how should the determination of 'acceptable risk,' (synonymous with safe) be undertaken?

- Is it proper for scientists, in their professional capacity, to step outside their so-called expertise and make value judgements?

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CHAPTER 6

TECHNOLOGY

Physics does not change the nature of the world it studies, and no science of behaviour can change the essential nature of man, even though both sciences yield technologies with a vast power to manipulate their subject matters. Burrhus Frederic Skinner

The individual serves the industrial system not by supplying it with savings and the resulting capital; he serves it by consuming its products. John Kenneth Galbraith

We are all controlled by the world in which we live, and part of that world has been and will be constructed by men. The question is this: are we to be controlled by accidents, by tyrants, or by ourselves in effective cultural design? Burrhus Frederic Skinner

GENERAL

Technology is at the core of science policy. This is not surprising because governments only pay lip service to the seeking of 'truth and beauty.' It is to technology, amongst other things, that they turn to try to satisfy their political, social and especially economic goals. Their support of science is also based on their newly found appreciation of the critical interaction between science and technology with science at the source of nearly all lucrative technological innovations.

It has been stated elsewhere in this book that technology is value laden. Actually this notion is somewhat contentious. Some believe that things have built-in values, positive or negative, because they represent the embodiment of an idea. As such, technology translates the world views of its inventors into systems, processes, services or objects. These values may be based on the degree of their usefulness, destructiveness, aesthetic qualities, validity, probity, etc. Such technologies shape individual and social behaviour as well as the contours of our world. There would appear to be much evidence in support of this view.

There is more supporting evidence for the following view: qualities seemingly present in things are actually extensions of human perceptions. In other words, values do not belong to things but to humanity. They are a human invention. The beauty of an object resides in us, and not in the object. The utility of an object is something we ascribe to it. A package of computer hardware and software is of no value to a primitive tribe of natives indigenous to the jungles of Brazil. To master artists, the paint brush, pencil and crayon are an extension of their arms and of themselves. This is also true for master musicians and their instruments, for world class athletes and their equipment and for scientists and their implements.

There is no disputing that technology has power, but it is the

power that we confer to it. We choose to answer the phone when it rings, to use inefficient polluting means of transportation and allow them to shape our cities and country-sides, to sit in front of our mindless television sets, to oversubscribe to medical and pharmaceutical articles and to toil in unhealthy workplaces. We allow our governments to acquire and research more devastating means of destruction as well as utilizing means of energy generation and transport that have questionable characteristics. There is no such thing as the 'technological imperative,' per se, in the sense that technology drives us. There is, however, a 'technological fix,' on which many of us are hooked. It is facile to blame technology for our ills. Omond Solandt, the founding chairperson of the Science Council of Canada often asserted that any technological development has the potential for both good and bad and the human condition being what it is, it would probably be used both ways.

Perhaps our off course views of technology have arisen because a simple technology often begets a more complex one, which begets a still more complicated one, and so on and so on...., until we have technologies, euphemistically labelled 'high tech,' that are vastly distanced from their simple origins and impossible for most of us to understand. This may give rise to the feeling that because we are helpless before much contemporary technology, it must have an

independent existence with its own perspective.

This technological mystique is further heightened by the reality of technological changes over the last century, exceeding by many orders of magnitude their totality over all of previous human history. Furthermore, their rate is accelerating at a pace that makes it close to, if not impossible, for humanity to cope with.

Three very important examples, (amongst many others such as those related to medicine, energy and armaments) of technologies that have burst upon the scene in the last hundred years are those dealing with transportation, communication and information. In a far fetched way they are related. After all, communication can be viewed as the transportation of ideas and information.

Individually and collectively, their impact has been fantastic but cause serious concerns. It is easy to summon a few examples: the privacy we enjoy may vanish with the coupling between incredible databases and advances in communications; modern transportation may have shrunk the world to such an extent that no country is immune from the social, political, economic and even medical problems brought about by peoples' resulting mobility; information data in a morass of useless abstracts and documents; information overload has made sorting out the wheat from the chaff much more difficult; the opening up of numerous interactive channels and the possibility of everyone floating up anything they wish, brings up a

vision of easily spread hate, pornographic material, and pseudo religious nonsense.

Technology has become an awesome object of devotion for many, for others an object of fear, for others still an opportunity for economic gain and finally, for a few, a panacea for all that ails the world. In some instances, these sentiments exceed those held for the monarchy, our nation, our most popular sports and entertainment figures, in some extreme cases our families, certainly our politicians and even our respective religions. Indeed many assert that technology has become the religion of the twentieth century and that its impact, in a relatively short period of time, is far greater and profounder than all our other religions put together. As with most religions it has its priesthood and its acolytes.

We are technology's willing slaves. For that matter, we always have been. We just did not realize it. Very few of us have learned how to master it. Today, its influence is recognized by nearly everyone, with growing concern.

There are many definitions of technology. All are of interest and are probably quite correct. Yet, they really don't capture how the term "technology" is commonly understood today. The following concise definition is offered with the hope that it is acceptable and

understandable. "Technology includes the ideas and all material things, in other words, the hardware consisting of such things as the raw materials, the tools, the machines, the devices, the factories, etc.; and all people and other living things; and the way these groups are organized and used to produce processes, goods and services that we either need or desire."

Throughout most of recorded history, humans did not devote much thought to technology as an entity into itself. It was and maybe still is, for the most part, taken for granted because it appears to be a natural and obvious part of any human culture. In truth, humans and technology are inseparable. They are its creator and its creature. This has always been so. Nomadic hunters used weapons on their prey and on their enemies. The group hunters also used weapons but organized themselves so that the collectivity became more efficient than the individual. This is still apparent among certain primitive peoples. Farmers used and still use animals, tools, machinery, the land, seeds, chemicals, waterways, etc. Very often they worked and still work collectively for higher efficiency, nowadays assisted by the most modern devices for financial and crop planning. Artists have always used a variety of materials and tools to produce visual, audio, theatrical and literary effects. Finally, as we are sometimes very painfully aware, just about all of our leisure time is dominated by technology in one manner or another.

Before we equate technology uniquely with the human race, we should remember that we are not the only animals with a technological bent. Ants build anthills and wage war in an organized fashion; birds build nests; bees build hives complex in structure; beavers build dams; lions, wild dogs, wolves, etc. hunt collectively; and chimps fashion and use tools.

There is, however, a major difference between these animals and ourselves. Their involvement with technology appears to be quite limited and rigidly programmed. They cannot adapt their technologies to changing conditions. No animal is as involved with technology as the human race is. Indeed it appears that technology is an intrinsic part of humanity's nature. Some outrightly attempt to reject technology. They may claim that it is harmful to both our body and spirit and that it goes against the will of "God". Whatever, we cannot deny technology anymore than we can reject food, air and water as essential to life.

And yet is there not a grain of truth in the speechifying of those luddite sounding individuals? Has technology gone out of control? Are we truly its master? John Kenneth Galbraith has asserted that, "we are becoming the servants in thought, as in action, of the machine we have created to serve us". To what extent have we become hooked on technology? Witness the way cities and highway systems have grown because of the internal combustion engines; and Technology89

changes in family patterns caused by advances in communications. Octavio Paz suggests that, "Alienation, if such an overused word still has meaning, is not only the result of social systems, be they capitalist or socialist, but of the very nature of technology; the new means of communication accentuate and strengthen non-communication."

Are there good versus evil technologies? Is technology morally neutral? Is the good or evil use of it nothing more than a manifestation of human nature? We may have struck a Faustian bargain with the devil when we developed nuclear power. Poorly used, it can either destroy us all in an insane war or cause immense harm as recently witnessed by the Chernobyl disaster.

LEVELS OF CONCERN

These concerns about technology were best summed up by John G. Burke and Marshall C. Eakin in their excellent book, "Technology and Change". The book is really a series of essays on various aspects of technology by some of the world's leading thinkers. In the introduction to the section called, "Technology On Trial", they refer to three levels of concern. The first addresses immediate or urgent problems, which are attributable to unchecked technological advance. Some of the major problem areas cited in this cluster are: our physical environment; hazardous working conditions; the

exploitation of the consumer; the use and misuse of computers; and finally problems associated with nuclear reactors and radioactive waste.

The second level of concern involves attempts to track down the sources of immediate and urgent problems, which are spawned by technological advance. This requires an honest effort to determine responsibility or to pinpoint deficiencies in the structure of our economic, political, legal or societal institutions or customs, which permitted the problems to arise in the first place. More about this later.

The third level of concern is both philosophical and ethical. It has to do with the very nature of technology and what effects its development has on human beings. Proponents of technology claim that although it is a necessary human activity, it is only one among many in which people engage. Others repudiate this description of technology. They say, that it is now autonomous - completely out of human control. It gives us abundance but destroys our freedom, because it shapes and directs all aspects of human life.

GOVERNMENT POLICIES AND THE GROWTH ETHIC

One probable and frequently cited source of our problems, that transcends political ideologies, is the growth ethic. It pervades our societies. It is commonly believed to be absolutely essential for affluence and crucial to our economy. No hard evidence for this notion exists. Maintaining a competitive edge or a competitive position seems much like keeping up with the Jones, or trying to stay in the same position while walking on constantly accelerating treadmill. Sooner or later something has to give.

The notion of growth is often promoted by the lure of sorely needed new jobs. What about the possible effects of capital intensive and low labour technologies such as microelectronics, biotechnology, robotics on employment?

Perhaps we should try to establish policies that promote linear as opposed to exponential growth. The former has the virtue of being regular and manageable while the latter is often completely out of control, like a cancerous tumour. Perhaps, we could discard or modify the growth ethic in order to delay a future when labour will no longer be as important a cog in the machinery producing wealth, as in the past.

Two sets of governmental policies may be needed, the first dealing with how the wealth produced by our society is distributed - and the second dealing with both the substance and style of decisions concerned with how that wealth is produced, in other words with industrial and technological policy. The process leading to these decisions is most likely at fault when blame for future problems has to be determined and should be of concern.

There are so many involved parties, actors and mechanisms that either regulate or promote technologies at the federal, provincial and even municipal government levels, that some rationalization of the process is sorely needed. On the other hand, it may be best to let well enough alone and continue to muddle through. That is, after all, what democracy is supposed to be all about. Is there anyone really wise or disinterested enough to make sagacious decisions about technology? Is there any person or body we are willing to trust with the power such decision making capability would proffer?

TECHNOLOGY TRANSFER

One important process that has become part and parcel of the liturgy of technology is "technology transfer". It presumably has some bearing on how technology decisions are to be made. The term "technology decisions" means the actual selection of a

technology after all the financial, environmental, technical, regulatory and marketing factors have been considered. The phrase, "technology transfer" has also become a well used bureaucratic cliche. Despite that, the concept has a basis in the real world.

At first glance, technology transfer appears to simply mean the transfer of a technology from its source or origins to where it is most needed. However, the transfer process turns out to be rather complex. In simpler agrarian times, technology transfer was often the straight forward transfer of know-how between the generations. The world was a simpler place to live in then and the technologies rather easy to understand and master.

Times have certainly changed. To successfully transfer a technology today requires the involvement of government, for regulatory and tax purposes, for direct investment, for assistance when the technology originates in government labs, and for the necessary communication and diplomatic links when transfer to other countries, especially the underdeveloped ones is deemed advisable. Financial bodies are required for the needed capital outlay; industries to either produce or use the new technologies; marketing experts to ensure its general acceptability; and finally a new breed of entrepreneurs who specialize in bringing together all the needed elements for a successful transfer. Of course we should not forget the imaginative persons who created the new

technological innovation in the first place. They require a supportive infrastructure and the ebb and flow of ideas. It would appear that anything enhancing this technology transfer process would be desirable. It is true, with one major caveat. According to current conventional wisdom, technology transfer requires strong linkages between government, corporate industry and the universities. This is certainly debatable.

The danger of strong links between government and industry to the exclusion or near exclusion of all other societal sectors, could be the promotion of an antidemocratic and a quasi-right wing fascistic society. Perhaps the proposed strong links between government and industry and the related financial institutions would be more acceptable were they matched by equally strong links between government and labour, between government and a whole host of public interest groups, between government and the poor, between government and the frail, between government and some of our native groups, between government and our scientific and artistic communities, and between government and any other important interests. There is very little chance of this occurring. Increasingly, however, the public directly involved or impacted by technology is demanding a greater say in technology decisions. pressures, universities remain one of the few bastions of freedom of inquiry in our world. Government has no place on the campuses Technology95

of a free society or in the newsrooms of our media or as a former prime minister once said, in the bedrooms of the nation. Let's keep it that way.

Finally, what about strong links between industry and academe? Strongly promoted, they have become quite popular. A counter position will be opposed by many, even though it should be given serious consideration. Such links are being established every day. More is the pity.

Universities are not commercial enterprises. This is the major reason for opposition to strong links between universities and industry. Universities remain amongst the few institutions that are supposed to be devoted to the pursuit of 'truth' by those engaged in the physical and social sciences, the arts, the fine arts and the humanities. They are supposed to be motivated principally by curiosity. In other words, the universities must remain a place where researchers of any type are allowed to carry out freely, curiosity oriented basic research. It is not supposed to matter whether this truth has commercial utility or not or whether it is palatable or not. Truth, not money, is supposed to be the goal of research. Also there should be no hierarchy of truths. The truth discovered by the student of ancient philosophy is possibly just as valuable as the truth discovered by the biotechnologist. University research should not be motivated by a preoccupation with profit 96Technology

seeking pursuits. The proper place for industrial research is industry and in some instances, government.

However, when the results of basic research have commercial possibilities, they should be made available to those who can exploit them. Let the links between universities and industry be a one way street. Output to industry but no input from industry.

TECHNOLOGY ASSESSMENT

One of the most popular terms in the liturgy of technology is "technology assessment." (T.A.) It has come to be imbued with an aura of sanctity. Nearly everyone is convinced of its essential role in the decision making and regulatory process, when deciding whether and how we should proceed with a specific technology. This has been so for about the last twenty years. During that period much has been written, conferences held and sermons

preached about it, usually in a positive vein. To question it is to attack motherhood. Yet it bears some further examination. After all, it has served as a politically and bureaucratically expedient tool for a number of years. In Canada, the federal government has two processes related to T.A.

What is usually meant by the term? There are two aspects to it - a what and a how. For the moment let us put the how aside. Technology97

Technology assessment means exactly what it says, that is, it assesses a technology to ascertain whether it should be purchased and used. It is a simple as that. We all do it, every time we purchase a car, house, gadget, tool, device, some health care or treatment. We often find ourselves going through the agonizing process of determining how much we require or desire the object in question, whether we can afford it and how it may change our lives. Usually this occurs when the technology in question is expensive and the purchase may represent a major investment such as a house or car. In such instances, we may call for expert advice or make the decision collectively with all who will be affected by the decision, normally the family.

Most of the time, our purchases are affordable. Thus, we give very little consideration to other than the superficial aspects of the technological object in question. As a result of incomplete assessment, we often find that the object of the purchase does not meet up to our expectations, or our needs. Unfortunately, a similar approach has sometimes been employed when we, collectively as a society, have selected technologies for nothing more than their sex appeal.

The key point about the assessments undertaken when decisions are being made, is that they are all future oriented, they are designed to gratify current or future needs as well as desires and to master 98Technology

difficulties. In other words T.A. has come to mean anticipating the impact and side effects, positive or negative of a new technology before going ahead with it. They may be of a first, second or nth order depending how far into the future one is looking and how far afield.

Assessing technologies that have long been in place is usually considered hindsight, viewed to be of little value. Assessing new technologies has glamour because most have never been used before. Also, technological developments are frequently of such a scale that the need to predict their impacts has become essential lest they have profound and wide consequences.

Out of this comes two major observations.

First: We need to monitor the impacts of past technologies for two reasons - to ensure that they are doing what they are supposed to at a reasonable cost, without harming us and without gobbling up good money after bad; and, of equal if not more importance, to learn about unforeseen consequences and acquire some baseline data so that we have some criteria for judging new technological developments.

Second: The technology assessment process should always include all individuals who have an interest in the issues under consideration Technology99

no matter what that interest is. Inputs from all the key actors are required. Such an assessment is supposed to weigh all relevant factors from all sources before any decision is made.

Technology decisions are difficult to make. No foolproof way exists. Collective decisions are not always wise or correct. Decisions taken unilaterally by individuals, groups or for that matter experts, are often not any better. At best, predictors may be wrong in a benign fashion. At worst, they may encourage wrong or harmful technologies and discourage needed ones. After all the future impact of new technology is almost always beyond anybody's imagination. One is reminded of an old adage. "Man plans. God laughs."

Like it or not, we cannot avoid assessing technology. The decision vis … vis any technology always involves choices and choice means assessing.

Harvey Brooks, the well known American physicist, has put forward a series of questions that need answering to accomplish realistic assessments. They include: Is T.A. feasible? What is the appropriate role of the public? What are the required standards of evidence? What are the impacts, actual and potential, on the process of technological innovation? Will T.A. become captive to the area being regulated? and finally; What effect has T.A had on the

strength and vigour of science, as distinct from technology?

Dr. Brooks further suggests that, ideally, T.A. should forecast, at least on a probabilistic basis, the full spectrum of possible consequences of technological advance, leaving to the political process the actual choice among the alternatives in the light of the best available knowledge of their likely consequences.

101CHAPTER 7

SAFETY, RISK AND UNCERTAINTY

He is no wise man that will quit a certainty for an uncertainty. Samuel Johnson

Great deeds are usually wrought at great risks. Herodotus

Take calculated risks. That is quite different from being rash.

George Smith Patton

As if there were safety in stupidity alone. Henry David Thoreau

GENERAL

The question of safety in our society is a subject that most of us do not give much thought to. It is taken for granted except when an obvious risk situation occurs, such as the problems with mussels and tuna fish of a few years ago, the spread of diseases such as AIDS or cancer, the proposed installations in of waste disposal devices, high voltage power lines in our back yards, and the occasional exposure to dangerous chemicals and energy forms.

Most of us want to feel safe and secure. At the very least, if we take risks we want to do so voluntarily, know what they are, want to feel that the risks are worth taking, and are negligible or easy

to overcome. This involves three major concepts namely, safety, risk and uncertainty.

SAFETY

We would go crazy if we thought of all the potential risks we continuously face. We not think of them because they are largely the implements of modern life. Most of us believe that we are safe and that someone is ensuring we remain so. For the most part, that someone is government using the most advanced scientific techniques.

It is important to establish a common understanding about what we mean by the terms "safe" or "safety." For many, those terms mean risk free: absolutely no risk is associated with whatever is being considered. However, risk is linked with every human activity, indeed there is a risk in just being. Nature has a way of overwhelming us with calamitous events such as earthquakes, fierce wind storms, tidal and regular floods, torrential rains, noxious gases, and drought.

The term "safe" now means that the risk under consideration is deemed acceptable. Thus, the terms "safety" and "acceptable risk" have become synonymous. If we agree with this notion of "acceptable risk," it becomes clear that society determines safety. Safety, Risk And Uncertainty83

In other words, in a democracy such as ours, we all have a role in deciding, "what is safe." Indeed that decision should never be left completely to the bureaucrats, politicians or even to the scientists.

The role of science becomes one of alerting us to the nature and magnitude of the risks and to suggest ways of alleviating them when they are unacceptable. Recognizing that the public at large is usually unaware of risks and thus in no position to decide which are acceptable, at the very least, those mandated to decide must be held publicly accountable and should always be prepared to explain their decisions and actions.

Further, and of equal importance, rendering some risks acceptable often entails costs. These costs may be quite high. The law of diminishing returns is often applicable. It becomes clear that someone has to decide how much safety we can afford or how much we are willing to buy and who is to pay for this protection.

Again, this becomes a political question because it often is in someone's vested interest to down-play or underestimate the risks for monetary gain. On the other hand, it may be in the interests of others to exaggerate the risks for political gain. It is easy to see why the debates around risks have generated so much controversy.

At the present time, our government affords us quite a bit of

protection through the regulatory process. Unfortunately, there are still those who would like to eliminate all forms of regulation and leave industry to regulate itself. They suggest that the market obliges industry to behave properly and when it does not, there are always the courts to fall back on.

There are many reasons why this should be totally rejected but one stands out. It is an after-the-fact approach. It does nothing, or next to nothing to prevent calamity. Further, it allows the few to impose risks on the many without their knowledge or consent. This is unacceptable.

Now how does government protect us? It fulfils this function mostly through the regulatory process, which sets certain rules of behaviour and various standards. These render the associated risks safe or as suggested earlier, acceptable. The regulatory process is also mandated to monitor and police those who may be breaking the codes and standards as well as monitor risks which are essentially no one's fault.

Because the variety of risks are so large, no one government department can be responsible for regulating all of them. While the Health Protection Branch of the Department of Health is the key government agency, it often finds itself working in conjunction with a host of other government regulatory departments and

agencies. It monitors and polices those risks under its mandate, and also often provides either the critical scientific support needed by the other agencies or backup when they have scientific facilities of their own.

The past problem with mussels illustrates how the Health Protection Branch works with the Department of Fisheries. It also depicts the complexities that regulatory scientists continuously face. The regulatory actions were carried out by the Department of Fisheries, while the Health Protection Branch of Health & Welfare Canada carried out the difficult scientific work which, for the most part, consisted of the following:

First a suspected connection had to be made between mussels from a certain place and the illness it caused. This is not simple because the illnesses were not concentrated in a particular place and because the number of cases were not that large. The final total number was over one hundred with two deaths. Next, the poisonous effects of the mussels had to be confirmed. This was done by feeding experimental animals the suspected mussels or some extract from them. Of course, mussels from all over the east coast were used.

