THE NEW CLIMATE FOR JOINT RESEARCH

CONFERENCE PROCEEDINGS

May 13, 1983

U.S. DEPARTMENT OF COMMERCE
Office of the Assistant Secretary for Productivity, Technology, & Innovation

Abstract

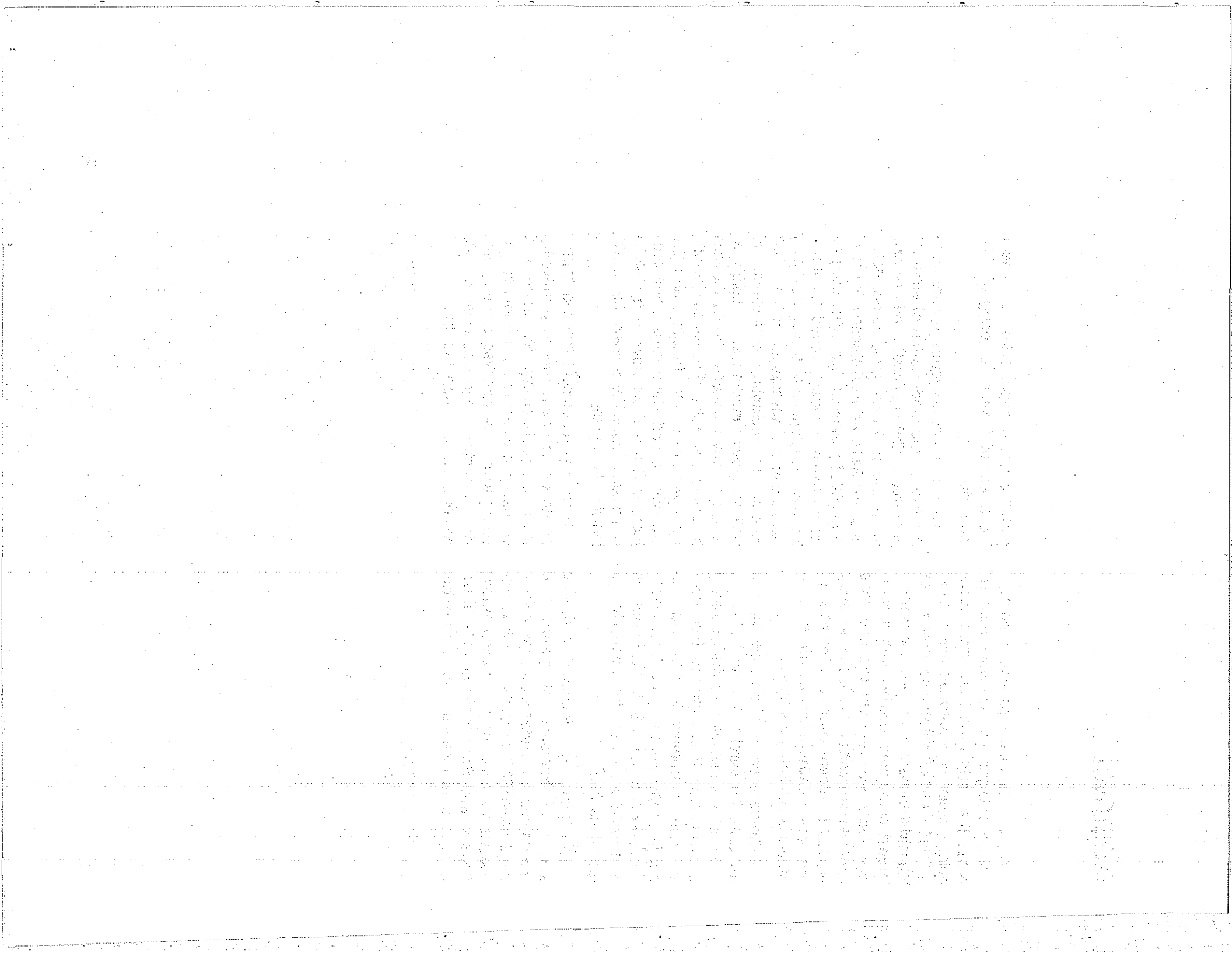
The U.S. has incomparable technological advantages over all other nations. It has the world's most advanced technology, a unique entrepreneurial culture, an unparalleled depth and breadth of industrial infrastructure, and the world's largest contiguous market with a common language. And yet this country's competitive position has been seriously eroded in recent years in a number of important industries. Leadership in others is similarly threatened.

A Conference on "The New Climate for Joint Research" was held May 13, 1983, at the invitation of the Secretary of Commerce. It brought together leaders from government, industry and academia to discuss the need for collaborative R&D if the U.S. is to reestablish and maintain industrial leadership in global markets.

The Conference focused on private sector mechanisms and government incentives for undertaking innovative large scale R&D projects. Panelists discussed the need for cooperation among Federal and State governments, business, and universities in order to better mobilize latent capabilities, and meet the threat of foreign targeting of U.S. industries.

Areas of maximum leverage were identified to be the modification of antitrust laws that inhibit cooperative efforts, and the provision of more effective tax incentives for R&D. An R&D Limited Partnership (RDLP) concept was articulated as an off-balance-sheet method for funding new developments through existing tax incentives. Advantages of the RDLP include: its availability to declining as well as growth industries; its ability to fund new developments without the loss of equity ownership that usually results from venture capital funding; and the capacity to undertake large scale projects that would be beyond the skills or resource capability of even the largest individual company.

There was agreement that the appropriate government role in promoting increased productivity, innovation, and cooperative effort is as a nonintervention-ist agent that removes barriers, provides incentives, and coalesces private sector initiatives where feasible.



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Preface

Successful translation of research and development into technological innovation and new products and processes is essential to economic growth, job formation, and international competitiveness. Advanced technology industries are important contributors to the economy in their own right and, in addition, can contribute new technology to upgrade the competitiveness of our traditional industries.

Foreign countries are targeting technology intensive industries. Accordingly, it is important for continued U.S. leadership that we work to remove barriers to innovation, and to provide appropriate incentives for translating new ideas into new products and processes. Otherwise, much of the innovative, basic R & D that is done in the United States will continue to be underutilized. In addition, we need to insure an adequate supply of scientists and engineers, access to capital at competitive rates, implementation of a managerial style which recognizes the technological and marketing imperative of dealing with constant changes, and a stable economic environment conducive to business investment and decisionmaking.

Cooperative R & D ventures can bring together a critical mass of resources necessary for the development of today's complex, often costly technologies, where individual companies, even the largest, working alone, cannot achieve the necessary scale of effort.

Joint research and development programs can have major procompetitive effects. Consortia can attack large-scale projects, otherwise out of reach. In addition, they can create new firms or rejuvenate existing firms. Smaller firms especially can benefit by gaining access to new technologies. Joint R & D programs can also reduce costly duplication of effort, provide efficient use of scarce technical personnel, and lead to necessary economies of scale in production.

In May, the Commerce Department brought together senior level executives from government, academia and the private sector to discuss the factors affecting cooperative R & D ventures. The Conference was called, "The New Climate for Joint Research." It presented seminal ideas for enhancing U.S. productivity and competitiveness by strengthening the process by which technological innovations are created and brought to the marketplace. The consensus was that Federal and state governments, businesses and universities must work together to promote greater numbers of cooperative research projects.

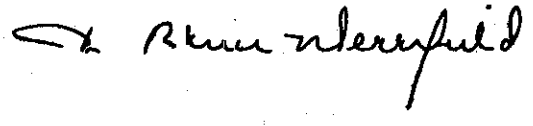
There also was general agreement that research and development limited partnerships, which are being used increasingly in a number of different technology areas, are a viable alternative financing mechanism.

Government policies must support industry in the development of new technologies. The comprehensive Administration strategy that is being pursued to do this, targets the many faceted process of innovation itself rather than selected end-products of the process. Basically these initiatives fall into the categories of: removing barriers to innovation, providing incentives for private sector initiatives, and catalyzing these initiatives in non-interventionist ways.

U.S. firms continue to express the view that they are handicapped in competing in international markets because antitrust laws inhibit joint R & D. The Departments of Commerce and Justice, as well as a number of Congressional committees, are seeking to remove antitrust barriers to innovation. Since the time of this Conference, the Administration has submitted to Congress "The National Productivity and Innovation Act of 1983," which would ease antitrust laws related to joint research ventures.

We possess the world's most advanced technology in numerous areas, an enviable industrial infrastructure, incomparable entrepreneurial and venture capital ability, and a large, integrated market. As the world economy undergoes major changes, we must work together to insure that the U.S. retains its leadership in innovation.

Conferences such as the one held in May are important to bring together the different groups that contribute to the innovation process. I would like to extend a special thanks to those who worked to make the Conference so successful, the speakers and invited participants; and the Department of Commerce personnel who assembled this document—Ago Ambre for his editorial expertise, and Carolyn Walker and Elaine Cardone for their secretarial assistance on the transcript and proceedings.



Executive Summary

I. Nature of the Problem

Secretary Malcolm Baldrige stated that "strengthening our industrial competitiveness is the most pressing need facing the United States today." Political and economic pressures are developing in every industrialized and developing country to increase exports and reduce imports. These pressures can be relieved by expanding the global economy, and expansion can only come through new technology.

Moreover, new forces of change will continuously restructure U.S. and world economies. At the same time, increasing international competition will accelerate and intensify structural changes caused by new technologies. These structural changes will be marked by increasing unemployment in declining industries, but with a growth of jobs in new areas. Greater attention will be given both to the promotion of high technology and to the reskilling of those who lose their jobs.

Other nations also are turning to technology development and application as a substitute for unsuccessful economic intervention. However, promoting "national technologies" could generate more protectionism, and trade and investment distortions. The U.S. will need to take positive actions in the face of these changes that are occurring, not just reactive "countermeasures" to other countries' actions.

A decade ago, the United States with only five percent of the world's population, generated about 75 percent of the world's technology. Now the U.S. share is about 50 percent and will continue to decline, but not because the U.S. will be generating less. The other 95 percent of the world is contributing more, since every nation understands that the application of technology is required for increased quality of life.

For example, according to Senator Mathias, spending for research and development as a share of GNP in the United States, has declined by one-fifth, while Japan's ratio has increased by one-third. Japan's positive trade balance in high technology products grew 35 percent from 1962 to 1980, while that of the United States grew only 12 percent. The U.S. world market share of high technology products declined by 15 percent during this period, while Japan's rose by 25 percent.

Policies of Japan and other governments to promote technology include:

- Subsidies for private sector development.
- Private sector/Government/University cooperation and coordination.
- Providing for government-industry communication, cross-fertilization of ideas, and a common perception of trends.
- Shielding home markets from foreign products.

The underlying question is then, what should U.S. policy be in the face of rapidly increasing world competition?

II. Policy Options

Howard Johnson of MIT called for developing a stronger national consensus for the U.S. to remain in the forefront of technological progress. Congressman Zschau said the U.S. should target the process of innovation, not industries. The government role in this process should be to ensure: 1) a commitment to basic research; 2) incentives for investment; 3) trained personnel; and, 4) export opportunities.

Harald Malmgren pointed out that the way R & D programs are organized is crucial. Abroad, cooperation and coordination of effort are combined with a modest amount of official support to reduce risks. Also, information sharing is seen as one key to reducing redundant exploration by individual firms. Separate efforts are coordinated so that an overall new technological system can be introduced, and some foreign governments are attempting to develop a common perception of future trends.

According to Malmgren, there is no such effort underway in the United States. There is little formal cross-fertilization of ideas, with the result that some industries do not fully understand the extent of the technological

changes that are occurring. Results of government-sponsored R & D must be disseminated so that even medium and small companies can benefit from this work. There is also a need to allow declining industries to consolidate—to alter antitrust laws not only to encourage R & D, but also to permit basic industries to rationalize.

Strengthening the competitiveness of American industries in the international arena calls for an economic climate that encourages the market to work as well as possible. Noninflationary growth, incentives to invest, and reasonable regulations provide the framework within which specific approaches can produce optimum results.

With technology seen as the key to competitiveness of U.S. industries, the symposium addressed (1) ways to increase efficiency in developing and applying advanced technology through cooperative efforts; (2) tax policy and financing R & D between the basic discovery phase and full scale commercialization; and (3) antitrust considerations in joint R & D.

III. Technological Cooperation

The U.S. performs about half of the world's R & D, much of which is redundant and fragmented among many companies. Foreign nations, on the other hand, allow or encourage pooling of skills and technology in collaborative efforts subsidized by the government. As a result, no individual U.S. company can compete against a nation that targets its product line. Therefore, competitiveness in global markets increasingly will require collaboration among U.S. companies. Moreover, the government role can no longer be an adversarial one, but rather must be a collaborative one that removes barriers, provides incentives, and catalyzes cooperative private sector initiatives without direct government invention.

Arguing for broad based intra-industrial cooperation was William Norris, who pointed to Control Data's successful participation in five consortium organizations. The United States is suffering needlessly from wasteful duplications of R & D among large firms. Fortunately, the move is underway to address this problem in the electronics area through cooperative research ventures, according to Norris.

Cooperative industry efforts were exemplified by the Semiconductor Research Cooperative (SRC) and by the Microelectronics and Computer Technology Corporation (MCC). SRC funds projects at many universities, partly to attract talent into the field and to develop many academic centers of excellence. MCC will be staffed to a considerable extent by personnel from shareholder companies. Its goals include R & D projects that individual firms could not afford on their own, reducing duplication of effort, and creating a better identification of R & D needs.

As Erich Bloch of IBM pointed out, research is the key not only to innovation but to productivity as well. Increased productivity in the computer industry has been based on a continuing flow of new ideas. George Low (Rensselaer Polytechnic Institute) agreed that lack of U.S. competitiveness in world markets stems from a relative decline in productivity and quality. He called for experimentation and flexibility, directed toward improved innovation, quality, and productivity.

Technological cooperation between industries and universities is a complex process. Low noted the basic differences between the output orientation of industry and the pursuit of knowledge for its own sake by the university. Reviewing eight categories of university-industry relationships, he pointed out that such linkages will be successful only if they are based on educational programs of intrinsic academic value.

State government efforts to encourage technological cooperation were addressed by John Mutz, who reviewed Indiana's activities to provide venture capital and to set up an extension system similar to the agricultural extension system to supply expertise to business firms. These efforts have been put on a permanent basis with institutional structures

like the Corporation for Science and Technology, which will allocate $150 million to R & D over the next eight years. Private-public partnership corporations were found to be an effective means of creating a forum for reaching consensus in Indiana.

IV. Tax Policies for R&D and the Use of Tax Incentives through R&D Limited Partnerships

Besides increased spending for basic research, the U.S. must increase its efficiency in *developing* and *applying* technology. Tax incentives can be a powerful stimulus to the application of advanced technology for increased productivity. Provisions of the Economic Recovery Tax Act (ERTA) and reduction of capital gains taxes from 49% to 28% has stimulated an explosion of venture capital funds over the last three years. However, incentives now in place are still uneven and require modifications and extensions.

Bruce Merrifield pointed out that there is a significant gap in incentives for funding applied research and development. The result is that foreign countries are acquiring advanced U.S. technology at very low cost and at a vulnerable (under capitalized) stage of development. Research and Development Limited Partnerships (RDLPs) offer a funding mechanism to fill this gap.

RDLP's are not new but did not begin to be widely used until after the Supreme Court's ruling in the 1974 Snow case. RDLP advantages include:

- They draw upon previously untapped venture capital—rather than on more traditional retained earnings or borrowing by corporations—for off-balance-sheet financing of R & D.

- They reduce or minimize risks for producers or users of innovations by transferring that risk to a larger number of limited partners.

- They permit the general partner to pursue R & D objectives that would be beyond the capacity of individual companies, in terms of skill or resource availability.

- They generate a continuing source of income to fund additional R & D which is further from commercialization (beyond five years), for which private financing is very difficult to obtain; and royalty payments are deductible to the corporation paying them.

- They offer the possibility that some government R & D might be financed through private sector funding if government labs were allowed to establish RDLPs or perform research for them.

John Chapoton of the Treasury Department agreed that, if there is a gap in funding of product development by the private sector, we should consider use of tax or other government policies to help fill it.

However, tax policies for R & D were generally found wanting. The incremental R & D tax credit is not available for R & D limited partnerships, or for start-up companies, which may be more than doubling their R & D spending. Also, it is not permanent. The consensus was for making the R & D incremental tax credit permanent and taking into account the special situation of small, rapidly growing firms. R & D tax credit provisions were cited by Erich Bloch as a major factor in launching the Semiconductor Research Corporation.

Chapoton acknowledged the lack of tax credits for RDLP arrangements and agreed to consider the need for new tax incentives for R & D and RDLPs. He also mentioned that software regulations would be significantly altered, and called for assistance in defining software and R & D.

Nicholas Moore of Coopers & Lybrand described the advantages and disadvantages of RDLPs, explaining that their payback is realized in long-term capital gains rates. He concluded that the concept is technically

sound. Charles Kokesh (Technology Funding, Inc.) pointed out that tax benefits are not the only incentive to setting up an RDLP. The expectation of a reasonable risk-weighted return is an equally important incentive.

Kokesh stated that "as the financing of these kinds of arrangements becomes more generally known, both to companies and to investors, a completely new financing industry will be created." He estimated that $2-3 billion per year would be invested in high technology companies through this mechanism.

V. Joint Research and the Issue of Antitrust

Foreign nation targeting of specific industries can overwhelm the capacity of individual U.S. companies to be competitive. It takes advantage of U.S. antitrust laws that inhibit both collaborative efforts in R & D, and rationalization of declining industries.

Professor Jesse Markham (Emory Law Center) emphasized that the U.S. is the only nation that has a comprehensive antitrust system under which its business must operate. Our system, drafted to suit needs of the nineteenth century, will not necessarily best serve us in a global economy. For, as Peter McCloskey of the Electronic Industries Association pointed out, even if American companies don't export, they still must compete against foreign countries in the domestic market.

The U.S. needs to modify its antitrust laws. Senator Mathias stated that traditionally, there has been very little joint research. In order to increase the number of these ventures, we need to make clear up front what business can and can't do. Uncertainty is a key by-product of the present system, and this lack of clarity in the antitrust laws unnecessarily hampers legitimate resource pooling in R & D.

The industry view offered by Peter McCloskey is that antitrust needs simplification and clarification, regardless of existing guidelines. Congressional support for R & D cooperation appears to be growing. The bill introduced by Senators Mathias and Hart on Joint Research and Development Ventures would permit self-certification by companies that want to start a joint venture. According to the bill, only if a firm has a 25 percent or greater share of the world market of a product, and its participation would cause the R & D joint venture's collective market share to exceed 50 percent, would it have to obtain special permission from the Justice Department.

However, William Baxter stated that the Justice Department's antitrust enforcement role is perceived to be more of a threat to R & D cooperation than it actually is. While considering rivalry in R & D highly desirable, Baxter does not view joint R & D as being in the same category as other activities that clearly restrain competition.

But treble damage suits do inhibit R & D according to Baxter, who sees the need to eliminate such suits, as well as change antitrust with regard to patents and copyrights, which affect incentives to invest. He stated his willingness to "take away" all private antitrust actions against joint research, including treble damages, as long as Justice retains the prerogative to seek an injunction against activity it deems harmful.

Baxter also indicated that the "relevant market" in determining market share often is now the international rather than the domestic market.

Irving Margulies' statement (Department of Commerce) outlined the tailoring of policies and antitrust laws by our major trading partners to permit joint R & D; as well as the fears of U.S. industry that joint R & D arrangements may risk treble damages and criminal sanctions under existing U.S. antitrust laws. Although recognizing the strong sentiment in the Justice Department and in the Congress to remove treble damages and criminal sanctions with regard to R & D ventures, several industry representatives expressed the view that clarification of the application of antitrust law to R & D joint ventures is overdue.

Conclusion

The consensus was that increased joint research and development ventures are essential to economic growth and international competitiveness. Cooperation among government, industry, and academia is required to bring this about. As a form of financing large-scale R & D projects beyond the technical or financial capability of an individual firm, research and development limited partnerships are an effective national response to foreign industrial targeting strategies.

Proceedings

Economic Recovery: The Stage is Set

Malcolm Baldrige
Secretary of Commerce

Good morning. It's Friday the 13th so you know you must be in Washington today. I was supposed to talk about the economic scene. I will touch on it, but first, I would like to state clearly that in my opinion, increased productivity and the fostering of technology are among the most important endeavors that American business can be involved in today. We're in a worldwide race; everybody here knows it. But the importance of that race to our future is perhaps more than any of us can fully appreciate at this time.

I think the most pressing need facing the United States today is to strengthen our industrial competitiveness both at home and abroad. Jobs, a rising standard of living, even world leadership is going to depend upon industrial competitiveness, perhaps more than any other single factor in the future. And competitiveness will require continual adaptation to the basic structural changes that are taking place all around us. These are great changes, and they are proceeding at a more rapid pace than most of us can assimilate. In effect, no one can fully comprehend everything that's going on.

There is growth in the output of sophisticated products in Third World Countries, and this growth will continue to accelerate. This growth is fueled by the increasingly rapid transfer of technology from developed to underdeveloped countries. The U.S. no longer has a monopoly on technology; we're all aware of that. But, one of the important facts is that nine out of ten scientists and engineers, who have ever lived in the history of the world, are now living and working. That means that although the United States currently has more than its share, not all of these people, by any stretch of the imagination, are living in the U.S. And that means that there is no area of technology in which we can count on maintaining clear leadership since others in the world will be continually trying to get ahead of us.

The President has certainly tried to create a better climate for economic growth. There's no way we can't have a recovery. So, let me just put that to one side. I do worry about future years because of the Federal budget deficit. Theory says that large budget deficits historically have never been correlated with high long-term interest rates. But no one can prove that, and I don't want to be in an Administration that tries to prove it one way or the other. I'm afraid of the way the proof might turn out; and we can't afford to take the chance. As it is, nine out of ten people in financial markets believe that high budget deficits do create the expectation of more inflation, and therefore, force long-term interest rates up.

Also, logic tells us that if a little over six percent of the GNP goes into savings, and the budget deficits are taking up four or four and one-half percent of the GNP, then it doesn't take much to see that only one and one-half percent is left for job-creating productive investment. Traditionally, half of what's left over for productive investment has gone into housing in the United States. So, if you cut that one and one-half percent in half again for job creating investment in areas other than housing, then not enough is left to accomplish what has to be done in this country. So, I view budget deficits as a very serious problem. I think it should be Priority Number One. I'm worried about whether Congress has the political will to face that problem squarely. There are some who believe, that even with a

deficit higher than I'd like to see, the coming recovery will be strong enough to create sufficient additional investment capital.

As for our policies for technological innovation, I think they need to be focused on improved product performance and quality. I'd like to underline quality three times, because I've been in management for some time myself, and I know what American quality is and could be. Too many industries have slipped in relation to their competitors in other countries. We had the best managers anywhere in the 1940s and 1950s. But in the 1960s, we began to slip. It wasn't that American management went backward, it just didn't go forward, while other countries were going forward.

I've seen good Mexican managers, for instance, that are as competent as any we have in the United States. That may be hard to believe, and the President of Mexico doesn't even believe it. He thinks that Mexican business has to be subsidized. I had a chance to tell him on this last trip that I have great faith in what his businessmen could do if they were just turned loose without Government subsidies. If these subsidies were just removed, you'd see some amazing results.

The same is true, obviously, about Japan, Germany, or any other country. American management has been too complacent, has rested on its laurels in too many instances. So, when I talk about quality, I mean the kind that comes from having people really understand, in the manufacturing and engineering processes, the difference between top quality and just run-of-the-mill performance that can be beaten by other countries.

We have graduated too few engineers, and too few skilled people who want to work in the factory. I've personally advised about 200 young people coming out of school. I've given the same pitch to all of them. I told them, if I were your age, I would go right into a plant because that's where we're short of good management. That's where we're getting beaten. It's no good to have a computer up in an ivory tower building models of quality control, when carrying out the model down on the shop floor is the real problem. It's imperative that we get that across. My success rate in giving this advice probably has been about two percent. Everybody wants to wear a white shirt and work in the main office. This has to be changed around either by a combination of pay incentives or the right kind of recruiting.

The problem is that we talk more about quality than we produce it, in too many of our industrial operations. And innovation too, certainly has to be of high quality if it's going to be successful. The responsibility for innovation rests, obviously, with the private sector. The Government has an important support role, wherever there are problems that business alone can't handle. And these problems have to be addressed in a cooperative manner between the two sectors.

On the Government side, the 1984 budget contains an increase of 17 percent in research and development funding, including a 10 percent increase in basic research. I'm not sure those statistics are the way they should be. Maybe that's one of the things we can talk about here.

We've proposed specific actions to upgrade science and math instruction and provide awards for new Ph.d's in technical disciplines. We've strengthened the Federal patent policy to enable most Federal contractors to obtain title of the inventions they produce with Federal funding. We passed the Export Trading Companies bill last year. That removes some antitrust barriers at the international marketing end of the innovation process, and we will talk today about the Commerce Department's new Industrial Technology Partnership Program in helping with development costs.

But there's much more that needs to be done. We need to reshape business management practices to emphasize the kinds of improvements we've talked about. We've got to get into long-term strategic planning and research planning with a clear view of the global market, not just the domestic market. We in Government, have to work with you in addressing the expected technical manpower shortages and in improving measures for worker retraining, to insure a reasonably

smooth transition in this period of industrial restructuring. That's a big job that does not admit to any easy answers.

The challenge is to make use of all resources, both public and private. The Government challenge is to remove barriers and provide incentives where necessary. And it's the job of the private sector to make the implementing decisions that get us back on track and keep us on the track. Some of those decisions may be painful in the short run, but we've got to think about the long run now. We've thought too much about the short run in the past.

This Administration has a strong feeling which I'm sure you share, that the Government should not target or direct industries, or pick winners or losers, or try to reallocate the money flows to any particular sector or group of sectors. We don't think anybody is smart enough to be able to do that as well as the marketplace can.

I don't think that point is in question. But I hear so many speeches that are negative about what the Government can do. A speaker will spend 15 minutes on a list of things that the Government shouldn't do, and take one minute to suggest what the Government should do. I would like to stop talking about what the Government shouldn't do. I'd rather have this discussion center around what the Government rightfully can do in partnership with our kind of market economy. We will have to develop policies that will enable us to stay ahead in the technological race and to deal with, not just the Japanese, but other competitors who deliberately target our industries, protect their infant industries, and subsidize others, while protecting their home market. They then call for free trade when a given emerging industry is up to speed and can compete abroad.

