

SCIENCE & TECHNOLOGY AND SOCIETY\*

Remarks by  
Gabor Strasser  
Strasser Associates Inc.  
SAI  
1502 Highwood Drive  
Arlington, Virginia 22207 USA

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## Abstract

Today there is little argument with the assertion that Science&Technology\* is a pervasive influence on society.

The interaction between Science&Technology and society affects many groups in many ways. These groups include:

- Scientists doing fundamental research in laboratories
- Government officials monitoring R&D contracts or allocating R&D funds
- Industrialists trying to turn a fair profit on some technological innovation
- Consumers availing themselves of technologically intensive products
- Society benefitting from a host of good effects, and occasionally having to cope with some of the bad effects of technology.

The views of these groups are anything but converging, as to what Science&Technology is, or ought to be all about. If the increasing dependence of society for its well-being upon Science&Technology continues, as I believe it will, then we must redouble our efforts to better harmonize the views and attitudes of these groups, such as those listed above.

The key questions seem to be

- How should we use science and technology, so as to serve the greatest interest of society, without doing undue harm to any special group?
- In what direction and to what extent should Science&Technology be developed?
- Who should pay for what parts of what costs in what ways?
- How are we going to preserve and transfer knowledge?

The roles Science&Technology plays in our lives have become too complex, too pervasive and too extensive. Hence, the harmonizing of views and attitudes of the many involved groups is too important to be entrusted to any one group, be it these scientists, engineers, government officials, politicians, industrialists, or educators. Some new institutional scheme, representing a coalition of interested and affected parties, needs to be created to tackle the questions posed above.

What issues must be examined first, and what impediments must be removed before such coalition can come into being are addressed in this paper.

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Throughout this paper the collective term, "Science&Technology", is used in the singular, except where designated otherwise.

## I. Introduction

I appreciate the opportunity to address this distinguished gathering.

As all of you here are aware, the number as well as the complexity of problems facing society are increasing. People, governments, institutions all over the world are groping for solutions. Unfortunately, more often than not, solutions elude us.

An all too small minority of the people who are grappling with or are concerned about such problems finally come to some conclusions: Maybe the way we set our priorities and maybe the way we go about solving our problems (these very processes themselves), must be reexamined and adjusted. Trying to solve new problems in old contexts too often leads to failure.

This group here today, I believe, is representative of the enlightened minority I just mentioned. Therefore, I am honored to be included among you.

A few months ago I had the privilege to address the Japan Industrial Planning Association (JIPA) here in Tokyo on the subjects of the quality of life, productivity, environment, and their interactions. I started out with ten statements to depict the world we live in today, to serve as a context for my subsequent remarks. I found these statements so appropriate for my purposes here today, that I decided to repeat them as a foundation for my remarks to you.

## II. A Context - A Foundation

1. Today, more things are changing faster than ever before. People and nations all over the world are caught up in a reexamination of their values and reordering of their priorities.
2. This is affecting not only the things we do, but also the contexts or institutional frameworks in which we do them.
3. Values, contexts, institutional frameworks are the foundations, benchmarks, and anchors of society. Together they represent some predictable, though not always pleasant haven. Psychologists tell us that such a haven is one of the requisites to keep our balance.

4. Changing the nature of this haven too rapidly can affect us in ways that range from disorientation to chaos. Today, we are finding ourselves in the midst of such a change. The trick is to get by with nothing worse than some mild disorientations.
5. With such shifting values, contexts and institutional frameworks, planning for the future "as usual" is also becoming more difficult.
6. To get around this problem, an adaptive, flexible posture is necessary to take advantage of emerging new, even if strange opportunities, without compromising our basic values.
7. These changes make it more difficult to search for and find the right balance between (1) keeping our options open, while (2) having to take necessary actions. By recognizing this, we can view current changes as providing opportunities, rather than as presenting liabilities.
8. Those who cling to techniques, developed to cater to the problems of the past, but which are no longer appropriate to solve the problems of the present or the future, will find themselves in chaotic situations.
9. In general, we cannot prevent change. However, we can affect its direction.
10. Setting the "right directions" for future changes is probably the most important, as well as difficult challenge facing our generation today.

As is often the case I got carried away and made an attempt to convert the message of these ten statements into a special form of verse of our host country, which then was translated into Japanese by the able interpreting staff JIPA. Here are both versions.

- (1) Ever faster pace,  
makes, compels us to take stock,  
learn to cope anew.
- (2) What is certain now:  
basic values must remain,  
although means must change.
- (3) On strong foundations  
lasting houses we must build.  
But if too fast: Chaos!
- (4) Shifting sands of change  
may blind us to the right way.  
We must use our minds.
- (5) Those who cling to past,  
will not help build our future,  
or even present.
- (6) Change will come to all.  
Let us be in charge of life,  
control ways we go.