As it turned out, the problem mussels came from a certain part of the P.E.I coast. Next came the biggest problem of all and that was

to identify the toxic agent in the mussels. First the agent had to be isolated. This is no mean trick when you do not know what you are trying to isolate. Then to identify it, its molecular structure had to be ascertained and again this required chemical detective work of the highest order. The toxic agent in the mussels turned out to be a rather rare substance known as domic acid. The final problem was to try to trace the source of that toxic agent.

As can be seen from the example of the contaminated mussels, the costly role of regulatory scientists is of extreme importance. There are not enough of them or for that matter enough regulators. We need more.

RISK

The concept of risk and how risk is managed is at the heart of the issue of "safety." It is also the core issue when the potential negative impacts of scientific and technological development are being considered. The key factors in the debate surrounding "risk" are present when risks appear to be imposed and when there is uncertainty over their magnitude.

Risk and uncertainty are inseparable. Without uncertainty there is no risk and therefore one is not taking a risk when one is sure of the outcome. However, a degree of uncertainty and therefore of Safety, Risk And Uncertainty107

risk is associated with any human activity, even one such as breathing. Since our lives consist of countless such endeavours and efforts, living is risk taking.

Most of us would agree that life replete with certainty and devoid of any risk would hardly be worth living. Yet there are levels and types of risks we are not willing to take. We spend lots of time and expend a great deal of energy striving for comfortable levels of security. We certainly do not wish to spend our lives on the edge of our chairs constantly aware and worrying about all the risks we face. Luckily, for the most part, we do not have to, since in the first instance, most risks are negligible and there is nothing we can do about others such as natural disasters, aging, the state of the world economy, or whether life exists on other planets in our or other galaxies.

In the second instance, there are those risks we can choose to avoid. We do not have to invest in the stock market, play at the gaming tables of gambling casinos, fly, smoke, overeat, drink, climb mountains, ski, speed on our highways, engage in criminal activities and so on. Also we can lessen risks by buying insurance, by investing in safe securities, by living a healthy life, perhaps by working hard although these days that does not seem to lessen the risk of unemployment, by purchasing quality products, and by being friendly and sociable.

In the third instance are the risks we, the citizens of our society, either individually or collectively choose to take. Unlike the first two instances we now, indeed, have something to worry about, for we have no reason to believe that these decisions, again either individually or collectively are rational, just and humane, and are based on sufficient, appropriate and factual information.

In a democratic society, such as ours is supposed to be, the

citizens have a fundamental right to accept or reject risks. The unilateral imposition of risks on an unknowing and unsuspecting citizenry represents the deprivation of this basic right and is, for the most part, unacceptable. However, this has occurred and to some extent still does. (An example could be the placement of high voltage power lines.) Only a diligent citizenry can prevent this sad state of affairs.

The current interest in risk has developed only recently. This has occurred because of a growing general awareness about the risks associated with some major technological developments and the perceived inadequacy on how these risks are handled, either by government or industry.

A concurrent interest in how the public perceives risks and hazards has also developed recently, because there are perplexing differences between these perceptions and those of the experts

who usually arrive at theirs through statistical extrapolations.

The idea that all hazards can be scaled to the size of the associated risk and that an acceptable level can thereby be established has become questionable. First because, "accepted" is not necessarily "acceptable" in the public's eye; and second, because, viewing risk in a uni-dimensional manner does not do justice to the complexities often involved. For example, statistical extrapolation would suggest that travelling by automobile is far riskier than travelling by air. Yet it is the plane crashes that receive much more media attention, a greater degree of government regulation and much more post accident investigation than any form of land travel. Also more fear is associated with flying, despite the statistics that clearly demonstrate that car travel as more dangerous.

Why is this so? There are three qualitative answers that are not as logical as the statistical ones but are equally important. First, the single major catastrophic event, even if rare, but where many lives are lost, is more striking than many much smaller accidents where for each the damage is less but the aggregate is substantially higher. Secondly and perhaps more important, is the feeling of helplessness coupled with the near certitude of death associated with airplane mechanical problems. After all, automobile drivers have some dominion over their toys and with their skills

can modify the risk. This is certainly not true for the passenger or often for that matter for the pilot in an airplane. Third is the simple, admittedly, irrational fear of flying and heights.

Herewith, a list of other factors which affect the public's perception of risk. They were culled from a Report of the British Royal Society on Risk Assessment.

Risks to non beneficiaries are regarded as worse than risks to beneficiaries, e.g. risk to the general public exposed to emissions from nuclear power stations is worse than risks to those receiving radio-therapy; Involuntary risks are regarded as worse than voluntary; Risks that are isolated and not compensated for by associated benefits are regarded as less acceptable than risks obtained in a largely beneficial context, e.g. exposures to X-Rays in fitting shoes versus risks from radon emission in buildings that otherwise provide warmth at a low energy cost; Immediate hazards

are regarded as worse than those which are deferred; Unfamiliar, unnatural or "new" hazards are regarded as worse than risks from familiar, natural and established causes; Risks arising from secret activities are regarded as worse than those derived from open activities; Risks evaluated by groups who are suspected of partiality are regarded as worse than risks evaluated by impartial groups; and finally, risks that some other person pays to put right are regarded as worse than risks individuals have to pay themselves to remedy. Safety, Risk And Uncertainty111

It is evident that the public's perception of risk is important. Its viewpoint must be considered, not as a form of indulgence or vote catching and especially not as error, but as essential input. In matters of illness, injury and even death, or in policy issues involving questions of morality, only the public can estimate the negative impact.

However, it is critical to appreciate what the terms hazard and risk signify scientifically, since they have specific meaning and significance for scientists specializing in environmental and occupational risk analysis. While related, they do not have an identical meaning and should not be used interchangeably.

"Hazard" refers to the nature and sometimes to the magnitude of the peril in question. For example, the potential hazards associated with floods are the extensive destruction of property and crops, the infliction of much harm to nearby fauna and flora and the loss of human life as well as much injury to it. The major hazard associated with exposure to the AIDS virus is the acquisition of that horrible and fatal disease.

"Risk", on the other hand, refers to one's chances of suffering the hazardous consequences of a particular activity or event. In other words the term, "risk", has a statistical connotation. It is often defined mathematically as the frequency of a hazardous occurrence, 112Safety, Risk And Uncertainty

times the magnitude of the associated hazard.

For example, suppose there is one major fire per week in a city of one million inhabitants. Let us also suppose there is one death for every two fires. The risk of dying in a fire for an inhabitant of that city in a given year is calculated by multiplying one fire by fifty two weeks, divided by two fires per death, and dividing that result into one million. The answer turns out to be, to the nearest hundred 38,500 to one. Now this seems simple enough. That is the problem. It is not only simple but simplistic.

It is a gross calculation. It does not take into account variations between individuals such as: what happens to an individual's risk if travelling out of town frequently?; what happens when one lives and works in edifices which are made mostly of non-inflammable materials and have the latest in fire prevention technology, as opposed to fire traps in districts not as well served by the fire departments; and what about those who, while still alive, are terminally ill and do not have much time left.

Here is another example which even more graphically illustrates the complexity of risk analysis and assessment. Let us assume that if a plane crashes into a building, everyone in it will perish. That is the hazard. What is the risk of getting killed in one's home by a plane crashing into it, if only one airplane a day flies over it when Safety, Risk And Uncertainty113

one is away at work? The answer appears to be zero.

It is not. As long as one airplane capable of flying exists anywhere in the world, there is a chance, albeit infinitesimally small, that it will fly over one's home when one is in it, crash into it and kill everyone in it. It therefore appears that such a risk cannot be nil.

What happens to the risk if, on a regular basis, the plane flies over when one is at home? The answer is now obvious. The risk, while still extremely small and impossible to measure, is real. What happens to the risk if fifty planes fly over each hour of the day? The risk, while still very small, has grown much larger. What happens to the risk if these fifty planes flying over each hour, are piloted by suicidal maniacs intent on crashing their planes into all the buildings in this region? The answer now depends, to a large degree, on the number of buildings in the vicinity, the ability of the pilots to succeed in their suicidal endeavours, visibility, the terrain and any capability the people on the ground have of defending their homes. In any case the risk has now become very large, indeed, unacceptably so. Quite clearly the accuracy of the calculation, even if based on as complete and accurate information as possible about the multitude of factors, would remain rather uncertain.

This approach, as applied to certain occupational risks, appears similar to playing dice with two die. One's chances of coming down with a specific occupational disease can vary all over the place in a manner analogous to one's chances of rolling a two with the die - one in thirty-six - rolling a seven - six in thirty-six - and rolling a twelve-again - one in thirty-six. It is disturbing to note that workers' health often appears to be the result of a lottery. When large numbers of workers are exposed to a particular hazardous chemical, only a certain percentage of them will become ill. It is impossible for contemporary science to predict with any accuracy who these individuals will be. Even if predictions become possible, it would still be a lottery, only of a different order. The predictions would have to be based on a person's genetic make-up, itself largely a matter of chance.

TOXICOLOGY AND EPIDEMIOLOGY

While there are numerous scientific disciplines associated with the measurement of risks to human health, the two most important are toxicology and epidemiology. The first, toxicology, is the science of measuring how dangerous or toxic to humans is exposure or intake of drugs or chemicals. The principal method used by toxicologists is animal experimentation. It has generated a great deal of controversy, particularly around the validity of extrapolating the results of these experiments to humans. There is still a great deal

of uncertainty about this, yet it remains the surest way of judging the hazardous nature of chemicals and drugs.

The second, epidemiology, is the science that searches for the sources or causes of diseases in given populations. Methods used may vary but are all statistical in nature. It is very difficult to pinpoint complex causes of disease such as a multiplicity of exposures to different chemicals and energy forms. Another

limitation of epidemiology is that it is "after the fact." It counts dead bodies. Humans become guinea pigs. Despite these reservations, epidemiology remains the most accurate way of measuring risk and is the only way we can ascertain whether the government policies designed to protect us are effective.

RISK - BENEFIT ANALYSIS

Two further points made quickly, although deserving much more time. First, risk-benefit analysis, a term that has become a cliche, is a commonly used method of measuring benefits against risks and is perfectly admissible when the units of each are the same. If the benefit is money, let the risk also be money. If the benefit is human lives saved, the risk should be lives lost. This occurs frequently in wartime. Two excruciating examples during WW2 were Churchill's decision to let the Germans bomb Coventry and Truman's decision to use the atomic bomb.

Second, however, this approach to risk benefit contains an inconsistency. For example, what about lives saved against money spent, as in the pharmaceutical industry or in improving highways or in reducing air pollution or mine safety. It may cost one million dollars to reduce a certain risk by 90% and ten million dollars to reduce it by 95% and 100 million dollars to reduce it to 99% and 200 million dollars to reduce it to 99.9%. (These escalating costs to reduce risk are what usually occur.) Then which of the above should be used? The first may be too little and the last may put the company out of business. A difficult quandary!

UNCERTAINTY

Disagreements about risk measurements, a relatively new science, (if one can call it that) which is replete with uncertainty, often occur. This uncertainty has fed the fuel of various controversies over occupational and environmental health. Some argue that the onus of proof is on those who claim that certain risks are just too high. Others assert that those who would expose workers and the general public to chemicals and energy forms must first demonstrate that they are safe, whatever that means. One thing is certain. These decisions should not be made arbitrarily. Our collective thinking must be utilized in the face of all the uncertainties when deciding whether certain risks are acceptable.

Uncertainty has important ramifications for science. It is also relevant in our day to day living, as we try to cope with the risks that we impose on ourselves and those imposed on us by others.

We all have a great deal of familiarity with uncertainty. We face it every day of our lives. Uncertainty about our health, our future, our finances, our jobs and our related performances, our grades when we are students, our personal relationships, the quality of our purchases, the continued viability of our society, our national security, our feelings and beliefs about the meaning of life and so on and so on. We all have to learn to cope with uncertainty because living in abject fear and paranoia would lead us to mental breakdown and irrational behaviour. Some of us who have not learned or do not have the capacity to deal with the vicissitudes of life, suffer.

Science is one area most of us believe devoid of uncertainty.

After all, it is to science we turn when we need expert advice and opinions in our courts, our legislatures, our biomedical centres, our homes, about our food supplies, our schools, our natural environment, our centres of technology and industry, our military establishments, and even our religious institutions. Scientists are amongst the most respected citizens in our society, often regarded as dispassionate, rational and objective fonts of wisdom. Scientific uncertainty is surely unthinkable. Look at all the

success science has had. Linking science and uncertainty must be a contradiction.

Alas, if only that were so. For some of us it would be a blessing to claim, as with religion, that science is perfect and that no uncertainty is associated with it. The truth is the exact opposite. Science is fraught with uncertainty. At a most fundamental level, this is a strength not a weakness. However, at a more superficial level, this uncertainty creates certain problems.

The most important scientific operational activity is probably measurement. All scientific measurements have some uncertainty. There are two principal types of uncertainty, the superficial and the fundamental. Superficial uncertainty comes about because of errors in measurement due to human frailty, or in the assembly of the measuring device or in the limits of accuracy of the measuring technique. In any case we call this type of uncertainty superficial, because improvements may remove or lessen the errors causing the uncertainty.

Fundamental uncertainty has nothing to do with the measuring techniques or with human inconsistency. Fundamental uncertainty is a law of nature. No matter if our measuring technique is 100% accurate and no matter whether the human tendency to err is eliminated, there can be no measurement made by humans that does

not have some uncertainty associated with it.

This law, while formally stated somewhat differently, is known as the Heisenberg Uncertainty Principle, after Werner Heisenberg who formulated it in the 1920s. It can be shown to be true for any scientific measurement. However, the error introduced is generally so small that it cannot be measured and therefore can be neglected. Heisenberg said it best: "Since the measuring device has been constructed by the observer.. we have to remember that what we observe is not nature in itself but nature exposed to our method of questioning." The mere act of observing something changes it.

If there is one area of science that we generally think of as having no uncertainty, it is mathematics. However, developments in the 19th and 20th centuries have forced mathematicians to realize that mathematics is not a series of self-evident consistent truths produced by infallible reasoning but that it is based upon arbitrary and inconsistent axioms.

With respect to the regulatory sciences such as analytical chemistry, epidemiology, toxicology, biological measurements, etc., the uncertainty is of the superficial kind and its degree varies between them. Analytical chemistry is by far the most exact. The uncertainties identified with the others are heightened when trying to establish a connection between the cause of certain diseases and

exposure to a possible causative agent because often there is a long time lag between the exposure and the onset of measurable symptoms.

Scientific controversy frequently occurs when there is uncertainty over data. It is further fuelled when there is dispute over associated values. Dr. A. Kantrowitz has recommended the creation and use of what he labelled "Science Courts." They would be assembled only when there is an urgent need to resolve a scientific and/or value scientific controversy, for the purposes of evaluating some public policy.

The court's function would be either to lessen or eliminate scientific uncertainty by separating out, as much as possible, scientific fact from value or opinion. A panel of disinterested scientists would sit as judges and render an informed opinion after hearing all the evidence. Proponents and antagonists of the policy in question would give evidence and be cross-examined. Paraphrasing Dr. Kantrowitz, "We have had an operational judicial system for very many centuries that for the most part has worked quite well. There is no reason why scientists cannot use the same type of mechanism to resolve their difficulties, with one caveat. There are to be no real lawyers anywhere near the proposed court."

While the Science Court has been proposed for a number issues, it was used only once to the knowledge of this author. It was contemplated for the controversy over the safety of mammograms when used to detect breast cancer but not used. It was used by a mid-western state over the debate about the safety of high voltage transmission power lines. When it was first put forward it generated a great deal of controversy. It was said to be costly, time consuming, very inexact and subject to political influence. Perhaps it is time that this notion be revisited.

In summary, science is characterized by uncertainty. It affects the critically important regulations designed to protect the environment and human health. In those areas, the degree of uncertainty is often high. Ironically, we have a pretty good idea of what we know. We are also very aware there is much that we do not know. The real uncertainty lies in the fact that we do not know what we do not know. That is humbling. True scientists are sincerely humble. Those who use scientific findings to make policy decisions should be imbued by the same attribute.

CHAPTER 8

ENERGY

Indolence is heaven's ally here,
And energy the child of hell:
The good man pouring from his pitcher clear,
But brims the poisoned well.
Herman Melville

We cannot control atomic energy to an extent which would be of any value commercially, and I believe we are not likely ever to be able to do so. Ernest Rutherford

Energy - the stuff of life. Jack Basuk

GENERAL

Of all technologies, those that produce, transmit, conserve and store energy are the most important. They enable humanity to survive. They shape and render all technologies operational. Choosing energy technologies is one of the most important science policy decisions a society makes. Major judgments involving energy are complex, often involving subtle factors. They have powerful impacts on the lives of most of us. When energy policy decisions are made and implemented, a better informed public must play a more meaningful role in ensuring that the public weal is protected. Energy123

These decisions should not be left to those with a vested interest in specific energy technologies. It is hard to imagine the oil industry promoting a new, inexpensive, totally non-polluting fuel for transportation devices. More than likely that industry would try to suppress it. It is equally difficult to envisage any of our public utilities being enthusiastic about a technology that would allow each of us to own our own energy source, without breakdowns in the system causing many to be bereft of energy at the same time. As a cynical utility executive observed at a major energy conference a few years ago: "We are opposed to solar energy. We cannot meter the sun." The two major utilities in Canada, Ontario Hydro with its emphasis on nuclear power and Quebec Hydro with its accent on selling hydro based electricity, are having difficulties. Both should improve their decision making process.

Throughout history, issues pertaining to the provision, distribution and conservation of energy as well as exposure to various energy forms have been critical. In a movie titled "Quest For Fire," a tribe of primitive people, living about 80 thousand years ago, lose the small flame they had learned to nurture and as a result face certain extinction. Three of them set out to find another flame and return to their tribe with it. Instead they accidently learn how to make fire and change the course of history.

That discovery can be likened to the discovery of the wheel, the steam engine, the internal combustion motor, electricity, electromagnetic waves, nuclear energy, jet propulsion, the transistor, and some even more recent discoveries such as the silicon chip, recombinant DNA splicing - which has created a new science that promises to revolutionize areas such as farming, medicine, mining, materials, and the latest: superconductivity, that appears to have enormous potential. What should be noted about all of these wonders is that without the discovery of how to create fire, none of the others would have been possible; second, they all had or promise to have enormous impacts on our world and on the way we live; and third, energy is involved with all of them. Indeed, they all represent an enormous advance, one way or another, in how energy is tapped, transformed and used.

Another movie that came out of Italy right after the second world war illustrates how important energy is. The movie was called

"Miracle In Milan." It features a heartbreaking scene: a group of homeless, destitute, hungry and obviously very cold people are milling about in a public place on a cloudy day. All of a sudden, a narrow ray of sunlight breaks through the clouds. The result is a near riot, as they all fight for that small warm place in the sun. Indeed, it can be argued that wealth, something that humans have always striven after, have fought and killed for, and never seem to have enough of, in one form or another, is really energy.

Nobody fights over barren territory; but if a territory has potential in terms of agricultural, timber, mineral, hydro and fossil fuel resources, it quickly assumes value, especially if the energy needed to extract these resources is low. Cheap human labour in the form of slavery is mostly a thing of the past; but inexpensive human toil, which is after all a form of energy, is still a way of inducing industry to establish factories in underdeveloped countries, where large unskilled populations can be exploited because of abysmal standards of living and low expectations. The most fundamental and critically important bottom line commodity for man is energy. Perhaps that is a self evident truth. If so, it bears repeating because it often appears to be lost sight of.

Going a little further, energy is not only absolutely essential for industry, but for life itself. The heated houses we live in and the clothes we wear protect us from the elements by allowing us to retain our body heat. The food, air and water we consume represent packages of energy required for the sustenance of life. The real source of these necessities is of course the sun, major provider of all of the earth's energy. Ill health can be viewed as a partial breakdown in our ability or in the ability of some of our organs to utilize the energy available or to produce needed energy. Death represents a total breakdown.

While energy is an essential input to life, perhaps life itself is

nothing more than a manifestation of energy. The term 'life force' which is sometimes used in a quasi mystical manner, may have merit. Life, as an energy form, may be part of an ecological balance with other energy forms, with various sorts of exchanges between them. If true, this would again emphasize our critical involvement with energy.

If life is an energy form, it may also be true of existence itself. After all, there appears to be three fundamental entities. They are matter, energy and space. It seems that Einstein managed to reduce them to one. Matter and energy turn out to be two aspects of the same thing and the geometry of space turns out to be dependant on the presence or absence or a manifestation of matter or energy. Actually, Einstein postulated the existence of "the field," which represents everything that exists.

THE SCIENCE OF ENERGY

What is meant by the term 'energy?' Everyone seems to intuitively know what energy is, but would be hard pressed to put it into words. Actually, even though the term is very frequently bandied about, it is misused rather infrequently. The scientific definition is an operational one. An operational definition of a quantitative thing is one which describes how that entity is measured. For example, a physicist would define a term like time by describing how it is

measured, in other words, how clocks work. This type of definition fails to give us a real grasp of or feeling for what is being defined. For the scientist, however, it provides consistency in the way the term is used and provides a basis for a mathematical formula which in turn provides a means of useful calculations.

Well then, how is energy defined? To the scientist, energy is closely synonymous with work. Potential energy is the capacity to do work, while kinetic energy is the work actually being done. That does not help very much. We now have to ask: what is work? Work is the application of a force through a certain distance. Again we have to ask: what is force? Well, force is something that when applied to a body having mass or weight, will cause it to change velocity, in other words to accelerate or to decelerate. Since we can measure weight, change in velocity or acceleration and distance easily, certain types of work and therefore certain types of energy are easy to measure. The type of energy or work just described is called mechanical. As everyone knows there are various types of energy, that can all be reduced to the mechanical type for purposes of measurement. It is true that transforming one type of energy to another sometimes requires rather sophisticated means, but it can and is being done.