Right now we have no effective responses to such tactics. We have an even more complex situation, with the developing countries' $550 billion dollars worth of external debt, that has to be paid off in hard currency. That means that those countries must either export more, or import less (or some combination of the two), to earn the hard currency necessary to pay off their debt.

At the same time, industrialized countries are experiencing a lower rate of economic growth than they did in the 1960's and 1970's. And that causes great political problems at home. There is massive unemployment in Europe because virtually no new jobs have been created there in the last decade. U.S. unemployment also is too high, but it is on the way down. In contrast, however, our job creation has grown rapidly in the last ten years.

So there are tremendous political pressures in the developed countries to raise GNP by increasing exports. Of course, the developing countries have to increase exports too, because of the IMF strictures. As a result, almost every country in the world is under great pressure to increase exports. At the same time those countries are under great pressure to reduce imports. These are conflicting needs and it's impossible for them to be realized at the same time.

How do we address this problem? The only way is to expand the global economy. And this can happen only through continual innovation and technological change. World leadership more than ever will be determined by technology leadership, since advanced technology is the critical factor not only in military security, but also in trading relations, and in rising productivity in the home market. Free trade will not be possible without an expanding world economy, and U.S. leadership in technology can make this happen.

So this is an important subject that we address here today. We have an outstanding group of speakers and I wish you well in this Conference.

Forces of Change: Need for Innovative Action

D. Bruce Merrifield
Assistant Secretary for
Productivity, Technology and Innovation
U.S. Department of Commerce

Thank you, Mr. Secretary. The introductory comments you have just heard underscore the urgency of understanding and coping with the great forces of change that are going to continuously restructure U.S. and world economies over this next decade.

In fact, management will be, by definition, a management of continuous change. There are a number of forces now operating worldwide that are of overriding interest.

One of these has been an adverse synergism between chronic inflation and former U.S. tax laws. The bottom line is that much of smokestack America has eroded its assets, in real terms, in seven or eight of the last ten years. A second great force for change is the technology explosion that has created something like 90 percent of all the knowledge we have in the world in the last 30 years. It will be continually obsoleting facilities and equipment, long before their useful lives can be realized. A third force is the "targeted industry strategy" that the Japanese have modeled so effectively, that it now is being copied worldwide; and a fourth is what I call the petrochemical shift. It really is the emergence of lesser developed countries into the world scene, capturing market share in industries that are dependent upon scarce natural resources over which they have control.

The over-simplified arithmetic below illustrates the adverse synergism of inflation with former tax laws.

Return on equity is an after-tax number, supposedly representative of retained earnings; available for new investments, acquisitions, R & D, etc. It averages about 15 percent in the United States. But it first must be corrected for dividend payout, which averages about 47 percent in this country. So, let's take about 7 of that 15 percent away. Then, secondly, inflation has to be subtracted since it is a direct hidden tax on equity. If inflation is 10 percent, the result is that real retained earnings are negative, even with a starting 15 percent ROE. And, of course, most of smokestack America has an average ROE in the 5 to 10 percent range. Many of these companies have been eroding their assets in real terms for much of the last decade.

Inflation
a Direct Tax on Equity

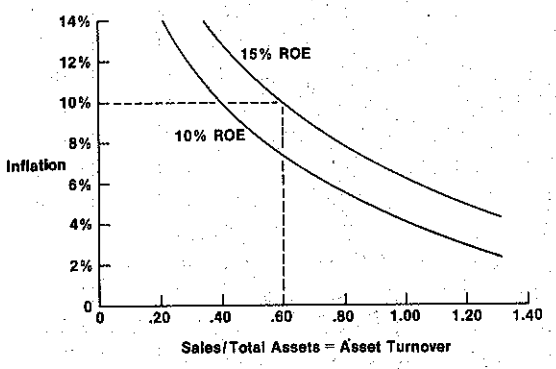
[RETURN ON EQUITY]	−	[DIVIDENDS PAID OUT]	−	[INFLATION RATE]	=	[REAL RETAINED EARNINGS]
15%	−	7%	−	10%	=	−2%

If you follow the Kidder Peabody Financial Quality Profiles, which are a much more sophisticated analysis of this effect (they are an inflation-corrected discretionary cash flow analysis) they demonstrate that most of the companies that make up the Dow Jones Average have actually eroded their assets in real terms for 7 or 8 of the last 10 years.

To illustrate this in another way, if inflation is plotted against sales divided by total assets,

even a 15 percent ROE company, at 10 percent inflation, will have a breakeven point at 60¢ of

Breakeven Points at High Inflation



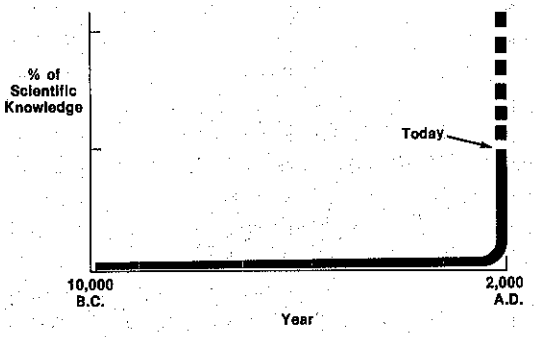
fixed assets per dollar of sales. Above 60¢, assets will be eroded in real terms. And of course, the average ratio of sales to fixed assets in much of smokestack America is well over $1.00. As a result, these companies have been eroding their assets over much of the last decade.

Another way to look at this is, if $1 million is invested in a facility or a piece of equipment that has a 20-year life, under former tax laws, the IRS would allow recovery in that period of time. But, at 10 percent inflation, it would cost $8 million to actually replace the facility. And, of course, the other $7 million has not been reserved. It has been falsely reported on the balance sheet as profits, 46 percent taxes have been paid out and 40-50 percent of the remainder has been spun out in dividends. It isn't there, and the company is in trouble. Ths effect has been pervasive and will cause a continuous process of restructuring in many U.S. industries over this decade.

The technology explosion is another of the great forces of change. This graph plots the accumulation of scientific knowledge from the beginning of civilization 10,000 years ago to 2000 A.D.

The graph is intended to illustrate that about 90 percent of everything we know in the sciences has been generated in just the last 30 years. Moreover, the knowledge base will probably double again in the next 10 or 15 years. Of course, 90 percent of the scientists and engineers who have ever lived also are now living and working, and they probably will double again in the next 10 or 15 years.

The Technology Explosion



Most of them will be outside the United States. It is important to realize that the United States, with only about five percent of the world's population, up until a decade ago, had been generating about 75 percent of the world's technology. Now, the U.S. share is down to about 50 percent. In another decade, it could be about one-third, not because we are generating less: actually, we will be generating much more. But rather because the other 95 percent of the world is now participating. Every nation now sees technology as the essential ingredient for quality of life, and intends to participate. The Chinese alone, with a billion people, one out of four in the world, intend to be at the leading edge of every technology by the end of this century.

It's hard to overstate the effects of this knowledge explosion, because in addition, there is an unexpected interaction among disciplines that produces surprise factor interventions that were not anticipated in the original work.

The result will be a continuous process of obsolescence that will telescope the average life cycle for any given product or process.

Of course, there is a proliferating array of high growth areas. The field of material sci-

ences is one of these. For example, graphite fiber reinforced epoxys that are stronger than steel and lighter than aluminum, don't corrode like steel, and don't stress fatigue, are going to have a major impact on steel and aluminum. The materials business, long served by steel and aluminum, is fragmenting into hundreds of niche markets, served by a proliferating array of engineering plastics, composites, laminants and ceramics. A fundamental restructuring of the materials business is in process. Not that steel and aluminum will go away, rather they will become smaller segments of the total materials business, just as the railroads now are a smaller segment of the transportation business.

In ceramics, the Japanese are now testing ceramic engines. These are adiabatic systems that operate up to about 1200°C, with no cooling systems, and are about one-third lighter, and one-third more efficient than conventional engines. They are in an early stage of development, but could have a major impact on this business within a few years.

The explosion in the world of material sciences will predictably restructure many businesses over the coming decade, and these are just examples.

Biochemistry is another great growth area where coming developments will modify our lives in many ways. Genetic engineering will have a major impact on agriculture, on medicine and in chemical manufacturing. Also, major advances in immunology may lead in this decade to a total conquest of most of the viral diseases, including cancer. Aging for example, seems to be primarily associated with low grade viral diseases that we carry in our bodies all our lives. Barney Clark, as you know, had three different viruses that destroyed his heart, and required the mechanical transplant. But as viral diseases are eliminated, the life span may be increased rather dramatically.

The electronics revolution, of course, will continue to be pervasive in our society. Electronic mail could have a devastating impact on the fine paper business, as fiber optics and satellite communications may have on the copper business, and others. These forces of change are interactive and will continuously restructure such older industries.

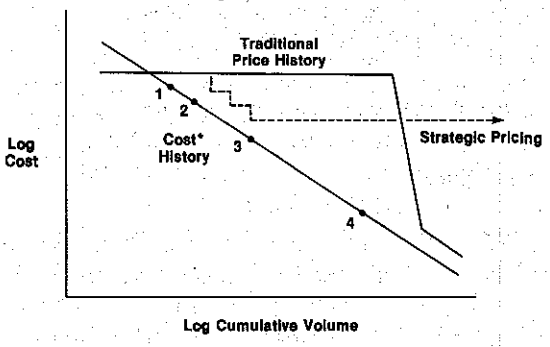
One major impact of electronics will be on the educational system. The opportunity now may exist for the first time since the invention of the printing press to make a major advance in the productivity of education. The concept would use videodisc and videotape technology, tied in with interactive computer systems, such as the Plato system, developed by Control Data Corporation. The quality of education, in science and math, for example, can be quickly escalated in primary and secondary schools to levels beyond anything that's ever before been possible. Beyond that, the great frontier of education will be in adult education, as the need for continuous anti-obsolescence programs increases rapidly.

These examples are just the tip of the iceberg. There are hundreds of derivatives in all of these areas. Moreover, most of the advanced technology in all areas is being developed in the United States. For good reasons, we have by far the most advanced technology of any country in the world, and if we mobilize our resources effectively, there is no question that we can maintain world leadership in technology and innovation. We now are not doing that very well.

The targeted industry strategy is the third great force mentioned earlier. The Japanese have modeled this most effectively. It is based on the learning curve first developed as a strategic planning device by the Boston Consulting Group in the late '60s. Japan was one of their first big customers and at that time, they had targeted shipbuilding, steel, consumer electronics, motorcycles, etc. for major efforts. Of course, they have been exceedingly effective in doing this.

The concept is simple. When the log of the cost of the product over its life history is plotted against the log of its cumulative volume, a downward sloping line results. Every time the volume doubles, the cost goes down about 25 percent, plus or minus.

Learning Curve Strategy



*Costs Decrease About 20% for Every Doubling of Total Industry Volume

BCG had plotted hundreds of products and found that this was a generality. The traditional price history followed the upper line on the graph where a company marketed a new product out of their pilot plant beneath their actual cost. But then, as volume grows in full production, economies of scale occur, and costs move down the line. The typical general manager, though, where bonus is based on this year's profits—will leave his price unchanged and in so doing allows competitors to enter the market under his price umbrella. Of course, he is really trading market share then, for short term profits. And traditionally, after about half the market is gone, the price structure collapses and no one makes any money.

BCG had two points: One is that the strategic course would have been to bring the price down incrementally with decreasing costs until the price is below the entry point of any competitor. Then, market dominance can be permanent with long term profits.

Alternatively, a late entrant can "forward price" to a point below other competitors' costs, and take all the new market growth, until economies of scale eventually catch up with that price.

Of course, the penalty there is to carry the negative cash flow in the interim. For a major business, the negative cash flow is prohibitive, and an individual company in this country can't do that effectively even if antitrust would allow it. But a nation can. And Japan understood this and adopted the strategy. The strategy has been very effective. The industry is first targeted and all the players brought together. Small players are eliminated to concentrate the business in the home market. The next step is to close out imports to further base load the economies of scale in the home market. The third step is to parcel out the R & D among the remaining players so that redundant effort is avoided.

This R & D is focused on manufacturing engineering improvements, not on innovation, and often starts with licensed technology, from the U.S., of course. Resulting developments are leveraged 80 to 90 percent, with low-cost capital. Finally, two-tier pricing is now possible because of the captive home market. All costs are collected into the first eight hour shift for that home market. The next two shifts can be exported at lower cost, and the product is forward-priced into the U.S. market, at a level designed to take all new market growth.

The Japanese have captured something like 50 percent of the numerically controlled machine tool market in a few years; nearly 70 percent of the 64K RAM market; 85 percent of the motorcycle business, and so forth. It's a very effective strategy that takes interesting advantage of U.S. antitrust laws which prevent our companies from collaborating on an equivalent scale. These antitrust laws now are anti-competitive, forcing us to lose market share, concentrate businesses, and reduce competition, rather than the other way around. It's very important that we begin to modify these laws so that they no longer operate as impediments to competitiveness in world markets. The point can be made that the antitrust laws are at best irrelevant in a period of explosive change. Even a 17 year patent life may rarely be realized because of the pace of technological change that will tend to obsolete it before it runs out.

Moreover, in commodity industries where other nations are subsidizing their businesses, there's no way in which any company in

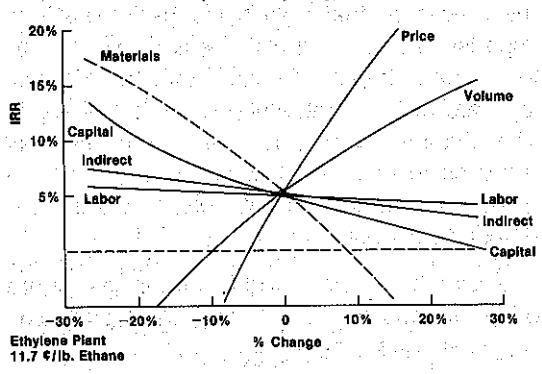
this country can possibly dominate a world market. Times have changed and modification of these laws is greatly required.

Another aspect is that the antitrust laws also prevent rationalization of impacted businesses. The steel business is an excellent example, where enormous global over-capacity will require the shut-down of many operations. The relatively few modern plants in the U.S. should be allowed to be put into a new consortium with equity participation by the contributors so that a viable world class, competitive industry can survive. But antitrust laws now do not allow this. In effect, antitrust laws are some of the barriers that prevent us from effectively utilizing the tremendous resources that we have.

The "targeted-industry" strategy, of course, has been so effective now, that many other countries are beginning to follow the Japanese model. These countries are targeting robotics, satellite communications, engineering plastics, biogenetics and many of the other emerging industries. And this will continue to be one of the great forces operating to restructure U.S. and world economies over this next decade.

The fourth great force is illustrated by the petrochemical shift. It too will result in major restructuring of world economies over the next few years. A computer simulation of a typical commodity petrochemical is illustrated here.

Commodity Petrochemicals Sensitivity Analysis
(100% Capacity)



I developed the system many years ago for operations analysis, acquisitions, and strategic planning. It uses an internal rate of return on the left as a quantitative measure of productivity. The IRR in effect is the bottom line, of all the factors that go into making or doing something.

This plot shows an ethylene plant in the Gulf Coast. It would be making about a five percent internal rate of return, if it were operating at 100 percent of capacity. Actually, it is only operating at 60 percent of capacity, which is about average for the commodity petrochemical group worldwide.

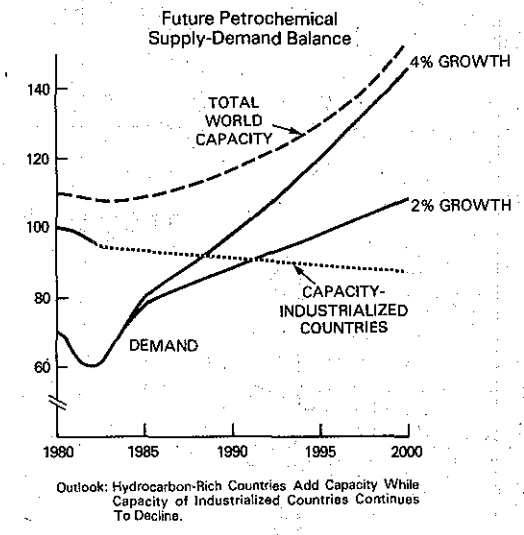
The U.S. has about $80 billion in sales of commodity petrochemicals in this country, and the conclusion is that much of this would disappear over some period of years. Part of the reason for this is that like steel and other commodities, this industry has enormous global overcapacity and is operating at a negative cash flow.

But the most important factor is that 50-80 percent of the cost of most of these $80 billion worth of commodity petrochemicals is in the natural gas feedstock that goes into them. In the U.S., natural gas must be charged in, of course, at the opportunity cost of energy in this country, which is about $3-4 per million BTUs. On the other hand, anyone who has ever flown over Saudi Arabia at night, has seen the flares 100 miles away. They flare their gas. In fact, 90 percent of the gas outside of the U.S. is flared, because it's being produced in underdeveloped countries that have no industrial infrastructure. They can't use it; they can't pipe it anywhere. It's too expensive to liquify it; they just burn it.

Many of these countries now are putting in turnkey plants to make methanol, ethanol, polyolefins, acetic acid, ammonia, and other commodities. The Mexicans are targeting ammonia. About 80 percent of the cost of ammonia is the cost of the natural gas feedstock here in the U.S. But they can charge natural gas in at negligible costs. It is obvious

that we cannot compete when natural gas is 50-80 percent of our costs.

The result will be gradual, worldwide shut down of basic petrochemical businesses in developed countries. The Supply-Demand picture is illustrated here.



Outlook: Hydrocarbon-Rich Countries Add Capacity While Capacity of Industrialized Countries Continues To Decline.

The bottom demand line shows worldwide operations at about 60 percent of capacity—enormous overcapacity in this business. And as recovery continues, capacity may increase to about 80 percent by 1985, but that is not a break-even point for most plants. The best industry growth estimates of four percent per year never quite match the worst case, lesser developed country add-ons that are now projected. And those are possibly conservative.

This, of course, is the tip of the iceberg. I suspect that much of the primary reduction of metals could go offshore; and anything that is labor intensive, of course, like the Atari operations will go offshore, wherever there is cheap labor. And this is a process that will require major adjustments. The Petrochemical Study is one of a series of competitive assessments that we are developing in Commerce for many of the critical areas of industry.

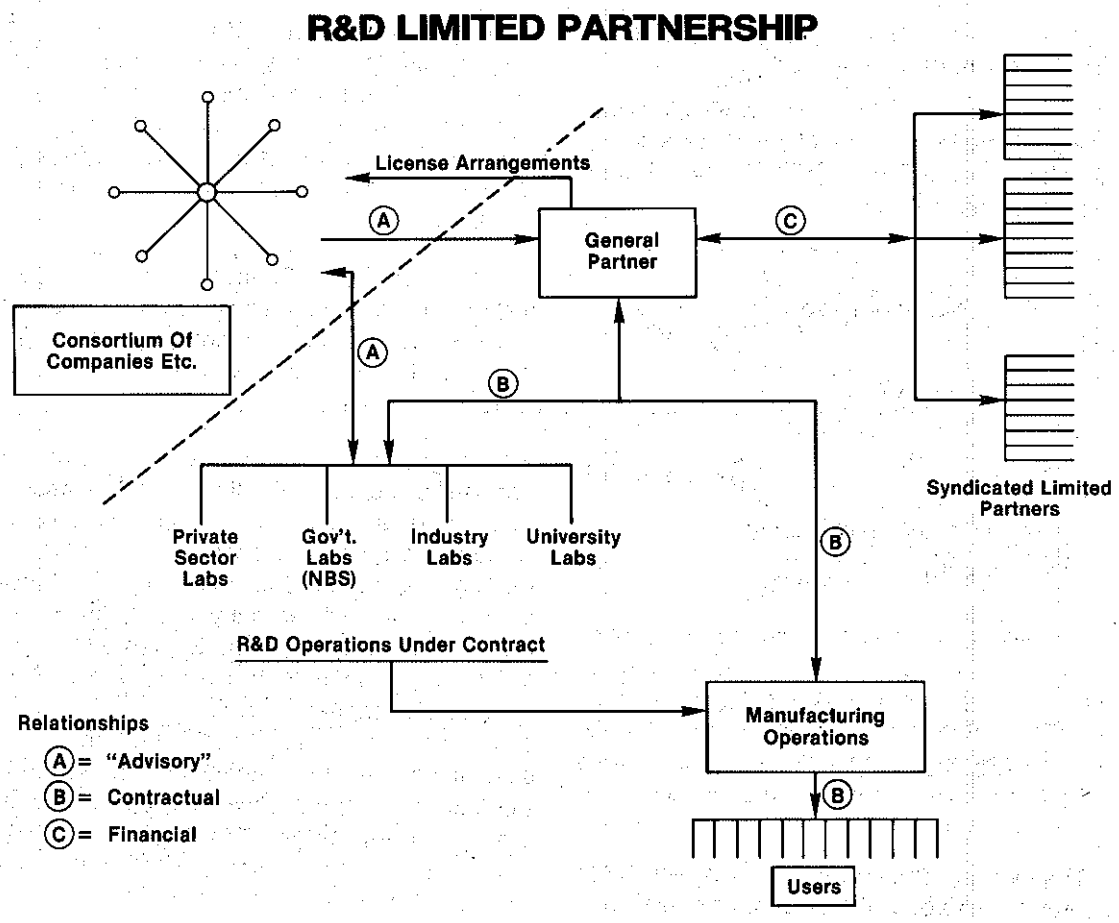
What response can we make to all these forces of change? Basically, we have to remove the regulatory barriers to innovation and to increased productivity. We have to modify our antitrust laws so we can collaborate and be competitive in world markets. We have to increase incentives for R & D and for manufacturing investments, and we have to clarify the limits and ambiguities in many of our regulatory laws.

The R & D Limited Partnership is one mechanism we have developed to facilitate cooperative R & D. We have a detailed document that explains exactly how to establish R & D Limited Partnerships.

This graph illustrates the R & D Limited Partnership concept. Briefly, it requires establishment of a separate legal entity called a General Partner. It is based on a 1954 law that has been around for a long time. However, it was not used for many years, until it was tested and validated by the Supreme Court in 1974. The Economic Recovery Tax Act, and reduction of capital gains to 20 percent, have combined with this law to stimulate an explosion of new venture capital businesses over the last three years. Most of these are small start-up companies. The big companies haven't recognized, until now, that the law also could apply to them.

The benefits of the concept are impressive. Companies can, in effect, fund efforts with off-balance sheet funding. The process avoids redundant R & D, distributes the risk, and allows projects to be undertaken that are beyond the skill or cash flow capability of any individual company. The General Partner, of course, is a separate legal entity and therefore, can manufacture on a scale that is competitive in global markets, or alternatively can contract with interested companies to do the manufacturing. Because of the antitrust laws, it is somewhat cumbersome to structure but still manageable.

Commerce literature explains the process in detail and anyone interested can contact my office for information and help. We see this as a powerful stimulus to innovation in the U.S. and we hope that it will multiply the total amount of R & D in this country.



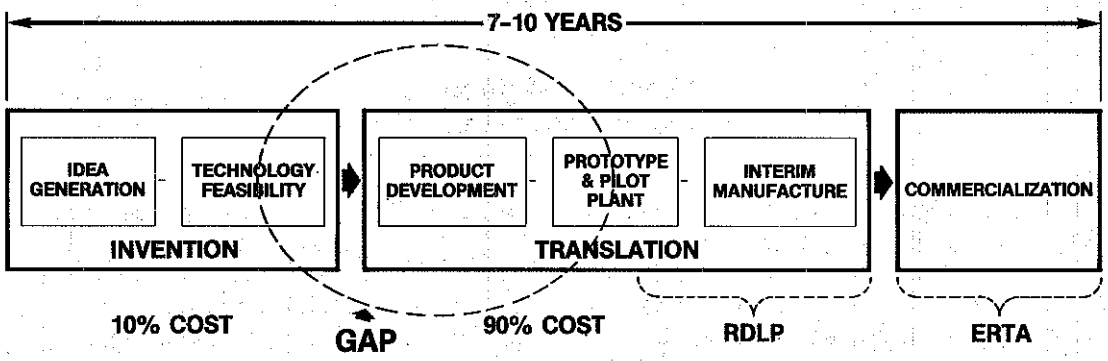
In summary, we should remind ourselves that the U.S. now competes in world markets. It's no longer a U.S. province in which we operate. Moreover, these great world forces of change will continuously restructure both U.S. and world economies over this decade. The challenge is to manage continuous change, and management by definition will be the management of continuous change. We will need to structure to manage change.

But the U.S. has major advantages over all other nations. We have, by far, the world's most advanced technology. In 1984, we will spend about $12 billion for basic research. No other country in the world even begins to match that. In addition, we have an incomparable industrial infrastructure in terms of depth and breadth and scope that can translate new concepts into useful products and processes. We have a unique entrepreneurial culture that takes risks and does things that nobody else seems able to do. Finally, we have the best capital formation capability, and the world's largest continuous market.

We have overwhelming advantages and the basic role of the Government is to remove barriers, provide incentives, and be the catalytic agent that can convene people and promote private sector initiatives. But the important thing is to keep the Government out of the management and the direction of activities in the private sector. It is this role that we are trying to pursue.

Let me just make one further comment. I put this chart up to help crystallize our thinking. This is a simplified innovation chart starting with an idea; and going through a technical feasibility stage in the laboratory; through a series of development stages; into a proto-

INNOVATION



$7.6 BILLION FY 1984
U.S. GOVERNMENT
BASIC RESEARCH

type, pilot plant stage, where you get engineering, cost and size data; and an interim manufacturing stage, where you get feedback from the marketplace before you go full-scale commercial. Now, as we go through these stages, the cost goes up exponentially, then comes down rapidly.

We have the Economic Recovery Tax Act which provides incentives for commercial operations. Again, simplistically, we think of this as a two-step process. This is the invention, and this is the translation of that invention into something useful. Ninety percent of the cost of the risk is associated with this second step. The first step is heavily funded. $7.6 billion will be spent by the Federal Government on basic R & D in 1984. This gives you a basic projection to next stages.

Technological Challenges to U.S. Competitiveness

Harald B. Malmgren
President, Malmgren, Inc.