①  
 かつて無王か如く早く。  
 新しきものへの対応を  
 学び、学ぶ心を強いられる

②  
 今、左しかたには。  
 基本的価値はとまり  
 方法は変わる

③  
 強固な土台に  
 永遠なる家を建てる  
 しかし急ぎおれば、混乱

④  
 衰亡の礎石  
 正しい道を、おいかしあかひ。  
 頭をゆかえろ



⑤

過去に固執する者は、  
未来を建設することはできない  
現在から

⑥

変化に合せて及ぶ  
生活のたゞ中に身を置く  
我々の行く道もコントロールする

Having thus laid the foundation for my remarks, now I must admit that I have no solutions, only concerns, questions, and some ideas, which I want to share with you to stimulate our forthcoming discussions, in the hope that we will leave this Conference with some new food for thought.

### III. The Evolution of Science and Technology in the Service of Mankind

Science, technology, and man have kept company for a very long time. Technology was perhaps born when man first fashioned some useful device, like a primitive tool, from objects such as rocks or sticks that he found lying around. As he progressed and managed to replicate devices based on his prior "systematized" knowledge (e.g., awareness of the hardness of rocks or the flexibility of sticks), we might say that science was born.

Throughout man's long association with science and technology the relationship has undergone many changes. Victors have rejoiced in weaponry made possible by technology; the vanquished cursed it. The youthful owner of his first high-powered, "technology-intensive" car may be ecstatic, while environmentalists and his parents may condemn it--even if for different reasons. Man first feared fire, then was awed by it, and finally harnessed it for his use.

Not only has the "climate" for science and technology been in an almost constant state of flux, but even at times when it stabilized, it hasn't been free of controversy. And so it continues. The pendulum swings, and periodically things "normalize", often without any purposeful interference on the part of any group.

While it is probably an overstatement that the "enchantment" of society with science and technology is at an all-time low, today the public is anything but enthusiastic about science and technology. Rarely has there been a greater need than today, for effective spokesmen for science and technology within a broad societal context.

The dependence of society's well-being upon science and technology has become so complex, pervasive, and extensive, that relying on random forces to right the pendulum is too risky. We have become an industrialized, technology-intensive society to such a degree that practically all of our desires, actions, and plans are dependent on technology. All one has to do to convince himself of

this fact is to trace his actions during any given day as he gets out from under his synthetic electric blanket in the morning, uses his electric toothbrush and shaver, takes his frozen orange juice out of the refrigerator, drinks instant coffee, drives through smog-filled streets to his air conditioned office, dictates to a machine, telephones a client, watches the news on television via satellite, etc.

As the number of societal options and conflicts increase, science and technology can help improve options and ameliorate many of our conflicts. I believe thus far we have seen only the tip of the iceberg of a whole new generation of conflicts, in our attempts to reconcile personal/materialistic with societal/environmental aspirations.

President Kennedy, when entertaining a group of distinguished scientists in the White House, is said to have remarked that never before has a greater percentage of currently existing knowledge been represented at one time in the White House--except perhaps when President Jefferson was having dinner alone. The remark was merely intended to be a witty one, but it does have a significant message. In Jefferson's time, the scope of our total knowledge was such that a genius like Jefferson could be aware of most of its aspects. Now, less than two centuries later, the knowledge explosion has been so massive that it was said in the 1950's that over half of all the noteworthy scientists in history were still living. To sort out and preserve the fruits of this knowledge explosion for the benefit of ourselves and future generations poses a formidable challenge.

Hard-earned knowledge keeps getting lost. The wheel gets reinvented repeatedly. The capabilities of our scientific/technical storage and retrieval systems have been far outpaced by the rate at which knowledge worth storing is being generated.

The interaction among science, technology, and society is a consequence of a variety of actions by a variety of groups, e.g.:

- Scientists doing fundamental research in laboratories
- Government Officials monitoring R&D contracts or allocating R&D funds
- Industrialists trying to turn a fair profit on some technological innovation

- Educators designing and teaching university curricula in science and engineering
- Consumers availing themselves of technologically intensive products
- The Public benefitting from a host of good effects, and occasionally having to cope with some of the bad effects of technology.

he views and interests of these groups are as diverse as the groups themselves. If the increasing dependence of society for its well-being upon science and technology continues, as I believe it will, then we must redouble our efforts to better harmonize the attitudes of these groups. To do so, we must answer some key questions:

- How should we use science and technology so as to serve the greatest interest of society, while minimizing and balancing in some acceptable fashion unavoidable side effects, without exposing any special group to any undue harm?
- In what direction and to what extent should science and technology be developed?
- Who should pay for what parts of what costs in what ways?
- How are we going to not just generate, but also preserve and transfer knowledge?