Work and energy are not exactly the same thing. They are measured the same way and have the same units. If a body has a

certain amount of potential energy, it does not mean that we can obtain that exact amount of work from it. According to the laws of thermodynamics, it is impossible to extract all the energy out of a body in the form of work we wish to accomplish.

This whole question can be best summed up by two familiar truisms. They are: "there is no such thing as a free lunch or; you can't get anything for nothing." While these are generally true for most life situations, they are even truer for energy. In fact, they can be said to sum up the Laws Of Thermodynamics in a nutshell. These laws are fundamental to an understanding of the relationship between work and energy.

First of all, anytime anyone puts some energy into a closed system, the energy released by that system cannot exceed the amount put in. As a matter of fact, the total amount out should equal the total amount in. This is the first Law of Thermodynamics, often called the Law of Conservation of Energy. Now that seems straightforward enough. If we put a certain amount of energy into a machine, we should get the same amount out of it. We do and yet we don't. We would get the same amount of energy out of it in the form of useful work if machines were 100 percent efficient. They are not. Let us illustrate with some examples.

First, a simple one we are all familiar with: an individual on a

bicycle puts in a certain amount of work when pedalling. The pedals and the distance the pedals rotate as they are pushed. Multiplying these two quantities yields the measure of work invested by the cyclist. The work yielded by the bicycle is also easy to calculate. It is simply the sum of the weights of the bicycle and rider, multiplied by the distance travelled. Now if the bicycle were 100 percent efficient, the two amounts would be equal. However, when measured, it turns out they are not. The

energy in is equal to the energy out but not to the work out because part of the energy out was heat due to friction that was dissipated. This inequality is crucial: The useful energy generated by a system is always less than the energy inserted into the system.

In the bicycle example, the work loss was not so great, because the energy in and the energy out were of the same kind. They were both forms of mechanical energy. Usually however, when the forms of energy are different, the loss is greater because the efficiency of transforming one type of energy into another is lots less. For example, the energy found in a liter of gasoline is chemical in nature. When gasoline is combusted or burnt, the energy in the chemical bonds that hold the atoms in a molecule of gasoline together, is partially used to form the new bonds of atoms in the products of the combustion. It is fractionally released in the

form of a burst of heat which in turn causes the gases in the cylinder head to rapidly expand, creating a sudden rise in pressure in that chamber, causing the cylinder to move. In other words chemical energy was transformed to heat, which in turn was changed to mechanical energy.

Again, within the molecules of gasoline, the energy getting converted to heat has been calculated. Comparing this to the actual amount of work done by an automobile clearly indicates a relative low efficiency. The work output of a car does not measure up to the energy in the fuel used to power it. While a great deal of energy in the form of heat is produced by the internal combustion engine, only a relatively small amount of it is available for useful work. In essence, this is the Second Law Of Thermodynamics, sometimes called the Law of Entropy.

To sum up, the first law states that energy in is equal to energy out and the second law asserts that work out is always less than energy out. It actually goes further, by spelling out when energy is or is not available for work and when it is, under what conditions and more or less how much. Some understanding of this is essential when decisions about energy must be made.

Energy is available for work when it flows from a system with a certain energy potential, to one with a lower energy potential. It is

analogous to the flow of water from high ground to low ground. Some of the energy that is flowing, but not all of it, can then be tapped to mill grain or to produce electricity in a hydro generator. Similarly, only some of the energy found in tidal waves, or in solar rays, or in wind, or in a lump of coal, or in a gallon of oil, or in fissionable material such as uranium or plutonium, can be tapped. The thermodynamic equations have been worked out to tell which of these sources, and under what set of circumstances, are the most efficient.

Most would agree, and quite correctly, that the heat energy in the still waters of some cold lake far exceeds that in a kettle of boiling water. Yet the energy in the kettle is more available. One of the reasons for this is another consequence of the Second Law: heat energy always flows from a body at a certain temperature to one at a lower temperature. Thus it is easy to get energy from a body at high temperature.

Two points have to be kept in mind. First, bodies at very high temperatures can be said to have high quality energy. It would be wasteful to use this type of energy for instances when relatively low temperature situations such as heating a house is required. Secondly, even though it is difficult to extract the energy found in that cold lake previously mentioned, it is not impossible. It is currently, routinely and successfully being achieved by heat pumps,

which extract heat from air at near freezing temperature. However, the temperature of this heat is rather low and it takes energy to extract it. As before, the heat extracted is less than the energy used to extract that heat.

Actually, energy in one form or another and in varying amounts is required for the extraction and use of all energy forms. It takes energy to mine a lump of coal, to build the stoves that use it or the electrical generating plants that require it, energy to transport it to where it is wanted and even a certain amount of energy is needed to ignite it. To determine the efficiency of all the various sources and categories of energy, a form of energy bookkeeping or accounting is required. Useful energy is costly not only in financial but in energy terms. While it is true they are often related, it is not always so. Oil was cheap when it cost very little money and energy to extract, refine and to transport it.

ENERGY POLICY

Burning garbage for energy purposes may not be that energy efficient. Garbage comes cheap, but it takes energy to gather it and even more to sort out the non-combustible materials or those that produce toxic gases.

What follows is a list of some of the key criteria necessary to

make decisions concerning energy, in other words, energy policy.

1. Both energy and financial bookkeeping or accounting:
2. Renewable versus non-renewable energy sources.
3. Pathway from source to end use.
4. The amount of pollution produced coupled with the costs of cleaning it up in terms of money and energy.
5. The environmental and social impacts.
6. Energy demand, taking into account how it may be affected by realistic energy conservation measures.
7. The need to match high quality and low quality sources of energy against high and low quality uses to avoid further waste of energy.
8. Finally the financial, political and bureaucratic aspects must be kept in mind. In other words, who will profit from any energy policy decision and who may or will take a loss.

Let us elaborate on three critically important ideas.

A renewable energy source is preferable to a non-renewable one. By renewable, we mean one that is available in near infinite supply or one that when used, is replaced by nature. Examples of renewable energy sources are solar, wind, tidal, hydro and to a lesser extent, lumber from forests. Examples of non-renewable energy sources are organic fuels such as wood, oil, coal and natural

gas, and nuclear fuels such as uranium or plutonium.

Secondly, the fewer the number of steps from the initial extraction of energy from its source to its end use, the better. It is cheaper from both energy and money points of view. The number of steps and transformations needed when oil is used to produce electricity, can be used as an example.

First, the crude oil has to be gathered. If it is present in large deposits in the ground as in Alberta or the Middle East, this is relatively easy. A simple well is constructed and the oil, under its own pressure, comes gushing out. However, when that pressure, in the due course of time, is no longer sufficient to push the oil out, it becomes necessary to pump it out. This is less simple and more costly but still relatively efficient.

Now when the oil is under the sea in some god forsaken place like the North Sea or the Arctic the costs of extraction go up considerably. This is also true when the oil is present in deposits of tar sands and shale. In both cases, it takes quite a bit of energy and thus money to extract it. In Canada, we enjoy the largest known deposit of tar sands in the world. To get the crude oil out of it requires separating the tar or, as it is better known, bitumen, from the sand and then extracting a form of crude oil from that bitumen. The most valuable oil fields are those with handy crude

that comes gushing out of the ground.

Now that we have the crude oil, the next step is to extract from it the forms of fuel needed for the various purposes required. These may range from fuel for transportation, to fuel for heavy industrial machinery, to heating fuel and finally fuel to generate electricity. This extraction process is called refining or, more technically, the cracking of crude oil. It requires expending a great deal of energy and money. This cannot be avoided.

With the exception of electricity, all other uses are an end in themselves. Electricity in and of itself is never an end use. Usually, it is converted into another form of energy such as electromagnetic, heat or mechanical. An extra step is thus required, when electricity is produced by oil, or other fossil fuels such as natural gas and coal.

It would appear preferable to produce electricity using another energy source. Hydro offers such an alternative. The energy contained by flowing water, a renewable resource, is converted directly to electricity. Alas, there are two problems. Viable hydro sources are scarce. Also they are usually located far enough away from the users that the cost of transmission is high, as are the losses. The negative aspects of oil and hydro made the nuclear option look very attractive. We will examine it shortly. Those forms

of energy that have a small or virtually no negative impact on our environment or ourselves are preferable over those that pollute, destroy our natural environments or are potentially dangerous. While solar, geothermal and wind energies seem to fit the bill, there is one that is, by far, the best. It is the energy not used - a sort of negative energy - because of highly efficient energy conservation techniques. Much more research should have been devoted to conservation in the past. Energy that could have been conserved has been shown to be equivalent to the substantial

amounts of energy produced but not needed. Further, the profligate developed world must learn to conserve energy, to set an example for the rest of the world. Energy consumption on a par with ours throughout the whole planet would most certainly have dire environmental results. Tragically, our utilities with their rigid emphasis on producing and marketing electrical energy, have failed us.

All three fossil fuels, namely coal, oil and natural gas contain contaminants, principally sulfur, that despoil the air we breathe if it is not removed from the source or when emitted. Hydroelectric dams and stations, if not properly planned, can have devastating effects on natural flora and fauna. Case in point, the Aswan dam in Egypt. Even the climate may be affected by both energy sources. The burning of fossil fuels may be responsible for the oft discussed Green House Effect, which, if true, may have dramatic world wide

effects on the climate. The altering of the direction of the flow of rivers for hydroelectric purposes may have a more direct regional effect on the climate, by altering the salinity of the water in that region.

THE NUCLEAR OPTION

Let us turn now briefly to the nuclear option. At the present time, nuclear energy is used solely for the production of electricity. It does this by using the heat given off by a nuclear reaction to produce steam at very high temperatures and pressure. This steam is then fed into a generator that produces electricity. This nuclear reaction is one where the atoms of fissionable fuel such as uranium split in a controlled chain fashion, giving off a great deal of heat.

Uranium ore has to be mined. The safety of uranium mining has often been called into question. The uranium ore must then be refined into either weapon or fuel grades. There have been some questionable practices about how the radioactive tailings have been dealt with after refinement. Actually, up to the incidents at Three Mile Island and Chernobyl, the general consensus was that the most severe hazards exist at the front and back ends of the nuclear industry, in the processing of uranium ores to derive reactor fuel, in the handling and reprocessing of reactor fuel and in the disposal of reactor wastes. Has Chernobyl changed that perception?

Before answering that question, let us pose another: putting the questions of risk and hazard momentarily aside, what are the pros and cons of nuclear power? The arguments usually put forward state that nuclear fuel is plentiful and shields us from reliance on oil. For political reasons, the sources of oil are not very reliable and in any case oil is a finite resource which will probably be depleted in the relatively near future.

The arguments against, demonstrate that nuclear energy is costly in terms of mining and refining the fuel, construction and decommissioning of nuclear power stations with relatively short lives, disposal of nuclear waste, and all the attendant safety precautions. Further, nuclear energy is of higher quality than its end use and therefore represents a waste of energy. Yet despite these reservations, nuclear power has a place in our energy grid as have all the energy sources mentioned, in-so-far as it may help to make us energy independent.

The question of the safe disposal of radioactive waste must be resolved. Further, and rightly or wrongly, we have devoted much to nuclear R & D, making Canada a world leader in the peaceful uses of the atom. The only way to develop safer and more efficient nuclear power is to continue what we have started. It would be a pity to throw it away.

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Now as to Chernobyl! In the early hours of April 26, 1986 and because of mishandling by a technical team, part of the reactor went critical, resulting in a steam explosion which blew the lid off the reactor. This in turn caused a further explosion, flinging molten materials into the air, causing fires all over, including 25% of the graphite core. The fight to contain the fire and the radioactivity claimed 35 lives, all firemen or plant workers. In all, 300 persons initially suffered some degree of radiation sickness. These were the official figures. The final count will certainly be much greater.

RADIOACTIVITY

Of all the energy technologies, the one that is most contentious and feared is nuclear, primarily because of the associated radioactivity. First of all and very briefly, let us try to place our concern about radioactivity in some historical context. Even though it was accidently discovered towards the end of the 19th century, it became evident only much later, that exposure to it represented a real hazard. Many of those early scientists who worked with radioactive materials died of cancer or leukaemia. For example, Madame Curie, one of the discoverers of radioactivity and of the very radioactive metal radium, and a number of her famous descendants, paid the ultimate price.

In the early years of this century, workers, unknowingly and

routinely, exposed themselves to fatal amounts of radioactivity. A famous case or, more appropriately, an infamous one, involved young women, who while painting the luminous dials on watches with radioactive paint, would lick the tip of their paintbrushes to keep them moist. One can only hazard a guess at what their lifespans turned out to be. Centuries earlier, it was noted in what later became Czechoslovakia, that miners working at or near pitchblende deposits contracted and died of various forms of cancer to a much greater extent than the rest of the population. However, by the mid-1930s, the nature of the hazard had become appreciated, if not the amount needed to cause harm.

Unfortunately and even though an enormous amount of information and data has been gathered by monitoring the Japanese survivors of the atomic bomb explosions at Hiroshima and Nagasaki, as well as monitoring other populations that have inadvertently been exposed, there is still a great deal of debate about how much is dangerous. Myriads of reports have been written. Each and every one of them has had its detractors, leading in turn to a heightening of the debate over the safety of nuclear power, principally over the exposure levels to radioactivity considered acceptable. The uncertainty over what amounts are safe is primarily due to a number of factors.

First, no one knows for sure what causes cancer or, more precisely

speaking, how it is caused. We know that radioactivity appears to sometimes play a key role, but not how. Until that process is understood, there will always be some doubt about how much is safe, especially when radioactivity produced by an isotope of cobalt exposed to some radioactivity. It may be argued that it played a key role in the evolution of life as we know it on this planet, and that without it we would not be here.

Second, what is factual about radioactivity, at least in part, can be held to be true for a number of natural and artificial chemicals, known to cause cancer. Awareness of the presence of many cancer causing agents only complicates the picture. What is the relative importance of each? Is it probable that they work in concert or is it possible that they may cancel each other out, in other words, function antagonistically?

Third, most exposures are small ones over long periods of time. It is much easier to identify a harmful agent when it causes immediate, clearly visible harm, even in small amounts. The question then becomes, what happens when each of the exposures appears to be harmless by itself, but numerous over a period of time? Are these exposures cumulative? More importantly, how do we find out?

Fourth, it should be noted that the onset of cancer symptoms

usually occurs long after exposure to its cause. There is a long gestation period. Up to now and more often than not, once these symptoms become manifest, the disease cannot be prevented from tragically taking its victim. There is no way, as yet, of telling what caused the cancer in the first place. This, despite the fact that the effects of radioactivity are usually "all or nothing". In other words, these effects, most notably cancer and genetic mutations, are akin to being pregnant: either you are or you are not. This is important to remember when the cause of a cancer is radiation, since other hazards may induce cancer through a series of pre-cancer states such as gastric ulcers and liver lesions.

Finally, why is it that only a certain percentage of people exposed to cancer causing agents, get the disease? Is the chance of acquiring cancer related to an individual's genetic make-up? If that is so, how will it ever be possible to ascertain what amounts of exposure are safe, since the term "safe" really refers to a level of risk that is considered acceptable.

These five points contribute to the uncertainty over the effects of exposures, and as such the debate over these effects has become very heated. What has brought this debate on at the present time? After all, as mentioned earlier, radioactivity has been around and known about for quite a while, but not by the public at large. It is only with the advent of atomic energy, primarily the bomb, that

the public has become aware of the hazards associated with radioactivity.

Actually, early fears of atomic or nuclear energy were identified with the fantastic explosive and devastating power of the bomb. While this is justifiably still true, the fear and awareness of the dangers of radioactivity loom just as large. We can thank Three Mile Island, Chernobyl, films like, "On The Beach" and "The China Syndrome" and most unfortunately, uranium miners whose plight due to occupational exposures came to the fore. We have become aware

of the possible build up of radon and its daughters in the basements of our homes, of the hazards associated with excessive use of x-rays and with certain high energy ultra-violet rays getting through to us because of a weakened shielding layer of ozone in the stratosphere.

Despite our growing awareness and more accurate perceptions about radioactivity, there is still an aura of mystery surrounding it. This aura is exacerbated by what appears to be the rather ominous nature of "radioactivity." It is invisible, odourless, relatively intangible and often connected with fictional death rays. As well, the general difficulty in understanding nuclear science and radio chemistry has given rise to myths that must be debunked.

For example, it is very necessary to understand that the chances of

a nuclear or atomic explosion at a nuclear power station is close to zero. The chances of an explosion due to the build up of steam under high pressure or to fire are much greater. This is what happened at Chernobyl and it was this type of explosion that was responsible for the spread of a radioactive cloud of dust. The public must be informed in order to provide rational input into the debate surrounding "radioactivity."

There are a number of points about radioactivity that should always be kept in mind.

1. Radioactivity is only one form of radiation. There are others such as Microwaves, Ultraviolet, Infrared, X-Rays, Light, Heat, Radio Waves. Anything that gives off a form of energy and or matter can be said to be radiating, thus many forms of radiation need not concern us.

2. The difference between radioactivity and all others is that specific material is radioactive when it is emitting energy and high energy particles spontaneously without any external energy provoking these emissions. Uranium and plutonium are examples of such matter.

3. Radioactive emissions are an example of ionizing radiation. So are x-rays and some ultra-violet rays. Ionizing radiation is the

most dangerous form of radiation. It occurs when the emitted radiation is strong enough to break the chemical bonds of the molecules in living cells, thus altering the integrity of this biological material. The worst form of this type of radiation is radioactivity because it is the most energetic.

4. The role of the Atomic Energy Control Board (AECB) merits some mention. This agency was initially created to oversee Canada's involvement in atomic energy (in particular the bomb) with an eye to national security issues. With the advent of Canada's entry into the peaceful uses of nuclear energy, especially nuclear power plants, AECB's role became that of a licensing body, and of a regulatory authority to ensure that all aspects of the nuclear industry were safe. Unfortunately, the debate over nuclear energy was not assuaged by the AECB for the following reasons.
- The aura of secrecy initially necessary persisted a long time, before AECB realized that it had to become more publicly accountable, and that the public had a right to make inputs.
- Quite justifiably, many of AECB's senior personnel were

recruited from Atomic Energy of Canada Limited, a crown corporation devoted to researching and promoting peaceful uses of nuclear energy and especially nuclear power. There was a definite perception that those promoting nuclear power had too powerful a role in AECB, in other words there was a perceived conflict of interest which did not do AECB's credibility much good.

- This was further exacerbated by AECB's dual mandate, that of a licensing body and that of a regulatory body. "How can one agency be both a promoter and regulator of anything?", AECB's detractors quite understandably asked and probably still do. The sensible thing to do is to separate the two mandates into two discrete agencies, one for licensing and the other for regulating. The regulatory agency would have to appreciate that there is, as yet, no completely rational way to decide on what are safe levels of exposure to radioactivity. That is the bottom line. In other words, the decision must be a political one and as such, it is up to all of us to make an input.

OTHER USES OF RADIOACTIVE SUBSTANCES

Finally, there are other uses of radioactive material. The one that comes easily to mind is the use of radioactive materials in medicine for the purposes of cancer therapy and as tracers. However, one that shows a great deal of commercial promise, despite the debate it has generated, is the exposure of food to ionizing radiation. It has been found that this process inhibits the sprouting of vegetables, it removes insects from various grains and spices, and it eliminates food-borne micro-organisms, including dangerous pathogenic bacteria from a wide variety of foods that normally spoil and easily become dangerous. Thus food irradiation has been shown to extend shelf life, reduce the use of chemical additives

and the incidence of food-borne infections.

In Canada, we have been dragging our feet by not taking full advantage of this relatively new technology to protect and preserve our food. For the most part, we are still using outmoded and far riskier chemical means. A recent parliamentary committee advocated no further or wider use of the process until work ascertaining its safety had been completed. This is a prime example of paralysis by analysis. Work already carried out seems to show that it does not pose a significant risk, or at most a risk equal with those due to the extensive use of chemical food additives. This does not mean that research and monitoring to ensure the safety of the process should cease. Unless there is more concrete evidence as to the perils of food irradiation, we should start using it more extensively on a product by product basis.

What is food irradiation? It is the exposure of food to pure high energy forms such as gamma radiation from the radioactive decay of isotopes like cobalt 60 and caesium 137 or X-Rays and or to high energy particles such as electron beams from electron accelerators. It is not as scary as it sounds. This type of food irradiation has been used in some countries since 1960, but in actual fact we have all been engaged in food irradiation for far longer.

Cooking is nothing more than another way of exposing food to heat

and radiant energy to produce products that are palatable, both from the points of view of taste and in some cases, safety. Every single method of treating food alters the integrity of the food in question. Perhaps a benefit versus whatever cost analysis should be undertaken, with the results published, so that people can ascertain for themselves what food treatment process is acceptable to them.

The acceptability of food irradiation is based on the findings of an International Joint Expert Committee report, published in 1981. That report stated that there was no evidence that food irradiated under a certain level poses any toxicological hazard or induces any significant radioactivity in the food. The principal reason to favour food irradiation is that nearly anything that lessens exposure to artificial chemicals, especially in the food and water we consume and in the air we breathe, is preferable.

Again, this does not mean there are no problems with food irradiation. Here are some:

- All foods contain germs, but the number and types can vary widely. Because of possible induced mutations, food irradiation may produce new strains of germs that are more dangerous and more resistant. So far, this problem has been shown to exist only in model systems.

