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Senate

JAPAN'S FIFTH GENERATION COMPUTER PROJECT

Mr. TSONGAS. Mr. President, much public attention has been given to Japan's premier technology initiative, the fifth generation computer project. This project commits the resources of government, industry, and universities to the development of an advanced generation of computers with the capability of giving Japan supremacy in the competition to develop information technologies.

I would like to share with my colleagues an article written by Prof. M. L. Dertouzos of the Massachusetts Institute of Technology which provides an excellent account of what the fifth generation computer project means to the United States. As importantly, Professor Dertouzos outlines a framework for responding to the challenge the fifth generation project represents. I urge all of my colleagues to give his ideas careful consideration:

The article follows:

PROFITABLE LONG-RANGE INDUSTRIAL RESEARCH: A RESPONSE TO THE JAPANESE FIFTH GENERATION COMPUTER CHALLENGE

(By Prof. M. L. Dertouzos)

1. INTRODUCTION

The familiar signs of a crisis in progress are once again upon us. Editorials, articles, TV specials, conferences, and corridor discussions bombard us with the newest Japanese challenge—the Fifth Generation Computer Project. Slated to consume upward of \$300 million, this industry university cooperative effort has a very ambitious goal: To convert in only one decade an amalgam of very-long-range research projects into socially beneficial products and services that will give Japan world supremacy in the information field.

Among the many challenges that have come from Japan, this is a singularly important one because it strives to gain control of the Information Revolution, a movement which in analogy to its industrial predecessor promises to radically change our way of life, dominate our economy and have significant geo-political representations.

For Japan, this development is as natural as it is inevitable. It matches their technological orientation and lack of natural resources with a technologically intensive resource that all can possess and no one can deplete—information! For the U.S. this development is critical, for it strikes at the heart of our technological leadership. In blunt terms, it forces us to ask whether we would like to see ten years from now our computer industry in the same shape as today's Detroit. Information processing and communications is, in my opinion, the most important area of prospective U.S. technoeconomic leadership. If we lose our lead in this area, we will suffer serious if not grave economic consequences. In short, we cannot ignore the Japanese challenge. We must respond!

Like every challenge, the Japanese assault on our informational dominance, if properly met, can lead to a valuable opportunity. Thus, in contemplating our response, we should not simply strive to preserve but rather to enhance our own technoeconomic position—a feasible prospect in light of the 10-year warning period that accompanies this challenge. Moreover, in doing so we shall have to reconsider, with some creativity, our traditional practices. In what follows, I would like to examine some of the steps that we might take, in this spirit and toward such a goal.

2. THE FIFTH GENERATION COMPUTER PROJECT.

Our first exposure to the Fifth Generation Computer Project took place nearly two years ago when one of our scientists brought back from Japan the first formal project plan. Our first reaction was resentment! We reacted emotionally because we saw in that plan many of the research projects of our own Laboratory and of our sister, the MIT Artificial Intelligence Laboratory. Dominant among these projects were the dataflow multiprocessor architectures of Professor Jack B. Dennis and the cognitive structures of Professor Gerald Sussman.

Before continuing, however, with the consequences of these early reactions, I would like to summarize for you the Fifth Generation Computer Project. Structurally, this plan calls for (1) multiprocessor mechanisms employing hundreds and later thousands of processors; (2) inference mechanisms capable of deriving higher-level concepts from lower-level ones; and (3) structured knowledge bases. These top-level objects use advanced software subsystems, which in turn, reside on top of a VLSI hardware base.

Functionally, the Fifth Generation project has set the impressive goals of achieving (1) machine translation; (2) speech and image understanding; (3) the construction of expert systems; and (4) applied problem solving.

Enveloping these structural and functional characteristics is a collection of societal and national goals which include: (1) increased productivity; (2) international competition; (3) saving energy and other resources; (4) coping with an increasingly aged Japanese society. Overall cohesiveness is achieved by the project's title, which suggests a generically new system. Finally, national unity if realized by the traditional Japanese cooperation among six participant companies and by the worthy objective of achieving technological and economic supremacy in the computer field.

Earlier comments notwithstanding, the Fifth Generation Computer Project can not be simply characterized as a copy of promising U.S. and European research. The project has been thoughtfully and creatively integrated, and is likely to lead to research approaches and results that will be original and uniquely Japanese. Furthermore, even if it does not achieve the precise objectives that have been set forth (a likely situation), it will undoubtedly create and educate a large number of specialists in Artificial Intelligence, multiprocessor architecture, and related fields.

Our initial anger at this plan quickly gave way to a different anger which, mixed with frustration, was directed at our own industry! The realization of this not-so-subtle transformation became clear to us when we confronted our Japanese colleagues, including the leadership of the Fifth Generation Project, with the inevitable question "Why in the world did you copy us?" Two answers were given: "You are research leaders. We follow!" and "You are interested in theoretical and prototypical results. We want to make real products and applications!" In their simplicity and directness these answers confirmed the well-known purpose of University research as the free pursuit and dissemination of ideas; and the natural consequence that when these ideas are good, they ought to be reduced to industrial practice.

It was through this chain of events and thoughts that the Japanese Plan led us to focus our attention on our own industrial complex—a system, that with few exceptions, is currently incapable of pursuing ideas with a very-long-term gestation period. The reasons for this uniform corporate behavior rest, of course, on the nature and dynamics of our free enterprise system: Our

corporate leaders strive to increase profitability and net capital assets in quarterly, or at best, two-year time frames. This is what we demand of them as directors and as stockholders, and this is what the Government silently endorses with its regulations and its taxation.