I didn't coordinate at all with Bruce Merrifield, but I must say that I agree with the thrust of what he had to say. After starting in Washington in the early 1960's in the defense area looking at new technology and thinking about the purpose of the weapons systems and their cost effectiveness, I got into the weapons trade field in 1964, and spent about 19 years negotiating with other governments, gradually getting deeper and deeper into issues of industrial policy.

The way our Government has looked at industry problems has been more or less in response to complaints. The American system is a complaint system. If people have a problem, they come to Washington and tell you what the problem is. Very rarely do officials ask anybody what's going right. In other words, in public policy we tend to be led by losers who have gotten behind the curve.

That's not a sound way to do things. A good example was our response in the 60's to the formation of the European Community. We were concerned about tariff structures and the discrimination that creation of the EEC could bring about. So the U.S. Government harnessed itself and went to work for five years negotiating tariffs internationally. We finished in 1967, and the industry reaction was, well, that's fine, nice job, but it's irrelevant to our problems. The problems today are really non-tariff barriers, standards, customs valuation, Government procurement policies, etc.

So in 1967, we began an inventory of non-tariff barriers in Geneva, getting the U.S. and other countries together. That took four or five years, and was followed by another seven years of world negotiations. These were completed in 1979, and industry people said, well, that's fine, you did a nice job, but it's not really relevant to our problems. Our problems are industrial policies, targeting policies, technology policies of foreign governments.

It takes a number of years to put an agreement on new rules together internationally, and the Government tends to be behind the curve, because it is reacting to complaints from specific companies. It very rarely anticipates anything. And, indeed, rarely does anyone in Government ask some winners to come to Washington and tell us what's going on.

But I think our government is coming to that stage now. It is trying to understand what other countries are doing. I did a study for the U.S. Government about a year and a half ago on methods other countries use to manage their technology and industrial policies. What is it that makes them work effectively? And, what is happening in technology? There is a lot of mythology involved, but the first thing I want to point out is that it's not the level of government spending that makes the difference. If you look at the amount of money spent, most governments of other countries spend much less than the U.S. does on R & D, particularly in private non-defense R & D. Except for West Germany. West Germany is probably the government that spends the most for R & D as a percentage of total public and private R & D funding. But Germany does it more quietly than everybody else.

Seventy-five percent of Japanese industrial R & D is privately funded, which is a much higher percentage level than in the U.S., which is about 50 percent. The amount of money spent by the Japanese government on R & D as a percentage of GNP is far lower than the

U.S., even for non-defense R & D. Therefore, the difference in effects of technology policies is not attributable to the amount of money spent. It's the way in which the government programs are organized, and this relates to the issues that Dr. Merrifield was talking about.

Now, it's clear that the technological changes currently underway are rapidly changing the office environment as well as manufacturing methods and environment. I think all of you are well aware of the trends. Once capital spending surges, it will be difficult to predict how rapidly the changes will come, but my guess is that the transformation of manufacturing will be much faster than many people think. There will be revolutions in, for example, the machine tool business.

The advances in information and communications technologies will greatly transform all the service industries, as well. The fact that you see Sears Roebuck, Merrill Lynch and other such institutions entering financial services is very logical. They're building communications grids, and once you have a worldwide grid, the incremental cost of adding additional services of any kind is very cheap. Increased competition that squeezes profits will require increased volume, which is gained by offering additional services.

We'll see very strange agglomerations: manufacturing companies going into service businesses. We already see some oil companies doing banking for other companies. We're going to see service companies going into engineering services. Citicorp already offers engineering services to other companies to build their worldwide communications grids.

There also will be tremendous progress in new materials. I have followed the Japanese developments in this area, and if a survey of technology investment were to be taken in Japan now, the number one priority in Japan is not what you would think. It's not computers. The number one industrial investment area is in new materials. That means ceramics, composites, particularly carbon fiber, and areas like fiber optics. The auto companies in Japan think that they can produce a car by 1990 that contains no metal at all. And therefore, they can make a much larger, lighter vehicle. They're planning similar applications for aircraft. By 1990 they, and we, also plan to make very light aircraft with very powerful engines, which can carry heavy loads and land on short runways. This means that air transport will become more competitive with trucking.

These changes are not so far away. They're in the pipeline now. Traditional sectors will undergo enormous change as well. Petrochemicals is one of the areas just mentioned. The Japanese are now scaling down their petrochemical industry through an industry cartel arrangement with the government. Companies exchange views on dropping different product lines. That kind of cartelization is also beginning in Europe. Everybody agrees it has to be done. I think people here will have to do something similar in the next two or three years.

There will be excess capacity for as far as you can see, and increased production by countries using otherwise flared gas will aggravate the situation. The Saudi's say they only want to take five percent of the world petrochemical markets, but they will have eight major complexes coming on-stream almost all at once, and those may account for much more than five percent; and that is just one new supplying country.

The intensified world competition that we can expect from industrialized and newly industrializing countries in a widening range of manufacturing areas, will combine with continuous technological change. We're going to see more and more countries entering fields that we didn't think they would be in. Brazil, for example, is exporting executive jets and coastal surveillance aircraft. The Brazilians, more than the French, are the major developers in the Iraqi nuclear power complex.

Technology transfer in the next few years also will be much faster, because of on-line worldwide communications systems. If an engineer can work on a CAD CAM system down the street from a plant, there's no reason why he can't live in Florida and work with a plant in Singapore. Many people will break away from

large companies and from salaried positions to set up their own consulting firms, in order to run factories in distant places. The governments of Singapore, Hong Kong, Korea, and the Philippines are all anxious to quickly upgrade their technology, because they see the end of the line for traditional businesses in their economies.

A dramatic example is a company in Europe that is looking at the robotics of sewing. Within a few years it will be possible to move to the point where people won't be necessary for mass production of apparel. And think of what that will do to the world textile industry. It would be a tremendous transformation, since textiles and apparel manufacture is the biggest single employer in the world in manufacturing.

Such changes in the future could be very dramatic. The possibilities are better understood in more countries than we might expect. There will be new "little Japans." We see Japan coming at us in every direction but there also will be new Japans in specific sectors where, with acquired technology, a product can be mass-produced.

So, what American industry faces is a continually changing set of problems. For example, what has struck me over the years in negotiating with Japan, is that the problems have changed every two or three years. The Japanese have kept moving. We fought with the Japanese about textiles in the 1960's and thought that was the end of the world, that they were going to inundate us. Now they don't export many textile products to us at all. In fact, they have a textile import problem.

In the 1970's we fought with the Japanese about steel and consumer electronics, such as TV's, CB radios, microwave ovens, and those problems too have faded in importance. Now we're fighting about robotics, chips and machine tools, and I think that too will pass. Because the Japanese will keep moving, and so will we, and the nature of the problem will change again.

One consequence of these changes will be very profound regional, sectoral and employment effects. I think the European governments are gradually waking up. The German government believes, for example, that if there's a capital spending surge in Europe within the next few years, that this will increase unemployment, not decrease it. The surveys of the German Ministries of Industry and Economics have indicated that the main thrust of capital spending by business in Germany, if there is a capital spending surge, will be in labor displacing innovations, rapidly pushing people out of the factories. That is the only practical way to get past the labor laws in Europe, and increase efficiency. So, they will see rising unemployment for the next seven or eight years. What makes this worse for them is that their baby boom came later than ours.

Now, what does that mean? Given the poor performance of the Western economies over the last decade, and the growing employment problem, there is tremendous political pressure on governments to do something, to experiment. But the experiments, so far, have not been very successful, and there's an increasing attention to technology as the way out.

Most governments today, including those of developing countries, are increasingly trying to guide structural change and to promote national technologies. That automatically generates protectionism and trade and investment distortions. So, industrial policy is being structured, as Secretary Baldridge pointed out, to limit imports and boost exports. The result will be world market gridlock, and the system could collapse if we're not careful.

In this context, the relative importance of subsidies in most countries is not that important. The Japanese, for example, actually subsidize less than the Federal Republic of Germany, France and Britain. In the U.S. defense and non-defense expenditures have to be separated, but in my view there is a growing convergence of defense R & D with civilian applications. For example, in defense we spend money on development of new materials to lighten vehicles so they can carry more weapons and control systems. We spend money on computers and telecommunications so we can access information, provide earlier inter-

ception with more accuracy and more speed. We spend money on ceramics to shield reentry vehicles from space, and to get greater thrust and fuel efficiency in engines. I asked Toyota and Kyocera, the ceramics firm in Japan that is the world's leader in ceramic research, where they made their breakthrough. They said the tiles on the U.S. space shuttle was one of the most important breakthoughs they had. They became interested in exactly what that shielding characteristic was, and whether it could be used in engines.

Most of these countries are building on acquired U.S. technology. Their basic strategy is that domestic cooperation and coordination between government and industry, research institutes and universities, increases the pace of technological change, and also increases the efficiency of R & D. In the U.S. we have normally considered such cooperation and coordination of effort to be anticompetitive.

In foreign countries cooperation and coordination of effort combined with a modest amount of official support, are perceived as a way of reducing risks. Information sharing is believed to reduce the redundant exploration of blind alleys by individual firms. It also focuses efforts in complementary patterns of development, exploits division of labor among firms and national institutes, builds momentum in the promising areas because money follows the momentum, and reduces the risks due to timing.

Within the Bell System, the Bell Labs keep track of different developments so that they can be brought into place in parallel. The Japanese, the Germans, and others all think that way: How do we make sure that each of the separate efforts will coordinate so that an overall new system can be introduced? Some governments believe that to achieve this requires a common perception of where everything is going. And so, the Japanese, have their MITI "Visions", but there is a lot of misunderstanding about what these visions are. Some people say that the Japanese government picks winners and losers. I don't think the Japanese believe they do that. What they do is to get everybody together in a room and ask, "What's happening? What do you think is the main thrust of where we're going?" They gather people from different areas and different companies, to consider what directions should be pursued. Commercial secrets are not shared, but they do share the general thrust of their thinking.

That system may be breaking down a little bit because Fujitsu, Hitachi and a few others are reaching the frontiers, and would like to feel more independent of the government. Increasingly, they're refusing government money because they don't want MITI to acquire rights to their patents, and they don't want to share them with other companies. So they may become less cooperative.

Except for some areas of coordination in West Germany, there has been no comparable mechanism in the U.S. or in Europe, or in any other country. And yet, some such global viewpoint is important. The new materials business is a case in point. I know of no major metals company that fully understands the full sweep of the new materials revolution that is occurring and the tremendous changes that will result in their industry. The copper companies are not following closely enough the work in ceramics and superconductors and fiber optics. I gave a talk to the Lead and Zinc Institute recently, and following that talk I had many calls from individuals saying that they had no idea of the impact that new materials would likely have on the zinc business. Our system doesn't effectively generate cross-fertilization of ideas across the traditional industry boundaries.

In foreign countries the cooperative approach has generally been combined with small official subsidies and has generally been focused on commercial applications. Japan is now shifting its official funding more towards basic research. That would be a change in their pattern, which could mean that they will develop some independent technologies. I think Bell feels that long-wave laser technology in Japan may be ahead of the U.S. now. And that's very important to communications, a strategically vital field.

In pursuing their national policies, many governments also try to shield their home markets from foreign competition, in order to exploit economies of scale at home. They encourage export activities and induce foreign enterprises to transfer technology to them. Developing countries will in the future be doing much more of that. Investments in Mexico or Brazil require that technology be brought in. Canada does a lot of that. The question is whether or not you participate in a market. To participate, you'll have to provide technology in order to get the key to the door.

So, the thrust of all of this lies in working together. And where an industrial sector is in trouble because technology overtakes industrial performance, the view in many countries is that it is then the job of government to rationalize the industry, shake it out, force mergers and consolidation, or else convene meetings where companies talk to each other about shaking out. This will happen more and more in Europe. Right now, the European governments are talking about how to rationalize petrochemicals, steel and all of the nonferrous metals. It is assumed that these sectors will have to contract between 20 and 40 percent in the next few years. This simultaneous contraction in all of Europe's smokestack industries will take place in a relatively short time period. The unemployment effects will be serious.

So, there has to be an American response to these changes, which will preserve the diversity and the competitiveness of our own system. But countermeasures alone won't work. The House Ways and Means Committee a few weeks ago was thinking about rewriting the countervailing duty law to allow countervailing action against the so-called subsidy effects of targeting policies of other countries. But members wondered whether that makes sense. I commented that we should beware of biting our tail chasing ourselves around the tree. The U.S. government actually subsidizes major sectors like computers and telecommunications even more than the Japanese. We might find that if we enshrine the principle of counteraction against official aids of other nations, we could get zapped ourselves by a number of foreign governments. It is important to think this through. There are countermeasures and countermeasures, and we really haven't carefully analyzed the specific nature of possible foreign advantages. We've concentrated too much on the idea that it must be subsidized funding of technology. And that's just not correct.

One of the things that we need to do is to trace, for example, the impact of our own government R & D programs on certain sectors. But that is very difficult. If you ask anyone in Defense or NASA, or DOE or DOT how much money is spent on a particular product line or a particular sector, they say they don't look at it that way. The Office of Management and Budget has no idea. For example, no one knows how much money the American Government spends on machine tools. There are a number of programs that all approach it from different ways. There are several Army, Navy, and Air Force programs, as well as DOD programs, but no one knows which ones deal with machine tools, and how much money is involved.

And yet, these programs have tremendous commercial applications. We need to disseminate broadly the general thrust of Government funding so that our medium and smaller sized companies can follow developments and exploit them too. As it is now, the corporation working on a particular program gets the advantage, but hardly anybody else knows what's going on.

The antitrust area is another vital area, not just for R & D cooperation, but also in the rationalization of basic industries. I don't see how we're going to get through the decade without allowing declining industries somehow to consolidate, allowing a certain amount of merger activity. If companies must just drift through the difficult transition, they will be forced to make decisions inappropriate for the industry as a whole, and their rate of return on investments is going to be very low.

Their ability to finance change will be small, as is the case now. The steel companies have unfunded pension liabilities and no profits. Any pension fund would be ill-advised to put

money in the steel industry right now. And, those that own steel stocks are just lucky that the stocks are staying where they are. If I had to make a judgment about basic smokestack industries without a change in antitrust policy in the U.S., I would say, sell all of it. Don't hold such stocks or bonds in any fiduciary portfolio, because they're all in trouble. Moreover, those companies can't easily shift.

Nippon Steel, for example, has a clear strategy to phase down the role of steel in their overall business activity. Nippon is the number one steel producer in the world, but by the early 1990's, they want to be in a lesser position. They want to diversify into new materials, where they want to be number one. But they don't want to be the number one steel producer. Mannesmann, in Germany thinks the same way. Mannesmann is moving into new materials and telecommunications, because they think the steel business is just not a business to stay in. There are other companies thinking that way in Japan, particularly in copper, aluminum, and almost all the nonferrous metals. These are considered to be unattractive businesses.

Negotiating with other governments to try to straighten this all out is not going to be easy. The political pressures from unemployment in Europe are such that no country there is in any mood to negotiate industrial policies with us. The Japanese probably would negotiate their policies to some extent, but I don't think the Europeans will. And the developing countries are not going to agree to anything that would limit their freedom of action. So, if we start global negotiations, we won't get very far. And then, if we get very angry, there would be domestic pressure to institute all sorts of countermeasures which will limit imports. That won't help us very much.

In the meantime, if we continue to worry about exports of technology to other places, we're also going to have problems. For example, Kyocera had a subsidiary in the U.S. called Dexcel that was recently sold to Gould so that it could continue to sell to the DOD. Some bureaucrat in the DOD said, Dexcel is not a segregated defense facility. Its parent is Japanese, so we can't buy from it. Kyocera's problem was a simple one. Their lawyers told them they could segregate Dexcel, but then, they would lose close contact with it. The Japanese don't like to work that way, so they sold it. Was it a bad decision to sell it? Kyocera management must have thought, "No, we'll make money on the sale, and we'll give Gould today's best technology. Of course, tomorrow's technology we'll keep in Japan, and we'll never give it to the U.S. again."

Some world-scale companies are gradually redeploying R&D to Japan right now, in order to avoid future export controls from the U.S. base. That problem is also one we have to avoid. So I can only encourage the kind of thrust that Dr. Merrifield and his group are pursuing. It takes courage to raise these fundamental issues. We've got to consider how best to organize to find an American solution to these problems, and to worry less about how much money other nations are spending. Because it isn't that much, and frankly they don't do it that well.

The European experience of throwing money at technology problems has not been productive. The British programs have not been terribly successful as you all know. Innovations are generated in Britain, but Americans commercialize them. The French government is spending a lot of money and getting very little from it because they're managed from the top. They are unable to duplicate the Japanese system, which is decentralized and based on consensus building. Bureaucrats and media can't effectively pick winners and losers. All they can realistically do is to make sure that everybody talks to everybody. And that is the kind of approach we need here before we begin any international negotiations.

International negotiations require consensus at home *and* abroad. The process of negotiation is one of explanation and building consensus by getting everybody more or less in agreement. Then when everything is almost settled, it takes about one evening of cigars and brandy to arrange the final deal. We don't yet have a consensus on what needs to be done in this country, and that will be essential.

Cooperation in R&D

William Norris
Chairman and Chief Executive Officer
Control Data Corporation

Let me begin by providing an answer to the question. "Can intra-industry technological cooperation become a plausible strategic option without neutralizing competitive technological advantage?" The answer is a resounding yes. Yes, urgently yes, not only is it plausible, but mandatory if this country is to reverse its steadily eroding position as the world's technological leader, and in the process, competition will in fact be enhanced.

My answer is not based on theory. I have been advocating broad-based cooperation for two decades and my company has been practicing it on a broad scale for more than a dozen years. Control Data is currently participating in five consortium organizations. They are all successful. The largest is Magnetic Peripherals Inc., in which five companies participate. The product is a line of magnetic memories for input to and output from computers, and the annual dollar value of output exceeds $1 billion.

Before providing further evidence of the merits of cooperation and reviewing a structure for efficiently accomplishing cooperation, we should be reminded of the challenge the U.S. faces with respect to its competitive position in world high-technology markets.

Our once strong competitive position in technology has been steadily eroding as other countries have taken a number of steps to accelerate their development and application of advanced technology. Broadly speaking, our foreign competitors have greatly accelerated research and development expenditures, have dramatically increased the number of trained scientific and technical personnel available to them, reduced the cost of capital for their key industries, reduced needless and wasteful duplication of technology development and fostered growth in targeted areas.

Clearly, the greatest progress in advancing and exploiting technology has been made by Japan in targeted industries where the Japanese Government has promoted cooperation among industry members at the base technology level as a key ingredient for success. Automobile, steel, shipbuilding and consumer electronics were the principal Japanese industries targeted for development in the generation after World War II. I need not remind you of Japanese successes in these areas.

Today, microelectronics and computers have replaced them as the most highly subsidized industries. This strategy is an ominous threat which has serious implications for virtually all modern industries because of the pervasive and rapidly growing application within them of microelectronics and computer technology products and services. In other words, superior microelectronics and computer technology provide the critical basis for competitive advantages in almost all other industries. Beyond the threat to industry is the threat to our national security. This country can ill afford to lag in semiconductor and computer technologies since they underpin the superiority of most of our weapons systems.

An adequate response requires myriad actions: However, by far the greatest and most rapid progress can be achieved by *increasing our efficency* in developing and applying technology. This, however, will require a vast increase in technological cooperation—which must include cooperation among large companies, between large and small companies, and among industry, academia and government. I will elaborate on each area.

Large Companies

The United States is needlessly suffering from an enormous and wasteful duplication of research and development among large corporations. The use of basic knowledge by one party should *never* preclude its use by another. For every corporation to rediscover what others have already learned represents waste of the most pernicious sort. Not only to each company—but also to society. Many different applications of the same base technology can be derived to promote effective competition in a broad spectrum of final product and service markets.

Companies in high technology industries have practiced a variety of forms of cooperation over the years. Cross-licensing of patents is common. Joint ventures, mainly short-lived, among two or three companies have proven to be useful. There are technology exchange agreements—but none of these adequately addresses the dual needs for large scale efforts plus a minimization of wasteful duplication in the use of technical resources.

Fortunately, these needs are beginning to be recognized. The Semiconductor Industry Association has created the Semiconductor Research Corporation. A second venture will commence operation next month. The Microelectronics and Computer Technology Corporation (MCC), a research and development venture, will be owned, operated and managed initially by twelve companies in the U.S. computer and semiconductor industries. I will comment further on MCC in a few minutes.

Small & Large Companies

In order to fully appreciate the enormous potential of greatly increased cooperation between large and small business, it is necessary to review a few relevant factors.

First, in addition to the prodigious amounts of unused or underutilized technology in their laboratories, large companies have assets in the form of underemployed management and professional personnel.

Second, small business is uniquely important in American society. It was the foundation on which our country was built and achieved greatness. It still is the primary means for encouraging and rewarding individual initiative. And it provides more products, services and jobs, relative to our GNP, than does small business in any other country.

Third, studies show that small companies produce 24 times more innovations per dollar than larger ones. Fourth, we have a well developed securities market where equity capital can be raised by small entrepreneurs. It is unique to America.

By making available its underused technology, and by offering its professional and management assistance to a small company, a large company can realize additional income from past investment, and through equity investments in and R & D contracts with small companies, large companies can gain more economical access to new products and markets. Three years ago, my company started making equity investments in small companies, many of which are now developing products and services which will be marketed by Control Data. In fact, quite a few of those products and services were developed by the small companies using Control Data technology.

Such programs accentuate the strongest attributes of both large and small enterprise. Small companies which are inherently more creative and flexible, with lower overhead, can frequently develop new products and services sooner for less cost; whereas larger companies, with greater resources, can provide efficiencies in production and marketing.

The potential of cooperation between large and small business can hardly be overemphasized. Since this opportunity is not as readily available to other countries, we must capitalize on it, just as the Japanese capitalize on the unique attributes of their culture.

University-Industry-Government

An essential underpinning for expanded industrial cooperation is a closer link between

industry and academia—both to more efficiently create and transfer new knowledge and to better train more people.

Critical U.S. shortages of scientific and technical personnel, inadequate laboratory facilities in universities, and lagging support for academic research have all been well documented. Fortunately, the need for much closer relationships between industry and universities is being recognized—as evidenced by the growing number of cooperative research and development programs. While this trend is encouraging, much remains to be done.

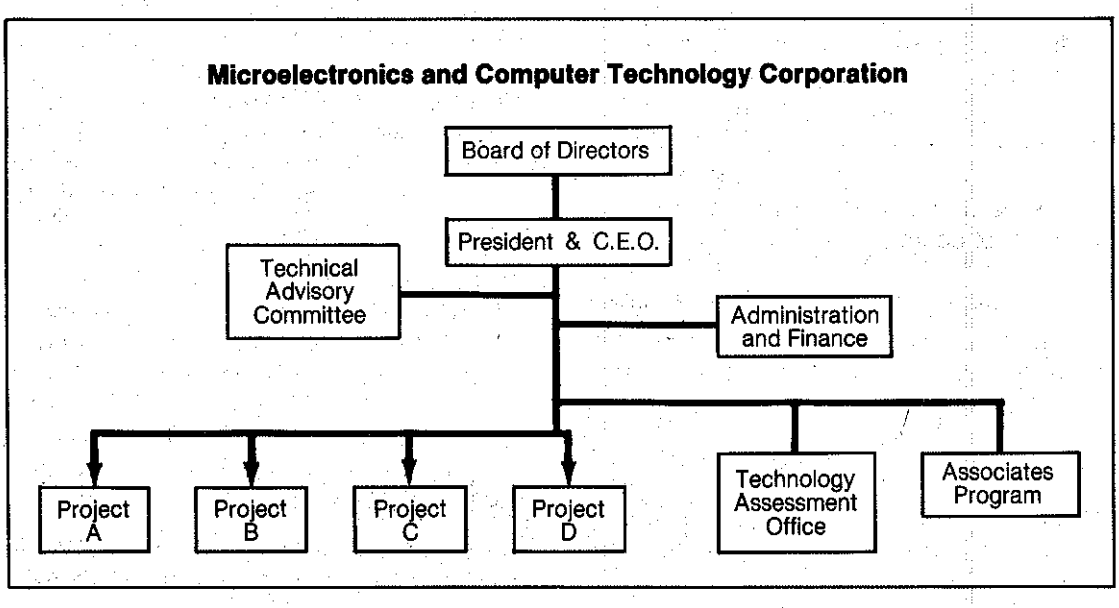
MCC

Next I will expand on my earlier reference to the Microelectronics and Computer Technology Corporation—MCC for short. Present participants are shown on the chart. MCC represents a cooperative effort to develop a broad base of fundamental technologies for use by members who will each add their own value and continue to compete with products and services of individual conception and design.

Projects will be undertaken by MCC that are stretching to go beyond the state of the art. Initially, four projects have been identified, lasting from five to ten years. All shareholders are not required to participate in each project. But each is required to participate in at least one. The organization of MCC is shown in skeletal form by the chart. A major function of the R & D advisory committee is to select the most promising research projects to be undertaken by MCC.

Microelectronics and Computer Technology Corporation (MCC)

Allied
Advanced Micro Devices
Control Data
Digital Equipment
Harris
Honeywell
Martin Marietta
Mostek
Motorola
NCR
National Semiconductor
RCA
Sperry



MCC projects will be staffed to a considerable extent by personnel from shareholder companies. At the completion of a project, these "borrowed" personnel will return to their respective companies. This flow of talent to and from shareholder companies is key to the success of MCC projects. In addition, such a process greatly facilitates the transfer of technologies to participating companies.

For convenience, MCC will hold title to all know-how and patents. Although participating companies will have initial rights to the technology and receive preferential treatment, technology will be licensed to other companies on reasonable terms. This is extremely important, especially for small companies.

National Resource

The formation of MCC represents a new national resource having significant and widespread benefits that include:

- The pooling of many of our most talented scientists and engineers into teams capable of most effectively conducting the complex multidisciplined research and development required for the derivation of advanced technology which can ultimately be of great benefit to our national defense.
- Licensing policies which result in broad diffusion of technologies.
- An open, industry coalition which offers a unique way for armed services to obtain high quality research and development without providing undue competitive advantages to a single company.
- Improved trade balances and more American jobs.

Benefits to MCC shareholders are very great and include:

- A significantly expanded scope of research and development to include projects that individual companies could not or would not undertake alone due to the costs and risks involved;
- A reduction in the needless and wasteful duplication of research and development;
- A lower ratio of invested capital to specific research and development results;
- A better definition of research & development needs and pitfalls; and last (but not least)
- A more efficient utilization of scarce scientific and technical talent.