- All treatment processes are known to cause nutritional changes in food. The effects of these changes will depend on whether the treated food is a major or minor component of the diet. Evidence suggests that nutritional losses are directly related to the doses of irradiation used. Further, nutritional losses are likely to increase when irradiation is used in addition to other processes, a situation that often occurs.

- Packaging of irradiated food has to be adequate to prevent recontamination because the integrity of the wrapping may be altered. New products may be formed from the packaging material which in turn can influence the smell, taste and safety of the food contained therein.

- Finally, last but far from least, are the environmental and occupational risks associated with food irradiation. They are bound to increase with the growing use of this process.

In conclusion a statement by the Science Council Of Canada, titled, 'Food Irradiation: Prospects for Canadian Technology Development,' stated, "Food irradiation is now a credible option for dealing with problems of food preservation, hygiene and quarantine protection. In some ways it is a preferable alternative to present treatment: it offers consumers the option of food with fewer chemical residues and it enables greater control of

food-borne diseases."

The Council urged that the federal government promote this new technology, be responsible for a public information program and ensure that all irradiated food is so labelled. We have one of the best nuclear industries in the world. Perhaps we should be using it more in an area that is much less contentious than nuclear power.

Let us close this chapter with a cheerful thought. Canada once considered the purchase of a fleet of nuclear submarines. What

would happen if a Chernobyl at sea incident occurs when such a sub is docked at a busy port?

151CHAPTER 9

THE HUMAN EQUATION

Every thoughtful man who hopes for the creation of a contemporary culture knows that this hinges on one central problem: to find a coherent relation between science and the humanities. Jacob Bronowski and Bruce Mazlish

We should not pretend to understand the world only by the intellect; we apprehend it just as much by feeling. Therefore the judgment of the intellect is, at best, only half of truth, and must, if it be honest, also come to an understanding of its inadequacy. Carl Gustav Jung

A census....treats people as if they were units, whereas they are not. Each is a universe. Ernst Friedrich Schumacher

We are, perhaps, uniquely among the earth's creatures, the worrying animal. We worry about our lives, fearing the future, discontent with the present, unable to take in the idea of dying, unable to sit still. Lewis Thomas

Science without poetry is like a canvas without feeling and colour. Poetry without science is like a canvas without form and meaning. The merging of science and poetry should allow beauty and truth to emerge. Jack Basuk
152The Human Equation

There are lasting spheres of interest and provocative issues that touch at the heart of humanity. Indeed, it is often said that they define humankind. Usually, they are very emotional and quite evocative. Contemporary science and technology have played a prominent role in redefining existing concerns and in creating new ones. This chapter attempts to deal with some of them. It is divided into two principal parts. The first deals with some fundamental life and death issues that touch on our sense of morality and ethics. The second considers issues related to how we think and what we do.

PART ONE - THE MORALITY OF BEING

BEHAVIOUR MODIFICATION

What follows is an unedited transcript of a commentary on basically one aspect of Behaviour Modification given by the author on his radio program "Science Briefs" aired on Sept. 2, 1987. It speaks for itself.

"This is Science Briefs and I am your host, Jack Basuk.

Today's program is dedicated to a good friend who shall remain nameless and anonymous. I must admit that I am uncomfortable with today's topic because it deals with a sensitive subject and also

the topic, behaviour modification, is one in which I have no expertise. My comments, for what they are worth, will be restricted to raising a few questions.

Before proceeding, a little more about my friend. When I first met him, I got the impression that he was slightly retarded. His speech is mildly slurred, his vocabulary appears to be rather limited, he is very shy and his general demeanour would probably put most people off. It did not take me long to realize how misleading my impression of him was. While he is no mental giant, he has a passionate love for both science and classical music and can speak with some authority on both, actually I am willing to bet with more knowledge, feeling and conviction than most. The slurring of his speech and general appearance is probably due to the drug injected into him on a regular basis by his psychiatrist.

That's right, my friend is one of those unfortunate people who was and still is, to some extent, a victim of mental illness. He has been under care since his mid teens. He is now in his mid-thirties. In other words, for the last fifteen to twenty years, there have been formal attempts to modify his behaviour, with what appears to be some limited success.

Now, when my friend learned about this program, he immediately suggested behaviour modification as a topic. I promised that I

would attempt to talk about it at the first opportunity. Today's program is my attempt to fulfil that promise.

When I started to think about today's program, it occurred to me that perhaps, it would be of interest to introduce the topic from the patient's point of view. After all, it had been my friend who had suggested the topic. I then asked him to put his feelings about his experiences down on paper with the promise that I would use them on air. With some editing, here they are."

"You are treated as a monkey and as a guinea pig. The mental health professionals estimate your worth by your good behaviour. If you step out of line, you are in trouble. Your whole concept of self goes down the drain.

You can feel bad and have bad feelings, yet you always have to behave like a school child and behave obediently. Nobody will support you unless you are good and work. If you have no friends and bad parents, your chances of getting better are dim. Nobody likes being prodded by doctors and answering their silly questions. Time and time again you are told you are sick, but nothing is done about it. You have no support from anyone. Doctors have big pay cheques. I understand it is their education that makes them so valuable. How do you make mental patients valuable to society? Perhaps you stop using behaviour techniques like adverse therapy,

and you urge them to get out into the world and do things for

themselves. But the fact of the matter is that many are homeless, have no place to go and have no contacts of any kind.

Staying at a hospital can be demanding and at times demeaning. I just hate mental health. When you are out of hospital and if you are lucky, you may be placed in a group home, but the same attitudes still exist. The only difference is you have to be busy. I see nothing wrong with this.

When we were kids, we were rewarded for good marks and for good behaviour in school. This is the backbone of life in a mental hospital. It is the same as the school system. If you have a learning problem, it is ignored and brushed off as brain damage. But they may say if you are good we will do this and that for you.

Can't love be found in a person who is treating you for an alleged problem? Isn't there any concern for the welfare of someone who has a problem and has to find a way to solve it? I guess it's better not to be sick, to have friends and a good job, so you will not fall victim to the various diseases that afflict the mind. It takes time to get better. I wonder why mental illness is so different from other medical problems such as cancer and heart disease? If we probe more into the mind, will people become more tolerant of those who are different and have problems? Is it right

to treat an adult like a child in a controlled structure? Where do ethics and morality play a role in the treatment of the mentally ill?

It's about time these questions were asked and looked into. The waste of potential, the misery that is brought on by the sometimes cruel and sometimes beneficial treatment is nothing but a guise for force. I do not want force applied against me. What are they trying to prove when they use force against someone who is confused and agitated?

Some way must be found to help people who are suffering from mental illnesses. If it is a real illness, treat it. But don't degrade the person to being an idiot. We are going to have to get rid of the attitudes that many professionals have in their work with the mentally ill and handicapped."

"That ends what my friend wrote about the way he feels about mental health therapy.

How does one respond to him? One thing that comes through immediately is his anger. We can't put that aside. I don't know whether it was or is justified but it is real. I also don't know whether that anger is part of the symptoms of his disorder. It appears to be based on a suspicion that, to some extent, he has

been discarded by his family and society and left to fend for himself in a world that hardly accepts him. He periodically receives an injection of a tranquillizer that allows him to function on the outside. It has become apparent that the use of tranquillizers has enabled our health care system to release many misfits into society although many of them are not, as yet, able to fit into its mainstream. My friend is probably better off on the outside, although I'm not sure that can be said for many of the others.

The question this raises is: are we, as a society, showing enough

compassion and care for those who need it, by allowing them to roam our streets with no care and nothing to do, simply because they have become tranquillized and don't appear to represent a threat? Are we more concerned about the short term financial costs involved, rather than the longer term costs to both the patient and to our society?

Now, my friend's anger also appeared to be caused by the rather dispassionate medical treatment he received and receives. I'm afraid that this is intrinsic to most behaviour modification therapies. They are based on the school of behaviourism which was founded by John B. Watson, who insisted that the psychologist can only observe and measure; therefore only stimuli and behaviour (rather than motives, drives, emotions or other abstractions) can be the foundation of a genuine scientific psychology. The goals of

such a discipline would be the prediction and control of behaviour. Is it any wonder that therapies based on this approach appear to be cold and dispassionate? In light of its obvious limitations why does it continue to be used so extensively? Probably because it is the only game in town, even if it is inadequate.

The thing that appeared to anger my friend the most, was the feeling that he was being coerced into a mode of behaviour and that he was being treated as a guinea pig. In other words, he was really referring to the power relationship he had and has with those treating him. He is still irate about being low man on the totem pole of that power hierarchy.

This, in and of itself, has very little to do with the therapy involved. Let's elaborate a little. Behaviour modification is involved in just about every social interaction imaginable. People are always trying to influence others. In most normal interactions, the power to do this or to resist is about equally divided. In all institutional arrangements, the power lies with the institution.

With the practice of medicine, the balance of power lies with the medical practitioner, although most of us are now demanding some sort of accountability from our doctors. However, those needing psychiatric help, for the most part, are at the mercy of their psychiatrists because they are in no position to question their

doctors' expertise. I'm not suggesting that all psychiatrists are insensitive to the position of authority they hold, but it appears there are many who are not sensitive enough to the resentment created by their authoritative manner. One would expect that of all people psychiatrists would know better. How come they don't?

Finally, I'm reminded of a cartoon that B.F. Skinner, the crown prince of behaviour modification, reprinted in one of his essays. It showed one mouse exclaiming to another, "Boy, have I got that guy up there fixed! Every time I press this bar, he gives me food!" Who is controlled, and how? A most appropriate question! I know that I would severely resent any overt attempt to control me."

ABORTION

The most heated current bioethical issue is "abortion." The controversial Supreme Court decision that struck down our abortion laws and appears to allow women the right to obtain an abortion on request, has re-kindled the debate over the topic, so much so,

that it may re-surface as a major issue in the next federal election. That decision was two edged. While it struck down a discriminatory law, some provinces, by default and for the time being, seem to be able to make it more difficult for women to get an abortion than ever before.

One might ask why this issue should be discussed under the rubric of science policy, when it appears to be primarily a social, legal, and ethical problem. Well, abortion - and its related issues - has become preeminent, not only because of their emotional aspects, but also because medical science and technology have made abortion easy to perform, available to all, in certain cases a form of therapy, and an option when the latest in prenatal diagnostic techniques such as ultra-sound and amniocentesis indicate a malformed fetus.

There are five key questions one should attempt to answer when considering the pros and cons of the issue.

1. Should abortion be favoured as a means of birth and population control? The answer is emphatically negative. There are three reasons. First and perhaps foremost is the moral dilemma requiring the wisdom of Solomon to resolve, a quality rare in most of us. Thus it is probably better not to face this dilemma. The way to do that leads naturally to the second reason, which is that there are other, relatively non-contentious ways of birth and population control, namely the prevention of unwanted pregnancies. The third reason involves the health of the pregnant woman. Abortion, as a surgical procedure, should only be used as last resort. After all, any type of surgery is traumatic.

2. Is abortion murder? Despite various contentions this is very difficult to answer. It depends on how the term is defined. If murder means the unjustified taking of human life, then abortion may be murder. In some instances, there may be no justification for it, since a fetus no matter how old or young, is living, and is human. However, a human living thing and a human being are not necessarily the same. In the early stages of its development, the fetus cannot, under any conditions, survive outside the womb. In other words it cannot have an independent existence because it is totally dependant on its natural mother. It is not a being in and of itself. Therefore, if murder means the taking of the life of a human being, abortion before a certain prenatal stage is not murder. At exactly what stage a fetus can have an independent existence seems to vary from fetus to fetus. There is no definite answer. Actually this is a red herring, since most abortions would normally take place before that point.

Whether it is more moral or less moral to extinguish a human living thing such as an early fetus, rather than the life of a human being, again raises questions difficult to answer. There might be minuscule merit to the argument that when the lives of normal adult humans are taken, they are robbed not only of their future but also of their capacity for enjoying life, based on all they have experienced and learnt. Since a fetus has not experienced anything outside the womb and since its consciousness is not really

developed, some may conclude that abortion robs less than regular

murder does. However, even a lesser evil should not be justified on such grounds.

One final point about this question of whether abortion is murder. One cannot help but be struck by some of our double standards. Whether we are in one camp or in the other vis … vis the debate, we all argue in favour of the sanctity of life. Yet many of us have no compunction about favouring capital punishment and, worse still, about sending our youth to kill and be killed in wars being waged for dubious reasons. To a large extent, we have become immune to much of the unspeakable horrors taking place in much of the world.

3. Those who favour the use of abortions argue that unwanted argument valid? It is rather weak when used to justify abortion. It masks one of our society's great weaknesses: its indifference to the plight of unwanted children. Let us concentrate on improving our social fabric and ourselves and not be diverted by irrelevant questions.

4. Should the rights of the fetus take precedence over the rights of the woman carrying that fetus? In other words, should there be laws governing, regulating or prohibiting abortions? The answer is no. No one should suggest that abortion is moral or ethically sound.

Yet it is axiomatic that no pregnant woman should be deprived of her rights over her body. However, what rights can a fetus have if the woman carrying it abuses herself or is suicidal?

There is another compelling reason. Any law about abortion, by its very nature, breaks one of the basic tenets of a democratic legal system: equality before the law. Laws governing abortion discriminate on a sexual basis. Our charter of rights should therefore prohibit such laws.

5. Is there a right or wrong side in the debate over abortion? The answer is no. Much of what both sides say is correct. Certainly, both sides have every right to try to convince the rest of us about the correctness of their positions. They do not have the right to impose their views. While their rightful role is to convince, it is also to educate. After all, if there are no unwanted pregnancies, there will no longer be a need for abortions. In this day of enlightenment, it is perplexing to understand why this approach has not been promoted more forcefully, similar to the "condoms to prevent AIDS" campaign. In a time of supposed tolerance of other peoples' views, in light of modern preventive means, and of a universal educational system that can use the most up-to-date means of disseminating information, this debate is incomprehensible.

SURROGATE MOTHERHOOD

In contrast to issues around abortion, rising concerns surrounding surrogate motherhood include controversy around certain aspects of the creation of life, such as whom life belongs to when created under unusual circumstances. Some examples have recently received quite a bit of attention, in particular one in the U.S., known as the case of Baby M.

What is 'surrogate motherhood?' Baby M's natural mother agreed, by written contract, to be artificially inseminated with the semen

of a married man whose wife could not conceive. Upon giving birth, she was supposed to then turn the infant over to its natural father, giving up all rights to the child for a previously agreed to sum of money. The natural father's wife would then adopt and raise the child as her own. The baby's natural mother changed her mind and decided she wanted to keep the child. The case went to court in the state of New Jersey. Baby M's natural mother won a partial victory. The contract was struck down by the court. She retained her status as the child's mother. However, custody of the child was given to its natural father with the natural mother being granted visiting rights.

Other similar court cases have been documented by the media. One cannot help feeling ambivalent about the issues surrounding

surrogate motherhood. Most persons's first reaction is to reject this means of providing childless couples with babies. The trafficking of babies or for that matter of any humans is unacceptable. However, the issues are not as simple as they first appear. The more one thinks about them the more confusing they become. The prospective parents and natural mother are not evil monsters. They are usually just trying to satisfy a very important personal need.

Why has this problem surfaced at the present time? After all, artificial insemination has been around for quite some time. Mostly, it is used to impregnate a married woman whose husband is infertile. The male donor is normally anonymous and the child is raised by the married couple with no one knowing who the natural father is. This seems straightforward. Yet during the early years of its use a man in the process of being divorced refused to provide child support because his child was the product of artificial insemination. He claimed it was not his. The judge rendered a decision impossible to understand: he agreed with the man.

What has changed? The case just described dealt with a barren man. Recently, some smart lawyers figured out how to use artificial insemination to provide couples with children when the wives cannot conceive. Surrogate motherhood is fraught with more problems than artificial insemination because the surrogate cannot

remain anonymous.

In our culture, up to very recently, a natural mother nearly always had first claim on a child she had given birth to. In other words, her rights vis-…-vis her child superseded anyone else's. This was based on the notion that her bond to her child was the strongest and therefore it would be in the child's best interest to remain with her. Taking her child from her would be a cruel and heartless act. This bond is presumably based on her genetic relationship to the child, because she carried the child for nine months and went through the pangs of giving birth. It is difficult to find any real evidence to support this contention. For example, there is nothing to indicate that the incidence of parents abusing their children is any greater amongst parents who have adopted their children than amongst natural parents.

To further confuse the issue, let us ask, "what is a mother?" According to the Oxford dictionary, a mother is someone who has given birth to a child. It is also someone who exercises the control of a mother, in other words someone who raises children

as if she were the natural mother. It is therefore possible that a child can have two different mothers. Sometimes a court has to decide who should keep and raise the child. Other times, a natural mother voluntarily gives up her child to an adoptive parent. Can she then be said to have been a surrogate mother? Is there that

much difference between her and the surrogate mother in the Baby M case?

The crucial issue centres about the commercial aspects of surrogate motherhood. It is important to remember that it is against the law to sell or buy any human being and especially the most defenseless one of all - a child. Does surrogate motherhood fall into that category? It is true that a child is handed over and money received by the surrogate mother. But the child goes to the natural father. He claims, and with some merit, that he has not bought a child, since he has as much claim it as the natural mother does. He cannot buy his own child. Thus the money given to the natural mother is not for the child but for a service she provided. The laws covering such a service are vague, even though many would consider it immoral.

Summarily, the question of surrogate motherhood involves the question of whose rights are paramount, the natural mother's, the natural father's, the child's, or those of consenting adults. The legislation of morality is one of the most difficult challenges any society can face. Most of the time, the resulting laws are either very difficult or impossible to enforce. Perhaps such laws should be promulgated only when the very fabric of our society is threatened. Some have expressed fear that all this will give rise to a new class of women who will do nothing but serve as hosts for other people

fetuses. This is doubtful. In the case of surrogate motherhood, perhaps there should be an escape clause in the contract, allowing the natural mother a certain length of time to change her mind.

Finally, to bewilder us some more, let us consider what happens when a woman has one of her ova fertilized by her husband's sperm in a test tube which will then be implanted in another woman's uterus. That woman will carry the fetus until birth. Who, now, is the mother, that is, the natural mother? ? ?

EUGENICS

Eugenics is a topic that nobody seems willing to discuss or even acknowledge, yet will undoubtedly become extremely important. Eugenics is the study of how to improve a living species by biological means. While it is applicable to any species, the one mostly thought of in that context is the human race.

This should have become quite topical because of the creation of a Nobel prize sperm bank a few years ago, in which only Nobel Prize winners are eligible donors of their spermata for the purposes of fertilizing appropriate women. It appears that the sperm is banked, and used when an appropriate female comes along. All this coupled with the growing potential of genetic engineering enhances the importance of this topic. It most certainly will pose many bioethical

dilemmas.

In light of the rather sorry state of the human condition, can anyone be opposed to such an attempt? After all, we have been trying to do just that throughout most of recorded human history, through non-biological and diverse means such as religion, political influence, downright coercion and in more recent times, education. These attempts can easily serve as the subject of very lengthy and heated debates.

Moreover, humans have been using biological means for a long time without giving it much thought. We have long been artificially breeding, to obtain desirable animals and plants. Perhaps, we have been doing the some of the same with ourselves. After all the so called aristocrats of nearly every country in the world have been inbreeding for a long time.

The old adage, "the fruit does not fall far from the tree," has been the operative factor in the arrangement of many marriages in the past. We also have all sorts of laws and taboos that outlaw incest or the mating of close family members. For the most part, these actions are biological controls and represent a tacit recognition of a fact that humans throughout history, including many today, have not wished to acknowledge. We are animals, fundamentally no different from most other animals, except that our nervous system

is the most highly developed one in the animal world. It is important to remember that such a difference is one of degree and not of kind and also that the natural laws that govern all non-human life, also govern us.

Now let us turn to briefly examining what is meant by improving the human stock. We probably would all agree that the elimination of genetic diseases or handicaps using means developed through the study of eugenics, is desirable and would represent a real improvement to the human condition. What next?

What if everyone were intelligent, strong, virile, fertile, charming, good looking, non-violent, patriotic, obedient, charitable, modest and creative? Could we agree on whether these traits are, in fact desirable and on what constitutes intelligence, beauty and appealing personality traits? These are very subjective matters.

It may be all right to breed cows that produce more milk, chickens that produce more eggs, strains of wheat that yield more to the acre, horses that can run faster, and dogs with certain physical and personality traits. It is in our nature to manipulate the natural world for our purposes, although we often fail to recognize the byproduct costs involved, such as the narrowing of the natural gene pool. However, it is a different kettle of fish when it comes to deciding how to shape humankind. Who is wise and objective

enough to decide what is a desirable human trait?

The question now turns into one of moral, political and philosophical dimensions. Those who believe in racial purity, in other words - racists such as the Nazis who carried out horrific eugenic experiments, social Darwinists who accept the process of the survival of the fittest as a means of natural selection, those advocating racial purity and others still imbued with the old fashioned notion of aristocracy, would probably not object too strenuously to breeding certain classes of people to serve as slaves, others to serve as managers, others to engage in intellectual

pursuits, others to breed, and others still to engage in other various tasks that they are presumably suited for. Should their views prevail, democracy as we know it would simply disappear. We must be continuously on guard against this type of demagoguery. The history of Canada's immigration policies, in this regard, cannot bear much scrutiny without evoking disgust.

Not all forms of eugenics should be avoided. Through genetic screening, potential parents can now be informed of their chances of having a diseased or malformed infant, even before conception. Using prenatal screening and diagnostic techniques, diseased or aborted. There is hardly any doubt that it will be possible, in the near future, to use genetic engineering to correct or eliminate

faulty genes.