The success of the Fifth Generation Computer Project as a rallying force within Japan, and a perceived economic threat outside, is undoubtedly rooted in the spectacular and tangible achievements of that country during the last thirty years. These achievements, in turn, are attributed to the attitudinal, cultural, managerial and work characteristics of the Japanese people. As a result of this realization, several U.S. proposals have been advanced calling for initiation in one way or another of these admirable traits; for example by radically changing our educational system and our management approaches. While there are undoubtedly many ways in which we could improve our own business practices by learning from the Japanese, I believe that creative exploitation of our own technical, social and economic system is preferable to blind imitation of theirs!

3. PREREQUISITES OF OUR RESPONSE

In order to be successful, I believe that our response should recognize the following assumptions:

3.1 It must work well within our own free enterprise system: Indeed, it must take advantage of the competitive and profit threads that make up our economic, political and social fabric. This assumption means that centralized research, government controlled cooperation, or the sharing of competitive secrets are not appropriate responses.

3.2 It must be a "U.S. positive" rather than a "Japan negative" approach. Thus, trying to stop the Japanese is not a feasible alternative. In particular, realization of the recently evolving trend to close our basic technology doors and keep our own advances from others can only lead to trouble! This is so because the uniqueness and the traditions of the U.S. in all of its endeavors are deeply rooted in the free enterprise of products, services and ideas. It is furthermore impractical because of the growing presence of multi-national corporations that diffuse national boundaries. To be sure, corporate secrets and technological applications that are vital to our national security must continue to be protected. But the rising proposals to arrest the export of basic science and technology, e.g. by restricting research publications and the educational activities of foreign students may have in the long run a negative effect on our overall national interest, precisely because such practices run counter to our basic principles.

3.3 It must strive to improve our productivity, i.e. to increase the quality and reliability of our products, at reduced costs. The Japanese have already demonstrated that our preconceptions to the contrary are simply wrong! Namely, increased quality and reliability can be achieved concurrently with lower product costs.

3.4 It must focus on long-term, high-technology research and development. Information-related high technology has always been our strength. In the past, it was also accompanied by a considerable time lead, primarily because of the absence of any serious international competition. Now, however, that this time lead is shrinking, we must consciously strive to lengthen it.

These assumptions lead us quite naturally to the following conclusion: Our response should strive to improve our productivity and to make very-long-range U.S. industrial research attractive and effective within our free enterprise system.

4. TOWARD A RESPONSE

The particular response that is the focus of this conference seems to fit the above prescription in several ways. I will not discuss it here, however, since that is our purpose during this entire meeting.

At the outset I must also admit that I have no concrete ideas on the first part of our response, namely on how to improve our productivity. This is, I hope, excusable and understandable since product quality, reliability and cost are not normally pursued in the University. This knowledge and experience, however, does reside among you—the representatives of our leading corporations. You must accordingly be the principal architects of our response in this area. The only suggestion I can make is that this meeting be viewed as a first step in a continuing dialogue, which will hopefully yield some tangible results. Perhaps what is in order here is an inter-company consortium whose principal purpose is to continue active discussion and search for such an approach. More concretely, I would like to hope that if nothing else were to come out of this conference, you would at least agree to set up such a group and discuss, on an inter-company basis, the problem of improving our productivity.

Proceeding now with the second part of our response I would like to raise for discussion an approach that is aimed at making very long range U.S. industrial research attractive and effective with our free enterprise system. This approach can be viewed as complementary to the main theme of this conference, or indeed to other approaches that we may wish to pursue. It is based on the following two ingredients:

4.1 Substantial short-term credits are made available by the government against long-term profits, to companies that pursue long-term research projects, e.g. with a product or service payoff 5-15 years in the future.

4.2 A consortium of leading non-profit research institutions identifies promising long-term research projects, serves as a clearing house to reduce duplication of effort, and acts as a communications medium for the participating corporations.

Let us now look at how U.S. corporations, the government and the above consortium would contribute to lengthening the time span of industrial research. First, corporations would have at least three interrelated incentives for pursuing long-term research: (1) an increase of current profits through reduced taxation, (2) the immediate benefits of unplanned research fallout which invariably accompany long-range research, and (3) the potential long-term benefits of the research itself.

The Government would experience a short-term deficit in funding the above tax credits, but would recover it in the long-run from the long-term corporate profits that would result from such research. Correspondingly-long-term government bonds or other instruments could be used to finance these credits, and the entire cycle could be further tuned to absorb the financial risks associated with long term research. Besides these financial considerations, the Government would also have the added incentive of discharging its obligations to the people by improving the long-term basis of our corporate infrastructure.

The consortium of leading non-profit institutions would do what its members do best, i.e. the identification of novel high-risk research ideas. These ideas, in turn, would be made available to the participating companies on a select-as-you-wish basis. Thus, a company could choose to pursue long-range research on ideas generated either by its own people or by the consortium—in either case, under that company's own control. Furthermore, before making this choice, such a company would also know from the consortium's records the number and the names of other companies which are pursuing various specific ideas. In this way, a company might choose to attack a project either because no one else is pursuing it, or conversely because it cannot afford not to compete with the companies that have chosen it. The information shared through the consortium would be controlled by the participating companies, and would inevitably

bly become sparser for any given project as individual breakthroughs are achieved and reduction to practice approaches. The consortium would also help in the communication process among the companies, thereby providing the equivalent of an antitrust shield. In this capacity, the consortium could also be used to search for or coordinate other inter-company approaches that may evolve beyond or in lieu of this approach. Finally, the incentives for the consortium would be the potential realization of its ideas and the funding received for their identification and early research.

CONCLUSION

A response to the Japanese challenge is a necessity and even an opportunity for the healthy development and growth of U.S. Information Technology. To be successful, our response must rest upon and indeed amplify the fundamental forces behind our own social and techno-economic heritage. It is in this spirit that I have made my remarks and that I join you in today's continuing discussion.