These benefits, individually and in combination, will serve to enhance the competitive position of shareholders and licensees in markets at home and abroad. As noted earlier, each company will draw upon MCC fundamental technologies, add value and compete in chosen markets with products and services of individual design. And the country will be the ultimate beneficiary—through the expansion of employment opportunities in emerging growth industries as well as through an expansion in the choice of products and services available to individual consumers.

Significantly, the Japanese have a long tradition of undertaking cooperative research programs at the basic and applied levels to achieve broad and rapid diffusion to individual Japanese companies. The policy has been highly effective—as we all know too well.

Deterrents

In view of the obviously attractive picture just presented, why hasn't technological cooperation been widely practiced in the U.S.? There are a number of complex and interrelated reasons. They include:

- Our anachronistic business culture;
- Our emphasis on short term horizons, a corresponding lack of fortitude in corporate management;
- The tunnel vision of our business schools; and
- A fear of antitrust challenges to successful cooperation.

There isn't enough time today to elaborate in detail on each reason but I will provide a few highlights.

Business Culture: With respect to our business culture, its evolution was greatly influenced by the availability of a huge and expanding domestic market. Thus historically, competition for most U.S. corporations was mainly other U.S. companies. Until the Japanese came into world markets with a business approach different—and more effective in important respects—there was little pressure for change. Indeed, given our great resources, we chose to tolerate a certain amount of waste and inefficiency for the sake of preserving each company's "individuality." Japan, on the other hand, a resource-poor country devastated by war, was forced to take another approach—and I suggest that perhaps the most important difference was the development of a Japanese tradition of cooperation in developing and exploiting base technologies.

Horizons: Another difference is the greater willingness in Japan to finance longer term investments. In large part, Japan's business is funded by banks through debt; debt-equity ratios are high and capital costs average 40 percent less than in the U.S. Also, Japanese companies can settle for lower earnings and the market price of their stock is not of day-to-day concern to their managers.

In contrast, U.S. companies must maintain much higher earnings on a continuing basis in order to sell equity—which is its principal means of obtaining an adequate capital base to sustain growth. In addition, there is always the threat of a takeover—which I characterize as white-collar thugs waiting for an opportunity to mug any company whose earnings fall or stock price dips. These problems push U.S. management to a quarter-to-quarter short term thinking syndrome.

None of this is easy to cope with, to say the least, but it's also true that U.S. corporate management has not aggressively tackled these problems. Legislation, otherwise unrestrictive, could be obtained to prevent hostile and socially destructive takeovers. And, as previously noted, the cash required to shoulder the risks and costs of new technologies could be markedly reduced through R & D cooperation.

Business Schools: While industry is losing ground to overseas competition, our business schools continue to refine old approaches instead of being in the vanguard to design and promote new ones to meet present and future needs. Most of them don't yet even perceive the need for wide-based technology cooperation, let alone join in the articulation of its merits.

Antitrust: Business school absence is also visible among those advocating changes in out-dated antitrust laws which are impediments to pooling resources in research and development.

Fortunately there has been some recognition of the need for change in this area. For example, in response to complaints about lack of clarity and other problems with antitrust laws, the Justice Department has developed what it calls its "business review procedure" and the FTC will in certain cases, issue "advisory opinions." However both procedures are incredibly time consuming and in virtually every situation, the legal opinions which emerge are inflexible, ambiguous and non-binding on either the agency which issued them or, obviously, courts or treble-damage claimants.

Our experience with MCC is typical. While we did not seek a formal business review, the antitrust division of the DOJ initiated investigation on its own in July, 1982. For five months, our lawyers answered questions, submitted boxes of documents and held meetings with the DOJ.

Finally, on December 27, 1982, the DOJ issued a press release which said it wasn't going to challenge the formation of MCC. But the press release went on to say that this decision "must not be construed as advanced approval of all (MCC) activities." That would depend, it said, on "a number of factors," including the percent of the industry that chose to participate as shareholders, which shareholders were in which research projects, and whether the costs and risks of a research

project were of such magnitude as to warrant a joint undertaking.

So after five months, our government issued a generic press release that it could have written had it never heard of MCC and which, in addition to not being binding on anyone, provides zero guidance to the MCC companies involved. Surely there is a more positive role which the Government could assume.

During 1983 several bills have been introduced in the Congress of the United States which recognize the shortcomings of the business review procedure and other problems. The one embodying the most comprehensive solution was introduced by Senators Charles McC. Mathias, Jr. (R-MD) and Gary Hart (D-Colo.) and three other sponsors. It provides a set of specific standards against which companies that want to cooperate in research and development can plan and implement their activities. It includes a provision requiring that such companies notify the Justice Department that they are forming an R & D cooperative organization and provide Justice with a statement explaining how the new organization complies with the standards. The bill should become law. If it does, it will replace the present environment of legal ambiguity with a straightforward and simplified approach.

Conclusion

Let me conclude by noting that I am optimistic about the growth of broad-based technological cooperation because I believe that the deterrents I have described can be alleviated, removed or ignored by those with enough foresight and courage to do what is clearly in their own best interests and those of the country. Interest is growing in cooperation. Because of its national visibility, MCC will help to further increase it. There is a high level of enthusiasm developing among participants. Already they can begin to see the tremendous benefits to be derived from cooperation. The scale of the effort is significant and I believe its implications as a national resource will be widely perceived.

Understanding and support for R & D cooperation is growing in Congress—I have learned that first hand, during personal meetings with a large number of Members in connection with my efforts to build support for legislation to encourage R & D cooperation.

Awareness of the need and support for more cooperation is also growing in the executive branch of government. The subject is on Cabinet Council agendas. The Department of Commerce is fostering R & D cooperation, as is the Office of Science and Technology Policy. Most significantly, late last year OSTP promulgated a new policy towards the aeronautics industry which encourages cooperation in research and technology. The aeronautics R & T policy statement is expected to be followed by additional statements pertaining to other important high technology fields and industries.

In the light of a receptive government environment, and with resource shortages aggravating the increasing risks and costs associated with R & D across the entire spectrum of U.S. industry, the stage is set for industry initiatives to rapidly expand R & D cooperation. Only through such cooperation can the U.S. reverse the deterioration that is undermining its position of world leadership in technology, and thereby preserve and enhance free-market competition while expanding the employment opportunities of its citizens and broadening the choices available to its consumers.

Discussion

FROM THE FLOOR: I note in the list of MCC companies, that IBM, AT & T, and TI aren't present. What positions did they take, and are they likely to provide antitrust challenges to MCC in the future, should it be successful?

NORRIS: They were all invited to participate. TI came to the first meeting and then decided to drop out. IBM was asked to participate. They're very much in favor of cooperation as you know. They are part of SRC but they thought that they might create antitrust problems for MCC and declined on that basis. I don't know about AT & T.

BOER: Mr. Norris, I'd like to ask two closely related questions that relate to the competitive aspects of MCC. Since there are 12 companies in the consortium, do you feel there's adequate incentive for any one of them to commercialize proprietary technology given the fact that the other 11 also would have access to it? Secondly, if you license to the outside, do you have a basis for discriminating among the licensees? For example, can MCC license to a small U.S. company versus a large Japanese one?

NORRIS: The first question was about adequate incentives. If you look at the technology in many of these companies, it's pretty hard to maintain a proprietary position. I don't think you're going to get a long leadtime on anybody with anything. That's a very general statement, but throughout the entire history of the computer, we've all been using the same base technology. The problem is to get it. And if you don't have it, you can't compete. So, I don't believe that's a problem. I think the incentives are positive because this cooperation provides the technology.

As far as the licensing is concerned, I'm in favor of cooperation worldwide, not just domestic. But before we get involved in licensing Japanese companies, we need to know if there would be an antitrust problem there. Also, there are restrictions on the transfer of technology. So from a practical point of view, I don't think it's an issue right now.

Philosophically speaking, until the Japanese are willing to provide us with equal access to their technology, I'm not in favor of licensing MCC technology, or any other technology.

ANCKER-JOHNSON: I'd like to restate the same questions as they might apply to the relationship between very large companies and startup companies. Control Data has such examples. For example, you mentioned equity incentives. How closely do you allow your corporate officers to be involved in startups?

NORRIS: It isn't a question of allowing. We encourage them to be involved from the management point of view. And any corporate officer who wants to be on the board of a small company is encouraged to do so. On the other hand, if any executive wishes to participate in the ownership, we encourage that also. But then, he would leave the company. In fact, we have an internal office where anyone who wishes to start his own company comes on a confidential basis, and will receive help in reviewing his concept. If he wishes to go ahead with it, we'll even help him find capital.

If the company is in our field of business, we'll even invest in it. The program has very been successful. Only 10 percent who contact the office actually do it. That means, of the 600 people who have come in, only 60 have started companies. Those other 500 have gone back to work with renewed dedication. Had we not helped them make that decision, then they would always be uncertain and possibly less productive.

FROM THE FLOOR: Mr. Norris, would your expectations be that MCC would be doing largely knowledge-oriented research, or would a substantial portion of it be what I'll call product concept oriented research?

NORRIS: The Chief Executive Officer of MCC is in the audience, and let's let him answer that question.

INMAN: In one program we are undertaking packaging of integrated circuits, which is an advanced development, very much product oriented. In computer software technology, CAD-CAM, and advanced computer architecture, we find it necessary to push the state of knowledge at the outset. But before they are spun off to the participating companies, the product concepts will be well developed, at least to a point just below the engineering development stage.

FROM THE FLOOR: I'd like to go back to a topic that Mr. Malmgren brought up. He touched very briefly on the effect export control was going to have on the views of one particular company. I would like you to expand on the effects you think the pending changes in export control laws are going to have on R & D. A good deal of attention has been paid to the effect on trade, but very little to the effect on R & D itself.

MALMGREN: Well, the Administration is not in a position to comment on this effectively so I can, and I'll be very frank. I do move around and talk rather regularly to industry and governments in Europe and Japan. Feelings are quite strong in Britain, France, and Germany against the new U.S. proposals. Mrs. Thatcher, in particular, is very negative about the orientation of our proposals. She's been excited about extra-territoriality for years, ever since the Iranian assets seizure. That created problems that never went to court in the U.K. but if they had, it would have been horrendous. The results might have changed world banking, because our government did overreach itself.

But in this particular area, I would say that the relevant Ministries in Bonn, Paris, and London are quietly advising their companies to go slow on doing anything with U.S. companies, that could be caught in the U.S. control net. Therefore, their guidance in certain areas of technology development is to be very careful, and to see if there aren't other ways in which research or licensing can be carried out. There is a certain way of thinking in some big companies. You can more or less book your patents in many different places, just as you might book a loan. And some companies are beginning to think about doing R & D in one country and moving it to another for the final development, so that it's outside the reach of the U.S. I think that's a very bad situation, but it has logic.

An example is sensor technology, which is terribly important, as you know, for manufacturing automation, but it's also important for national security. We will not get the cooperation of other governments if we pursue the particular approach we're taking right now. They will just back off and shield themselves, and companies involved will increasingly look for ways to get around our controls.

The most interesting example was when Dresser was asked to unplug communications between their operations in Texas and in France. I've heard that particular lesson discussed in several foreign capitals. No one wants to be in a position of having whole factories or operations aborted, because there's a particular flow of information from an engineer in Dallas, or Houston, to a plant in another country. And that concern already is generating some attitudes about security of communications and the need for coding. This is not very good for us at all.

Our recent actions have been starting a train of thought abroad that's inimical to U.S. interests. And, just like some of the other things we do, it will tend to push technology out even faster than it would otherwise flow, which doesn't make any sense, since we have such a strong base. I may be disagreeing with the thrust of the Administration, but I think most people in the Government agree with me.

PANEL 1:

Technological Cooperation

Introduction

Howard W. Johnson
Chairman, MIT Corporation

Our subject, ladies and gentlemen, is technological cooperation. We're fortunate to have a great panel on technological cooperation as a response to the challenges of America's position in world technological competition.

What do we mean by technological cooperation? The definition certainly embraces cooperation between industries and universities, between government and industry, and cooperation among members of particular industries. It certainly implies greater awareness in these different sectors of the needs of the others, and a reduction in the tensions of adversarial relationships that clearly hinder our ability to compete in world trade.

The time has come for building a stronger national consensus to advance technology as a vital factor in trade competition; and for actions to back U.S. intentions to stay in the forefront of technological progress. The message has several elements: Advanced technology is a key to our future economic and military strength, and we will pursue the benefits of front-ranked technology through appropriate policies that encourage investment in both material and intellectual capital.

Third, we will continue negotiations to moderate the policies of our trading partners, which often place single American enterprises in competition with foreign combinations that include governments and entire segments of industry.

Some of you have seen the report of the National Academy of Engineering and the National Academy of Sciences, labeled "International Competition in Advanced Technology: Decisions for America." It makes many of the same points we're making here, points on which participants from industry, academia, and government agree.

The capacity to innovate and to develop does not just refer to a single sector. It refers to education, research and development, but it also refers to the ability to translate ideas into marketable products, including the increasingly important intangible products represented by services, and to press them into international competition. We're not talking about particular industries or companies, or processes or professions, but rather an elaborate process that must be sustained in full vigor.

There's one aspect of today's interaction that I would like to talk about, which is particularly pleasing to me. And that's the willingness of officials from so many parts of our government, both legislative and executive, Federal and state, to meet in the spirit of frank exploration of facts and ideas relating to this Nation's competitiveness in world commerce. As people in the private and public sectors all probe for sound policies, it's heartening to see our leaders today venturing a bit in search of a range of measures and pressing forward, and I for one, would like to thank Bruce and all of his colleagues for giving us this chance to come together.

We will now hear from George Low, President Low of RPI, who is well known to many of you here. You all have the biographical statements in your notebooks, and I promised our speakers I won't introduce them again. But it's always impressed me that George Low not only leads a great university, but in his earlier life as a leader of NASA and before that NACA, he was a principal practitioner and manager of bringing together the leading edges of technology in the solution of a major problem. And in that role, he won not only one DSM of the NASA, but three of them. It's a great honor to introduce Dr. George Low.

Industry-University Cooperative Research

George M. Low
President, Rensselaer Polytechnic Institute

American universities are an extraordinary resource to the Nation, and to industry, for the stimulation of new ideas, the application of these ideas, and especially for the educated and trained people they provide. It is no wonder, therefore, that there is a renewed interest in industry-university cooperation. This interest stems from the following factors:

1. The realization that the lack of United States competitiveness in world markets stems from a relative decline in productivity and quality, and the concurrent hope that an infusion of new people and new ideas will help turn this situation around.
2. The fact that the lines between basic knowledge and its application are becoming blurred in a number of fields; and that fundamental research often provides solutions to industry's problems.
3. The cutback in federal funding of research, and the need for universities to seek other sources of funds, notably from industry.

The linkages between industry and education are sometimes viewed with suspicion, and often with ignorance of each other's ways. This should not be surprising because industry's and the academy's motivations are so different. Industry is output oriented: The end result must be the efficient production of goods and services in a competitive environment. The university is knowledge oriented: Knowledge for its own sake is not only an accepted result—it is a desired result.

Industry must be protective of its ideas and processes, of its rights of ownership. Open communication and publication are often antithetical to industry's objectives. The university, on the other hand, with its mandate of educating students and generating new ideas, must be able to communicate its ideas freely, and to publish the results of its research as soon as possible.

These differences are basic. Nonetheless, there are also many common objectives and common needs. Universities produce a stream of educated people and a store of fundamental knowledge. Companies, especially those working at the cutting edge of knowledge, need a steady inflow of bright people and fresh ideas. University professors will teach better, and do better research, if they can bring to their classrooms and laboratories knowledge about the latest applications in their field; such knowledge can only come from close ties to industry.

Public opinion is often swayed by the teachings and writings of university faculties. Hence, a better understanding by faculty members of the motivations and ways of industry will lead to greater public acceptance of the corporation. In turn, expanded dialog between the university and industry may lead to a heightened awareness by industry of its public responsibilities.

Finally, the quality of a university education depends heavily on external support, on funds and on gifts of equipment. Much of this support must come from private sources, especially from industry. For all of these reasons, it is essential that universities and industry indeed be partners in the research enterprise, that each learn to understand the other's ways, and that each be prepared to give as well as to take, without either partner giving up its basic responsibilities to society.

There are many ways in which successful relations between industry and universities can be forged. In all of these I would state an overriding principle, as follows:

University-industry linkages will be successful only if they are based on educational programs of intrinsic academic value.

Perhaps I can best explain this with an example from my own institution. Today, one of our most successful relationships with industry is in computer graphics—in computer-aided design. This relationship is all encompassing. It involves an affiliates program with many companies: specific research and problem solving arrangements with individual firms; continuing education and training programs, both broadly based and specifically tailored for a company's needs; consulting by faculty members and an exchange wherein people from industry serve as adjunct faculty in our institution. It also involves the payment of fees by industry, and gifts or loans of equipment and software. Above all, it involves an exchange of ideas and knowledge that is beneficial to both partners. Today, we can count more than 100 separate arrangements and agreements with industry in this program alone.

But we did not start out with industy relations in mind. In fact, our computer graphics effort had its genesis about seven years ago in a desire to improve undergraduate engineering education. We were concerned about the loss of all "hands on" experience in the curriculum—such as drafting, surveying, and shop courses—and searched for the modern equivalent of these. The answer was in the then emerging new tool of the engineer—the interactive computer graphics terminal. We set up a classroom of 36 terminals, driven by two minicomputers, and developed demonstration programs for most of our undergraduate engineering courses. Soon 2,700 students, our entire undergraduate engineering enrollment, passed through that classroom every year.

Next came graduate education and research. Graduate students were first involved in developing the computer programs for undergraduate teaching demonstrations. From this, they and their faculty saw opportunities for fundamental research, both in the development of graphics techniques, and in their applications. Physically, this research is conducted in the same laboratory complex that includes the undergraduate classroom, thus assuring linkages between graduate and undergraduate education.

All of this happened in a period when industry recognized computer-aided design as a fundamental tool in its quest for improved quality and increased productivity. The all-pervasive ties with industry, which I described a moment ago, thus were a natural outcome of our educational program—a program that clearly had its own intrinsic academic value, and that value is still maintained today.

Categories of University-Industry Linkages

Over time, many different types of relationships have evolved between universities and industry. In general, they fall in one of the following categories:

- **Consulting**—Faculty members enter into individual agreements with a firm to provide consulting services in their field of expertise. To encourage professional development, universities generally allow and often expect their faculty to spend up to one day per week in consulting activities. When faculty members are on a nine month contract, they may also spend their summers in consulting work.
- **Research Grants and Contracts**—In contrast to consulting, here the arrangement is between the university and a company. In response to a formal contractual agreement, a faculty member (or a group of faculty), generally supported by graduate students, will agree to perform research in a specific field. A critical question is the right of ownership of the results of the research.
- **Major Contracts**—A special case of the research grant or contract is the major

contract, wherein a university enters into a multi-year, multi-million dollar contract with a company to do research, generally in a broad area. Examples are Monsanto's $23.5 million, five-year contract with Washington University to conduct product-oriented genetic studies, and Exxon's $8 million, ten-year agreement with MIT to study combustion methods. The sheer magnitude of these contracts has spurred a debate about the university's potential loss of its basic academic values.

- **Affiliate Programs**—In these programs, companies become "affiliates" of a program, a department, a group of departments, or of the university as a whole, for a membership fee. In return, the affiliates receive a window into the university's research, through mutual visits, conferences, and publications. The affiliates may also participate in special training programs or short courses. The university receives advice on the needs of the marketplace, and may wish to alter its curriculum accordingly. These relationships, in turn, often result in additional consulting arrangements or research contracts. Companies also get to know capabilities and people, and often get an insight into where to recruit the best graduates with advanced degrees. The outstanding example of such an affiliates program is the MIT Industrial Liaison Program—a massive effort that earns about $6 million annually in membership fees from nearly 300 member companies.
- **University Consortia**—There exist a number of university consortia, which bring to bear the combined strengths of several universities on a specific problem, or set of problems. Most of these, in the past, were established to operate research facilities for the Government. Today, however, there are some moves to form such consortia to aid in the economic development of a region by fostering university-industry ties. One example is the Microelectronics Center at Research Triangle Park in North Carolina. Another is a consortium of 15 New York State universities, recently formed in partnership with industry.
- **Industry Cooperatives**—In fields where an entire industry perceives a need for more basic research, and more educated professionals, companies have formed cooperative arrangements for dealing with universities. A good example is the Semiconductor Research Cooperative, a subsidiary of the Semiconductor Industry Association, which will support centers of excellence and individual research programs. Funding of several million dollars, collected in fees from member companies, will be distributed to universities in response to specific proposals.
- **Exchanges of People**—Many of these categories of cooperation lead to exchanges of people: engineers, scientists, or managers from industry coming to campus to deliver lectures or as adjunct faculty, and faculty members spending a sabbatical leave working for a company. Both industry and the university gain from these relationships—the university through an exposure to the "real world," and industry through the infusion of new ideas.
- **Incubators and Research Parks**—A natural result of advanced technology activity on campus is the spawning of entrepreneurial enterprise—initiated by recent graduates and faculty, or by outsiders who are attracted to the university environment. Universities have encouraged such ventures by helping start-ups to incubate—by providing them advice, laboratory and library services, and often inexpensive space; and through the development of affiliated industrial parks. The best example, of course, is Stanford Industrial Park, the springboard for the Silicon Valley semiconductor and biotechnology industries. The outcome for the companies and for the university is a mutually supportive environment, an excitement that spawns new ideas and dynamic enterprise.

I have described, briefly, eight categories of university-industry relationships. I believe that all existing linkages can be classified in one or more of these categories. They are often interconnected and nurture each other.

Industrial affiliates programs lead to consulting and research contracts, and vice versa. New companies may spring from any of them, and in turn, will lead to more consulting and research. Consortia and cooperatives are formed whenever universities or companies see a gain from working together for mutual benefit.

At my own institution we are involved in seven of the eight categories. Perhaps a brief account of how some of these relationships came into being will help focus the issue of how one organizes for university-industry relations while preserving academic values.

I have already described our effort in computer graphics. Over time, we started similar efforts in manufacturing technology and in integrated electronics. All the programs started with an educational thrust, involving teaching and research at the undergraduate and graduate levels. All three eventually led to significant industry linkages, involving consulting and research, as well as affiliates programs. They all now have industry advisory councils, to help guide the direction of research; but all three cherish their educational heritage and are governed with full understanding that their basic mission resides in their *educational* goals and objectives.

With these programs came the entrepreneurs: graduate students, instructors, and research assistants who had ideas of their own for a product or service, and who wanted to develop those ideas. We decided to facilitate their efforts through our Incubator Program. We provide them with inexpensive space, and easy access to faculty consultants, management expertise, and library and computing services. Thus, we become a resource to them that is the equivalent of a corporate R & D laboratory. We also provide introductions to appropriate financial institutions or venture capitalists. The result has been the startup of about 16 new companies, in the last two years, with 12 currently active in RPI's Incubator Program.

Finally, mostly because we do not have around us the high technology environment that is so essential for a thriving research university, we decided to develop Rensselaer Technology Park, our own research park. On land owned by RPI, we have installed the roads and utilities for the first phase of this development, and the first tenant—National Semiconductor—is building its facility.

The result, for us, is an environment that we cannot create in the classroom alone, an extension of our laboratories to demonstrate to some of our students and faculty what is involved in starting and maintaining the stuff of which American industry is made.

Concerns About University-Industry Cooperation

Cooperation between industry and universities is not without potential danger to both institutions. The principal concerns are:

1. The possible erosion of basic academic values, of the educational goals of teaching and research, of giving faculty members their choice of questions to pursue, and of maintaining the university as a credible and impartial resource.
2. The conflicts of interest that may arise when trade secrets interfere with the freedom to publish, or when managing one's investments interferes with one's commitment to teaching and scholarly work.
3. From industry's point of view, the possible leakage of information to domestic and foreign competitors when research results are communicated openly in traditional academic fashion.

I will not discuss these concerns in detail. Instead I will briefly set forth a few principles that, if followed, will allay the concerns without precluding viable university-industry relationships. They are:

1. The choice of the research or projects to be undertaken must reside in the university and its faculty; there must be absolute freedom to accept and to reject the work that is to be done.

2. The vast majority of the work to be done must be of a kind that can be communicated and published freely. Scientific communication must not only be open, but it must also be complete in that it must include all relevant information about methods and techniques. Such communication assures the expansion of knowledge, and provides the only valid measure of the quality of work of doctoral students, the faculty, and the university.
3. At times it may be necessary to delay publication for a short period of time—of the order of three to six months—for patent filings, or perhaps for a sponsoring organization's review. These delays are not considered detrimental to open communication, provided the ultimate right of the university to publish is absolute.
4. Proprietary work, that is work the results of which cannot be communicated freely, should only be done in exceptional cases. When such work is undertaken, the university and its faculty must exercise great caution to assure that basic academic values are maintained.
5. Members of the academic community involved in commercial enterprise must avoid real or apparent conflicts of interest and conflicts of commitment. Administrators and faculty members must devote most of their energies to the university—to their principal duties of teaching and research.

For further discussion of these principles I refer you to the proceedings of a National Conference on University-Corporate Relations In Science and Technology held last December 15 at the University of Pennsylvania, and especially to papers delivered by President Giamatti of Yale, and by me.

Conclusion

I have described many forms of industry-university cooperation, and then discussed some of the potential dangers inherent in these relationships. The basic conclusions that I would draw are:

1. There are many ways by which industry and universities may cooperate in the research effort, and the best way will depend on each specific situation: the specific company, the specific university, and the specific work to be done.
2. Both partners have to recognize the other's concerns in forming these relationships, and have to be prepared to give and take in a true spirit of partnership, in an effort to reach common understandings and common goals.

In short, it is a time to experiment, and a time to be quite flexible, but with a clearly established set of purposes:

To form the kind of relationships that will assist American industry in its quest for innovation, quality and productivity while providing the best possible education for the engineers and scientists who will have to seize the extraordinary opportunities that will surely present themselves for future developments.