Now, what about initiatives such as the Nobel Prize sperm bank? Logic would dictate that if you mate intelligent males and females, the chances of intelligent children being produced are much greater. On the surface this appears to be, in and of itself, a good thing, if it works and if there are no unforseen pitfalls. Let us examine this a little further.

- First, there are no guarantees that mating two very intelligent persons will produce intelligent children. There are just too many other variables of which we are still ignorant. Many very bright people have parented not so bright children.

- Children so conceived may be intolerably burdened by impossible expectations leading to psychological disorders.

- Third, while restrictive artificial interbreeding between very bright people, as opposed to more random breeding, might produce more intelligent people, it is just possible that, over the long term, some undesirable traits may also emerge, as has often occurred with the aristocracy. This is consistent with the view that the health of any species is directly related to the diversity of its gene pool.

- Finally, while we can assume that a Nobel Prize winner is intelligent, how do we select the woman who is to be impregnated? Must she also have earned a Nobel Prize? Unfortunately, there are not many female winners of the prize. Is she to be selected on the basis of her I.Q.? All an I.Q. test measures is one's ability to do well on an I.Q. test. It is certainly not an accurate measure of that human being. After all, what is so special about intelligence without wisdom? What have all the so called intelligent people done with our world? Perhaps intelligence coupled with humility and gentility, are characteristics that should be in far greater demand.

DEATH AND SUICIDE

Everyone has strong feelings about dying and death and the oft accompanying issues of euthanasia and rational suicide. We all to have to face our mortality. These are very difficult and emotional topics. Most people scrupulously avoid thinking about death and dying. Actually, that is a euphemism for stating that most of us are fearful of death and dying. It is easier to avoid these realities than to confront them head on. However, as with many other issues, science and technology are obliging us to face such challenges.

Poets are often able to put our collective deepest feelings into magical words. No one did this better than Shakespeare. In his famous "TO BE OR NOT TO BE" soliloquy from Hamlet he iterated,

in magnificent verse, the contradictory and paradoxical emotions humans have about death and dying. He suggested that on the one hand death is welcome as a relief from all the agonies that life bestows on us and on the other, the uncertainties about what may follow are quite distressful and foster the inclination that we are better off with the difficulties we know than face those we do not. For some, who do not believe in any sort of existence after death, their own non-existence is something they cannot or do not wish to imagine. They dread this fate.

As much as most of us fear death, we probably fear dying even more. The amount of suffering that afflicts most terminally ill patients is not reassuring. Franklin Roosevelt once said, "There is nothing to fear, but fear itself." Before each of us can deal with the dilemma posed by death and dying with logic and emotional acceptance, these fears must be honestly acknowledged and confronted.

A cynic once defined life as, "a terminal disease." That may be so, but there is no reason why the end of the voyage of life should not be as painless as possible. Ironically, it appears that the tremendous advances in biomedicine are exacerbating our fears. Zenen Makuch in a 'Dying With Dignity' newsletter comments, "It has become recognized that a person's death will be either sudden and unexpected, or else, prolonged, involving pain and mental and

physical decay. In the latter situation, it is more likely to occur in a hospital bed than at home. In earlier times, death was more likely to brought about by an infectious disease and, therefore, was not so unexpected or prolonged. It was more common to die quietly and gently at home, surrounded by family and friends."

Euthanasia, rational suicide or the taking of any life for any reason is emphatically not being advocated here. However, we must live and perhaps die in accordance with our values and beliefs. Consistent with liberal democratic principles, what is being advocated is freedom of choice, no matter how repugnant the choice may appear to be and as long as the choice affects only the person making it. After all, during our lives we are free to make all sorts of choices. The right to make final, informed choice should be ours as well.

Each time someone chooses to die, a complex set of factors renders that situation unique. There is no definition of euthanasia that can suit every ethical problem where death is an option. Just as it is improper to suggest that life should always be terminated when it has lost its "quality," it is equally inappropriate and unrealistic to assert that an effort to prolong life should always be made, no matter the circumstances. A further complication is that physicians have been trained to save life and to relieve pain and suffering. Here these two roles conflict. To better appreciate the complexity

of these issues it would be useful to define and briefly discuss some pertinent terms.

- While euthanasia originally meant, "a quiet and easy death," it has come to mean, "the action by an external party of inducing a gentle and easy death."

- Voluntary euthanasia occurs when a conscious and mentally competent patient requests it.

- Rational suicide occurs when a mentally competent person takes his or her own life by his or her own hand for what appears to be sound reasons.

- Involuntary euthanasia occurs when prior consent has not been given and the patient is unconscious or mentally incompetent. In some cases, this type of euthanasia may occur against the patient's will and in others, without it. The latter case is usually referred to as non-voluntary.

- Assisted suicide, one that has become a hot topic, occurs when the person committing suicide is provided with means to end his/her life by someone, usually an M.D.

- A living will is one in which an individual makes it known that

he or she does not wish to be resuscitated or kept alive by artificial means, if he or she is unconscious or in a coma after a horrible accident, has become the victim of a painful and incurable disease or has lost most normal faculties due to old age. The virtues of the living will is that the patient has made the decision in a competent fashion when well and under no pressure from family and friends. Dying people are seldom able to make rational decisions. On the other hand, euthanasia once accomplished is not reversible. There can be no second thoughts. Under the guise of a living will, the potential for criminal homicide becomes greater. Furthermore, if more and more people opt for euthanasia, research into the relief of chronic pain could lose its current support.

What about public opinion? Holland is a country where euthanasia is largely accepted. In a country of 14 million citizens, somewhere between 6000 and 10,000 people a year - perhaps 8 percent of the total deaths - are thought to die voluntarily at the hands of their doctors. In the U.S., a recent public opinion poll indicates a dramatic shift in support of euthanasia. In 1973, 52% of those polled opposed euthanasia while 38% favoured it. In 1985, the percentage of those opposing euthanasia fell to 36% while those favouring it rose to 61%. In Canada, an alliance known as "Dying With Dignity" has chapters throughout the nation.

Finally, a very subjective thought by Dylan Thomas the famous

Welsh poet, who ironically died at the early age of thirty-nine. He wrote,

"Do not go gentle into that good night,
Old age should burn and rave at close of day;
Rage, rage against the dying of the light."

PART 2 - MUSCLES AND MIND

THE QUALITY OF LIFE

About a year before her death, the author's elderly mother was asked about her impressions of the fantastic technological changes

that had occurred during her lifetime. She had been born in eastern Poland some 88 years before in a farm house without floors, running water, central heating, electricity and telecommunications. Modern means of transportation, medicine, the wide variety of foods, the availability of leisure time, the tremendous amount of cultural stimuli and so many of the things we commonly take for granted today were totally unavailable and anyone speculating about them was taken to be either an idle dreamer or a madman.

According to her, the peasants she was raised with spent their lives eking out a bare living working hard and long hours. They were too tired at night to do anything but eat supper and go to sleep. The sabbath, various religious holidays and special events

such as marriages, funerals, courtship and passage rituals became the means by which these people enjoyed social interactions and their rich folklore, which turned out to be very abundant in terms of music and dance.

She acknowledged that the modern marvellous technologies had kept her alive and reasonably healthy for someone her age. She was well informed and provided with plenty of entertainment. However, she strongly asserted that she was much happier as a poor peasant in Eastern Europe. Perhaps her views were the ramblings of an old woman romanticizing the past. On the other hand, perhaps she was making a profound statement about modern life.

To a large extent, we confuse the quality of our lives with our standard of living. While there can be no doubt they are related, having all the material things we need does not guarantee a sense of happiness or well being. Of course, no one is implying that the starving, the ill clothed and housed, the destitute, the impoverished, the physically infirm with no medical help and public health facilities available, the victims of political, military, civil and economic terrorism and those simply living in downright squalor, are living the good life and enjoying it. Anyone who suggests such a thing is a romantic fool.

Today, we in the Western world enjoy a standard of living that is

unparalleled in human history. In our society, the poorest live in cleaner conditions, have a greater variety of information, intellectual stimulation, entertainment, leisure activities and available food available than the wealthiest members of the aristocracy a mere one hundred and fifty years ago. Most of us can look forward to living a longer and healthier life than our forefathers. Indeed, the potential for fulfilling our most hedonistic desires and fantasies appears more possible than ever before. Yet something is wrong, indeed terribly wrong.

All indicators substantiate this. At a personal level some examples are: our inchoate consumption of alcohol, tranquillizers and other drugs, our increasing divorce rate with attendant physical and mental abuse of our mates and our children; our need to keep up with the Joneses leading to a profligate consumption that fuels the need to acquire more income with more of the accompanying stress; the decline of our sense of ethics and morality as witnessed by the, "every man for himself syndrome"; our rising involvement and dependence on mystics of every persuasion, leading in turn to less tolerance and acceptance of those different from ourselves; our growing suicide rate especially among our youth; and finally our

apparent passivity and fatalist outlook on most things because it is easier to let the so called experts act and because people feel that the individual does not matter and can no longer affect the world.

At a more general level, things are even worse. Again some examples:

The unacceptable economic inequities and the lack of political freedom in so many parts of the world; the ever present military and terrorist activities leading to the slaughter of countless people; the horrendous racial, religious and nationalistic prejudices that still plague us; the inexcusable overabundant exploitation of our non-renewable natural resources; the despoliation of our natural environment; and finally the vicious exploitation of humans by humans. There are of course many more examples.

We are truly schizophrenic because while we are capable of all the horrors listed above, -they are our doing-, we have shown that we also are capable of wide ranging thoughts and acts of great import, profundity, wisdom, general benefice and beauty. It is this contrary duality in our nature that is most frustrating. Pogo, Walt Kelly's comic strip character was quite right when he said, "I recognize the enemy and they is us."

We are the architects of our destiny. To paraphrase Robert Browning, "We are the masters of our souls and the captains of our ships." We must take hold. It has often been said that the proper study of "man" is "man". It is difficult to imagine fruitful results

from a study when the object of the study is the one carrying it out. Somehow we must improve the human condition before we become obsolete. If the past is any criterion, there is little reason for optimism.

A number of years ago, the speaker at a Science Council workshop was recounting to a group of bureaucrats the discussions held at a five day conference he had attended, where the problems of the world had been intensely discussed. He ended on a very pessimistic note whereupon a senior civil servant, unable to contain himself, cried out, "We have to be optimistic. It is the only way we can solve our problems." The speaker sadly replied, "I agree. We must remain optimistic, right up to the very end."

WORK

Most of us spend a significant portion of our lives engaged in an activity labelled work, that we have been conditioned to believe is necessary for our individual well being, for our health, and for the economic and social survival of our society. We have been instilled with the notion that it has all sorts of virtues. Even religion has frequently been invoked to suggest that this activity is God's will.

A probably contentious, definition of work is that it is an activity engaged in solely for economic reasons. In other words, most of us

work to make enough money to pay the bills covering the essentials of life and for the enjoyment of some of its amenities. Thus work is based on need. Arguably, those who work for power, excessive

money, or simply because they enjoy it as a sort of hobby are not engaged as defined above.

What does work have to do with science and technology? The reply is, "a great deal." If we assume that most technology is science based and that work is a manifestation of technology, the relationship becomes quite clear. For the sake of brevity, we will restrict our discussion to the impacts of technology on labour and working people.

Some of the ways that technology impacts on labour include: the structure of employment and unemployment (job security); occupational structures; labour mobility; job satisfaction; hours of work versus leisure time; systems of payment which encompass piecework and timework approaches, job evaluation and merit rating, income guarantees, income and age; changes in the workplace; labour-management cooperation in managing technological change; and most importantly, occupational health. This list was culled from the table of contents of a research report, titled, "Trade Unions and Technological Change," authored by the Swedish trade union, "LO," in 1966 and published in 1967.

For purposes of succinctness what follows is a brief discussion of two of the impacts noted above, namely occupational health and job security.

Occupational Health

An activity presumed to be as important and virtuous as work should at the very least be benign as far as health is concerned, and at the very most, be health promoting. Unfortunately, this has not been the case. The evidence gathered over many years, indeed centuries, suggests that work is dangerous to health.

Jeanne M. Stellman and Susan M. Daum in their book, "Work Is Dangerous To Your Health," very eloquently make this case. They wrote: "Each day, millions of workers enter a battlefield, but they fight no foreign enemy and conquer no lands. No borders are in dispute. The war they are fighting is against the poisonous chemicals they work with and the working conditions that place serious mental and physical stress upon them. The battlefield is the work place."

In light of the rather long history of occupational disease; in light of all the research that has and is being undertaken; in light of all the concern voiced in the many books that have been published, papers written and conferences and meetings held; in light of all

the legislation that has been passed and bodies created or mandated to deal with the problems of occupational health; in light of all the collective bargaining that has taken place around occupational health issues because of the increased awareness of workers; why is it that serious occupational health issues still exist? In particular, why has exposure to toxic substances become a major problem at so many work sites in this modern, technologically advanced and information conscious society?

Again Drs. Baum and Stellman very eloquently answer. They wrote, "The primary concern of businessmen and engineers with workers lies in increasing their productivity. It means that maintenance

crews are cut down to the minimum number and machinery is not kept in good working order. It means that there are fewer shutdowns for preventive maintenance. Increasing productivity means that the speed of production lines is kept at a maximum, which physically drains and injures workers and produces shoddier merchandise for the consumer. Greater productivity often means less investment in proper ventilation, air pollution control and other devices that make the work environment safer. In essence, greater productivity may demand that workers sacrifice their lives and well-being for more production and profit."

The Stellman-Daum quotations are a strong indictment of traditional workplace technologies. Actually, it is not the technologies that

should be denounced but rather the system that allows health robbing technologies to be used in the workplace. It is management's prerogative to decide what to produce and how. Thus, it is management that decides on the design of the workplace. Workers are usually not consulted; they are frequently considered to be nothing more than another cog in the machinery. Management's prime imperative when making technological decisions is the reduction of costs. Very little attention has been paid to human costs except when workers, through collective action and continued vigilance, have compelled management to reduce or eliminate health risks, or when government has set and enforced obligatory safety standards. Workers must have a say in the design of the workplace, since technology takes on the values of those who control it.

One sided corporate control of workplace technologies or of related ones such as medicine is not in the best interest of working people. It is equally true that such control over the science behind occupational health is not in the best interests of working people. Clearly, the choice of research questions will have a strong bearing on the occupational health decisions affecting workers' lives. These choices have been made by institutions, organizations, agencies, corporations and individuals paying for the research. The choices usually reflect their interests and values.

Finally, stress is one research area that clearly requires further work. In recent times, it has been suggested that stress may be the leading cause of nearly all diseases. There are many possible sources of stress, but few are more responsible for it than the work place. While stress may translate itself into a variety of symptoms, it can lead directly to actual diseases such as ulcers, migraine, asthma, ulcerative colitis, high blood pressure and most deadly of all, coronary heart disease.

Job and Income Security

It is evident that in today's Canadian job market, there is no longer any job or income security. As far as Canadians are concerned, reasons for this are free trade, the current world wide depression governments cannot cope with, the seeming intractable problem of government deficits and debts with accompanying high interest rates, and so called industrial or economic restructuring. It is the latter that bears further mention here because of the pertinent roles of science and technology.

Many jobs have been lost because companies, when striving for a competitive edge, have had to introduce highly efficient labour saving devices. This has always been true but never to such an extent and with such speed. It is becoming evident that computer

driven machines (robots) will eventually displace all those who produce the material things that we use and that provide the services we have come to appreciate. The future of work is highly speculative.

Traditionally, labour served two functions. It was a key factor in the production of wealth. It was also a means, albeit a contentious one, of distributing it. (This was and is largely due to the argument that human toil should be evaluated as if humans are nothing more than marketable things.) If labour loses the first function, obviously, it cannot satisfy the second. Relevant government policy still presumes that labour will continue to fulfil both functions. This will have to be rethought. It has become necessary for governments to devise industrial policies that promote industrial innovation and efficiency. If labour ceases to produce wealth, it may become necessary to formulate novel public policies to distribute wealth as fairly and equitably as possible by separating work from monetary reward.

Sports

The most popular manner of consuming leisure time is probably sports, either by active participation or by passively being a spectator. It should be pointed out that many if not most in the developed world have been inculcated with a somewhat irrational

love of sports.

The reader might well ask, "What is such a topic doing in a book devoted to science policy?" Well, there are a number of reasons. Sports have become an all pervasive element in our lives. We often take it for granted and do not consciously recognize its impact on our culture, health, work, learning and leisure time. It is high time a research effort was made to answer a slew of pertinent questions about sports and athletics.

True, a large body of sports related research is already available. In some instances it has led to questionable actions on the part of athletes and their trainers. There is a need to carefully examine this research because of the current tacit assumption that better athletic performance is indicative of better health. This is really very questionable. There have been tremendous strides made in sports medicine and psychology. However, we still do not fully appreciate their significance.

The inroads that technology has made into nearly every aspect of sports have been fantastic and financially very rewarding for the manufacturers of sports equipment. There have been just too many innovations to list here. In some instances, such as with skateboards, snowmobiles, hang-gliders, etc., new sports have been created by the introduction of new pieces of sports equipment.

Before proceeding further, it is important to draw a distinction between athletics and sports. Athletics is the practice of physical exercise or activity for reasons of pleasure, relaxation and

improvement of health, strength, reflexes and muscular coordination, while sports refers to engaging in competitive pastimes or games. Sports may or may not be athletic in nature. However and again for our purposes, the topic of sports will be restricted to athletic activities.

Whether we are passive spectators vicariously involved or active participants, for most of us, sports belongs in our leisure time. It allows us to harmlessly blow off steam, forget our daily problems, enjoy some comradeship, in certain cases learn something about cooperative efforts and perhaps most importantly, relieve our inner tensions. In other words, sports has become one of the major means of relaxing in our crazy world. Or has it? Let us take a closer look.

Sports by their very nature are competitive. There is nothing wrong with that. However, a disturbing factor has insidiously crept into our sporting activities. It is best illustrated by two famous quotes from two noted American coaches. First, there was Leo Durocher, the former baseball coach who insisted that, "Nice guys finish last." However, Vince Lombardie, who is perhaps the most revered football coach ever, made a most disturbing remark when

he said, and it is often quoted with awe, that, "Winning isn't everything. It's the only thing." This attitude has come to permeate nearly all sporting activities, no matter whether they are of the so called amateur or professional varieties.

In large measure, this is due to the commercialization of sports. Sports have become a key part of the entertainment industry and as such have to compete with other entertainment means. When very big money is involved, investments must be protected. When that is the case, some very offensive incidents are bound to occur. We have all witnessed ugly exhibitions of stick swinging in hockey, throwing at a batter's head in baseball, dangerous uses of elbows in football and basketball, ridiculous temper tantrums in tennis, etc.

Even the Olympics have been affected. The founding spirit of the modern Olympics seems now largely ignored. It was supposed to be a celebration of sports, bringing athletes from all over the world together to compete with each other, and not an athletic competition between nations with medals assiduously counted as badges of combat. Gold medals have yielded a fantastic commercial value for the winners. Striving for gold medals has come to literally mean striving for gold.

Olympic gold medal winners merit the plaudits of the world because

they are wonderful and exciting athletes who have striven for excellence. All the competitors merit applause for the same basic reasons.

It is most unfortunate when disappointment is expressed about the performances of athletes by their national governing bodies. These usually decide to throw more money to produce more winners of Olympic medals. This is a top down instead of a bottom up approach and it is wrong. The athletes do their best. No more should be expected. As for the money, it would be preferable to see it used for the provision of more facilities and instruction for everyone, so that all could benefit by participating in healthy

competition. Perhaps we could become imbued with inner peace and tune into ourselves, our competitors and our world. Perhaps someday the Olympic governing bodies will become sage enough to throw away all nationalistic trappings, allowing the Olympics to glorify sports and not nations, and the athletes to enjoy competition for its own sake.

Very few of us have much in-depth knowledge about the subject of sports. There are myriads of questions from a variety of outlooks that need answering and should be researched. They range from the politicization and commercialization of sports to a series of psychological questions involving our collective hopes, dreams, frustrations, post-competition withdrawal symptoms, the thrill of

dangerous sports, motivations, the differences in sexual attitudes, the differences in athletic abilities of the sexes, the need to win and dominate, and to a whole slew of health and biologically related questions.

Finally, a word about the oft cited "role model function for our youth" of athletes. The thought that they might or in fact do is enough to fill any thoughtful person with apprehension. No one should be promoted as a model for anyone else. First, asking anyone to play such a role is asking too much. What we end up doing is promoting a false illusory idol that is larger than life, with expectations that often cannot be met. This leads in turn to disappointment and shattered dreams. Second, we are all unique and have differing strengths and weaknesses. What is most important is that we all learn to live within and with ourselves and not try to emulate others whose virtues might be dubious. There is reason to be sceptical about our market system of values. It is one that rewards professional athletes with obscene amounts of money and yet begrudges paying adequately people such as nurses and teachers, to name just a few, who make a far more important contribution to society.

THE HUMAN INTELLECT

While science is largely responsible for many of the incredible

technological wonders we currently enjoy, much more important is its impact on our way of thinking, our entire intellectual endeavours, our philosophies, our political and educational systems, our economy and even our religions.

What is science? Much has been written on the subject, including the philosophies and sociologies of science. It means different things to many people. Yet it is simply a very systematic search for truth about the universe we are a part of.

Science has a particular methodology which insists on testing the so called truths or discoveries that are put forward. While some rather revolutionary attitudinal changes towards this methodology are taking place, traditionally the particular strength of the scientific method has been to separate the observer from what he or she was observing, allowing for a greater degree of objectivity. This has worked extremely well in sciences such as physics, chemistry and certain areas of biology. It works less well in the study of humans, where ethical considerations often severely restrict the carrying out of biomedical experiments.