Answering these questions in such a way as to satisfy as many as possible of the interests of all concerned is too complex and important an assignment to be entrusted to any one group, be it scientists, engineers, government officials, politicians, industrialists, or educators. What is really needed to tackle the questions is some new institutional scheme, representing a coalition of interested and affected parties.

What this new coalition ought to be like I do not know. I have some ideas as to what the problems are, what things need to be done, and why we cannot do them.

IV. What Are Some of the Problems  
and What Needs to be Done?

As mentioned earlier, national and world resources are strained by the combined effects of population increase and the ever-rising expectations of peoples everywhere. There is a gap between our aspirations and what we can afford. At present this gap is increasing. For the sake of world order, somehow we must arrest this ever-widening gap and then reduce it.

Three obvious ways in combination come to mind to accomplish this.

- (1) We must become more selective in our aspirations and more knowledgeable about trade-offs. We must realize that a choice to get something automatically precludes getting other things, due to overall resource limitations.
- (2) Through various means, we must continue to strive for the magnification, efficient use, and recycling of our ambient natural resources.
- (3) We should concentrate not only on how to make things better, but also on how to use them better. That is, we should be focusing as much on the efficiency of consumption as we have been on the efficiency of production.

We postulate national programs in the U.S. in such desirable areas as health care delivery, education, economic development, and the amelioration of environmental pollution or urban blight, among many others. Most of these are defensible in their own right. It is when we try to put them all together that we run into trouble, since the rationales for such efforts are often in conflict. Or, the total costs of individually desirable and defensible Federal programs may exceed not only the Federal budget, but the GNP many times over.

Today, more than ever, we need to avail ourselves of rational integrated approaches to come to grips with our pressing national problems in some mutually consistent fashion.

Science and technology have served us well in the past, in helping meet national goals and objectives in such areas as defense, space, and nuclear energy. Now they must be joined with ever increasing frequency by other mechanisms of ever greater importance, to solve such problems as environmental pollution, improvements in housing or the upgrading of our quality of life in general.

Because of the great dependence of past national goals upon science and technology, and because of the objectivity and quantifiability of this enabling mechanism, our scientific/technological capabilities have way outrun in quantity, quality, sophistication, and effectiveness most of our other enabling mechanisms. These include our abilities (1) to govern ourselves, (2) to resolve societal conflicts, (3) to "agree" on what a better quality-of-life is, (4) to render law and justice, (5) to decide the kind of education we need and then provide it, (6) to determine the kind of health care we should have and then deliver it, (7) to resolve public versus personal rights in a pluralistic society, (8) to differentiate between and cope with government-imposed risks upon, and self-assumed risks by the individual citizen, (9) to effectively arbitrate hosts of individually defensible, but when taken together, conflicting positions for some common good, and finally (10) to develop policies and mechanisms whereby effective resource development and equitable public consumption could be brought into some better balance, thus reducing disparities that generate conflicts.

As a result society began to view the improvement of these less-developed but essential enabling mechanisms as more important than to concentrate on the further fine-tuning of science and technology. This is one of the reasons why science and technology have been nudged from center stage.

#### V. Shortcomings in Our Present Approach and System

Our current, somewhat fragmented approaches to our problems only work acceptably when available resources substantially exceed the demands that we place upon them. As our resources and demands for such resources come into balance, or turn negative, the necessity for efficiency, overall understanding, and better management becomes obvious. This is the problem we are facing today. When crises occur intermittently with long periods of lulls in between, it is not imperative that we look at our problems in their totality. But, when crises begin to overlap (e.g., intermittent sporadic wars in the world, international monetary crises, inflation and unemployment, social unrest, urban blight, environmental pollution, etc.), it behooves us to sort out these problems and their interrelationships and ask ourselves questions like the following: How can we better use what we have for those things that we consider most important? How do we keep

support for important programs from falling below some acceptable threshold levels? How can the political system get credit from the public for embarking on essential courses of action that are tedious and time-consuming, with the pay-off well in the future? Why must the political system keep proving itself primarily by what it can fix today, especially since most of our pressing problems do not respond to quick-fix treatments?

VI. Where Do We Go From Here?

No one can tell for sure. A few observations, however, are safe to reiterate.