The State Perspective on Technological Cooperation

John M. Mutz
Lieutenant Governor of Indiana

The Indiana General Assembly a number of years ago assigned the responsibility of Commissioner of Agriculture as well as Director of the Department of Commerce to the Lieutenant Governor. It's against that backdrop that I appear here today to talk about the Middle West's perspective. In Indiana and in other Midwestern states, an agonizing reappraisal is going on among those who have governmental responsibility. That reappraisal is the result of fear that suddenly became a reality when the recession became a great deal more difficult to deal with.

We began to analyze what was going on the East Coast and the West Coast, and in a few other parts of the country, where unique cooperative relationships had been taking place. We found that in Indiana, and I'm sure this is true in the other Midwestern states, the major research universities and colleges are not private institutions. They are publicly supported institutions, subject to review by the legislature, which substantially changes the ground rules.

We also found that there was a tremendous amount of skepticism on the part of the public and those who represent the public. For the unemployed auto workers, the relationship between R&D and jobs is not readily discernible. How do additional activities between business and industry and the academic world put them back to work? Many of them may never go back to work in an auto plant, and I think we have to realize that this is a social problem that is unlikely to be solved fully by these relationships, no matter how good a job we do.

There already is a skepticism within the legislative bodies of many of our States about what goes on in our publicly supported universities. What is the role of these institutions? Should they concentrate on teaching or should they grant a great deal of latitude for faculty members with bright ideas to perform other functions that benefit society?

We also found doubts among faculty members of our major institutions. Doesn't a relationship with industry jeopardize academic freedom? Doesn't it jeopardize the right to publish research results? The State government had doubts as well. They didn't like the idea of an individual company merchandising its product on the basis that it was developed at Purdue University, for example. It became clear that "economic development" was the magic phrase that sold the cooperative process. During the last session of the Indiana General Assembly, virtually anybody who wanted anything from the legislature used "state economic development" to advance his cause, whether it was banking reform or utility regulation.

And so, we found it to be an ideal time to make some substantial changes. In the past, I had about a $23 million budget for economic development. Today, as a result of the legislative session that ended in April, we have a $121 million state commitment to economic development in Indiana. That remarkable change resulted from fear and genuine concern about the changes in the structural base of our economy.

While mechanisms or approaches may differ, most Midwestern states are trying to create an atmosphere in which the best that the human mind can offer can be brought into the entrepreneurial world. We are aware of how important bright minds and bright ideas are

to the success of our society. So we're trying to cultivate an atmosphere that attracts this talent to our communities. One big reason the East and West Coasts are on the leading edge of technologies is that they offer environments that appeal to people with such expertise and abilities.

After looking at our situation in the Middle West, we decided that four essential ingredients are necessary to encourage cooperative R & D in our region. They include: (1) a new emphasis on venture capital; (2) access on the part of emerging and small businesses to the expertise that exists on college campuses; (3) the creation of joint ventures between the academic world and the private sector; and (4) state tax incentives to encourage these activities.

As for venture capital, Indiana had virtually no organized, formal venture capital activity. To be sure, there always have been individual investors, but we had no venture capital organization such as you find in certain parts of the country. For example, there were no active SBIC's headquartered in the State of Indiana two years ago.

So, to get that kind of alternative investment going, we created a profit-making corporation at the State level, through the legislature, called the Corporation for Innovation Development. And through a 30 percent tax credit, we encouraged the investment by Indiana private citizens and corporations in the common stock of that venture. We have now raised nearly $10 million of equity for the Corporation for Innovation Development.

We also have the ability to invest in SBIC's. And when we do, the tax credit automatically becomes available to the equity participants in the SBIC's. The result is that we now have two active SBIC's, and I believe four others have applications pending. The two SBIC's have already started to make investments in Indiana ventures that employ people and enlarge the tax base in the state.

The venture capital corporation is a profit-making venture. Its only relationship to government is in the tax credit, and certain exemptions it receives from state tax liability. Also, three of the seven-member board are appointed by me; the other four members are elected by the shareholders. The Corporation is staffed by individuals who have experience and background in the venture capital business. They are rewarded with rather handsome salaries compared with what State government pays, and a bonus program similar to those in other venture capital concerns. So, what we started is the beginning of a network of venture capital activity. That addresses the first of our concerns.

The second concern was access to expertise. A lot of people who start a new business venture do not realize that there are many things that have to be done before you go to a venture capital company for funding. They need advice on how to prepare financial estimates and business plans, and present proof of the technology. A variety of things have to take place before venture capital becomes available.

To help new ventures with these preliminaries we created another public-private partnership. The purpose of the Institute for New Business Ventures is to provide access for individuals who want to start a new business, test a new technology, or a new idea. One of the backup mechanisms for the Institute is a new extension program established by Purdue University.

I mention it as an extension system because it functions very similarly to the Agricultural Extension system that has been part of the land grant college system for over a hundred years. In this case, it is an extension system from the engineering school. The idea is to make available the expertise that is available on the campus of Purdue University.

The issue of joint ventures between the academic and the business worlds was addressed by yet another public-private partnership. In the Corporation for Science and Technology, board members represent the academic community, the business community, and the public sector. Its major functions are to develop policies for recommendation to the boards of trustees of the public institutions, and to convince the legislature and the trustees of the

merits of all the relationships we have described.

We are making it very clear that there is a public policy concern in Indiana about encouraging academic-business relationships, and that there are ways to structure business consortia that contribute to a research effort while preserving the academic rights of institutions. Among the people who participate in the Corporation for Science and Technology are eight chief executive officers of the major companies in Indiana that do research, and the presidents of the eight major universities and colleges. They are the people who have to get their boards of trustees to agree to policy matters. The organization also supports existing research projects, and provides forums for interchanges of ideas and activities. The goal is to group together companies with similar concerns.

Five major steel companies operate in Indiana. We are now the largest steel-producing state in the United States. That certainly gives us incentive to take an interest in advanced materials research. There is also a large diesel engine industry in Indiana. So research and development of engines would be another important area for consideration.

We asked the legislature to make a State commitment to research and development activity for the first time in the history of our State, as is happening in other Midwestern States. We said that $150 million over the next eight years should be allocated from State resources for direct aid to R & D activities in the state of Indiana. The money is allocated to the Corporation for Science and Technology which decides how it is to be spent. And it can be spent on any one eight categories of relationships between business and institutions as previously described.

We already have a consortium in action at Purdue University. Five major U.S. companies have joined in a program involving the computer and the advanced manufacturing plant of the future. In this manner, the State is contributing to the research effort on that particular campus. Researchers and institutional structures tend to follow money. We think that if we take the lead at the State level, we can encourage additional linkages between the private sector and the academic world. That is the goal of the Corporation for Science and Technology. The $150 million commitment is no longer a pipe dream because the first installment of $20 million was approved by the last session of the legislature. We are now in a position to put the program into action.

The fourth part of our program is a series of tax incentives. There are tax incentives to encourage investment in venture capital, and tax incentives to encourage R & D activities in Indiana. We are one of, I think, four States that now have a parallel tax credit for R & D, similar to the 25 percent Federal tax credit. Ours is a 5 percent tax credit against State tax liability, based on the incremental expenditures for research activity.

These four approaches are designed to foster the relationships we've been talking about here, and to send a clear message to the business and academic communities that we want to create an atmosphere that encourages a mutually beneficial relationship. There are very good reasons for the approach we chose. One, we found that public-private partnership corporations are the best way to develop a consensus among the leadership in the state. About three years ago, I went to see J. Irwin Miller, the board chairman of the Cummins Engine Company in Indiana, who said, if you got the key people in Indiana in the same room more often, exciting things would happen. The fact is that the traditional business organizations have not been accomplishing that job. But the public-private partnership corporation with its specific agenda, bolstered by available funds and expert staff, have provided a forum for consensus building.

The second reason is that we live in the world of politics. As a politician, I would like very much to see the results of all these efforts occur in September and October of the even numbered years, so that I could go to the electorate and say, look at what we accomplished here. But these investments in human capital are not likely to produce results just in time for the elections. A major concern was

what's going to happen if people are elected who have different points of view. And so, we've created institutional structures. They're put in place in such a way that they will be very difficult to destroy. Similar statutes and similar approaches exist in most of the Midwestern States.

In short, the two things that I believe we have achieved are consensus and continuity, both extremely important in making cooperative R & D ventures work.

Cooperative Industry Efforts

Erich Bloch
Vice President, IBM

I will skim the surface of cooperative industry efforts in general and focus in depth on the Semiconductor Research Cooperative, which can serve as a model for similar efforts in different industries.

Let me review what led up to the formation of the Semiconductor Research Cooperative, or SRC. In 1980, the association that represents the semiconductor industry, the SIA, focused on self-help action by the industry vis-a-vis increasing competition from abroad, especially from Japan. The semiconductor industry recognized the problem early and unlike many other industries, took serious action in its own behalf. It recognized that research has been and will continue to be the base of this industry. The battle in the marketplace is often won or lost in the laboratory.

Research is a key, not only to innovation, but also to productivity. Many of the productivity improvements of both the computer and semiconductor industries can be traced not necessarily to economies of scale, or better tools, but to innovative programs, ideas, and concepts. A key strategy, therefore, is to outinnovate your competitor. While the U.S. has significant strengths in the area of R & D, it does not have a monopoly. As for the mix within R & D, it is mostly development and not much research. We need to turn this around and focus more on research; in addition to development.

Another realization was that the complexity of the technology is increasing: therefore requires a higher investment; lead times are increasing; equipment is getting more complex; and there's a shortage of skilled researchers and technicians. It was also clear that our universities represented an underutilized capability.

The SRC is a reality today. It has increased its membership to over 20 companies. It has funded about 50 projects so far in various universities, some large, some small, and we're looking at future activity beyond what we initially anticipated.

Let me discuss some of the reasons for the SRC. Attached is a chart of worldwide semiconductor sales covering the largest merchant companies. There are five companies that are Japanese among the eleven top companies. If one had looked at this chart 5 or 10 years ago, one would have seen a heavier preponderance of U.S. companies. And the danger is, looking at this chart five years from now, if we don't do anything about it, the number of U.S. companies might have declined again.

If one considers how much is spent on R & D, U.S. companies spent around ten percent of their sales on R & D, Japan's spending ranges between thirteen and fifteen percent. If one considers the total R & D expenditure of companies such as NEC, Fujitsu, or Hitachi, one sees an entirely different picture: Their total R & D effort is five or six percent of sales. But their spending in this one important area called "semiconductors," is quite different.

There have been cooperative efforts in Europe, in Japan, in the United States in the past. I'll spend very little time on Europe, but we should not underestimate some of the new efforts that are going on. The ESPRIT program (European Strategic Program for Research and Information Technology,) is aimed at semiconductors, telecommunications, and computers. There is a plan to spend a billion dollars on R & D over the next five years.

By far the most important cooperative effort is in Japan. Rather than reflecting on the past

VLSI effort, let me reflect on the future. The following research efforts are underway: an opto-electronics program, which is important for telecommunications and computers. There's a high-speed scientific computing effort to produce a high-performance computer, with five companies participating but no academic involvement. The program that has probably gotten the most publicity is the fifth-generation computer program that is primarily funded by MITI and staffed by academics with cooperation from industry.

I don't know what the upshot of these programs will be. But I would warn that we should not underestimate their effectiveness. At the very least they will have done two things: trained a large number of people and on a grander scale than in the past; involved Japanese universities in a research effort in a challenging technology.

Let's turn to the SRC, and talk a little bit about its goals, objectives, and accomplishments.

The goals are simple: to plan and to promote, conduct and sponsor research to improve the understanding of semiconductor materials, devices, and phenomena and develop new design and manufacturing technologies. We're therefore not only focusing on science research, but also on engineering areas. We also want to increase the number of highly trained microelectronic scientists and engineers available to the industry in the long haul, and make research results available to the semiconductor industry on a timely basis.

The objectives are: to get a clearer view of the limits, the directions, the opportunities and problems in semiconductor technology; to decrease fragmentation and control the redundancy in U.S. semiconductor research. As Bill Norris, mentioned, the latter is a serious problem. A critical mass of research is needed in areas that many companies cannot afford by themselves. We also seek to enhance the image of the industry in order to attract talent at the university level, enhance university-industry cooperation.

The program operates on a contract basis. These are not gifts or donations to universities. We're doing the research in the universities, using university faculties, graduate students, and undergraduates. We're not investing in buildings. We're investing in knowledge. Through contracts, we want to build up centers of competence that can evolve and undertake broad areas of investigations.

We also are looking forward to super centers that link a few universities. Just as cooperation in industry is important, cooperation between universities is also important because a single university may not have the wherewithal to perform a complex, long and difficult task. It is the sharing of knowledge and equipment that is important. The areas we are looking at are silicon materials, microscience, device fabrication, design of automation system components, reliability and quality.

Our educational objective is to attract students to graduate schools by funding some programs and providing the funding for universities to attract competent instructors and professors. We established two centers, a computer-aided design center at Carnegie-Mellon and Berkeley together and a microstructures center at Cornell. We are negotiating with MIT on a materials contract; North Carolina's MCNC on manufacturing research, and with RPI on beam technology.

In addition, we have negotiated, or given out 38 other contracts of a smaller nature to various universities. One of our principles is that we will involve not just first-tier universities, but also second-and third-tier universities. It will be important for us in the future to have more schools like MIT, CMU, RPI or Berkeley. The United States should not have to depend on a half a dozen that are in the forefront of technology.

In 1982, we raised about $5-6 million of funds. In 1983, we will be running close to $11 million. We want to get to $15-$20 million in 1984 and 1985. Remember that 1982 and 1983 were probably the worst years for launching a program of this sort. However,

the fact that we survived those years gives me great hope for the future.

I should say something about our membership. We have 20 members today, comprising large and small companies; merchant semiconductor makers and captive producers. We have a very innovative relationship with SEMI. SEMI is an association of semiconductor equipment manufactures; mostly small companies, with sales of $10 million, or $20 million, that cannot participate in a program by themselves. But they can get the information through their association.

Now, to focus on the future. We are looking, at Government participation through DOD. We also are looking at a leapfrog project in memory, not leapfrogging Japan, but leapfrogging the technology to develop perhaps a four or ten megabit chip.

These are some of the approaches. We're depending very heavily on industry. But some other things could help us. For instance, R & D tax credits. They have helped to launch the SRC program. Unfortunately, the R & D tax credit expires in 1985. I think an extension of the R & D tax credit is extremely important. However, the R & D tax credit is incremental. It depends on past expenditures and looks at the increment over the last three years. Where universities conduct research funded by industry, it would help both the university and industry, and the Government if the R & D tax credit were allowable on an absolute basis, instead of an incremental one.

Let me summarize. Cooperative research is an idea whose time has come. Five years ago, one could not have launched such a program in the semiconductor industry. We must go further. We need university-industry-government cooperation, not confrontation. Having this meeting today is a sign that we are starting on a promising path. Let us keep in mind that we want to use our technological base more productively. For the semiconductor industry the strategy is simple: to out-innovate our competitors, and to make sure that there's rapid translation from research into quality products.

Discussion

JOHNSON: I can sense that there are many seconds in the audience to your motion on research credits. The floor is now open for your questions, or comments.

FROM THE FLOOR: For Mr. Bloch. Would SRC welcome contributions from companies that are not now involved in electronics work?

BLOCH: One of the prerequisites of membership is that you have to manufacture semiconductor devices or materials in the United States, either for your own use, as with IBM and CDC, or for merchant sale, as with Intel, AMD, and others. This is one of the provisions. We made an exception for SEMI, the association of small or medium firms that manufacture equipment. But that is a related activity. We do want to stay pretty close to that kind of relationship.

FROM THE FLOOR: I think Mr. Bloch touched a critical point that should be very broadly supported. The present treatment of the R & D tax credit is rather ineffective in its present form. And I also call to your attention the fact that defense contractors have only a partial recovery: Part of their R & D is not recovered. Both in the area of recovery and in the general tax law, we've got a long way to go.

FROM THE FLOOR: One of the proposals in the Commerce Department's material is that a university might serve as a general partner for a R & D partnership. Can either you or Dr. Low comment on the attitude of your organizations toward such initiatives?

JOHNSON: It is a relatively new idea. At MIT we're looking at it with a great deal of interest, and we're open to offers.

LOW: I think it offers a very interesting new arrangement.

MUTZ: May I comment on that? At MIT, are you willing to let the underwriter of such a venture use MIT as the sales tool for the securities?

JOHNSON: That's a delicate point. It's not so much the reluctance of an institution like ours to be entrepreneurial or supportive of profit-making. But it is, rather, that our franchise is from a Commonwealth that stipulates we are not to compete with private industry. We are very conscious of that problem. I don't think it's insoluable, but there would be a lot of opposition among our corporate supporters if a profit-making organization were to use a State or a private educational institution as a sales device.

MUTZ: We're thrashing this issue out because we have had a couple of R & D promoters propose to make an institution the general partner. So far, none of the boards of trustees of our major research universities has been willing to go outright commercial. They are willing to perform research under contract from a partnership. There can be special arrangements so that patents can be jointly owned by the partnership and the university research foundation. This is being done. But it would be difficult for the university to be the general partner. It's not going to happen very soon.

MERRIFIELD: John, you might want to check with Arizona State. The State legislature there has given them special dispensation to do that sort of thing. Basically you set up a separate legal entity that reverts to the university as a non-profit organization once it goes commercial, and then revenues flow back to the university. So that could be a powerful tool for private sector funding of university operations, salaries, better facilities, equipment, and so forth. I think there's a mechanism for doing this, but you might also want to check with Columbia and several other schools.

FROM THE FLOOR: I haven't heard a single mention of the role of the National Laboratories. Here you have a huge technological resource and a huge investment. To be more specific, I'd like to ask Dr. Bloch whether this SRC would run programs at the National Labs?

BLOCH: The SRC has had discussions with national laboratories, especially with Los Alamos. The labs offer excellent skills as well as other resources. We have talked to them. But keep in mind that a prime objective of the SRC is to focus on universities because we want to attract talent. That would get lost if one focuses entirely on national laboratories. But I think there is an in between situation that needs active exploring. You are absolutely right to mention it.

MERRIFIELD: Of course, the national laboratories are an important national resource. We would like to propose legislation that will allow them to set up limited partnerships as well as general partnerships. All the labs are interested: Sandia, Los Alamos, Livermore, Oak Ridge, etc. I'm not sure just yet what kind of legislation would be required. In addition, the labs can operate as a contractual source of enormously capable skills. If we could get the national laboratories to collaborate with the industrial sector, it would enhance the resources of the labs as well as benefit industrial R & D.

Luncheon Address

Edwin L. Harper
Assistant to the President
for Policy Development

I am delighted to be here. Even though giving a talk after lunch violates one of the fundamental rules of wise decision making in Washington: Never give a talk during the day. Always be an after dinner speaker because, by then, nobody will be sober enough to remember what you say. Facing a sober audience is always a sobering experience in itself.

My Adam Smith tie was mentioned in the introduction. It's like my Union League tie in Philadelphia. The Union League tie is all Republican elephants. I always try and remember to wear it when the Republican leadership comes to the White House for the weekly meeting, and I try to remember not to wear it when the bipartisan leadership comes to the White House. My nightmare is that some morning I'm going to walk into the Cabinet room and be there with the wrong uniform on.

A friend of mine, Jim Miller, former colleague and Chairman of the Federal Trade Commission, always wears Adam Smith ties, regardless of the occasion. It led to an interesting breakfast colloquy at his home the other day. His five year old asked the six year old if he knew who Adam Smith is? And the six year old volunteered that Adam Smith was a tie-maker. The five year old said, no, that's wrong, he was an economist. He was that famous economist who found that fundamental economic truth that free men don't eat lunch. That's a true story.

It is a pleasure to be with you. And, we're here about an important and timely topic. Only yesterday, the Wall Street Journal devoted a full column to the new Microelectronics and Computer Technology Corporation. They are going to spend as much as $100 million a year on research and development. And I know from personal exposure that cities across the country were vying to have MCC locate in their backyard. Because not only will they make that expenditure on R & D and employ some 400 engineers and computer scientists, but across the country there's a recognition that R & D is a very important element of our future.

In contemplating the future of American R & D in an increasingly competitive world, the ancient Chinese curse comes to mind: May you live in interesting times. And indeed, we live in interesting times. In just the last 30 years, something like 90% of all scientific knowledge has been generated. Furthermore, this pool of knowledge will probably double in the next 10 to 15 years. And if we can predict anything with certainty, it is that the pace of change will accelerate and be even more dizzying in the future than it is now.

Yet, I don't think we need to regard this prospect as a curse against which we have no talisman to protect us. Rather, maintaining America's technological edge in an increasingly competitive world is a challenge to be faced and met, and I think, one we can meet successfully.

Our future as a commercial power depends on improving the quality of our R & D. But we need to meet this challenge in the right way. At the present time, there's a lot of ink being spilled and a lot of hot air being expended over what I regard as an inappropriate response to this challenge. And that's the notion of a national industrial policy. Maybe I've overstated it. Since there's no agreement on what anybody means by an industrial policy, different advocates have different schemes.

But for the purpose of this discussion, I'd like just to deal with those who think that the

Government can encourage new technologies by investing in the winners. The idea has some superficial appeal: Let the Government direct resources to those industries that are most likely to be successful in the future. The difficulty is that we don't know which firms and which industries are going to be really successful.

It's only by seeing where investors and workers devote their resources and which products consumers are willing to buy that we know who the winners are and who the losers are. And by that time, I'm not sure we need Government aid. The role for Government would make sense only if Government were better at foreseeing the future than our investors, workers, and the marketplace. Is that likely? Well, not when Government decision makers are risking other people's money.

We can point to some classic instances, in fact, where governments have made bad investment decisions. The British and French governments sank billions into the Concorde, the supersonic money loser. Japanese industrial policies, which are often held up to us as models, once tried to persuade Honda not to manufacture automobiles because of the belief that Honda would not be competitive enough. Of course, Honda today enjoys success, precisely because it ignored the policy makers' advice.

To take an example closer to home, what Government official would have had the courage to lend money to Steve Jobs? Can you imagine as a Government official wanting to keep your job, an individual coming in and saying, I'm going to put a personal computer in everybody's home? Well, today, that sounds reasonable. But how would it have sounded only five to ten years ago? Steve Jobs started with an empty garage and an idea, and built the Apple Computer Company; and started a whole new industry which employs tens of thousands of workers and whose annual sales are in the billions of dollars. Those who advocate a national industrial policy point to the home computer industry as a winner. But how many would have predicted it as a winner before it even existed. It's easy to pick a winner once you know who's won.

I'm not sure that the Government can second guess the marketplace. And maybe our friend, Adam Smith, still is valid on this point, despite those who insist that he is a little bit passe. For the record, Adam Smith uttered a good rejoinder to the argument for an industrial policy about 200 years ago. He said in *The Wealth of the Nations,* "The statesman who would attempt to direct private people in what manner they ought employ their capitals would not only load himself with a most unnecessary attention, but assume an authority which could be safely trusted, not only to no single person, but to no counsel or senate, whatsoever. And which would nowhere be so dangerous as in the hands of a man who had folly and presumption enough to fancy him fit to exercise it."

Well, if not an industrial policy, what then? Even Adam Smith did not totally exclude Government from the economic life of a nation. But I suggest that the role of Government should be vastly different from that recommended by those of the state planner mentality who urge us on to some concept of a thoroughgoing national industrial policy.

The Reagan Administration sees the Government's role primarily in terms of giving American creative genius the widest possible scope. No government can match the resourcefulness and ingenuity of the marketplace. Rather than try, it should devote its efforts to enabling the marketplace to work. The market works best in an environment where monetary growth is stable, where there are incentives to save and to invest, where the size and cost of government is limited, and where government regulations are reasonable and no more numerous than are necessary.

That is the very economic platform on which Ronald Reagan campaigned for President. As a candidate, he pledged to bring down inflation, to lower taxes, to get Federal spending under control, to cut back Government red tape. Well, let's consider the record in achieving these goals, and thus, their implications for research and development.

Inflation has been brought down from double digits to 3.9 percent last year, and almost zero for the past six months *(Economic Report of the President,* February 1983, p. 225). In fact, contrary to advanced press speculation this morning, the Producer Price Index went down again this month. By July 1983, personal income tax rates will have been cut by 25 percent with indexing to take effect in 1985.

Even with needed defense expenditures, the growth in the rate of Federal spending will fall from 17.4 percent in FY 80 to 5.4 percent in FY 84. New Federal regulations have been cut by a third, saving American businesses $9-11 billion in investment costs and $6 billion a year in annual recurring costs.

Furthermore, we're ahead of our three-year goal in reducing Federal paperwork by 25 percent. The implications for research and development, indeed for the economy as a whole, are, I think obvious. And, once again, we have a climate in this country that favors capital formation, favors risk taking, and the creation of new enterprises.

With inflation and tax rates down, bracket creep is no longer ravaging the pay checks and savings accounts of the American people. Gold, antiques and tax shelters are less attractive than they were at the end of the last decade. There's a real incentive to invest in exciting new business ventures. At the same time, fewer and more sensible Government regulations favor innovation, instead of stifling it.

In the late 1970's, there was a genuine fear that rigid, regulatory constraints would make technological breakthroughs unwelcome. The fear was that to bring one's operations into conformity with Federal rules would be expensive and time-consuming. Having done so once, how many factory owners would risk having to do the same thing again by utilizing a new process?

In addition, the Reagan Administration has undertaken policies specifically designed to encourage research and development. To spur the private sector to greater efforts on behalf of R & D, we have done the following: In the Economic Recovery Tax Act, we supported a provision of the 25 percent tax credit for increases in R & D non-capital spending; an increased deduction for donations of scientific research equipment to colleges and universities; and a reduced cost recovery period for R & D capital expenditures to three years, from a previous average of 12 years.

The Department of Commerce has instituted a program to promote Research and Development Limited Partnerships. Wide use of this mechanism is being encouraged to assist firms and other private sector organizations to raise money for R & D and the subsequent commercialization of new products and new processes.

We've also made some progress on the patent front. The President has directed Federal agencies to allow nearly all Federal R & D contractors to own federally-funded inventions. Previously, only small business and nonprofit organizations could keep patents on federally-funded inventions. This should greatly increase and accelerate the introduction and commercialization of new products and processes because firms will be able to reap the reward from their creative efforts.

We're working to clarify Federal antitrust policy on joint and cooperative R & D. We're encouraging closer cooperation among industry, academia, and Federal research centers, when research is basic and long range. We're also considering antitrust reform legislation to facilitate such arrangements. I know that Bill Baxter will discuss this in greater length this afternoon.