The social sciences such as political science, economics, various aspects of psychology, sociology, anthropology, archaeology, have not fared as well under the scientific method, since the subject and object of these disciplines are identical, namely ourselves, making

objectivity very difficult, if not impossible. While there is an urgent need to know more about ourselves both individually and collectively, a radically new approach in the social science areas is needed. Giants of the calibre of Galileo, Newton, Gauss, Maxwell Einstein and Darwin, who served the natural sciences so well both with substance and methodology, are sorely needed by the social sciences.

it as one. While science is compatible with theistic doctrines, intrinsically it is not a religion. Anyone who accepts so called scientific truths as religious dogma is doing science a great disservice.

Science differs fundamentally from religion for the following reasons: religion is mostly a matter of faith; in other words, the acceptance of religious ideas occurs without rigorous scientific testing. As Karl Popper, the well known philosopher of science, has pointed out, before any new scientific ideas are accepted by the scientific community, experiments attempting to prove them false have to be carried out. Dogma has no place in true science.

The truths that science deals with are restricted to answering the whats and hows of the observable world. Through observation, a relationship between perceived phenomena is made. Upon close

examination, an explanation in the form of a theory clarifies the how of the relationship, but not the why. Science does not attempt to answer the reason why we exist or for that matter why anything exists, including the existence of nothing. That is left to the philosophers, meta-physicists and theologians.

There is a growing appreciation that observing the observable world is more complex than previously thought. All the tools we use to observe and more importantly to measure natural events are devices we fabricate, including the principal language of science, mathematics. As such, they are extensions of what we are or more specifically of our nervous systems. If we were different, would what we observe and conclude to be true be different? Is so called truth discovered or invented?

We have also come to appreciate that the mere act of observing changes the observed. For the most part, the change is extremely small and thus relatively insignificant. However, the fact remains that what is observed is less than the truth.

These limitations of science, limitations that make science differ markedly from religion, lead in turn to the relativistic nature of scientific truth. In science, there is no such thing as an absolute truth. This despite the fact that there are a few scientific laws that appear to be absolutely true, meaning that exceptions to them

have not, as yet, been discovered. The history of science is replete with examples of changes in attitudes, perceptions and in the laws of science. It is as if reality were a chameleon changing with time and in directions totally unforeseen. Anyone looking to science for

the comfort of answers as solid as the rock of Gibraltar, would be well advised to look elsewhere.

Despite the differences between science and religion, the truly religious and the truly scientific person are oddly very much alike. They are both imbued with a profound sense of humility. For the religious person, God is a metaphor for human ignorance and awe before the infinite panoply and mystery of existence. The humility of the truly scientific person is based exactly on the same factors. They are also often guilty of reductionism. Science has often attempted to reduce all of nature to a few principles, and religion to a Creator. It has been said that when and if science discovers the ultimate truth, it will also discover God.

Unfortunately, there are many, perhaps a majority, who while passing themselves off as either religious or scientific, claim to know the truth. Furthermore, they often go on to assert their truth as the only truth, all others being false. What is most objectionable is the arrogance of anyone who claims to know the absolute truth with absolute certainty. It is sometimes comic to bear witness to the arrogance of their sanctimonious humility.

They cloak themselves with this false modesty and enshrine their ideas with rituals, monuments, outlandish costumes, and all the gloss of modern contemporary public relations expertise. All scientists, nationalists, political and religious ideologues, and moralists, who absolutely know what is right and what is true fall into this category.

Untoward harm has been bred by bigotry, intolerance, hatred, war, narrowness of thought, prejudice of every kind and uncounted other evils. They must be fought, not with their ugly weapons, but with ideas. It is tragic that, on occasion, the ideas used in these battles must be accompanied by the sword.

We are witnessing what Norman Corwin has aptly called "The Trivialization of America," the title of his most absorbing book. This trivialization which is unfortunately accompanied by a diminishment in the collective intellect is not restricted to the U.S. Somehow we must learn how to open our minds and to embrace ideas whose validity have been demonstrated without prejudice no matter what the source.

Science has become distorted by commercial, political, social and military interests. They have discovered that science can have utility. Since they are the prime sources of funds for scientific research, they have also become the major authority on the

direction that most scientific research takes.

Science, seeking to discover truth, may or may not be useful. However it is rapidly being replaced by so called scientific research aimed at conferring benefits. Traditionally, science has been value free. It did not mean that the search for truth was or is without value. It meant that the results of scientific investigations were as independent as possible from the biases and vested interests of the investigator. What currently passes for scientific research can often no longer be thought to be value free.

There is no reason why a scientific approach cannot be used to solve problems and to confer benefits. However, that simply is not

science and should not be confused with it. This confusion between what is true basic science and pseudo-science often called applied science has led to true science being drastically short changed when it comes to funding.

This confusion has been further compounded by the unclear relationship between science and technology, dealt with earlier in this book. Suffice to say that while they are not the same thing, a very strong mutual interdependence has been established between them.

An enormous and disproportionate amount of our resources is going

towards the development of technology, as if it will solve all our problems. In this battle for resources, science loses again. That loss is also society's. Without a basic understanding of what we and our world are all about, the application of some technology is nothing more than a band aid, ending up creating more problems than it solves.

The confusion between science, technology and applied-science has led to a growing perception that science is not value free, and that it has become politicized, commercialized and costly. As a result, an anti-science movement has arisen, mainly because of unrealistic expectations not met. Those who blame science for all the ills of the world truly do not have an appreciation of what science is. Science does not pretend to have solutions for the world's problems. Any so called scientist who suggests this is not behaving as a scientist should. This widespread perception needs to be urgently corrected.

There is perhaps a more important but somewhat subtle reason for the decline in the popularity of science. It has to do with our socio-political system.

We live in what is loosely called a liberal democracy. The term democracy literally means a society that is governed by the views of a majority of its citizens. The word, "liberal" in the term

"liberal democracy," has to do with protecting the rights of the individual or minority groups. It guarantees our basic freedoms as individuals. These two forces, namely the power of the majority and the rights of the minorities and individuals can and do sometimes conflict. At the best of times, there is a healthy tension between them. At the worst, it is the tyranny of either the majority or of the privileged few that prevail. Neither is very satisfactory.

Science is not democratic nor should it be. The truth which it pursues cannot be the subject of a referendum. History has shown that again and again, most popular beliefs have turned out to be false. True scientists follow their own intuition and logic wherever it takes them. They must be independent thinkers. They tend to be critical of the prevailing scientific paradigms of the day, no matter how popular amongst their peers these are.

Furthermore, because science is an aristocracy based on merit, the great scientists of today or for that matter of any day, are part of an elite, one that often appears to be out of touch with the day to day realities plaguing most of us. Since we often cannot understand them, we have tended to become suspicious and distrustful. This

attitude is understandable: science can be trusted but trusting scientists is another matter. Science has suffered as a result.

While science is not democratic, as neither are the arts, or all other competitive aspects of human activity and education, to be fruitful, those engaged in these undertakings must be free within the confines of their endeavours. For the scientists, it is essential that they be free to follow their curiosity and communicate with others whose interests are similar, by publishing, by attending conferences, and by correspondence. No major discovery was ever made in a vacuum. There is no place for restrictions of any type impeding the flow of ideas. Furthermore, if the funding of research is severely diminished, the quality and amount of research in Canada will certainly suffer, leading to a further inability to communicate with the scientific elite elsewhere. This is a slippery slope that can have disastrous consequences for Canadian science.

Censorship

As an aside, let us take this a little further into a non scientific but very sensitive area, namely, censorship. This has become a hot topic mostly because of the perceived growth of violence, pornography and hate in literature. Liberal views on this are bound to be contentious, since they are opposed to all censorship, with two exceptions. First, children must be protected. How this should be done is not clear. Second, the advocacy of violence against any individual, or group cannot be considered acceptable and must be outlawed.

The depiction of something despicable is not the same as its advocacy. But even if it were, censorship should not be used, subject to the provisions just mentioned. It was Voltaire who coined the operative phrase when he said, "I disapprove of what you say, but I will defend to the death your right to say it." Taking his cue, we should be free to spread false doctrines, to lie, and to depict anything we wish, short of harming children or advocating violence.

One of the costs of a free society is the presence of the bad along with the good. No politician is trustworthy enough to decide what should be read or seen. Such intrusion on individual freedom is not acceptable. More importantly however, censorship always ends up by being indiscriminate. It is the tool of the mediocre. We cannot afford to reject a good idea that may be hidden in a morass of junk. Good ideas, good art, good anything are hard to come by.

A final thought. Amongst its many virtues, the major value of science is that for scientists, it is a voyage of discovery, obliging them to open their minds and be receptive to new ideas, no matter how odd. Science, as opposed to just about any ideology, liberates. That is its major virtue. Given the current state of our world, we need lots more of it.

THE SUPPORT OF SCIENCE

There is only one proven method of assisting the advancement of pure science - that of picking men of genius, backing them

heavily and leaving them to direct themselves.
James Bryant Conant

No, a thousand times no; there does not exist a category of science to which one can give the name applied science. There are science and the application of science, bound together as the fruit to the tree which bears it. Louis Pasteur

GENERAL

One of the pillars of any science policy is how science, or more appropriately scientific research, is supported or funded. Government involvement, which is crucial, is frequently labelled policies for science. A certain amount of controversy is often associated with them - actually a great deal. They are much more complex than usually perceived and their long term importance cannot be underestimated.

One point that should not be belaboured: whether the total amounts of money provided by whoever, be it government, industry, private foundations, charitable organizations or philanthropic

individuals, is adequate. The reason is simple. It never is. While money is important, it is often forgotten that people are more so and that it is people that need to be funded, not some abstraction such as an institution, building or administrative bureaucracy.

To offset any thought that what follows is the standard academic approach with its usual attempt at objectivity, calm detachment resulting in an extreme case of fence sitting, here are three points couched in the strongest terms possible. The language may still be too sedate.

1. Science is one of those activities we humans cannot get enough of. The amount of scientific activities and resources devoted to it is one measure of how civilized a society is. There can be no excessive searching for truth in the disinterested, rational, objective and yet very passionate manner that science commands.

2. Science has suffered grievously at the hands of successive governments in our nation, at the very least since, the early 70s. Not only has the general levels of funding diminished in real dollars over this time period, but the decisions concerning the allocation of funds has been and is questionable. They show a lack of appreciation of what science really is and fail to distinguish realistically between various types of scientific endeavours and also between science and technology. Everything seems to have been put

into the same hopper and treated the same way, with no awareness of the tremendous variation and richness in scientific activities, coupled with their long term aspects. It is true that government has every right to make decisions that bear on how scientific resources are allocated. Unfortunately, our government also has every right to make wrong decisions which is exactly what it has done. The finger should not only be pointed at and given to our current government. Past governments have also behaved in an abysmal and short sighted fashion.

3. It astonishing and most reprehensible that, for the most part, the leaders of the scientific community have either not spoken at all or have commented in a rather timid fashion about government

science policy. There have been some exceptions, notably Dr. John Polanyi, Canada's second Nobel Prize winner in science, and Dr. Gordon McNabb, former head of The Natural Sciences and Engineering Research Council. It is true that scientists are not noted for their political acumen or for their courage outside their immediate areas of interest; they prefer to be left alone doing their research; most are probably imbued with the, "lets not rock the boat," or, "leave well enough alone," or "it could be worse," syndromes.

Furthermore, their professional associations have also been conspicuously silent. There does not appear to be one overriding

scientific society to speak on behalf of science. The now defunct Canadian Association for the Advancement of Science in Canada never really took off as a replacement for SCITEC. No one amongst the scientific elite in government seems to be willing to take on that task, although there were instrumentalities such as the Ministry of State For Science and Technology and the Science Council of Canada. Perhaps the Royal Society of Canada could and should. In any case, the scientific community must descend from its ivory tower, get off its butt, get its hands dirty, take up the cudgels on behalf of science and learn what is often a very painful lesson: never allow yourself to be bullied. Always bully a bully. They will usually back down.

THE IMPORTANCE OF SCIENCE

Why should science be funded as a very high priority? The question is not as dumb as it sounds. What immediate relevance has science for those striving to stay alive without much hope because of lack of nourishment, those who are disenfranchised, those who are unemployed and trying to make ends meet, those who have been dislocated because of the introduction of new technologies and those who have become the victims of terrorist and military activities? Science and technology, as yet, do not appear to have done much to alleviate the awful inequities that exist in our world, although they promise much.

Moreover, if science is truly a disinterested search for "truth", how does it compare with other such endeavours in the history of human intellectual development, endeavours for the most part, not subsidized, and today still receiving hardly any assistance? The worlds of philosophy, law, literature, politics, music, painting and sculpture, religion, etc. have made enormous contributions to the development of human thought. The truths they have uncovered are just as valuable as any of a scientific nature.

So then what is so special about science? If compared with the arts and philosophy, not much. Actually, the distinction between the three has become somewhat blurred. However, in a relatively short period of time, science has provided us with an astonishing amount of knowledge and insights about our world and ourselves. The real importance of science is not only that knowledge and the hope that goes with it; science approaches the world with self critical incredulity, with no firm knowledge of the truth, but with the expectation that today's truth is tomorrow's myth. It is both open ended and open minded. It liberates the mind and the human spirit. Those truly imbued with the spirit of science are better humans for it. That is why science should be both supported and taught.

As stated in the previous chapter, those social entities that know with moral certitude what is good and bad and what is true and

false are verily the real fountains of evil. They are the breeding grounds of mediocrity, charlatanism, ignorance and despotism. For ample evidence of this all one has to do is to turn on a radio or television set each night for the news and question period, and on Sunday mornings for self righteous and often bigoted platitudes. Unfortunately, it is often these very influences that help shape science policy, by misusing, abusing or deliberately misinterpreting science.

THE ALLOCATION OF SCARCE FUNDS

The wisdom of Solomon is frequently required when deciding how to allocate scarce resources; in other words how to split the pie. If the amount and type of support is less than a critical amount for any particular area of science, one may just as well forget that area. These days good quality science, does not come cheap.

What happens too often, and usually for political reasons, is that the pie is divided into many pieces, resulting in subcritical amounts for each and the devastation of all or at least of most of the areas. The solution seems simple enough. Either increase the size of the pie so that each area's requirements are fulfilled or make the very difficult choices between what is often competing interests. The first option is just about impossible because the resources are simply not there. Increasing the size of the science pie and would

mean sacrificing some area outside science with unacceptable political results. This would require political wisdom of the first order, a commodity sorely lacking in the world today, let alone in our country.

The second option is unpalatable because someone is bound to get gored and one is never sure that the decision to fund a specific area was correct. It does not seem to matter whether the decision is based on the perception of a need for that specific area of research; either the researcher must be found and a necessary infrastructure put in place, or else everything needed is at hand and ready to go; all that is required is money.

These are hard choices. Yet it is axiomatic that under no circumstances should any area of research be funded sub-critically - that is simply throwing away good resources. The collective wisdom of a panel of knowledgeable people should prevail. Criteria such as the potential of the area, costs, chances of success, i.e. credibility and expertise of the research team, should be employed when making these choices. To be fair, this approach, called the peer review system, is the one normally used by the granting councils. One can only speculate how granting decisions are made when political and bureaucratic pressure is applied. After all, their autonomy is critical.

While Terry Fox and Rick Hanson are to be commended for having sensitized the public to certain research needs in the area of biomedicine, they hardly qualify as credible experts in making research allocation decisions. Generally speaking, charities should not influence research priorities. They can point to certain social

needs but only research experts have the proficiency and knowledge required to make these decisions. No one can quarrel with their motives and intentions; however, it was Samuel Johnson who said, "Hell is paved with good intentions."

Science has an internal ecology. This very important aspect should always be kept under advisement when support for science is being debated. That vital characteristic must be protected and nurtured. Under and over exploitation must be avoided. Quixotic expectations as to the results of scientific research will most assuredly lead to inappropriate disillusionment. Basic science is not amenable to direction. It is science that leads, not the scientists. This very exciting trip may lead nowhere or to the promised land. Finally, a balance between the various components of the scientific ecology must be sustained.

Four of the major components just referred to are; Research based on Scientific Theory, Curiosity Oriented Basic Research, Mission Oriented Basic Research, and Applied Research. It is critical to remember that these components feed on each other. If any one of them is deficient, they all suffer.

For the last twenty odd years, Basic Research in Canada has been given short shrift by governments. This has been a most near-sighted policy, leading in some instances to irreparable harm. Each of the four components mentioned above has to be given its due by all those in the public and private sectors who decide such things. A healthy balance between the four components must be maintained.

THE SOCIOLOGY OF SCIENCE

Science also has sociological aspects that bear some mention. At one time scientists were able to work in relative isolation. They still needed to communicate with other scientists to keep abreast of the latest developments in their respective fields. Science has grown more complex and the need for free communication is more important than ever before. Impediments to that intercourse that do not involve proprietary information and national security should not be allowed.

However, the strong need and desire for intercommunication in science probably gave rise to what has been called the "publish or perish syndrome." It was also a way of judging one's peers. The more one published the higher the esteem one garnered. It is uncertain whether this state of affairs is still as strong as it once was; hopefully not.

As scientific research has grown more complex, sophisticated and more meaningful vis-…-vis the human and natural environment, research teams of a multi-disciplinary nature have become the norm. It often takes a great deal of care, trial and error, and time, to put a good team together. Dismantling such a team should only be undertaken after every means of keeping it together have been considered. Good teams are too rare. Their disappearance represents a real loss, since it is usually impossible to reconstruct them once they are gone. The people making up these teams are not automatons. They cannot be turned on and off like a light switch. Eliminating excellent teams of scientists is similar to the classic example of throwing the baby out with the bath water.

GOVERNMENT FUNDING

Government funding of science is accomplished in a number of different ways - through grants, loans, equity purchases in research oriented companies, contracts, tax write offs and by actually doing the research inside a government department or crown agency. None of these ways of funding is more appropriate in any one area of scientific research or in any one type of research.

What is disturbing about government funding of science is that it very often does not distinguish between scientific research and technological development. Today, political expediency seems to require subservience to the requirements of technology. Funds normally earmarked for scientific research are being diverted to technology, with claims piously made, that there has been no diminution of funds for science. That is simply not true.

THE PRIVATIZATION OF GOVERNMENT LABORATORIES

A number of years ago, the Ottawa Citizen ran a small somewhat disquieting article. The headline read, "Privatizing Federal Labs Viewed As 'Appropriate'. The article further stated that the laboratories of the National Research Council and other government departments may be privatized, as the result of a new policy aimed at bringing industry and government labs closer. To accomplish this, most government laboratories would be asked to set up advisory councils composed of industry and regional representatives. The privatization was expected to evolve as these new advisory councils began to direct laboratory work. While there are about 110 federal laboratories, thirty will be immediately affected and eventually all may be.

The general tenor of the article was positive, in the sense that everyone quoted in it was generally in favour of this new policy.

One can be sure that many bureaucrats, government politicians and industrialists agree on the privatization of government labs. However, the indiscriminate selling off to the private sector is horrific.

Our current government is very much into having the private sector take over much previously in the domain of government departments and crown corporations. In some instances, privatization may be quite appropriate, but only when the public interest is well served by such a move. Presumably, the government feels that the public interest will be best served by such a move. How will it be best served, is the question. Perhaps the government feels that there is a great deal of useless work being carried out in government labs and that taxpayers are not getting their money's worth. Or perhaps it feels that the private sector can carry out this work, if it is useful, at a lower cost and more efficiently. Or, perhaps this is a means of inducing the private sector to do more research and development. If this occurs, perhaps, just perhaps, more new products and services will be developed in Canada, to the benefit of our entrepreneurs, industrialists, labour force and the public at large, because of increased revenues to the government. These are good reasons, if valid, or if they do not entail other hidden factors and costs. Let us examine them. First, let us put the question of the utility of

government labs to rest.

They are valuable publicly owned assets. If they were not, they would also be of no use to the private sector. Why are they so valuable? Principally because of what they do and the important role they play in Canadian science.

What do they do? The answer is, many things. Scientific work carried out in labs is multi-facetted. In government labs, it can range from esoteric basic research experiments at the frontiers of science, designed to uncover fundamental truths, to advanced applied research experiments whose purpose is to solve problems important to society, industry and government, to more immediate applied research possibly leading to new commercially desirable products or services, to the monitoring of the quality of the air we breathe and the water we drink as well as the safety and efficacy of the foods, drugs and goods we consume, and finally to the setting and maintenance of standards of time, weight, scientific measurements, and the operation of transportation, communication and medical devices.

Are government labs supposed to do all these things? The answer is not an easy one. A government lab is supposed to do work that is related to the mission of the government department, ministry or agency under whose umbrella it operates. For example, labs operating within the Department of Agriculture are supposed to do scientific work important to the agricultural community, those

within the Department of National Defence are supposed to do defence related work, those within Health are supposed to do work important to the protection and promotion of our health. It sometimes appears that the actual work being carried out is not related to the laboratory's original mission. That is because it is nearly always impossible to pigeonhole scientific work into neat little packages.

The nature of scientific work is such that no matter where it starts from, it will of necessity spread into other areas. All scientists worth their salt will follow a scientific line of endeavour wherever it takes them and will, quite properly, resist any attempt by others to impose a deviation from that line. This has often occurred and it is a good thing both for Canadian science, that is fragile enough and for the Canadian public, that needs quality scientists wherever.

What is advocated here is periodic reviews of government labs to ensure that they have not strayed too far from their mission. Furthermore, serious consideration should be given to the restructuring of government scientific resources, perhaps even to separating them from their departments and agencies.