- (1) Technology must become an ever more integrated part of society as a whole. Therefore, national policy will have an ever greater impact on the directions in which technology will be allowed to or helped to move.
- (2) The incidents will continue to decrease, where a significant, pervasive technical development can be undertaken (a) without scrutiny as to what desirable societal objectives the development would support, and (b) without examining the impacts of the development (both positive and negative) upon society, should it be implemented.
- (3) In our world of ever increasing complexity, where our diminishing natural resources are being strained to meet our ever rising expectations and aspirations, all of our enabling mechanisms will come under such scrutiny, so as to get them better orchestrated for the attainment of our goals and objectives.
- (4) Hence it is not implied that technology is expected to play subservient roles, only that it will have to become more of a "team member". Nor is it implied that socialism should supplant our form of government. Quite the contrary. The hard-nosed management techniques of our capitalistic system will have to be invoked on broader and broader fronts so as to assure that our assets are used in a most effective manner in meeting our aspirations.

- (5) Since technology has and will continue to depend on applied research to fill the gaps in technology before it can be put to various uses, and since much of our basic research is funded to underpin our applied research capability, it is clear that whatever will impact on the funding of technology, the same things, to some extent, will impact on the funding of basic research--even if only indirectly or belatedly.
- (6) Since most of the basic research underwritten in the past could be traced to technological needs deriving from national or societal goals and objectives, it is safe to say that the funding of much of our future basic research will be very much influenced by national and societal needs, wants, and concerns. Incidentally the generic aspects of this assertion is anything but novel. The change we can expect is in the mix of the specifics of what society will want on the one hand and tolerate on the other.
- (7) How will we manage our affairs in the future is anything but a foregone conclusion. The need for somehow reconciling differing value systems in a pluralistic society in toto or in parts, so that reasonably clear objective functions may be articulated, is one perceived need. Another is the necessity to form multidisciplinary teams for interdisciplinary attacks on our complex societal problems. We don't quite know yet how to meet either of these needs.
- (8) But even if we assumed that we could state collective objectives, and we did have the proper interdisciplinary teams (of which technology represents but one member), we would still fail.
- (9) We would fail because today's institutional mechanisms are not geared to solve tomorrow's problems. They are failing at coming to grips with today's problems.



(10) Hence the challenge is three-fold:

(a) A better way to determine goals and objectives in light of

- the pluralistic nature of our society
- the conflicting nature of many of our objectives
- the shortcomings in our resources vis-à-vis our various aspirations when taken collectively.

(It may be that some different, heretofore unknown mechanism will have to supplant what is now commonly called: "objectives setting".)

(b) We must make significant strides in building the kind of interdisciplinary teams which are clearly called for to successfully attack the pressing complex problems facing us today.

(c) We must reexamine our institutional mechanisms to see to it that they help rather than hinder in the pursuit of our aspirations.

(11) The challenge for science and technology is to become more integrated team members for the improvement of our many dimensional world. This is the reason why it was suggested earlier, that because of the exceedingly important role that science and technology play in our lives, the policies guiding their applications should likewise be entrusted not to scientists or engineers, or any other kind of group alone, but to some enlightened, many-dimensional coalition.

#### Concluding Remarks

In the future, physical, natural and social scientists will have to do a better job of interrelating and synthesizing their knowledge, and then better integrating it with the knowledge of still others, for coordinated assaults on our many complex problems.

At the same time our sociopolitical and institutional systems must provide the proper incentives and milieu to assure the success of such an effort. Many believe that neither the proper incentives nor the milieu exists today.

Let me attempt a simplistic analogy.

We may view our many, complex societal problems as representing a heavy load to be supported on a three-legged stool.

Let us also assume, in this analogy, that the greater the number and the complexity of our societal problems, or the "heavier the load", the longer the legs of the stool must be--even though this would not make sense from the point of view of structural analysis.

One of these supporting legs represents the sum total of our individual unintegrated knowledge, together with our ambient, unexploited resources. I believe this leg of the stool is adequate.

The second supporting leg may represent our intellectual and managerial abilities to adequately develop, integrate and synthesize the things represented by the first leg, in view of our objective; namely, to support the load, that is, to solve our many complex societal problems. This leg is wanting. It is "too short", if you will.

The third supporting leg represents the institutional, organizational, political mechanisms within which societies, such as ours, must operate. Since these mechanisms are wanting too, the third leg of the stool is not long enough either.

Even if only one of the three legs were shorter than what is called for, the stool would tip over. We are faced with a situation today, where two of the three legs of our stool do not measure up. It is rather clear where our efforts should be focused.