Where research and development is needed for the good of our society, and where the social returns exceed the private returns, then Government has a role. Thus, the Reagan Administration has proposed substantial increases in the FY 84 R & D budget.

The President requested a 17 percent increase over 1983 in the R & D funding levels. The proposed FY 84 budget includes $47 billion for this purpose. We've proposed a 10 percent increase in the funding of basic research, to a level of $6.6 billion in 1984. For

agencies supporting the physical sciences, engineering, math, and computer sciences, we're proposing a 15 percent increase. We're proposing a 29 percent increase in defense R & D. This request includes $900 million for basic research in such areas as microelectronics, materials research and computer languages.

We're reducing Federal involvement, on the other hand, in near term development, demonstration and commercialization projects for civilian technologies. This type of work can more appropriately be done by the private sector, and the economic benefits are capturable by the private sector economic entities which are going to commercialize those products.

We do live in interesting times indeed. We should view our present situation as a challenge to be met and mastered rather than a curse. I don't think we need to have patience for "doomsayers" who claim that our best days are behind us. Despite the problems that we face, I see cause for tremendous optimism. Let's add up the pluses. Energy prices have fallen and have stabilized. And I think they're probably going to remain that way for the immediate future. In the last decade, we absorbed the last of the post-war baby boom into the job market. These individuals are now approaching the peak of their productive years. We have an Administration committed to economic policies that reward savings and investment, and are designed to foster economic growth.

Add to these factors the tremendous advantages that this country enjoys in terms of resources, infrastructure, and an educated and dynamic population. And you have the ingredients for genuine, long-term economic growth. With the help of people like you in this room, research and development will lead the way.

Discussion

FROM THE FLOOR: Do you see an increasingly receptive mood in the Congress to go along with these legislative proposals?

HARPER: I do. A lot of these issues are going to be fought issue by issue. The antitrust issue is one where I'm a little bit concerned because I saw a poll last fall that indicated about 60 percent of the businessmen in America recognized the need for the changes in the antitrust laws. About 50 percent of the population in general recognized a need, and about 30 percent of the Members of Congress recognized a need for change.

On the other hand, yesterday I met with Ed Zschau and members of his technological task force from the House Republican side. They are looking to enlist about 100 members in their technology task force, and I'm sure the antitrust issue will have a high priority.

PANEL 2:

Tax Policy and the Advantages of R&D Limited Partnerships

Introduction

John E. Chapoton
Assistant Secretary for Tax Policy
U.S. Department of the Treasury

I think Ed Harper laid the groundwork pretty well for my thinking in this area, and that is the basic question of Government venturing into the private capital area in general. The 1981 Economic Recovery Tax Act of course gave significant benefits for cost recovery in the tax area. Basically, we're now looking at near the equivalent of expensing for capital costs across the board. When I say expensing, I mean allowing businesses to write off the present value of the capital outlay for equipment in this country. (The present value of the accelerated cost recovery deduction and the investment tax credit is basically the present value equivalent of the expensing.)

When you turn to the research and experimentation area, investment in R & D has essentially a zero effective tax rate before considering the R & D credit. We basically have a zero effective tax rate on the labor, materials and capital outlays for R & D. Then, when you add the R & D credit, we see a benefit of as much as 12.5 percent of the increase in qualified R & D expenses.

As you know, in the 1981 Act, the ACRS reduced the recovery life of short term property such that, in some cases, the property fared no better than it had under pre-existing law, and modified by TEFRA, it was in some cases even a step backwards. But if you take seven-year class property that was entitled to a 10 percent investment tax credit (and 200 percent declining balance depreciation) down to a three-year life (and basically 150 percent declining balance depreciation), with TEFRA, half the basis for which you can recover your investment is reduced by 50 percent of the credit. If it's a 10 percent credit, the basis is reduced by half of that amount, so the overall benefit from ACRS has been diminished.

We have to recognize that prior to 1981, longer lived property had been dealt with unfairly, particularly when you had very high inflation. That is, the capital cost recovery was not keeping up with inflation and it was decided that we should give greater benefit to longer lived property. That was a conscious decision at that time by the Congress, and by the business community, in which we acquiesced.

I would also add that if you would take the shorter lived property, and there is rapid turnover, then, from a tax standpoint, you're still better off even after TEFRA and ERTA.

You're better off than pre-1981, because the turnover, the recapture rules have been changed. Add to that, the R & D credit, and there's a significant improvement.

As you know, the IRS published regulations on the R & D tax credit which were adopted in the 1981 Act. Those regulations have been unpopular, particularly in the restrictive approach they're taking to software. I can tell you that the regulations will be altered with respect to software, but I cannot tell you exactly how far the relaxation will go or what form it will take. We are having a great deal of difficulty in drawing the line in software in particular, and in defining R & D in general.

A lot of people pointed this out in 1981, and when you start talking about a tax credit equal to 25 percent of incremental costs, drawing the line becomes much more important than it did under prior law. We've been seeking help but haven't gotten as much help as I had hoped we would. It's easy to come in and say that "the line shouldn't be drawn there," but to say where it should be drawn is not easy, and I hope we can talk about that here.

There also has been concern on two levels regarding the lack of specific rules with respect to R & D limited partnerships. One is the general lack of availability of the R & D credit for most R & D limited partnership arrangements, a factor of the legislation which will be discussed as the Administration considers whether there should be changes in the R & D tax credit legislation. But apart from the availability of the credit, what kind of arrangements qualify for the deduction for R & D expenses with respect to the investor in a limited partnership? There is a lot of uncertainty in the existing tax law rules that are applicable to those types of arrangements.

Basically the problem is that the tax law clearly requires that the expenses be incurred in connection with the taxpayer's trade or business. "In connection with" are the magic words that mean it does not have to be an operational business, but it has to be a business. The taxpayer has to contemplate a business, and not a pure passive investment.

When you put that restriction in, it means that the partnership must contemplate carrying on a business with respect to the R & D undertaken, so that the future income will be business income. When you apply those rules to a lot of limited partnership arrangements, it's difficult for them to comply. It is a technical tax requirement though, and one which is not limited to the R & D area. The general requirement that a trade or business exist before a certain type of expense can be deducted is found elsewhere in the tax law.

Research and Development Limited Partnerships: Their Advantages

Nicholas G. Moore
Managing Partner
Coopers & Lybrand

We are meeting today to examine innovative ways to finance large-scale research and development for major U.S. technological breakthroughs. Research and development limited partnerships deserve our attention as an important means for businesses to share the financial risks of their R & D activities. Through the use of R & D partnerships, businesses can attract capital from individuals, venture capital firms, and other sources without liability for repayment if the project is unsuccessful. R & D partnerships can help supply the technological lead time that is so critical for the U.S. to maintain a competitive edge internationally.

Historical Perspective

R & D partnerships have been evolving as a financial alternative since 1974. The earliest partnerships that we formed were to provide seed money to startup ventures. These partnerships raised the money to carry very early stage companies through often-protracted development periods, before venture capital could be raised from more traditional sources. Later, early stage operating companies began to consider R & D partnerships as a means to finance new or second generation products that faced either a high technical risk or a long development period, or both.

Finally, mature companies are now using R & D financing to raise very large amounts of money. To these companies the R & D partnerships offers a way to shift the development risk to outside investors—to avoid betting the company on a speculative new technology. To the private investors, a joint investment like this with a well-established company is less risky than one with an early stage company. This is because the investment generally involves a technology development and a market risk, but a greatly reduced management or manufacturing risk if an established company is involved. From the solid network of regional and national investment banking firms now involved in funding offerings such as these, it appears that R & D partnerships have gained acceptance in the investment community.

R&D Partnerships—Alternative Structures

Over time a variety of R & D partnership structures have evolved. Typically, the investment banking type of financings take the form of "royalty" R & D partnerships or joint ventures. On the other hand, many venture capital financings of startup companies now are cast in the form of "equity" R & D partnerships. Occasionally a hybrid type of transaction will be structured as a royalty partnership with equity kickers, perhaps in the form of warrants.

Several basic concepts are common to all forms of R & D partnerships. Generally, the limited partner investors receive a tax deduction for a substantial part of their initial investments. In addition, if the deal is property structured, investors will receive favorable capital gain treatment of their royalty or equity payback. A sponsoring corporation (or corporations) performs research on a particular project on behalf of the partnership, which owns the technology being developed. The corporation controls the commercial exploitation of the product that results from the research, and has an *option* to buy the technology from the partnership. If the corporation exercises its option, its payment to the partnership may

take the form of royalties, stock, or a combination of royalties and equity (typically warrants), depending on the structure of the particular deal.

Advantages

This financing structure is attractive to both the corporation and the investors. The corporation enjoys some of these advantages:

- Because the corporation is under no obligation to commercially exploit the technology—nor to repay the funds advanced to fund the research—this arrangement virtually eliminates the company's risk in undertaking a new project.
- The cost of capital—if the company elects to purchase and exploit the technology—must be evaluated, but is generally less than conventional debt or equity alternatives.
- Existing shareholders suffer little or no dilution, and the company is able to retain control of the technology it undertakes to develop.
- Individual investors represent an entirely new source of capital.
- Some structures may permit "off balance sheet financing". The company may be able to finance development projects with little or no impact on earnings for financial statement purposes.
- The "payback" of the financing is often timed and tied to the shipment of products. This means that the company is not burdened with cash outlays for debt service until the product is fully developed and being sold.
- Flexibility on the terms of the payback can be built in. For example, a company may purchase the technology from the investors using royalties over time, a lump sum buyout, or, in some cases, by substituting equity.
- Royalty payments may be deductible to the corporation.

To the individual investors, this form of investment has a similar array of advantages:

- Because substantially all of the initial investment is deductible, the risk for a taxpayer in the 50% tax bracket is effectively cut in half.
- Early stage venture capital investments are made available—high risk, high reward, plus tax benefits equal a potentially very high internal rate of return.
- In royalty R & D partnerships, the return to investors is not dependent on bottom line profitability; payment begins as soon as the product is shipped.
- Long-term capital gain treatment means the payback is taxed at a maximum rate of 20%.
- Limited partners may be able to hedge their risk by investing in funds or pools that take positions in several different projects.

Disadvantages

In spite of the numerous advantages of R & D financings, they are not right for all companies. First, the use of the funds raised will be strictly limited to research and development activities, except to the extent that the company generates profit on the contract. Next, only high margin products are appropriate for royalty partnerships, since generous royalties directly reduce profit margins. Depending on the particular structure, the company's cost of the capital may be relatively high. Third, the company must be prepared to give up potential tax loss carryforwards and R & D tax credits, since the investors, rather than the company, are taking the deductions for the research expenses. Finally, the formation and structuring of an R & D partnership can bear a high transaction cost, and may be dilutive of management's time.

Individuals must also exercise caution when considering an investment in an R & D partnership. These investments have an inherently very high risk. Investors must evaluate market, management, and competitive risks very

closely, bearing in mind that the corporation has the right to walk away from the project and not exercise its option, leaving the investor with a highly illiquid asset. If the general partner in the R & D partnership is related to the corporation, for example as an officer, the general partner will face many conflicts of interest, not all of which will necessarily be resolved in favor of the limited partners. In addition, an R & D partnership represents a very illiquid investment and, in fact, the partnership may require additional financing in order to complete the project.

Unless Congress decides to support these investments in R & D through legislative action, investors will always face some uncertainty as to the expected tax benefits, particularly with respect to long term capital gain treatment. To the contrary, recent changes in the tax law under TEFRA have been designed to discourage individual investments in R & D. It is too early to assess the impact of the recent change to include research and development expense deductions as a tax preference item for the alternative minimum tax, but it is certain to reduce the attractiveness of the R & D limited partnership to a great number of potential investors.

Conclusions

The application of the R & D partnership concept to joint research by more than one company is technically sound. In this context, the corporate sponsor would simply be an entity owned by several companies. A trade association or the like might act as an independent general partner for the limited partnership. This would allow private sector investors to provide the capital to fund very large scale industry-wide research and development efforts. This is one important way to help U.S. industry meet the challenges to our technical leadership.

The notion of cooperation among entities to develop ideas and products is not really all that futuristic. Many such transactions are now occurring or have already taken place. For example, my firm is working on a major financing right now that is a joint effort between a small research intensive California company and a large, stable Midwestern company that has production and distribution capability in a vertical market. A large national investment banking firm is underwriting the offering and finds the respective capabilities of the firms to be very attractive.

Stanford Research Institute has been using R & D partnerships to commercialize product ideas resulting from the basic research it performs for its clients. The purpose of the partnership is to create new companies. SRI shares in the commercial success of its ideas because it owns a substantial portion of the corporate general partner.

A number of investment pools, both blind and specified, have been formed to hedge the investor's risk by investing in several public companies. These may be opportunistic blind pools, or formed to invest in specific technologies, such as software. In addition, professionally managed venture capital funds are being formed to invest in early stage companies on an equity basis using the partnership financing technique.

The basic R & D partnership concept is already being used in a variety of ways to utilize private sector dollars to fund some basic research as well as a great deal of product development. In this manner, significant technological advances are coming about as the result of the combined efforts of many entities. The R & D partnership concept can easily be extended to bring private investment money to fund large scale joint research projects by several companies. This type of risk-sharing arrangement should be encouraged as an important defense to our country's technological leadership position.

RDLP Arrangement-Making

Charles R. Kokesh
President
Technology Funding Inc.

I'm sure that all of you have heard of the Three Great Lies. Well, it turns out that there are three great lies for research and development: (1) It *will* work if only we spend some more money; (2) Your R & D partnership will make money; and (3) "I'm from the Government, and I'm here to help."

I'd like to point out that the attraction of R & D limited partnerships depends greatly on your perspective. I notice that we have Jesse Aweida, Chairman of Storage Technology here. STC is one of the largest of the corporations that have taken advantage of the R & D partnership funding mechanism. And, STC's management has done a superb job of highlighting the importance of R & D partnerships as a funding mechanism. Indeed, you could call Jesse a pioneer—you can tell a pioneer by the arrows in his back.

It is one thing when a large company looks to tax-oriented investors or the kinds of investment banking firms that are used to raise sizeable partnerships. It is very different from the perspective of William Norris regarding the MCC or of Dr. Bloch regarding the Semiconductor Research Corporation where consortium members provide the funds.

Then there is the perspective of the academia-business consortium, where academic institutions are looking to corporations for funding; the potential for payback to the investors is much more tenuous. In addition, John Mutz of Indiana addressed the government-business perspective with its unique problems and benefits.

Not to be overlooked are the arrangements between business and private profit or nonprofit research institutions such as the Stanford Research Institute and Battelle. SRI, in conjunction with Sutro & Co., has developed a funding program that is expected to raise millions of dollars over several years for worthy research projects.

But the perspective I would like to bring today is that of the venture capital community. Those of you who have any perspective on the venture community will appreciate that up until about a year or so ago, R & D partnerships were viewed as nothing more than tax shelter promoters and syndicators doing a further job of exploiting the public.

Well, that is until certain members of the venture capital community developed R & D partnerships. Several landmark events occurred in recent years. Hambrecht and Quist helped form Bay Partners II, a venture capital fund that invests in start-ups via the "equity partnership" approach. Last year, John Mumford of Crosspoint, raised a new $20 million fund for equity partnerships from individual investors and financial institutions that support the high technology industry. And Wally Davis left Mayfield Fund, where he was one of the founders, to start Alpha Fund that will also use the equity R & D partnership approach to fund start-ups and early stage deals.

Last year, Technology Funding Inc. accomplished a first. We launched the first publicly registered venture capital fund, the Software Fund, for individual tax-oriented investors. Another venture of ours also deserves to be called a landmark. We are in the process of raising a $50 million R & D partnership for *tax-exempt* investors. Most of the money—80 percent—will be invested in the research and development projects of established companies.

So, as you can see there are many different perspectives. From our point of view, there are five items to consider. We've all paid lip

service to the notion that it is a good idea to have more research, more cooperation and less duplication, and at least a neutral tax policy. But who is going to pay for it? Bruce Merrifield was the only speaker who made any real reference to this very real issue.

We need to look to individuals, corporations, and tax exempt investors, and we must provide incentives for each of them. Tax benefits should not be the only incentive. Investing motivated solely by the tax code is simply another good way to lose money. Investors should do it for the expectation of a reasonable risk-weighted return, and that return is very difficult to come by.

What is a reasonable return? I think it probably is in the region of 40% to 60%, compounded, after tax, even allowing for the tax benefits. As Nick Moore pointed out, sometimes R & D partnership arrangements end up costing the company much more than they anticipated; sometimes that "cost" is the transaction cost in terms of management time and attention. Then, there are questions about the financial terms on these deals. How and by whom will the funds be raised? And finally, what are the real Government barriers?

Let me summarize these points from a perspective that I don't think has been offered. Limited partnerships are supposed to offer the investor significant tax advantages. Today, that only *may* be true. If they are not properly structured, and it is a potential morass, there will be no tax benefits. There should at least be the potential for a high return, and I believe, as I will show you in a second, that some of these deals do not make any sense on their face. And, of course, if there is a return, it can be greatly amplified, and reduce the cost to the companies if the investor achieves a capital gains conversion. That is *the* most difficult thing to achieve with an R & D partnership.

From the corporation's point of view, as Nick Moore pointed out, and I think has been implicit in the Commerce Department's support of this activity, R & D partnerships should be a cheaper cost of funds and should open up an alternative source of funds. If you transfer the development risk, it may encourage companies to take on riskier projects than they would have attempted with their own resources. That would be one of the real benefits to the assault on Japan, Inc.—to allow our management to use what amounts to not off balance sheet, but off P & L financing. There would be no near-term negative impact on the profit and loss statement. It would be attractive for a company to show positive earnings, while radically increasing the amount of money going into research and development.

From the limited partner's perspective, we have to make sure that tax policy does provide for an immediate deduction against ordinary income. It would be nice if the R & D partnerships could get the tax credit. In fact, in the venture capital partnerships where TFI is the general partner, we have been advised by a reputable, big-eight accounting firm that we at least have a filing position. We also think that we have a very good possibility of achieving long term gains for our investors.

The performance of our partnerships suggests that we can achieve in five to seven years a fourfold to sixfold return on capital. With the tax benefits, that translates into six to eight times the original investment, roughly equal to a 40% to 60% after-tax internal rate of return. That return provides the financial incentive, but it requires very special projects that companies may well prefer to keep to themselves.

Let's look at what it takes to achieve those returns. Let's assume an initial investment of $100,000. If all we want to achieve is a four to one cash return, a return most venture capital funds would regard as inadequately small, a pure royalty deal would have to produce $400,000. With a four percent royalty rate it would take $10 million in total sales or about 100 times the venture amount. A million-dollar investment would have to produce $100 million in sales! Projects funded at $20 to $30 million would have to produce gross sales of $2 to $3 billion at a royalty rate of only four percent.

If you raise the royalty rate to 10%, you will reduce the multiplier from 100 to 40. So, roy-

alty rates between four to ten percent mean that gross sales have to be 40 to 100 times the research amount. And those of you in the business community realize those multiples are not the average return that you get on an invested R & D dollar. Further, this simple analysis ignores the tremendous cost of getting a product into market.

This arithmetic shows that more than a "garden variety" royalty partnership is needed. At least an equity kicker is needed, if not a direct equity orientation, as in Bay Partners, Crosspoint, or Alpha Fund. You have to have additional incentives in order to provide a return that makes any sense. But tax policies make it almost impossible to have a reasonable filing position for long term gain, if you begin to add an equity component.

What all this implies is that tax policy should be changed to allow investors who are taking such risks to get the benefit of capital gain. That also applies to the large projects that we have heard about. E.F. Hutton has been working for some time on several $100 million projects, in areas such as jet engines and biotechnology. These projects will require huge sales and incredibly high returns on research to be able to provide an attractive return to investors.

TFI has developed over the last several years a different approach to R & D partnerships. It is probably something that you have not seen before. In this approach, the partnership enters into a joint venture with the corporation. The partnership contributes dollars, and in the case of the early stage venture capital investing that we do, a tremendous amount of management time.

The company contributes management, existing technology, marketing and production capability, and very frequently, additional money, especially when we are working with a larger, established firm. That joint venture is nothing more than a partnership.

During the initial phase of the joint venture, the mechanism allows for the operating losses to be allocated to our investing partnership. This is an example of the fundamental notion of partnership flow-through, and a tax code section allows the special allocation of those losses to the people who paid for the expenditures, in this case, the individual limited partners. The unusual thing about this approach, is that if the joint venture meets the "trade or business" test, that is, it has an existing business activity within it already, then the investing partnership would also be entitled to deduct marketing, general and administrative expenses—all "ordinary and necessary business expenses" per Section 162. In addition, of course, the joint venture can contract with the corporation or perform research at its own level and be entitled to deductions under Section 174.

This approach allows the partnership funding mechanism to provide additional dollars for getting a product into the market. It is one thing to develop a product, but that may be one of the easier parts of the process. You still have to manufacture it, you have to be able to sell it at a cost that allows a reasonable margin, and then you have to get an adequate market share.

During the operating period of the joint venture, which also creates a holding period for the asset necessary for capital gains treatment, there will probably be sales in the joint venture. Handling the revenue stream can be done in different ways to achieve various joint benefits. The partnership agreement can and usually provides for the allocation of net income on a predetermined ratio to the company and to the partnership. Obviously, that income is ordinary income to the investing partnership and does not meet the capital gains conversion objective.

To achieve conversion, the joint venture agreement gives the corporation the right of first purchase to the partnership's interest in the joint venture. Upon the exercise of that right of first purchase, the partnership is automatically dissolved, according to tax law and generally accepted accounting principles. The joint venture assets acquired by the purchasing corporation achieve a step-up in basis to the corporation. So, if you put $1 million into the joint venture, and agree to buy it for $4

million as a payout over time, then the value of the assets would be $4 million. The corporation would record both an asset of $4 million and a corresponding $4 million liability due to the partnership.

Several benefits accrue to the corporation, depending on the nature of the assets of the joint venture. Some or all of the assets may be amortized over the estimated useful life, one measure of which could be the period or the term under which payments were to be made to the partnership. The net effect is that the corporation's payments to the partnership could be deductible to the corporation, thereby reducing the effective, after-tax cost of financing.

It may be desirable to do exactly the opposite, so that the corporation can make the payments but never have a deduction. From the corporation's point of view, higher reported earnings may be more desirable than a lower financing cost, because the higher earnings per share at a given price-earnings ratio should enable the firm to raise more equity at a lower effective dilution.

The partnership interest in the joint venture is itself a capital asset, under Section 741. The sale of that asset, with the appropriate holding period, is entitled to long term capital gains treatment.

As these financing arrangements become more known to companies and to investors, a completely new financing industry will be created. My guesstimate is that tax-oriented investors would probably be willing to put $2 to $3 billion a year into high technology companies through this mechanism. I believe that the appetite for tax-exempt investors to make the same kind of investment—without any tax benefits—is even larger.

Tax Policy Initiatives to Promote High Technology

Ed Zschau
U.S. House of Representatives

A few weeks ago, I had the privilege of being aboard the Queen's Yacht Britannia docked in San Francisco Bay. During the reception held aboard the yacht, Queen Elizabeth asked me a most provocative question, "Why is it that there are so many high technology companies in the Silicon Valley area that you represent?" Unfortunately, I didn't have a very good answer at the time, but the Queen's question is a question that needs to be answered. If we are to maintain our technological leadership in the United States, we have to understand how such technology evolves and what the proper role of government is in the process of innovation.

So far this year, about one hundred bills to promote high technology have been introduced in Congress. All this interest in promoting technology may be a mixed blessing. Although it's good to have the importance of technology to this nation's economic well-being recognized and fostered, there is a chance that all this interest may result in too much government involvement. For example, some of the suggestions being made these days include establishing some sort of national technology planning board to operate much in the way that we imagine the Ministry of International Trade and Industry (MITI) in Japan to function. These proposals suggest that this central planning board would identify the new areas of opportunity and somehow channel resources to those industries and technologies of the future while de-emphasizing or ignoring the so-called sunset industries that don't seem to hold much promise.

In my opinion, that's an approach that is doomed to fail. Even venture capitalists and company managers who are intimately involved with new technologies and innovation admit they don't have a very high success rate in picking such winners. Government bureaucrats subject to political pressures would do worse.

However, we can't ignore the fact that government actions do affect technology and industry. We need to coordinate those actions in a consistent direction. However, I believe that targeting of a different kind is appropriate here. Rather than targeting specific industries or specific technologies, our government should be targeting the process of innovation. That is, the appropriate role for the federal government is to create an environment in this country in which innovation and new ideas are likely to flourish.

Recently, I was asked to become the founding chairman of the Board of Directors for a new High Technology Museum and Science Center being planned for the Silicon Valley area. That museum's charter is to provide an educational resource that will foster technological development in the future. Part of that resource is the documentation of the process of innovation through examples, stories and specific technologies.

There are many such stories to be told about Silicon Valley innovators. William Shockley came to Silicon Valley from Bell Laboratories and formed a transistor manufacturing company, Shockley Labs. A group of his young engineers, headed by Bob Noyce, formed a company based on the idea that many of these transistors could be put on a single silicon chip. That invention of the integrated circuit formed the basis for the founding of Fairchild Semiconductor, the patriarch of many semiconductor firms. Later Bob Noyce and

others left Fairchild to form a new company, Intel, the first manufacturer of the microprocessor, a computer on a chip. And all around the area companies formed based on using microprocessors. Perhaps the most familiar is Apple Computer. The stories of new ideas and new products, economic growth and jobs keep on repeating.

The same phenomenon took place in the genetic engineering field with the foundation of the basic research conducted at Stanford and the University of California, among others.

Several companies have been formed to apply the techniques of gene splicing or genetic engineering for the production of new pharmaceuticals such as growth hormones, interferon and human insulin. We have just scratched the surface of the genetic engineering field. It promises many breakthroughs and phenomenal growth for the future.

The process of innovation documented by these stories requires four prerequisites:

- a commitment to basic research;
- incentives for the risk-takers—investors to risk their capital and innovators to risk their careers;
- an adequate supply of trained technical people; and
- ample market opportunities, both at home and abroad.

The proper role of government is to make sure that these four prerequisites for innovation continue to remain strong in this country.

I would like to touch on how tax policy can insure a robust environment for innovation.

We don't have to look back very far to see the dramatic impact of tax policy on incentives for investment. In the mid-1970s, venture capital was drying up. My company, System Industries, almost went bankrupt two times. We wound up selling technology to a Japanese company just to get the money to meet the payroll.