Can the private sector carry out most of this work more cost effectively and if so should these labs therefore be turned over to

it? There is reason to believe that the result will mean sacrificing quality and good people. Labs involved in protecting our health and our environment, labs related to our national security, and many of our industrial labs should not be privatized. In the first two instances, the reasons are related to potential conflict of interest situations. The horror stories that have occurred, particularly in

the U.S., concerning cost overruns and scientific fraud are really shocking.

As for privatizing government labs doing industrial work, the lack of a scientific, industrial infrastructure in Canada which could turn them into viable industrial R & D operations is worrisome. They would probably be bought by large multinationals at bargain prices for tax write off purposes and end up doing donkey work while most of the real innovative work would continue to be done at headquarters somewhere in the U.S. The fragility of Canadian science, unlike that in the U.S., is much too great to allow this to happen. To the extent that useful work would continue, it probably would no longer be as readily available to small, imaginative, entrepreneurial Canadian business firms.

In summary, the real value of our government scientific resources based also on our past tremendous investment in them is just too great to indiscriminately turn them over to the private sector. Moreover, in light of our current government's record, the

potential for patronage and rip-off sales commissions can make one rather suspicious.

MILITARY RESEARCH

One area of government supported scientific endeavours that merits special attention is military research. It has been suggested that the majority of all living scientists now working are engaged in tasks that, one way or another, are related to the needs of the military. In other words, they are involved in military research. While it is the military that more often than not pays for this research and has a research arm of its own in Canada, a good deal of it is hidden in other government departments, universities, institutes and the private sector. One way or another, we as taxpayers end up paying the shot, even though the arms producing industry is one of the most lucrative around.

This type of research is called defence research, which is consistent with labelling the government department in charge of our military, the Department of National Defence. We like to think that we are spending all that money on ways and means to defend ourselves so that our potential enemies, whoever they are, will think twice about attacking us.

Of course, we also realize that the best defence is a good offense.

However, we and our allies would however never think of attacking first. After all, we represent all that is good and virtuous in the world. We really seem to believe that arming ourselves to the teeth and engaging in scientific military research and development to be at least one step ahead of our enemies is a way of preventing wars. While obviously there is some truth to this, it really bears more scrutiny. However, before we can examine this notion further, it is necessary to take a very cursory look at the history of military research. It goes back a long way.

In one form or another, man has been experimenting with ways and means of beating his enemies since the dawn of human history. The reader may recall the extraordinary opening sequence in Stanley Kubrick's great movie, 2001, in which a group of apes accidently discover how to lethally use clubs on their enemies. Mr.

Kubrick was trying to metaphorically suggest this was the start of a certain technological madness based upon scientific research, that has continued with a dizzying escalation ever since. It also suggests that aggression and violence represent two aspects of the dark side of human nature, a side we may have inherited from our nonhuman forebears. We must learn to curb if ever we are to live harmoniously with each other and our environment.

It is probable that the first human military technological breakthroughs came with the use of tools normally used for peaceful purposes but easily converted to weaponry. The bow and arrow, the slingshot and the plough share are examples. Of course, the deployment and use of groups of warriors organized in hierarchical groups called armies required a new mind set, based on some rational analysis that changed things forever. The victors of Biblical wars, the Trojan wars, the war between Sparta and Greece, the Roman wars, the Gothic wars, etc. did not win because they were numerically superior, but because they were better prepared, better disciplined and better armed. One of Greece's early and greatest scientists, Archimedes, was one of the first known scientist to develop military technology. Actually he is the distant originator of the guided missile. He developed a catapult effectively used by the Greek army.

From about biblical times to about the beginning of the 17th century, military techniques hardly changed. With the discovery of how to use gunpowder in rifles, guns and cannons, things started to really pick up. The ability to kill more people more quickly had really commenced.

The advent of WW1 was in the minds of many, an artificial war that allowed the munitions makers an opportunity to make their fortunes, as well as a chance to test their wares. It also served to unite people under the banner of a new nationalism, making them forget their misery and helping capitalist nations fight the growing spread of socialism.

Some very real military technological breakthroughs took place in this first of wars to end all wars. Science and technology were at last recognized for their tremendous military value. Airplanes, tanks, submarines and poison gas were used for the first time. The chemical explosive power of armaments increased by many orders of magnitude.

Both WW2 and the post war era are marked by fantastic innovations in military hardware. Radar, jet aircraft, guided missiles, the uranium and hydrogen bombs, chemical and microbiological warfare, napalm, explosive devices that can cause damage in myriads of ways, computers, and lasers, are just a few examples.

Other innovations are in the offing such as: thermal guns that are powered by steam created by jets of hot gases; hyper velocity rockets that can penetrate all kinds of armour; electric cannons using magnets to accelerate projectiles to unprecedented speeds; and the use of robots to replace regular combat soldiers in very dangerous situations.

The advances in military hardware since WW2 are greater than in

all previous history. It is well known that there now exists enough
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explosive power to destroy all life on our planet many times over. We have already used weapons of mass destruction against civilian populations. One of the major horrors of the Holocaust was that for the first time, an industrial approach was used for the mass extermination of human beings. The gas chambers and ovens, the transportation systems, and the means used in the concentration camps, were all organized in such a fashion as to facilitate the taking of as many lives as possible in the shortest time possible. This was a true systems approach to genocide. Perhaps only cockroaches will survive what appears to be the next inevitable and perhaps totally final Holocaust.

One of the inescapable consequences of the arms industry has been and still is the tremendous trade in armaments. Two further tragic repercussions of this have been: the escalation in what can be called mini-wars which have already exacted a countless toll in human lives and suffering and; underdeveloped countries purchasing armaments which they can ill afford, as their people continue to suffer and go without. One can cynically observe that they are encouraged to engage in such frolicsome play to provide the superpowers with opportunities to test out some of their new found toys. After all, life in these countries is cheap.

It seems that while military scientific research and technology have provided us with much to improve our lives, they have been

maintain that we must be armed to maintain the peace. That may be true. However, when does it stop? Every time our enemies or ourselves come up with something new, the other immediately seeks and usually finds the same technology or one that can neutralize it. This can go on forever until the inevitable occurs.

What is needed is research into a science for peace. The notion that war is needed to create, build and sustain nations should be meticulously probed. Also, if absolute peace were declared immediately, the effects on our economy would be disastrous. We need to learn how to carry out a changeover to a true peace time economy.

There is little reason to be optimistic. All military scientific endeavours throughout history have led to the current potential for complete annihilation of the planet. These efforts do not auger well for our future. In contemplating that history, the last word uttered in the movie, "The Bridge On The River Kwai," seems most germane. "Madness!"

225CHAPTER 11

INDUSTRY, TRADE AND COMMERCE

Life without industry is guilt, industry without art is brutality.
John Ruskin

Free trade is not a principle, it is an expedient.
Benjamin Disraeli

Where wealth and freedom reign contentment fails,
And honour sinks where commerce long prevails.
Oliver Goldsmith

This chapter is devoted to some brief speculations about how science is affected by current business and trade practices, by looking at the potential impact of Free Trade on science and at the pharmaceutical industry, a strong science based industry.

FREE TRADE

One of the key issues in the next federal election, likely to take place this fall, (1993) may well be Free Trade. Under no circumstances should the following conjectures be considered as a definitive argument about it, one way or another. After all, the debate includes many factors. Its potential impact on science in Canada is only one, albeit a reasonably important one. While the

impact of Free Trade on employment in Canada has been obvious, the jury is still out on its consequences for science.

Before proceeding further, it is important to establish what is meant by the term "Free Trade." Ideally, Free Trade means the total free flow of goods, services, professional expertise, capital, labour and information across national boundaries, unhampered by tariffs or other artificial barriers and governed uniquely by market forces in which competition reigns.

If this is the case, why did it take so long to arrive at a Free Trade agreement with the U.S.? What was negotiated appears to be only a partial agreement. Decisions were made on an case by case basis as to which items would be allowed to flow freely between the borders of the US and Canada, the timing of such free flow, and what would constitute unfair competition. Finally, some sort of dispute resolving mechanism was developed, in the event one side accused the other of unfair practices.

For the sake of clarity and brevity, let us at this point narrow our definition of science into basic and applied research. The former refers to research that is motivated principally by curiosity, and the latter refers to research that is motivated by utility. Usually, basic research is carried out in universities, certain research institutes, occasionally in government laboratories

and very occasionally in industry. Applied research is usually found in government and industrial laboratories. Its occurrence in universities appears to be on the increase. Whether this is a good thing is debatable.

Anything that diminishes the amount and quality of science in Canada is unacceptable. When judging the state of science in our country, a number of factors directly determining its amounts and quality must be considered. Herewith are some factors about the impact of Free Trade on science in Canada.

Factor No. 1 - The Free Flow of Information.

Up to relatively recent times, basic science could be considered as the epitome of Free Trade. The only restriction was the natural desire to publish first and therefore receive the credit and the honours that went along with a major discovery. Scientists vied

with each other to publish in prestigious journals or make presentations at major conferences. In other words, there was a very free flow of information between scientists from everywhere and as a result nearly all new major findings, theories or laws were really the outcome of the cooperative efforts of many.

Unfortunately, restrictions on the free flow of even basic research findings are becoming more prevalent, often on the grounds of

national security, but more frequently because of the growing awareness of the commercial spin offs of such work. On the whole, it is difficult to see how Free Trade will diminish the free flow of basic information. However, if the competitive nature of basic research is intensified through Free Trade, Canadian scientists may not continue to have access to crucial information, once freely received. As stated in the previous chapter this could have dire consequences for scientific research in Canada because Canadian scientists could lose their membership in the exclusive club of the scientific elite and Canadian scientific research most certainly will suffer accordingly.

Expectations are different with respect to applied research. It is understood that results are proprietary and not freely available. They can still be obtained under commercial agreements or licences on both sides of the border.

The information age was heralded with the oft repeated maxim that 'knowledge is power.' Inexpensive computers have made scientific and other data available to many people. That is a positive development: data should be accessible to all who need it. The problem, however, is the manner in which data is amassed and stored. There is a tendency to centralize the large preserve of information into data-banks. With Free Trade making the US-Canadian borders more transparent than ever before, data related

activities will tend to congregate where the financial and market resources are more plentiful, namely south of our border. The danger is for Canada to be possibly locked out of the knowledge loop, having contributed freely to its elaboration.

Our historical record at handling our resources does not bode well for the future. We send our raw materials south and buy them back with value added through manufacturing, often at inflated prices. Chances are we will not handle this newest of resources, information, any better.

The north south flow of information into databases located in the US will prevent Canada from developing a Canadian approach to the balance between accessibility and protection of confidentiality. In this scenario, moreover, Canadian generated data will be outside of the boundaries protected by Canadian laws. We are in a vulnerable position in many aspects of the Free Trade Agreement. The one related to the flow of information merits special attention.

Factor No. 2 - The Number and Quality of Scientists in Canada. This obviously depends on the number and quality of our schools and research institutes. That quality is usually dependant upon the amount of resources that are available to them and that in turn depends on how well our economy is doing. Under Free Trade, the health of our economy will be predicated on our ability to compete

in the US market. If we can compete successfully, then we will be able to attract leading scientists from all over, and avert a brain drain to the US. This, in turn, will enhance our educational and research institutes and thus our innovative potential, enabling us to compete even more successfully. Success feeds on itself.

Factor No. 3 - Industrial Research and Development in Canada. The amount of industrial research and development in Canada is rather low. This despite all sorts of incentives such as those recently obtained by the pharmaceutical industry. Actually, all the evidence appears to support the hypothesis stated under factor No.2. The amount and quality of science depends on the economy. Usually, the first thing that is cut when an economy is lagging, is science. We have seen this countless times. Some argue that it is precisely at that moment that we need science the most. They are probably right but there really is no solid evidence to support that position.

Research and Development in Canada is further complicated by the fact that Canada has largely a branch plant economy. Much of our industry is American owned. While they do some very small amounts of token research here, by far their research is carried out near their most important market, obviously the US. Free Trade will certainly not improve this situation for Canada, while it may make it marginally worse.
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Factor No. 4 - The Americanization of Science in Canada. It would appear that opening our borders to enable us to compete more efficiently in the US market may oblige us to accept many aspects of American practices, culture and priorities. Scientific priorities in Canada will be largely shaped by scientific priorities in the US. They are already. Do we want more?

THE PHARMACEUTICAL INDUSTRY

The recently passed federal legislation having to do with proprietary rights in the pharmaceutical industry, coupled with the results of an Ontario study of a few years ago dealing with the use of prescription drugs in that province, and the somewhat critical role drugs play in providing us all with some measure of health care and protection, suggest that a look at the drug industry is quite appropriate.

For the purposes of this book, the term "drugs" means those legal pharmaceutical products that we either prescribe for ourselves by simply purchasing them over the counter at our local drugstore or those prescribed for us by our doctors. Illegal drugs are quite another matter and a potential subject of another essay.

Our culture is drug laden. We rely far too much on drugs to either cure what ails us or to alleviate distressing symptoms. There

appears to be a pill, syrup, injection, capsule, spray for every medical situation, whether it has been self-diagnosed or diagnosed by a medical practitioner.

We fully expect our doctor to prescribe something after a visit and would be disappointed if he or she did not. Since most of us are enamoured with the idea of a quick technological fix for just about anything, it is understandable that we have embraced the

same illusion about pharmaceutical technology.

Simple solutions to problems often complex are far more appealing than altering one's lifestyle, changing one's attitude and recognizing that good health is based on a holistic approach. With some obvious exceptions, taking a pill seldom cures. It seductively alleviates symptoms. Yet, we are and will continue to fruitlessly search for Dr. Erlich's magic bullet - a single pharmaceutical cure for everything that ails you. We yearn for the magic elixirs of earlier times and continue to fall for the sales pitches of modern medicine men hawking their snake oil.

Sadly, our elderly are the most vulnerable. Their health is often precarious. They are not always able to judge what is in their own best interest. Often, little can be done to help them. Prescribing drugs, which they obtain gratis, turns out to be the easiest way to deal with their troubles. Everybody is satisfied because something is

being done. In truth, we are waiting for nature to take its course, not always realizing that over-prescribing most likely hastens the final solution.

The commercial aspects of the situation should not be neglected. According to the Ontario study mentioned earlier, Ontarians are among the highest users of prescription drugs in the world. Too many doctors over-prescribe drugs to patients who collect pills from different doctors. Doctors were often guilty of prescribing brand name medications, when generic drugs doing the same job were available at one third the cost.

Since it is the province that pays for the prescription drugs of 1.5 million senior citizens and welfare recipients, as well as medications prescribed in hospitals, clinics and nursing homes, the current annual cost of $580 million is footed by the taxpayer. In 1972, the annual cost was $15 million. Obviously, something must be done. The powerful pharmaceutical industry can certainly not be relied upon to keep the costs down.

Despite our over-reliance and indulgence on excessively expensive pharmaceutics, it is necessary to present the other side of the story. Drugs are essential to the delivery of health care. Firstly, symptoms often need to be abated, because often it is the symptoms that kill and not the original cause. Secondly, drugs

sometimes have curative powers. For example, most bacterial diseases are still remedied by the judicious use of antibiotics and cancer has been cured by chemo-therapy. Thirdly, drugs can be used to prevent disease, such as vitamins for a variety of disorders, aspirin for heart disease, and those that reduce blood cholesterol. Finally, the proper and judicious use of drugs for the elderly is absolutely essential, not only in keeping them alive but also with some capacity to continue enjoying life. In other words, whether we like it or not, drugs are important to all of us.

While it is doctors who most frequently prescribe drugs and it is the province that very often pays for them, it is the Drug Directorate of the Health Protection Branch of the Department of Health Canada that decides which drugs will be allowed. This agency approves or denies applications by drug companies to market their products. Probably the most important criterion used is the pharmacological adage which states that the more effectively therapeutic a drug is, the more toxic it is likely to be. We would

do well to remember this when we are tempted to overuse.

What happens is this. A company creates a new drug. A new drug is one that has never been used before in any fashion and for which the company makes a specific therapeutic claim. It can be natural or artificial. A new drug can also be one that has been used before, but for which a new therapeutic claim is being made.

The company then applies for permission to market the drug in one of three categories. Although the protocols vary, depending on which category is involved, it must provide the agency with evidence as to the efficacy of the drug, what is a safe and effective dosage, what are the possible side effects and what are the contra-indications.

The first category is as a Proprietary Medicine, usually sold over the counter, for which a notice of certificate is issued. These medicines are akin to the old patent medicines. Usually, the therapeutic claim is either minor or relatively trivial. More importantly, the risk associated with their use is also so low that there is no concern about the safety of these medicines. Perhaps their only real value is that of a placebo.

The second category, also sold over the counter, is issued a drug identification number. Both the efficacy and the potential hazard are much higher than those in the previous category, so much so that the label is required to contain safe dosage and contra-indications information.

The third category is also issued a drug identification number but it can only be sold with a doctor's prescription. Again, both the risks and efficacy are much higher than in the second category and usually the results are supposed to be carefully monitored by the

attending physician.

In all three categories, the attendant benefits, as measured against the risks involved, are considered by the agency before permission to market the drug is either granted or denied. With few exceptions, such as of the infamous drug thalidomide, Canadians have been and are being very well protected. Perhaps, as some claim, a little too well, because of the great length of time it takes to get a new drug approved. Yet, better safe than sorry.

Next, a word about recent legislation preventing the introduction into the market of a generic copy of a new drug by another company for twenty years. Previously, the company introducing a new drug had exclusive patent rights over it for seven years if manufactured abroad and ten years if manufactured in Canada. Earlier still, these rights lasted for only four years. The strength of the pharmaceutical industry's Ottawa lobby has put us all on notice.

What was all the fuss about? After all, pharmaceutical companies introducing new drugs, presumably have to carry out a great deal of R&D to create the drug, ascertain its therapeutic value, side effects and contra-indications, prepare all the horrendous paper work and go through all the necessary red tape. Are they not entitled to lengthy exclusive rights over the products they

created, as other companies are with other products?

The answer is no. Life saving, and health promoting and preserving drugs are not like other products. Canada, unlike the U.S., has granted as a right, not a privilege, an equal high standard of health care, at either no or very little cost, to every Canadian citizen. This is something we can all be proud of. If, however, as a result of this legislation, the cost of new drugs increases dramatically, that right could simply disappear, as many will no longer be able to afford needed drugs. The government has promised to monitor the price of drugs and take action if companies unjustifiably raise prices. We shall see!

Already, there is anecdotal evidence that the price of some drugs has increased substantially. To many, it appears that the major pharmaceutical companies have been given a license to print money. The government replies that not enough data about new drug prices has been generated to decide whether any action is warranted. With the political philosophy espoused by our current government, any strict enforcement of prices is doubtful.

The government's stated major reason for the latest legislation was that this would encourage more home grown pharmaceutical R&D. This to, is to be monitored, although to be fair, it will take some time to see the results, if any.

There is every reason to believe that R&D will not substantially increase. Most of the large drug companies are foreign owned. They, of necessity, will continue to do their research where it is most profitable, near their largest market. With the Free Trade Pact now law, they have even less of a reason to engage in R&D in Canada. One can be sure that for the sake of appearance, they will label some of their Canadian activities as R&D, while carrying out their important R&D elsewhere. For the same reasons there is always the possibility that home grown companies, if they are not bought out by American companies, will move south or move their R&D in that direction. Pharmaceutical companies in Canada must be carefully regulated as to their prices and R&D operations. Twenty years is too long for exclusive rights over any new drug product, especially those produced outside Canada, with research carried out elsewhere.

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EPILOGUE - A PARABLE

Knowledge is proud that it has learned so much;
Wisdom is humble that it knows no more. William Cowper

Authority without wisdom is like a heavy axe without an edge.
fitter to bruise than polish. Anne Bradstreet
We thought we were done with these things but we were wrong.
We thought, because we had power, we had wisdom.

Stephen Vincent Ben,t

Once upon a time there existed an aboriginal tribe of indigenous peoples. They lived in a remote area of temperate clime and were quite isolated from other tribes and the civilized world. They subsisted on crude forms of agriculture, fishing and hunting.

Through the centuries, they had developed a sort of ecological balance with their natural environment. Through empirical observations, they had learnt not to take more out of their natural surroundings than could naturally be replenished by it. Their population remained relatively constant because their life/death cycles had become synchronous with their environs. This truly static society had hardly changed throughout its history. They were a simple people whose main aim was to survive as a group.

That survival was totally dependant on the cooperative efforts of all, something that had become embedded into their way of life.

They had no sense of property. Everything belonged to everybody. In other words, they lived communally. There was no crime other than isolated acts of violence which were handled without delay. The miscreant was immediately cast out of the tribe and left to fend alone, usually unsuccessfully.

Marriage did not exist. Polygamy and polyandry were the order of the day. Children belonged to all adults and their welfare was the collective responsibility of the tribe. There was no sense of morality as we define it because there was no need for it.

Leisure time was filled with tribal dances and songs, friendly competition and storytelling. Their religion was pantheistic and polytheistic. There was a god for every natural phenomenon that they depended on for their survival. When the old got ill, it was viewed as part of the natural order of things, with the inevitable outcome stoically accepted. Illness for younger members of the tribe was treated by the medicine man whose medical lore had been gathered over centuries of empirical observation. Complex abstract concepts were absent from their thoughts. Their very simple language reflected this. They painted and adorned themselves with natural dyes, glittering gems of many colours which were amply

present, and a certain yellow malleable metal also readily and easily available.

They were led by chiefs who, while having total authority, were usually quite wise and benevolent, with the best interests of their people at heart. The latest chief had just succeeded to this high position after the death of his father. He was still quite young, and had strong aspirations to improve the lot of his people. He had thus made himself more aware of the marvels that existed in the outside world. They reinforced his vision. He had also learned the value of the naturally occurring gems and metals belonging to the tribe and had decided to use them to bring progress and prosperity to his community.

He became enamoured with science and technology. He envisaged a modern agricultural industry together with new means of communication and transportation, the latter requiring modern roads, railways, airports and bridges and the former, electrical energy. This in turn would provide jobs and disposable income and

would result in some form of commerce which would certainly extend far beyond the borders of his community.

To bring his people into the twentieth century would require that they change their ways and their beliefs. An educational system would be required, stressing the importance of science and

technology as well as the virtues of a democratic society based on free enterprise and capitalism. A sense of right and wrong coupled with the virtues of private property would have to be introduced to ensure harmonious change. Also, an awareness of modern medicine would inform the people about illnesses they had never heard of and about medical treatment, so that they could live longer.

He realized that he urgently required assistance and advice. He enticed a host of experts in scientific, economic, agricultural, industrial, health and fiscal, policies, to advise him. They all became enthusiastic supporters. Their counsel was followed and within his lifetime his dream was realized.

The economic base of this new society was precious metals and gems, as well as the exportation of one major agricultural product. All was going well until the market for the latter dried up and the supply of the former disappeared.

Once upon a time, there existed a peaceful, serene tribe of aboriginals who lived in a pristine environment. Both the tribe and the pristine environment no longer exist. Progress had claimed yet another victim.

APPENDIX A

A SELECTION OF RELEVANT, IRRELEVANT AND IRREVERENT CITATIONS

Someone who had begun to read geometry with Euclid, when he had learned the first proposition, asked Euclid, "But what shall I get by learning these things?" whereupon Euclid called his slave and said, "Give him three-pence since he must make gain out of what he learns."

"The die is cast; I have written my book; it will be read either in the present age or by posterity, it matters not which; it may well await a reader, since God has waited 6000 years for an interpreter of his words." Johann Kepler

"If we evolved a race of Isaac Newtons, that would not be progress. For the price Newton had to pay for being a supreme intellect was that he was incapable of friendship, love, fatherhood and many other desirable things. As a man he was a failure; as a monster he was superb." Aldous Huxley

"There is no difficulty in deciding a case - only hear both sides patiently, then consider what you think justice requires, and decide accordingly; but never give your reasons, for your judgement will probably be right, but your reasons will certainly be wrong." Lord Mansfield

"Thought is only a flash between two long nights, but this flash is

everything." Henri Poincar,

"It is a profoundly erroneous truism, repeated by all copy books and by eminent people when they are making speeches, that we should cultivate the habit of thinking of what we are doing. The precise opposite is the case. Civilization advances by extending the number of important operations which we can perform without thinking about them." Alfred North Whitehead

"One cannot escape the feeling that these mathematical formulae have an independent existence and an intelligence of their own, that they are wiser than we are, wiser than their discoverers, that we get more out of them than was originally put into them." Heinrich Hertz

"Let nature and let art do as they please, When all is done, life is an incurable disease." Abraham Cowley

"Factual science may collect statistics and make charts. But its predictions are, as has been well said, but past history reversed." John Dewey

"The errors of definitions multiply themselves according as the reckoning proceeds; and leads men into absurdities, which at last

they see but cannot avoid, without reckoning anew from the beginning." Thomas Hobbes

"Mathematicians are like lovers... Grant a mathematician the least principle, and he will draw from it a consequence which you must also grant him, and from this consequence another." Fontenelle

"For if a man who has never seen a fire should prove by adequate reasoning that fire burns and injures things and destroys them, his mind would not be satisfied thereby, nor would he avoid fire, until he placed his hand or some combustible substance in the fire, so that he might prove by experience that which reasoning taught. But when he has actual experience of combustion his mind is made certain and rests in the full light of truth. Therefore, reasoning does not suffice, but experience does." Roger Bacon

"I do hate sums. There is no greater mistake than to call arithmetic an exact science. There are permutations and variations which ordinary accountants fail to discover; hidden laws of number which requires a mind like mine to perceive. For instance, if you add a sum from the bottom up, and then again from the top down, the result is always different." Mrs. La Touche (19th century Math. Gazette):

"Logic, like whisky, loses its beneficial effect when taken in too large quantities." Lord Dunsany

"Nature gets credit which should in truth be reserved for ourselves; the rose for its scent, the nightingale for its song, and the sun for its radiance. The poets are entirely mistaken. They should address their lyrics to themselves and should turn them into odes of self congratulation on the excellence of the human mind." Alfred North Whitehead

"The truth that is suppressed by friends is the readiest weapon of

the enemy." Robert Louis Stevenson

"Give me where to stand and I will move the earth." Archimedes

"The least initial deviation from the truth is multiplied later a thousand fold." Aristotle

"The actuality of thought is life." Aristotle

"How is it possible that this culture loving era could be so monstrously amoral? All our lauded technological progress - our very civilization - is like the axe in the hand of the pathological criminal." Albert Einstein

"Happy is the man who has been able to ascertain the causes of things." Lucretius

"Not everyone whose sole income is wages is a productive worker. A producer is not just any worker but one whose labour increases capital." Karl Marx

"The falseness of an opinion is not a reason for us to object to it.... The question is how far is it life furthering, life preserving and perhaps species creating?" Friedrich Nietszche

"Minds are like parachutes. They only function when they are open." Sir James Dewar

"It is certainly not the least charm of a theory that it is refutable." Friedrich Nietszche

"No one is such a liar as the indignant man." Friedrich Nietsche

"The sick are the greatest danger for the healthy; it is not from the strongest that harm comes to the strong, but from the weakest." Friedrich Nietszche

"Liberal institutions straightaway cease from being liberal the moment they are soundly established: once this is attained no

more grievous and more thorough enemies of freedom exist than liberal institutions." Friedrich Nietszche

"Even a thought, even a possibility, can shatter us and transform us." Friedrich Nietszche

"The art of progress is to preserve order amid change and to preserve change amid order." Alfred North Whitehead

"The best lack all conviction, while the worst are full of passionate intensity." William Butler Yeats

"Bad conscience, the desire for self mortification is the wellspring for all altruistic values." Friedrich Nietszche

"The power and techniques which are available for the control and manipulation of the environment constitute in themselves an environment which we do not know how to control." Herschel the well known British astronomer

"I have never heard of a crime of which I myself am not capable." Johann Wolfgang von Goethe

"The great man of an age is one who can put into words the will of his age, tell his age what its will is, and accomplish it. What he

does is the heart and essence of his age; He actualizes his age." Georg Wilhelm Friedrich Hegel

"The entire historical process is a reflection of historical law through the accidental. In the language of biology, we might say that historical law is realized through the natural selection of accidents." Leo Tolstoy

"Those classes or individuals who are prophets of decline and assume that progress is dead, belong to the class or sector of the world that has played a predominant part in the advancement of civilization in the past." Georg Wilhelm Friedrich Hegel

"The present is pregnant of the future." Gottfried Leibnitz

"The firm determination to submit to experiment is not enough; there are still dangerous hypotheses; first and foremost, those which are tacit and unconscious. Since we make them without knowing it we are powerless to abandon them." Henri Poincar,

"We often think that when we have completed our study of the number one, we know all about the number two, because two is one and one. We forget we still have to make a study of and." Oswald Spengler

"The layman, or the practical man in the street says, 'What is that to me?' The answer is positive and weighty. Our life is entirely dependant on the doctrines of ethics, sociology, political economy, government, law, medical sciences, etc. This affects everyone consciously or unconsciously, particularly the man in the street, because he is the most defenseless." Alfred Korzybski

"I am tempted to think that religious fanaticism, often, is not the result of conviction, but rather of doubt and insecurity." George Sarton

"The social and economic rewards for such scientific activities do not primarily accrue to the scientist or the intellectual. Still that has perhaps been his own moral speciation, a choice of one properly humane activity; to have knowledge of things; not to have things. If he lives and has knowledge, all is well." Thomas Hobbes

"A democracy is no more than an aristocracy of orators." Thomas Hobbes

"The obligation of subjects to the sovereign is understood to last as long and no longer than the power lasteth by which he is able to protect them." Thomas Hobbes

"Specialists without spirit, sensualists without heart, this nullity

imagines it has reached a level of civilization never before attained." Max Weber

"Revolution is a crime until it succeeds. Traditional values are either no longer sacred or nothing but sacred." Paul Valery

"While timorous knowledge stands considering, audacious ignorance hath done the deed." Baruch Spinoza

"Conscience makes cowards of us all and the native hue of resolution is sicklied over with the pale cast of thought and enterprises of great pith and moment, with this regard,their currents turn awry and lose the name of action." Shakespeare

"Men think themselves free in so far as they are conscious of their volitions and desires, and are ignorant of the causes by which they are disposed to will and desire." Baruch Spinoza

"Men of the same trade rarely gather without a conspiracy to the general detriment being contrived." Adam Smith

"Crime is not always vulgar, but vulgarity is always a crime." Oscar Wilde

"So even this 'coherence test of truth' may indicate not as much

the objective validity of the theory, rather as the groove in which the author's mind runs. Instead of his theory being as wide as reality, his perception of reality may be as narrow as his theory." Kenneth Craik

"The visible world is no longer a reality, and the unseen world is no longer a dream." William Butler Yeats

"He who will not apply new remedies must expect new evils - for time is the greatest innovator." Francis Bacon
"The conflicts of thought in the 18th and 19th centuries were governed by the fact 'that the world had got hold of a general idea (Science) which the world could neither live with nor live without." Alfred North Whitehead

"Objects of perception which are presupposed in the common thought of civilized beings are almost wholly hypothetical. The material universe is largely a concept of the imagination which rests on a slender basis of direct sense presentation." Alfred North Whitehead

"There is not a sentence which adequately states its own meaning. There is always a background of pre-supposition which defies analysis." Alfred North Whitehead

"He who has a why to live, can bear almost any how." Friedrich Wilhelm Nietszche

"Half of mens' actions are ruled by chance and the other half by men themselves." Niccolo Machiavelli

"The man who speaks with primordial images speaks with a thousand tongues." Carl Jung

"The long term belongs to the collectivity. The individual must reap the fruits of the season - and unless his natural prodigality and improvidence is curbed, he will devour the cathedrals, the

symphonies and the poems that distinguish our kind from those others that have crawled and climbed over the planet's surface." Friedrich Wilhelm Nietszche

"Two things fill the mind with ever-increasing wonder and awe, the more often and the more intensely the mind of thought is drawn to them: the starry heavens above me and the moral law

"The world has achieved brilliance without conscience. Ours is a world of nuclear giants and ethical infants." Omar Bradley

"The future offers very little hope for those who expect that our

new mechanical slaves will offer us a world in which we may rest from thinking. Help us they may, but at the cost of supreme demands upon our honesty and intelligence. The world of the future will be an ever more demanding struggle against the limitations of our intelligence, not a comfortable hammock in which we can lie down to be waited upon by our robot slaves." Norbert Wiener

Finally, some thoughts about and from Bertrand Russell, one of the 20th century's intellectual giants, and a mental liberator par excellence.

Russell was a universal man. His talents lay in many areas. While he is best known as a mathematician, mainly because of his epic work on the subject with Alfred North Whitehead, he was also a philosopher of renown, a political commentator and activist, an essayist and a writer of fiction. What is refreshing about him is the clarity of his thinking as reflected by the beautiful simplicity of his writings. His mind was truly open. Even towards the end of his life, he remained receptive to new ideas, ever fighting against dogma. Asked whether he was willing to die for his beliefs. "Certainly not," he replied, "I could be wrong."

"If our hypothesis is about anything and not about some one or more particular things, then our deductions constitute mathematics.

Thus mathematics may be defined as the subject in which we never know what we are talking about, nor whether what we are saying is true."

"The history of western culture without mathematics is like Hamlet without Ophelia. Mathematics is like Ophelia: very charming and a little mad."

"The misfortunes of human beings may be divided into two classes: first, those inflicted by the non-human environment, and, second, those inflicted by other people. As mankind has progressed in knowledge and technique, the second class has become a continually increasing percentage of the total. .... At the present moment, large parts of the world are faced with the threat of famine, but although natural causes have contributed to the situation, the principal causes are human. ... For years, the civilized nations of the world have devoted their best energies to killing each other, and they find it difficult suddenly to switch over to keeping each in one place by means of a superabundance in another, as would easily be done if the economic system were in normal working order. ... It is now man that is man's worst enemy."

"The twin conceptions of sin and vindictive punishment seem to be at the root of much that is most vigorous, both in religion and

politics. I cannot believe as some psychoanalysts do, that the feeling of sin is innate, though I believe it to be a product of very early infancy. I think that, if this feeling could be eradicated, the amount of cruelty in the world would be very greatly diminished. Given that we are all sinners and that we all deserve punishment, there is evidently much to be said for a system that causes the punishment to fall upon others than ourselves. Calvinists, by the fact of undeserved mercy, would go to heaven, and their feelings that sin deserved punishment would receive a merely vicarious satisfaction. Communists have a similar outlook. When we are born, we do not choose whether we are to be born capitalists or proletarians, but if the latter, we are among the elect, and if the former, we are not. Without any choice on our own parts, by the working of economic-determinism, we are fated to be on the right side in the one case, and on the wrong side in the other."

"Another passion that gives rise to false beliefs that are politically harmful is pride - pride of nationality, race, sex, class, or creed. When I was young, France was still regarded as the traditional enemy of England, and I gathered as an unquestionable truth that one Englishman could defeat three Frenchmen. When Germany became the enemy this belief was modified and the English ceased to mention derisively the French propensity for eating frogs. But in spite of governmental efforts, I think few Englishmen succeeded in

genuinely regarding the French as their equals. Americans and Englishmen, when they become acquainted with the Balkans, feel an astonished contempt when they study the mutual enmities of Bulgarians and Serbs, or Hungarians and Rumanians. It is evident to them that these enmities are absurd and that the belief of each little nation in its own superiority has no objective basis. But most of them are quite unable to see that the national pride of a Great Power is essentially as unjustifiable as that of a little Balkan country."

"Whatever you think is going to happen ten years hence, and unless it something like the sun rising tomorrow, that has nothing to do with human relations, you are almost sure to be wrong. I find this thought consoling when I remember some gloomy prophesies of which I myself have been rashly guilty. But you will say: "How is statesmanship possible except on the assumption that the future can be to some extent foretold?" I admit that some degree of prevision is necessary. It is a fair prophecy that if you tell a man he is a fool and a knave he will not love you, and it is a fair prophecy that if you say the same thing to 70,000,000 people they will not love you. It is safe to assume that a great modern war will not raise the level of prosperity even among the victors. Such generalizations are not difficult. What is difficult is to foresee in detail the long term consequences of a concrete policy. Few men will run this risk unless they are supported by a theory or

ideology, for it is only these that makes men completely incautious."

"Man is a rational animal - so at least I have been told. Throughout a long life, I have looked diligently for evidence in

favour of this statement, but so far I have not had the good fortune to come across it. On the contrary, I have seen great nations, formerly leaders of civilization, led astray by preachers of bombastic nonsense. I have seen cruelty, persecution, and superstition increasing by leaps and bounds, until we have almost reached the point where praise of rationality is held to mark a man as an old fogey. All this is depressing and in order to escape, I have been driven to study the past and have found that folly is perennial and yet the human race has survived. The follies of our own times are easier to bear when they are seen against the backdrop of past follies."

"If it comes to burning somebody at the stake for not believing the conventional wisdom, then it is worthwhile to remember that after all he may be right and it is not worth while to persecute him. In general if a man says, for instance, that the earth is flat, I am quite willing that he should propagate his opinion as hard as he likes. He may, of course, be right but I do not think that he is. In practice you will, I think, do better to assume that the earth is round, although, of course, you may be mistaken. Therefore, I do

not think that we should go in for complete scepticism, but for a doctrine of degrees of probability. I think that, on the whole, that is the kind of doctrine that the world needs. The world has become very full of new dogmas. The old ones have perhaps decayed, but new ones have arisen and, on the whole, I think that a dogma is harmful in proportion to its novelty. New dogmas are much worse than old ones."

260APPENDIX B

A STATISTICAL PROFILE OF THE HEALTH OF
SENIORS IN CANADA

The following data was culled from a series of Vignettes designed by the National Council On Aging in 1992.

HOW HEALTHY? FOR HOW LONG?

* Between 1975-77 and 1985-87,
life expectancy at age 65 increased for men from 14 to 14.9 years and for women from 18 to 19.1 years.
life expectancy at birth increased for men from 70.2 to 73.1 years and for women from 77.5 to 79.7 years.
* Among common health problems reported by seniors in 1985

55% mentioned arthritis-rheumatism
39% mentioned hypertension
24% mentioned respiratory difficulties.
* Persons aged 65+ in 1985 were twice as likely to report respiratory problems, arthritis or rheumatism and hypertension, and at least three times as likely to report heart trouble than the total population.
* Approximately 80% of persons aged 65+ report one or more chronic conditions in Canada, but only 20% report that they have major limitations to their activities which cause them to need assistance with activities of daily living. (1991 data)

* Between 1971 and 1986, coronary heart disease declined 30% for senior males and 35% for senior females.

MAJOR CAUSES OF DEATH?

* In 1986, the leading causes of death among seniors were
for men, coronary heart disease, lung cancer, stroke and chronic bronchitis, emphysema and asthma
for women, coronary heart disease, stroke, colorectal cancer and pneumonia
* The percentage of deaths due to cardiovascular disease starts to increase quite sharply around the age of menopause in women, and after 35 for men.
* In 1987, 41% of deaths from all causes for men were due to cardiovascular disease versus 44% for women.
* Cancer incidence rises steeply with age in both sexes. The incidence of all cancers combined is increasing at 1.2% per year in males and 0.3% in females. If it were not for lung cancer, mortality from cancer would be stable in males and decreasing in females. About 2/3 of cancer deaths in both sexes occur in persons aged 65+. (1991 data)
* Osteoporosis affects about 25% of postmenopausal women. Hip fractures related to osteoporosis result in death in 12% to 20% of cases and in disability in up to 75% of surviving patients. (1987 data)

* In 1977, 335 seniors committed suicide. (about 10% of all suicides)
In 1986, 473 seniors committed suicide. (about 13% of all suicides; the rate is three times higher among men than among women)

MENTALLY HEALTHY?

* The rate of dementia among seniors was estimated
at 5.6% in 1981 (132,000 seniors)
at 6.0% in 1991 (190,000 seniors)
By 2006, there may be as many as 324,000 seniors with dementia. (an increase of 71% in 15 years)
* The rate of dementia is thought to be
1.4% among persons aged 65 to 69
38.6% among seniors aged 90+.
(incidence increases with age) (1986 data)
* It is estimated that 30% to 40% of seniors living in long-term care facilities have a moderately severe dementing illness. There are 1 to 2 persons with dementia in the community for every institutionalized individual with dementia. (1986 data)
* In 1985, 30% of seniors reported that their lives was 'fairly stressful' or 'very stressful'. (in contrast to 52% of people under 55)

* Loneliness was a problem for 27% of the OAS/CPP recipients surveyed in 1990.

Appendix B - A Profile Of Seniors' Health In Canada263

HEALTHY LIFESTYLE?

* 64% of seniors rate their health as good, very good or excellent for their age. (1985 data)
* In 1985, 92% of seniors said that they were either pretty happy or very happy.
* 51% of seniors report daily or frequent exercise. Another 36% say they never exercise. (1985 data)
* Seniors are half as likely to smoke as persons under 55. (19% vs 37%) Seniors are a third less likely to drink alcohol than persons under 55. (61% vs 87%)(1985 data)
* Studies have shown that 99% of people aged 60+ would like to have sex if a willing partner was available.
* 87% of seniors said that they had not skipped breakfast in the week before being interviewed for the 1985 Health Promotion Survey. More than one out of two seniors also said that they had done something the previous year to improve their health.

CONSUMING HEALTH SERVICES? AT WHAT COST?

* Although the number of geriatric specialists has increased to 87 in 1993 from 5 in 1981, 550 to 700 will be needed by year 2000.
* In 1985-86 nearly 90% of seniors consulted a physician, while only 33% of persons aged 65 to 74 and 22% of those aged 75+

physician, dentist or nurse.
* 53% of Canadians aged 55+ reported that they would be content with a doctor's decision not to prescribe certain medications even if they requested them.
37% said they would approach another physician to get the prescription. (1991 data)
* Women's use of sleeping pills and tranquillizers exceeds that of men. Use also increases steadily with age.
23% of women aged 65+ report current sleeping pill use.
14% of women 65+ use tranquillizers.
Over 60% of women using these drugs reported that their lives were "fairly stressful" or "very stressful". (1985 data)
* 78% of the increase in health care costs in industrialized countries over the past 25 years was due to the number of physicians and to the number and level of services they provide per patient. Only 22% was due to demographic factors including population aging.

Erratum

The following paragraph replaces the paragraph that starts on the bottom of page 128 and continues on page 129.

First, a simple one we are all familiar with: an individual on a bicycle puts in a certain amount of work when pedalling. The amount can be easily calculated by measuring the force on the pedals and the distance the pedals rotate as they are pushed. Multiplying these two quantities yields the measure of work invested by the cyclist. The work yielded by the bicycle is also easy to calculate. It is simply the kinetic energy developed by the

bicycle and rider and is equal to 1/2mv2 where m equals the mass of the bicycle and rider and v equals the final velocity of the bicycle after the force has ceased being applied. Now if the bicycle were 100 percent efficient, the two amounts would be equal. However, when measured, it turns out they are not. The energy in is equal to the energy out but not to the measurable energy out because part of the energy out was heat due to friction developed by the slight skid of the wheels that was dissipated. This inequality is crucial: The useful energy generated by a system is always less than the energy inserted into the system.

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