The scarcity of venture capital was the result of the increase in the capital gains tax from 25 percent to nearly 50 percent that had occurred in the early 1970s. However, in 1978 and again in 1981, Congress reduced the tax rate on capital gains to 20 percent. The results have been phenomenal. In the first 18 months after the capital gains tax was lowered, $1 billion of new venture capital was made available to venture capital funds for investment in small companies. That's in contrast to the $50 million annual rate of venture capital accumulation during the eight-year period in the 1970s when the tax rate on capital gains was high. Last year $1.7 billion of new venture capital was made available to venture capital funds which have enabled many companies in Silicon Valley and all throughout the United States to get started and grow.

In 1981, Congress had another good idea to improve incentives for risk-takers. This time it was to encourage individual entrepreneurs to leave secure jobs to start new ventures. Congress created a new incentive stock option that would enable gains from the exercise of such options to qualify for capital gains tax treatment instead of ordinary income treatment.

Unfortunately, that idea was implemented terribly. Congress put a cap on the number of options that could be granted, which in my opinion serves no useful purpose. It also required that gains from the exercise of such options be added preference income and subject to higher taxation. As a result, we've almost emasculated the incentive stock option. It's essential that this be reviewed by Congress and altered to provide adequate incentives for entrepreneurs.

The R & D tax credit passed by Congress in 1981 was another good idea implemented badly. It provides for a 25 percent tax credit on increases in R & D spending. Unfortunately, Congress made the tax credit temporary, not realizing that you can't motivate long-term R & D investment programs with a temporary tax credit. Recently Congressman Pete Stark introduced a bill to make the R & D tax credit permanent. I'm hoping that the Administration will support that change and that it will pass this year. I believe it would have a dra-

matic effect on R & D funds going into risky projects.

I'm not sure that it's possible to say with certainty whether or not the R & D tax credit has worked, but it appears to be doing a good job. The McGraw-Hill study of R & D expenditures in the last couple of years has shown that despite a severe recession, R & D expenditures in the U.S. increased. That's the first time in the post-war years that R & D spending in America has risen during a recession. Even though that's not conclusive evidence, it does suggest that the R & D tax credit may be effective.

Tax policy can also help provide trained technical people needed to do the work in technology industries. If nothing is done we'll have a shortage during the next few years. The American Electronics Association has estimated there will be a shortfall of about 90,000 engineers and computer scientists over the next five years. This is a key problem which could prevent the continued growth of high technology companies.

The shortage stems from the fact that American colleges and universities don't have sufficient capacity to turn out enough trained technical people due to a financial problem. We have about 2,000 faculty openings in our college and university engineering schools. Each year, more openings are created than there are new Ph.D.s to fill them. We also need more equipment for scientific and engineering education. Tax policy can be used as a motivator for private industry to contribute resources to address these shortages.

I think that the R & D tax credit should be expanded to cover cash contributions made by corporations for faculty salaries and fellowships. Also the deduction for corporate donations of equipment should be expanded to include not just research equipment, but also equipment used for teaching purposes. These ideas are incorporated in Senate Bills S.1194 and S.1195 introduced recently by Senators Danforth and Bentsen.

Finally, in addition to basic research incentives for risk-takers and a strong technical education system, we need ample market opportunities. In particular, we need to expand our exports. Unfortunately, in 1979 the United States trade negotiators agreed to eliminate the DISC (the Domestic International Sales Corporation) which was an important motivator in financing aid, particularly for small exporters. I'm hoping that the Treasury will be successful in coming up with a new tax program that performs the same functions as the DISC, but isn't called a DISC so we can fulfill our commitment to eliminate the DISC but still retain needed incentives for exports.

I hope that Federal government policies will be implemented to foster the process of innovation to make sure we have adequate research, adequate incentives for risk-takers, adequate supply of trained technical people and ample market opportunities. Tax policy plays a vital role in strengthening all of these prerequisites for innovation.

Discussion

CHAPOTON: Charlie, I am inclined to agree with almost of all your analyses. I would just comment that the conversion of capital gains at the end might cause difficulty, both in limiting the upside and making sure that you haven't turned the whole vehicle into a non-business operation, into a closed loop.

FROM THE FLOOR: Have you seen the use of the limited partnerships jointly with more than one company? Or has it always been one individual company?

MOORE: No. As a matter of fact, right now I'm working on a transaction with a small California genetic engineering company of 15 to 20 scientists and a large Mid-Western company in the animal vaccine business. The investment banking community is much more inclined to do the transaction if there is a large company with a distribution and marketing capability in place, combined with the creativity of a small company. So in this particular transaction there were two companies involved, and it did create a lot of synergy. As I mentioned, I also believe this device has direct applicability to combined company research such as that which MCC contemplates.

FROM THE FLOOR: Nick, you mentioned that the company had to accept risk to get the full benefits, and in Bruce's explanation, I thought it was a take or pay kind of a deal.

MOORE: No. At least as the law is presently constituted, the fundamental concept of transference of risk is in place, from a tax and from an accounting standpoint. It's absolutely essential that the risk be resident in the partnership and not in the sponsoring corporation in order to accomplish not only tax deductibility to the partnership, but also to achieve off balance sheet financing.

MERRIFIELD: Let me point out that this is conditional on meeting the specifications, so the risk is there.

MOORE: Yes, that's correct. But there is a very difficult drafting problem particularly in the conventional royalty R&D partnership. It may be impossible to achieve your tax and accounting objectives without more risk than a take or pay would imply.

FROM THE FLOOR: I would like to go back to Bruce Merrifield's statement that there's a gap out there and ask two questions. I want to ask you to comment on his allegation of a gap, and secondly, to ask Mr. Kokesh if I understood correctly that step two in his plan would in fact cover it in part.

CHAPOTON: Well, I can answer the first question very quickly. We have been discussing that very point, whether there is a gap and whether tax policy or other Government policy can and should fill it. And I think there is a consensus that, if it is the case, that is the type of thing the marketplace would not take care of. I think that was a point Ed Harper made, and it certainly is a point Bruce has made before, and we're very sympathetic to that point, too.

FROM THE FLOOR: I'm not sure I understand completely the relationship to what Bruce Merrifield alleges is a gap.

KOKESH: Well, from our point of view, as long as the investment as a whole made economic sense, and that's total time weighted return, we're indifferent to where we come in on that curve, early or late. Obviously if we're coming in to a much more risky transaction very early on, where much of that transition from concept to product has yet to take place, then we are going to want a higher return and probably a much more equity-oriented return. On the other hand, if we are coming in very late and providing the final dollars to get a product out of development and into the market, there should be substantially less risk and a return adjustment. But I do not see the gap from our point of view.

CHAPOTON: You're not involved where the gap is, or you don't think the gap exists?

KOKESH: I don't think the gap exists. It is a very simple notion in my mind that if we put money in on day one, wherever day one is, we still want to get a reasonable return over the total time of investment.

FROM THE FLOOR: Here we're talking about R & D funding which implies the money is to be spent on R & D so the company can have it off balance sheet. Suppose that you actually have proven the feasibility of the product, and you want to make a heavy investment to get it into production. Is that R & D? And is it a different form of financing for R & D that should be kept off balance sheet?

KOKESH: Let me take a shot at that. From a conventional royalty partnership relying exclusively on Section 174 to provide tax oriented investors a deduction, that second stage just may not be fundable through this mechanism. In an equity partnership, a portion would be either Section 174 or other normal operating expenses deductible to the company, but only if the partnership met the "trade or business" test. Finally, from our point of view—the joint venture approach—if you are using tax-oriented investors, it still has to be a tax deductible concept regardless which side it is on, but it does not have to fit under Section 174. If you are using tax-exempt investors as in our institutional fund, frankly, we do not care, and I would rather invest at that stage.

FROM THE FLOOR: I think that's where the gap is from a corporation point of view.

KOKESH: For the accounting treatment?

FROM THE FLOOR: Yes.

KOKESH: Again, if you're using the joint venture model, with the current concepts of how these are accounted for under generally accepted accounting principles—as long as we paid for it in the joint venture, and there was an appropriate special allocation for valid business purposes—it can still be off balance sheet to the corporation, but funded by the partnership.

FROM THE FLOOR: Wouldn't it be easier to simplify the whole process through amendments to the tax legislation? Think of the amount of money that was raised in a short period of time under the new tax legislation. Could something be done in this R & D area by the Government through legislation to simplify the whole process and make it more flexible?

CHAPOTON: That's a very fair question. The leasing trust shows you that we supported that type of legislation very strongly. You do run into a problem if you don't meet some basic standards that people think are fair. In this, as in other areas, you've got to comply with the standards there. You've got to compute taxable income.

You can easily, under existing partnership rules, allocate expenses which are otherwise deductible to a certain group of partners, if the credit's available. I have to agree with Charlie's inference that if the credit is going to do what it's supposed to do, it makes a lot of sense if it is available in that mechanism, so you can also allocate the credit. I think you could simplify these rules, and I'm not sure you'd need legislation, except to make the credit available.

As you know, Treasury has recently published some regulations for partnership allocations which will greatly simplify, and provide more certainty, to those rules. When you turn to the legislative arena, though, you've got to remember the lesson we learned with the leasing rules. That is, Congress and the people are not going to stand for a sham-type transaction in the tax law. In safe harbor leasing, the benefits were available without regard to the tax situation of the company putting the asset in place. I think it still makes good economic sense, but you just cannot sell that type of arrangement politically.

FROM THE FLOOR: Charlie, in regard to the leverage buy-out concepts that you talk about, the last step in this process, in your viewpoint, is there a time period in which the joint venture has to really operate in a business, that is, they have to actually engage themselves in business and sell?

KOKESH: Under current law, the joint venture needs to operate a sufficient time in order to provide a tax-oriented investor with a sufficient holding period for his interest in the joint venture. That interest in the joint venture is his capital asset. If the joint venture does not operate for at least 12 months, obviously even with a sale as short term gain, there are some very real questions about what a Section 174 asset is. When does it become a capital asset? What are the things that might be precluded underneath it? But, in general, I think those questions could be clarified by Treasury Regulation or Revenue Procedure, rather than by outright changes in the law.

CHAPOTON: I would add that there would also have to be a realistic possibility that the company and the partnership would operate a business.

KOKESH: I think that was your comment earlier, Buck, that it might be a closed loop. I think that is one of the problems with using this approach on a one-company, one-partnership basis. But the real benefits of using it in our approach, as a venture capital fund where we add a tremendous amount of economic substance, are: first, that it could be operated as a business; second, that if the corporation did not exercise its right to purchase, we might purchase, or arrange for the sale to a third party.

FROM THE FLOOR: In many circumstances, capital will have to be put up by the corporation to operate as a business. What is the role of the joint venture in this secondary capital investment, after the R & D stage, let's say in building a plant?

KOKESH: Let us not say, some circumstances, let us say always, if it is to be successful. I have yet to see a deal that does not need a great deal more money. In fact, that is one of the reasons that we created this structure, to be able to continue to fund beyond a research phase, and to provide a mechanism for raising more money at the joint venture level. And we have successfully done that in several cases. So, the answer is, it can be done at that point but it has to be contemplated at the outset. You have to be realistic about the total funding required.

By the way, there is one other interesting feature of the joint venture approach. Whether they are inside existing corporations or something like MCC, the joint venture approach allows the allocation of a certain amount of equity interest directly to the key management. This is completely independent of the corporation's basic incentive stock option plan, or stock bonus plan, so that entrepreneurs in large companies can still get some of the economic benefit, without being forced to leave the company—the sort of thing that Bill Norris referred to this morning.

PANEL 3:

Joint Research and the Issue of Antitrust

Introduction

Jesse W. Markham
Professor
Law and Economics Center
Emory University

I appreciate Bruce's having bypassed those one-liners that are usually attached to introductions of economists. Back in this very city, a couple of years ago, someone who introduced me said, "you may define an economist as someone who would marry Farrah Fawcett Majors for her money." And that impressed me as being among the cruelest of the comments that could be made about my profession. The implications of this cutting remark are that my profession is concerned and motivated solely for the maximization of welfare along some unidimensional line defined in financial terms, and I hope to say nothing in my remarks to confirm this implication.

Now, we have a trio of triple-threat stars here who will deal with these issues and who, fortunately for me, require no introduction at all. They appear with regularity on TV networks, ABC, CBS, NBC, TIME Magazine, the New York Times, the Baltimore Sun, the Washington Post, and even, every now and then, in some of the better known media. But I do want to say a word or so about all of them. Bill Baxter and I have been in many conferences. He is one of the few speakers about whom I can say that I always have a slight sense of regret when he stops talking. Senator Mathias, I'd love to have had as my student. All of you may recall that he was one of the few that got his homework in on time, and his speech was out there available to you. And, as for Pete McCloskey, I thought I was familiar with most of his accomplishments, then I saw that he presided over an organization that accounted for $104 billion in sales. That's slightly more than half of next year's forecast Federal budget deficit, which means it is an immense amount of money.

I'm going to confine my very few introductory remarks to a couple of propositions—most of them really have been taken up, or at least have been exposed to us throughout the day. The first of these is certainly a widely held view that U.S. corporations have begun, if they have not already lost, a technological race with Western Europe and Japan. And this widely held view is cursed or blessed, depending upon one's point of view, with numerous not all together reconcilable explanations.

On the one hand, it is urged that U.S. management has shifted its time horizon from the long to the very short run, and from the relatively risky to the relatively certain. Corporate America has somehow become singularly motivated by instant cash flow and profit gratification. Since R & D outlayers contemplate both risk and long-run payout periods, U.S. management has neglected the vital ingredient of innovational effort. And I cite as my source for that the very popular work by my two former colleagues, Abernathy and Hayes.

A second explanation that's frequently given is that our R & D effort has somehow recently become centered on giant scale project types. That is, we concentrate on things like the space shuttle, but somehow, founder and find it very difficult to perfect a front wheel drive automobile that is energy efficient. As Professor Robert Hayes has put it, U.S. corporations are driven by the prospects of the giant erratic leaps of the hare rather than the more predictable plodding progress of the tortoise and, as we all know, in that fable, the tortoise won.

A third explanation is that American business is now solely the remaining business system that must function on several very vital

fronts, where business and government occupy adversary positions. In sharp contrast with the consensual and cooperative system of Japan, the rationalization of industry in most of Western Europe, and the complete congruity, of course, of business and government in Socialistic states, the U.S. Government, particularly Congress, tends to view corporations as "them" rather than us. Corporations occasionally serve as whipping boys when this serves a political objective. Let me say, right now, Senator Mathias, this has absolutely nothing to do with you personally.

Now, one of the best, or the worst examples I think one might recall, is that shortly after the OPEC energy crisis, Congress dumped no less than 29 bills into the hopper demanding various horizontal, vertical, and diversifying dissolutions or dediversifying dissolutions on the major oil companies. More pertinent to the issue at hand, we are also the only nation that has a comprehensive system of antitrust under which our business operates.

Now, if in any sense, the foregoing propositions are causally related, we may well consider carefully assessing those public policies by which U.S. industry is governed, contemplating appropriate remedial action. I do not believe by the way, in this connection as does one of my fellow economists, Lester Thurow, that our entire antitrust apparatus should be dismantled because it inflicts social costs that exceed social benefits. I do believe, however, that a policy crafted to suit commercial and social needs as they were defined in the late 19th century, is not likely, on simple pragmatic grounds, to best serve the nation's needs in the immediate past, present and future global economy.

Specifically, it is surely worth considering whether existing antitrust constraints on joint activities, including the contingency of treble damage suits, serve to inhibit R & D, which on balance is procompetitive. Even beyond joint R & D, it's worth considering whether certain corporate acts - e.g., a modified rationalization of our existing steel industry which might contravene antitrust statutes as traditionally administered - should not be permitted if one could show that they strengthen U.S. industry's competitive position in the global economy. In any case, we have an abundance of expertise to deal with this.

The View from Justice

William F. Baxter
Assistant Attorney General for Antitrust
U.S. Department of Justice

There is a great deal of confusion about the topic of today's discussion, but let me see if I can sort things out. First, of all, we're talking about the formation of units to do joint R & D. It is widely thought that the antitrust laws are terribly restrictive and harsh, with respect to such units. There is more illusion and misconception than truth in that belief.

I want to distinguish an area that is closely related but technically has nothing to do with what we are talking about. There are many, many antitrust doctrines, most of them foolish, that restrict the ability of owners of intellectual property, the holders of patents, the holders of copyrights, and the owners of trade secrets to license others and exploit those properties.

Here is a fruitful area for antitrust reform, and I would not try to defend probably 90 percent of the cases in the area. I think these doctrines are enormously damaging. They seriously undercut the incentives of the patent and copyright systems and trade secrets. My opinion is that the mistaken notions about the restrictiveness of antitrust with respect to joint ventures stem largely from this body of antitrust law, rather than any body of antitrust law dealing with joint R & D activity as such. And certainly, one of the fragments of evidence in support of that assertion is that there is very, very little antitrust doctrine that deals with joint ventures, as such. It is an area where there is very little law. And I am at something of a loss to account for this pervasive notion that there's a lot of law and it's very restrictive.

I don't mean to suggest that it is an inappropriate area for antitrust doctrine. I don't think that at all. I think there are some very legitimate competitive concerns, when one begins talking about joint R & D.

Rivalry, in R & D, as in any other commercial activity, is, in my view, highly desirable. It is what makes a competitive system work. And firms, by and large, do R & D, invest in R & D, for several reasons. First of all, they're afraid that if they don't do it, someone else will do it, and they'll be put at a competitive disadvantage. Consequently, there's this defensive spur to R & D investment. There is as well the affirmative incentive to find something new and better and to obtain an exclusive position with respect to it. Now, this is where the antitrust doctrines that relate to intellectual property come into play. If you can't exploit R & D after you perform it, the incentive to do R & D is obviously seriously undermined. And, again, I urge you to keep in mind the distinction between those restrictive doctrines with respect to exploitation and the issues that arise on group formation.

Whenever people start getting together into groups, the number of actors is reduced, and so there certainly is a risk that this may lessen rivalry. To take an extreme example, if all the firms in an industry get together to form a single joint venture and say, do all of their R & D through this mechanism, and are entitled to share in the benefits of the R & D, then that industry, by private action, has repealed the patent statutes. There is no longer any fear that someone else may get ahead. No one need do R & D to protect themselves because, whatever is developed, will be available to the group. There's no danger of falling behind. And, on the other hand, there's no chance of getting ahead. There is a danger of over-inclusiveness in joint R & D, and it's one

of the two legitimate competitive concerns.

Any time firms which make up over 50 percent of an industry get together, very serious competitive problems are posed. The justification for allowing R & D to be done in joint ventures stems basically from the fact that there are often very significant economies of scale associated with research and development. If the scale economies at the R & D level in an industry exceed the scale economies that characterize that industry at the production and marketing level, we should have a strong preference for the industry doing the R & D in somewhat larger groups. If we deny the industry the right to do R & D in somewhat larger groups, all we will have done in the long run is to force consolidation of the industry at the marketing and production level.

In short, the scale economies at the R & D level will eventually drive firms into a higher level of concentration at all the levels, and that would be absolutely perverse antitrust policy. (That is not to suggest we don't have lots of perverse antitrust policy around; however, we should avoid it wherever we can). If it is assumed that scale economies justify something on the order of 50 percent or more of the firms getting together—that is, the joint venture is a natural monopoly, it follows that the firms in the industry that are excluded from the venture likely will be permanently disadvantaged. Although this is one of the antitrust concerns in this area, the natural monopoly phenomenon is sufficiently rare that this concern does not loom very large.

The most significant antitrust concern is that the joint venture will include too many, rather than too few, of the firms in an industry. Let me start at the other end of the spectrum. If you have a relatively atomistic industry, an industry with 25 or 35 firms, and five or six of them want to get together and do R & D, should we have any concern? I would say that there's no point in making a serious inquiry into whether the scale economies justify those five or six firms getting together. There is room for several joint ventures of similar size. If the scale economies are not there, they're not going to realize any particular advantage. If they exist, the other firms can form their own joint ventures, and there will still be rivalry among joint ventures. All the incentives that our intellectual property systems were intended to create will still be present. So, if 15 percent of an industry, or maybe even 20 percent of an industry get together, my inclination would be to say, no problem. It doesn't even require a close look.

Now, there's a big excluded middle there, from 15 percent of the industry to 50 percent of the industry. And here, I'm going to "waffle," and say such proportions represent progressively more difficult problems as the group becomes more and more inclusive. And, when you get up to 35-40 percent of the industry, you have extremely severe problems on your hands. But that is the tradeoff: You weigh the social value of obtaining greater scale economies on one hand, against the social harms of a greatly reduced number of players.

The loss of rivalry takes two different forms. First, there is a loss in rivalry in the R & D activity itself. There are fewer people doing R & D, fewer independent ideas about what's worth attacking next, or what scientific avenues are worth exploring next. And that's a loss. But there is also the danger of clubbiness, easy communication being carried forward from the R & D level into the production and marketing level. And in this context the position of the proposed research on the basic/applied spectrum is important to me. The scientists doing basic research will not be involved in the marketing and pricing decisions of the firm. As the R & D becomes more and more application-oriented, product-oriented, the people who will get involved in the activities of the venture will, in all likelihood, have more and more involvement in the commercial activities of the firm at the production and marketing level, and make ever more likely loss of rivalry at the production and marketing level.

These remarks are really more a menu of my fears than a clear set of rules, but I hope they are at least suggestive of the attitudes that the current Antitrust Division would take toward these problems. Thank you.

The View from Industry

Peter F. McCloskey
President
Electronic Industries Association

I heard, in the last session, the suggestion that perhaps there should be some clarifying legislation on joint R & D. I think we have the same problem on the other side of the issue. The last discussion was on the limited partnership concept, and was primarily directed at company's off-balance sheet financing through the partnerships. The issue we're now addressing are joint ventures by companies engaged in the research themselves in order to achieve needed economies of scale. This is, of course, triggered in large measure by the success of the industrial policies of our trading partners. In Japan, in particular, targeted industry programs have produced for them major leapfrogs in technology, and breakthroughs that they've been able to utilize effectively in penetrating the world marketplace.

The one thing, that we are increasingly realizing in our industry, is that every company in the electronics industry is in the world marketplace, whether they export anything or not; because the people that they're competing against are foreign companies as well as domestic companies. One of the things Bill [Baxter] didn't address, but I heard him say it the other day, so I'll repeat it, was that in measuring market share for joint research ventures, whether it be 15 percent or 50 percent, it's the world marketplace areas that is the test. That certainly recognizes the reality of the world marketplace.

The second thing, as we address this issue, is that there really has been very little historically in the way of joint research, of the type that we're now talking about. The Justice Department guidelines for joint research cite only 20 examples of joint research that have gone through a business review procedure. A close reading of those examples will show that almost none of them are of the MCC variety, and only about three or four were really joint research at all. And so, there has been a great hesitancy. This is a vehicle that's not been used before.

Managements around the country are looking at it now and saying, "Should we use it? What are the pros, and what are the cons, and what are my risks?" What they would like to have is some certainty that what they do in the open will not be subject to second guessing. I attended the Conference in Greenleaf a year and three months ago when MCC was first brought up by Bill Norris. After leaving that meeting, I was surprised in retrospect that it ever came to fruition. I knew most of those Chief Executives, and they all came to that meeting without a commitment to go ahead, because of their concern on the antitrust issue.

Now, maybe the antitrust is just a strawman, the perception, as Bill says, rather than the reality. Because it's never been historically used, it's kind of counter to our culture. Most business executives have not thought of it as one of the arrows in the quiver that they might be able to use in this industrial warfare game. But, the realities of the marketplace today, the success of some targeted programs abroad, have made it much more imperative that we address that issue now.

And so, I think the task before us is for simplification, for clarification of just what it is you can do, and what it is you can't do, keeping in mind the guidelines that have been

expressed. But the concern is, what is the relevant market?

In talking about 64K RAMS, we said that the Japanese targeted that specific aspect of the industry. Was that the relevant market? Or is it the semiconductor memory market, or is it the semiconductor market itself? Or is it something even broader than that? That makes a huge difference to the companies involved. And when you're engaging in joint research, you're not 100 percent sure what the outcome is going to be. You may well wind up in some area where there's a disproportionate market share.

So, I think the need is for a device that would allow people in good faith, to enter into a program, do exactly what they said they were going to do, and in retrospect, not be attacked. I think it was January 25 of this year that the press release went out that said that MCC had been formed. And I think it was two or three days later that Joe Alioto sent a letter to all of those companies, saying, "I don't even know how you got together. That's clearly wrong. You shouldn't even discuss the concept of joint research without that being illegal. And second, I urge you to cease and desist. Third, I really don't care what Bill Baxter says, the civil antitrust bar is the enforcement mechanism for antitrust." And having just won the NFL suit for the Oakland Raiders, one assumes he's got the resources to follow through on that kind of attack, and that's disconcerting, believe me. I assure you it would give the Chief Executive Officers of those participating companies a great measure of relief if something could be done, and that's by way of introduction of our next speaker.

The View from Congress

Charles McC. Mathias, Jr.
U.S. Senate

I think this is a very timely subject. And my role is a very limited one, which is to tell you about legislative efforts that are intended to encourage joint research and development. I wish I could keep you here all day describing those, but it's rather a short tale.

For years, demographers have been telling us that we have a shift from a production society to a service society. And, I suppose we ought not be really astonished that we're beginning to see the evidence mounting on all sides that that's exactly what's happening. I think when people have heard that phrase, a service society, perhaps too many have visualized an enormous international McDonald's under golden arches, handing out billions of hamburgers—service in a literal sense. But I'm talking about the very specific development in which the modern tool of all trades, the computer, plays such a central role.

Our international high-tech competition is nipping at our heels. We have begun to feel that impact of the competition. And there is a sense, on the Hill, I think, that we've got to maintain the lead, and we have to do it without mimicking the kind of pervasive government intervention, supervision and subsidization that some of our leading trading partners favor. The kind of statistics that are getting congressional attention are the fact that over the past 20 years, our research and development expenditures have declined by one-fifth as measured as a share of GNP, whereas Japan's R & D expenditures have increased by one-third, measured as a share of GNP. From 1962 to 1980, Japan's trade balance in high technology products grew 35 percent while the United States' grew only 12 percent. The United States' share of the world market for high technology products declined by 15 percent during this period, while Japan's rose by 25 percent. Japan holds 40 percent of the domestic United States market for 16,000 bit memory chips, 70 percent for the 64,000 bit chips, and they're expected to be the first in the market in this country on the 256,000 bit chip.

I might just add to those depressing facts, the estimate that our trade deficit is going to run about $70 billion dollars, twice as big as the worst nightmare anybody ever had! And that's jolting the Congress to attention. Our failure to train enough engineers, I think, accounts for one aspect of this narrowing lead. Japan, with half our population, has 5,000 more electrical engineers. One of the Vice Presidents of Xerox recently complained that universities produce only about 200 computer science Ph.Ds annually, which is about the number that just one major corporation recently stated it needs to hire each year.

As General Baxter has just been saying, the limits that antitrust laws place on joint R & D activity are, of course, standing in the way of aggressive action to meet this foreign competition. Under the direction of the Japanese Ministry of International Trade and Industry, and with a pretty good subsidy of $450 million, eight Japanese computer and electronics firms have formed a consortium for a ten year research and development effort to produce the first fifth generation computer. This is a machine that will have artificial intelligence that will allow it to interact with the spoken human voice. It can answer questions directly. And for good measure, it can throw in any other incidental related information that might be of interest to the questioner.

The Pentagon needs this kind of a wonder for security reasons, and it's planned its own major research project to get the United States into the race. Everyone agrees, or I think everyone agrees, that the government can't overcome the challenge single-handed. I think we

all recognize the value of competition in R & D as well as in the more usual commercial context. And, certainly, Mr. Baxter speaks with a great deal of authority on this subject. But, due to the highly capital-intensive nature of high-tech basic research and the shortage of scientific and engineering talent, I think there is a reasonable expectation that Congress may decide to allow some limited pooling of resources. In 1972, the Justice Department developed a business review procedure that allowed companies to get advanced approval of a proposed joint venture, a process supposed to minimize that threat of private treble damage suits. But it really hasn't been very convincing to the people who count—the business executives who make the decisions to put millions of dollars in joint research.

As I understand it, there have only been about 24 applications for antitrust clearance between 1972 and 1981. This is not a very encouraging record. It's that kind of background that's led to a swarm of formal and informal proposals that have been made in Congress, and let me just run through them very briefly.

My own Joint Research and Development Ventures Act was introduced with Gary Hart last year, and we have re-introduced it this year, with a little more support, including Senators Chafee, Spector, Baucus, and Pete Wilson. It will permit self-certification for companies that want to start a joint venture. If they meet the objectives standards set out in the bill, then they would be free to go forward. And the government would receive notification, and could start an investigation if it wanted.

The self-certification standards fall into four categories. Any firms may participate in the venture on the same terms or join in the venture for the purpose of participating in only some of the research projects. The only condition is that if a firm has a 25 percent or greater share of the world market of a product, and its participation would cause the joint venture's collective market share to exceed 50 percent, it would have to obtain special advance permission from the Justice Department. The joint venture can only engage in research and development. Participation in the venture places no restriction on separate research projects by the individual companies.

The bill requires a Management Board composed of one representative from each company as well as three outside representatives. The Board would select the presiding officer, decide what projects the venture should undertake, and allocate the costs among the participants. All inventions and discoveries made by the venture should be reported to the members. Patents are owned by the venture and licensed to any of the members for three years, after which the inventions become available for licensing to non-participating United States firms.

Now, there are other bills that have been introduced over the past year, by John Glenn and Paul Tsongas, and by Representative Edwards. They resemble one another in requiring some form of approval or certification by the Department of Justice for a proposed joint venture. But they would limit the Attorney General's discretion to deny certification if the venture meets certain threshold requirements. The Glenn and Tsongas bills would give immunity from government or private antitrust action if the venture is certified. The Edwards bill precludes government actions but allows private suits for single damages against activities within the scope of the certificate.

This is a very welcome opportunity not only to hear my fellow panelists, but also to get the views of the audience on all of these ideas. Because I think that these bills represent only the most recent kind of expression of congressional interest in this subject. My own beginning in this area goes back to 1958 when Senator Javits and the late Senator Beall, who, with the kind of foresight that they usually exercised, introduced a bill to allow small businesses to engage in joint research, and authorized the Small Business Administration to make loans to assist them. So, this is not breaking ground, as far as the Congress is concerned, but I think it may be reaching a point where we can finally get it accomplished.

I have showered you with some fairly bleak statistics, on the grounds that we are losing to international competition. But let me close on a more upbeat note by recognizing the recent formation of a true American style high-tech venture: the Microelectronics and Computer Technology Corporation, put together by 12 independent and competitive microelectronic and computer companies. I think the very fact that you can get these companies to recognize that they had to lower the sword and establish a cooperative forum, is perhaps the best testimony we have—it's a testimony of the marketplace that there is urgency in our situation.

I think the Senate is sensitive to this urgency, and I personally would like to do everything I can to encourage more cooperative research programs, because I think this is the only way we're likely to remain competitive in global markets.

The View from Commerce

Irving P. Margulies
Deputy General Counsel
U.S. Department of Commerce

Need for U.S. industry to increase joint research and development

This Department is seriously concerned that the fear of violating antitrust laws has caused U.S. firms to refrain from conducting joint research and development on a scale comparable to the companies of our major trading partners. This fear adversely affects our ability to compete in foreign markets.

There is no disagreement that joint research and development programs play an important role in the innovation process. Some firms, particularly smaller firms, because of prohibitive costs, are unable to engage independently in research and development on an efficient scale. Many research and development efforts could be carried out on a joint basis by firms willing to share the costs and rewards of such efforts. For large firms, joint research and development may be highly cost-effective in developing new and better products, particularly in competing against their aggressive overseas counterparts. Moreover, today's technological problems are often so large and complex as to be beyond the capability of a single firm. For all of these reasons, joint research efforts can be key factors in the ability of countries to stay competitive in many new or technologically evolving international marketplaces.

Our major trading partners have tailored their policies and antitrust laws to recognize that the ability to solve modern technological problems and to compete successfully in international markets requires firms to collaborate in joint research and development projects. Firms in Japan, France and West Germany, through permissible arrangements under their antitrust laws, have been able to overtake the U.S. in certain targeted industries where the U.S. had a technological lead. These industries were identified in a 1982 Department of Commerce study, and are set out in the following table.

Targeted Industries

	Japan	*France*	*West Germany*
Computers	X	X	X
Microelectronics	X	X	X
Electronic Instruments	X		
Lasers	X		
Optical Communication	X		
Electronic Office Equipment		X	X
Biotechnology	X	X	
Robots	X	X	
Energy Conservation Equipment		X	
Underwater Exploration Equipment	X		
Aerospace	X	X	
Telecommunications	X	X	

Thus, Japanese antitrust law has permitted Japanese firms in recent years, under the administrative guidance of the Ministry of International Trade and Industry (MITI), to conduct collaborative research and development in targeted areas such as computers, microelectronics, electronic instruments, lasers, optical communication, robots, and aerospace. Earlier this year Mr. Kuzuhero Fuchi, Director of Japan's Institute for New Generation Computer Technology (NGCT), announced a ten-year collaborative joint research and development venture with industry to create a so called "Fifth Generation" computer by which they hope to leapfrog U.S. industry.

Similarly, French antitrust law did not deter French firms from conducting massive joint research and development projects in such areas as aerospace, telecommunications, micro-electronics, energy, and conservation equipment. West German firms also have not been inhibited by antitrust restrictions in conducting joint research and development in computers, microelectronics, and electronic office equipment.

Further, the European community has exempted several collaborative joint research agreements of individual member countries from the antitrust restrictions of Article 85 of the European Economic Community. For example, the European consortium Airbus Industrie led by France and West Germany has been able to conduct joint research and development which assisted them in capturing roughly a quarter of the jet aircraft market in 1981. Prior to that, joint research and development had been authorized in such areas as nuclear oxide fuels and electronic components.

Perception that U.S. antitrust laws inhibit joint research and development

On the other hand, U.S. firms have consistently expressed the view that they are handicapped in competing in international markets because our antitrust laws inhibit joint research and development. U.S. firms say they are hesitant to invest heavily in joint research and development arrangements because of the high risk of treble damages and criminal sanctions under existing antitrust law.

The high risk perceived by U.S. companies in conducting joint research and development has persisted despite the Department of Justice "Antitrust Guide Concerning Research Joint Ventures" which attempts to clarify how the antitrust laws apply to a given set of facts. For one thing, guidelines by their nature have to be somewhat ambiguous to allow room for flexibility of enforcement policies which can vary from one Administration to the next. For another, given the role of the courts in the field of antitrust, there is a limit to how much we can clarify any given statute to get the results we want.

The Business Review Procedure of the Department of Justice also has not dispelled industry's fear in this area. These procedures provide that upon a request setting forth proposed business conduct, the Department of Justice may issue a letter stating its enforcement intention. U.S. industry argues that even a favorable business review letter is of doubtful value because it is too conditional and uncertain. It has also pointed out that the letter is not binding on the courts in third party suits and that there is no assurance that the enforcement policy stated therein will not change from one Administration to the other.

An illustration of the conditional and uncertain commitment by the Department of Justice in this area is its press release, dated December 27, 1982 announcing its intent not to challenge the joint research venture set up by the Microelectronics and Computer Technology Corporation (MCC). The statement contains the following caveat:

> "Baxter cautioned that the proposed joint venture has the potential either of facilitating new and intensified research efforts or of lessening competition in research, and that the Department's decision not to challenge the formation of the joint venture must not be construed as advance approval of all of its future activities.
>
> "An evaluation of the antitrust consequences of the joint venture's future activities, he said, will depend on a number of factors. Among them, he said, are the percentage of the industry that chooses to participate as shareholders in the venture, the identity of the shareholder firms choosing to participate in particular research projects, and whether the costs and risks of particular research projects are of a magnitude that warrants a joint undertaking."

Legislative proposals dealing with joint research and development in the 98th Congress

The Commerce Department's concern that industry is inhibited by the antitrust laws in conducting joint research and development is also shared by members of the legislative branch who have introduced four bills in the 98th Congress on this subject.

These are bills H.R. 108, H.R. 1952, S. 568 and S. 737. All of these bills recognize that our antitrust laws should be modified to encourage joint research and development by U.S. industries. These bills also emphasize that increased joint research and development is necessary to enable U.S. industry to maintain its competitive advantage in global markets.

For your information let me briefly summarize these bills: H.R. 108 introduced by Representative Edwards of California requires the Attorney General, in response to a written application, to issue a certificate of review if the research and development program "is not likely to violate the antitrust laws..." A certificate of review immunizes a joint research and development program against antitrust criminal actions; against civil liability, including treble damages; and prohibits certain injunctions under the Clayton Act. Participants would generally need to have their Certificate of Review amended to reflect any changes.

S. 568 introduced by Senator Tsongas would give immunity against specified antitrust criminal and civil actions, including treble damages, to those carrying out a joint resarch and development venture which has been approved by the Attorney General. Participation in the venture has to be open to all U.S. firms. The results of these ventures must be made available to firms within six years of the applicable invention, patent or methodology. The bill also restricts the conditions a venture could place upon its participants.

S. 737 introduced by Senator Mathias and H.R. 1952 introduced by Representative Synar are identical bills. They provide essentially the same immunity, including exemption from antitrust criminal actions and antitrust civil damages, as S. 568. These bills, unlike the others, do not require advance approval of the joint research and development program by the Attorney General in order to obtain such immunity. They do however, require notification of the formation of the research and development venture, and annual reports to the Attorney General. The Attorney General may investigate any venture and is required to specify conforming actions a noncomplying venture could take. If the venture fails to take the conforming actions within 60 days, the Attorney General must seek dissolution in court.

In addition, these two bills establish restrictions on the length of programs, the way ventures are organized, and the licensing of resulting patents. The bill also provides that when a proposed participant in a program accounts for 25 percent of total worldwide industry sales of a product, and all participants in the program combined would have more than 50 percent of total worldwide industry sales of that product, the participant having the 25 percent share must be excluded from the program. However, that participant may be included in the program if the Attorney General finds that the program does not apply directly to future production, or that the participant is critical to the success of the program and the program is in the national interest.

The Administration's proposal to amend the antitrust laws to encourage joint research and development

On March 24 this Administration approved a four-part proposal to amend the Clayton Act to eliminate recovery of treble damages in "rule of reason" cases and to expand protection for owners of intellectual property. This package is now being informally circulated in Congress. I will only comment briefly on this package as I am sure that Mr. Baxter will want to discuss it in some detail.

Of specific concern to this Panel is the proposed amendment which would provide that agreements to engage in joint research and

development shall not be deemed unlawful per se in actions under the antitrust laws. The effect of this amendment would eliminate any risk of treble damages for joint research and development. In this respect it would make U.S. law similar to the laws of Japan, France, and West Germany which do not provide for mandatory treble damages. The amendment would also assure that courts in dealing with such agreements would use a "rule of reason" analysis. Under this analysis procompetitive benefits, such as evidence that the arrangement would enhance the competitiveness of U.S. firms in global markets, would be weighed against any argued anticompetitive effects.

This Department supports this proposed legislation. It eliminates treble damages which in our view is the single most important deterrent to joint research and development agreements. The fact that such agreements will be judged under the "rule of reason" is also a major step forward. Another significant plus for this proposal is that it avoids intervention by the government as to how the research will be conducted and does not impose burdensome administrative requirements on either the government or industry.

It is in the interest of the public and private sectors to review our antitrust laws to ensure our competitive position in world markets. The expansion of research and development joint ventures by U.S. industry in an acceptable legal form will ensure our ability to meet accelerating and aggressive foreign competition.

Discussion

MARKHAM: Thank you very much Bill [Baxter]. I would infer that you would look very carefully at joint R & D activities in any industry already having a very high concentration ratio.

INMAN: My reaction to this issue comes not from my current job, but from practical experience the last 10 years spending billions of dollars of taxpayers' money running R & D programs for the Department of Defense. And I reject out of hand the idea that you can decide how to do R & D on scale. That's exactly the argument that was used by the OMB analysts and the OST systems analysts in trying to decide how R & D would be done.

The [military] services argued that they ought to run this country's cryptologic research independently. And I'll defer to those who saw the classified results, that these results came from the quality of the management, from focusing resources on R & D, and not by any arbitrary effort to decide on economies of scale to parcel out R & D by 15 percent in one place, or 50 percent in another. That's the road to ruin. In fact, that's the way we're doing it now. We need legislation quickly that clarifies joint research across the board. You draw the line by how you operate, how you procure, and it is there you must make sensible decisions tied to use, or tied to the marketplace. But to transfer that same approach in deciding economies of scale to R & D is going to result, even if we didn't have an international marketplace, in failure to keep up.

The reality is that we do have an international marketplace. And as you look at the troubled world out ahead of us, we're going to be in very intense economic competition with our friends, with our allies. And while we have a military adversary that can't compete economically, that's going to look for opportunities to use military force to assert power, the only way we are going to stay in position is through political leadership and technical leadership. If we don't structure our R & D to make sure that we lead, we're going to open up a whole range of problems for this country. You have to look at how the R & D is managed, how it's certified and who gets access to the results, not how you organize it.

MARKHAM: Bill [Baxter], you might want to respond. You used economies of scale, I believe, as one of the criteria by which you might judge whether or not a joint research organization would pass muster.

BAXTER: Yes, I did, and I'm really not sure I understand. If economies of scale are not significant, as he seems to suggest, then I see no case whatsoever for collaborative activity. Let each company do its own project, and let it manage well, and procure well. But I really think we are using "economies of scale" in different senses, because I'm not convinced that you really mean to tell me that there are not significant scale economies in R & D.

INMAN: The economies you get are the ability to focus talent on the areas where there is a potential for breakthrough, not by dividing the effort. Maybe I misunderstood you, Sir, but my great worry is that rules based on economies of scale would preclude focusing talent that might give you a breakthrough. I look at the shortfall in the production of talent that we aren't going to be able to correct, no matter how much we invest, for the next 10 years. And I worry in those 10 years, how we are going to be able to keep the lead in a whole range of industries, not just electronics, unless we can bring the talent to focus on areas where breakthroughs are in process.

FROM THE FLOOR: For one who runs R & D the worst thing in the world is to be continually looking over your shoulder. Having made that statement, I have a question. What do you think of joint ventures between say, U.S. firms, and a German firm, or U.S. firms and Japanese firms? What rules do you apply in that case?

BAXTER: Well, I would apply exactly the same rules I described. I would say that, in theory, it really should be the world industry that we're talking about, and it follows that I'd apply the same rules to a U.S. firm and a German firm.

Having said that, let me come back and qualify it just a bit—to try and make clear why my own answer to that question makes me nervous. There's a quality difference between foreign competition and domestic competition. Domestic competition is here to stay. But foreign competition is a sometime thing, and it can be affected dramatically by exogenous developments that can turn it on or off. Shifts in currency, exchange rates, international agreements such as we've seen in the steel and automobile industries, can suddenly and drastically attenuate foreign competition. So I have a certain affinity for preserving competition, wherever possible, in U.S. markets. But it will not always be possible. I have no illusions about that, and by and large, I did intend to refer to international markets because I think we're talking about markets for ideas, for knowledge and information, and those markets are international markets for the most part.

SCHMITT: Suppose the Japanese firms had gotten together and captured 40 percent of the market on a cooperative basis, what would be your attitude then toward U.S. firms if they got together to capture 40 percent of the market? Would the Japanese situation make a difference to you, or not?

BAXTER: If I were convinced that such extensive aggregations were really needed to assemble the necessary amounts of capital and the necessary talent, it would make a difference to me. And that, incidently, is what I mean by economies of scale.

FROM THE FLOOR: I'd like to make the point that the most difficult competitor here is the nationalized, subsidized competitor. And it seems to me that some of the remarks that Admiral Inman made about research become crucial. Because technology is the only possible answer to the nationalized, subsidized competitor that can offer below-market financing, and cut prices without regard for costs.

MATHIAS: Mr. Baxter raised the point that international competition is a sometime thing. We are facing a cumulative budget deficit for 1984 to 1988, which is optimistically set at a trillion, one hundred fifty two billions of dollars. I say optimistically, because I think that although the economic assumptions are fairly prudent, the political assumptions are just wild. So, however you look at that, it seems to me you're going to face relatively high interest rates in the United States, a relatively hard dollar, and that means relatively difficult international competition, at least through 1988, and probably longer.

MARKHAM: If I could make one additional statement to confirm what the Senator said, I just left a conference that raised the question of why real interest rates are staying as high as they are. They are very high relative to any historical level when you consider that the rate of inflation now is down to virtually zero over the past three or four months, and down to 3.8 percent for the last year. That gives you a real interest rate in excess of 6.5 percent, compared with the 2.5 percent average since about 1880, when we started compiling interest rate data. The only answer that anyone could come up with is that these tremendous Federal deficits create the expectation that interest rates will not come down. Eventually you're going to get that crowding out effect.

MATHIAS: And this becomes a factor in the competitive marketplace.

FROM THE FLOOR: One could make that argument, perhaps successfully, with respect to long-term interest rates, but it's hard to rationalize it on the short-term.

MARKHAM: That can be anticipated, very easily, if you take a look at the term structure of interest rates; they are competitive, and one does affect the other. Corporations have the option of either floating 20-year bonds, or going into the 90-day note market. I understand the logic of the question "why do these risks hit us?" unless you expect them to happen in 90 days, but you get a competitiveness between long and short run. After all, is one substitutable for the other?

FROM THE FLOOR: True enough, but one would think that it's the short term ones that ought to eventually affect the long term ones, rather than vice-versa.

MARKHAM: Not if you have the long-run expectation of high rates.

FROM THE FLOOR: I'm George Scalise of Advanced Micro Devices and a member of the MCC. I'd like to ask Senator Mathias about the prospects for legislation during this session; and Mr. Baxter, what is the Justice Department's view of that legislation, and how it's going to be implemented?

MATHIAS: Maybe I ought to let Mr. Baxter answer his question first because that will affect my answer.

BAXTER: Well, I haven't seen all the legislation to which the Senator has referred. I have seen the Edwards Bill, H.R. 6262 and I can imagine going down that path, although I would prefer not to go down a path that involves advanced Justice Department certification. That has lots of drawbacks.

We, too, have some legislation that we've taken up to the Hill, and I think its responsive to these concerns. One bill involves just a general detrebling of damages outside the hard core cartel area. There is, in my view, absolutely no justification for the existence of treble damages for behavior that is carried out right in the open and there's no question about whether it's going to be discovered. The only time people violate the law under those circumstances is as a consequence of uncertainty and mistake, and I see no justification for treble damages there. And that, it seems to me, would go a long way toward removing this deterrent to joint R & D activity.

That's as far as the legislation went: It simply cuts back to a single-damage remedy. I would have no hesitation in taking away all private antitrust actions against joint R & D and any damage remedy on the part of the Government. It seems to me enough that we have the option to go into court and ask for an injunction against activity that we think is harmful.

We have also taken up legislation that addresses the crimps on the ability to exploit technology that I referred to. As to the chances of that legislation, or the Senator's, it is a very difficult call, given the political season that is almost upon us. It is not an easy period to get anything constructive done.

MATHIAS: If I could just answer briefly, we no longer have an antitrust subcommittee in the Senate, so that deprives us of a little of the sharp focus that we would normally expect on this issue. But the full Senate Judiciary Committee is going to hold a hearing on May 23rd.

If Mr. Baxter is available to testify on the 23rd of May, I will personally see that he is provided well in advance with all of the pending bills. I have to agree with Mr. Baxter that, as you get deeper and deeper into this vortex of the political whirlpool, things get more difficult. But, on the other hand, there are also opportunities in a situation of this sort. If a clear national problem is perceived, and, as Admiral Inman has suggested, some leadership is exercised, that becomes an opportunity to get something done so you can have something to brag about when you get to election day.

People would perceive facilitating R & D as a positive step we could take that is actually good for the Government, because it's going to relieve the Treasury of paying for research. I think everybody acknowledges that, and this is a way of forwarding President Reagan's concept of having the private sector freed to do the things that the Government isn't going to do for it any more.

INMAN: We are now in an international marketplace. In 1960, there was no major segment in U.S. industry that was impacted more than 10 percent by international trade. In 1980, there are many industries that have to contend with import penetrations of 25 percent, and even up to 50 percent. And when we try to retreat behind protective barriers, history ought to tell us that's not a satisfactory way to go. But even if you didn't look at history, as you look at the challenges out ahead of us, if

we can't in fact, ensure that we compete, and keep competition going, we're not going to manage our relationship with the Soviet Union. Despite all the worry about nuclear warheads and missiles, this is where the greatest danger lies.

So, in looking at the bulk of industry now, and how it operates, we are, as a country, going to have to focus on the fact that it is and will remain an international marketplace throughout our lifetime and that of our children. We have to find the means and the management to take maximum advantage across all the industries, of the graduate scientists that we're producing. Because while there are wonderful opportunities out there with all kinds of technology explosions, we aren't producing enough graduate scientists to exploit it. So, we're going to have to assure as we approach new laws and the interpretation of old ones, that we insist on making maximum use of the limited supply of scientists.

With my own experience with MCC, I would be willing to sign up right away for Baxter's interpretation of legislation, as satisfying for an MCC kind of operation. All of this may not be an answer for other industries, but it's the small companies that could really benefit—those unwilling to join us because of worry about the cost of the private treble damage losses piled on top of the R & D costs.

McCLOSKEY: I'd just like to add that, having been a close observer of this move toward the concept of joint research in the previous Administration as well as this, Mr. Baxter has a very enlightened view, it seems to me, of the situation and direction. And, the offer that I heard here now, which was the concept of limiting third party suits completely, and leaving the Government's remedy injunction only, sounds very attractive to me, and one that we could work very well with.

MARKHAM: In my written statement, I had devoted some space to the fact that we operate in a global economy. It turns out that the U.S. share of trade in the manufacturing sector has declined in 20 years from 24 percent to 14 percent. If you view the United States as a geographical area that is part of the global market, there's no question that U.S. producers have lost ground tremendously in such industries as automobiles, steel, consumer electronics, chemicals, footwear, textiles, and a few others. That raises the following concern.

Let's suppose that corporations take some actions, whether it's joint research arrangements or whatever, that could be perceived normally to be unlawful under our antitrust laws as currently administered and interpreted. If you viewed such actions strictly within the context of the U.S. market, taking into account market shares and the like, they would appear to restrain competition. But you could make a case that whatever these actions were, they would strengthen the competitive position of some corporations under intense competitive pressure in the global market. If you then redefine the market to be global, you could view such actions as pro-competitive in a global context. Is there any way that such an approach can be accommodated under the rules and the enabling legislation followed by the Department of Justice?

I suppose if you had an Assistant Attorney General for Global Antitrust, he might view it from that perspective, in very much the same way that, when I was with the Federal Trade Commission, we viewed the merger of two very weak automobile companies to form American Motors, maintaining it was pro-competitive, because it made possible a fourth competitor in the domestic automobile market.

At that time, it was legitimate to consider the domestic automobile market. But let's suppose that American now had to merge with say, Chrysler Motor Company, or two steel companies had to merge in order to maintain competitiveness in a global market. What would be the relevant market definition now? How would you look at this?

BAXTER: I really don't find that a problem. There's nothing in the antitrust laws that makes any reference to U.S. markets. References are to relevant markets and lines of commerce, and to restraints of trade, which I maintain equivalent to the phrase, restrictions on output.

Anything that works to increase output is pro-competitive, as far as I'm concerned. The statutes do not constrain us. I have taken the position many times that the relevant market for antitrust purposes will often be an international market, and where it is, we draw conclusions based on an international market. So, I think that's a false problem.

FROM THE FLOOR: In the case of your proposed legislation, Mr. Baxter, in the event of a change in Administration, how would that affect your Department's view of this issue?

BAXTER: I get that question all the time. I really don't think we would go back to the old antitrust. I realize a lot of people think that I've made big changes, but that's only partially true. These changes have been evolving over the past couple of decades. They reflect an intellectual revolution in industrial organization from the late 1950's that is still going on. So, the ideas that I have brought into the Justice Department, into the antitrust laws, are now old ideas widely shared in industrial organizations. I guess you could never rule out the possibility that there are still Mike Pertschuks in the world, but I find it extremely unlikely that anybody would come along and really turn back antitrust policy in a significant way. There will be no intellectual support for it whatsoever, and I really regard myself as the first robin of spring rather than the spinner of the world. I don't think there's a serious risk that we're going back to the old style which I regard as mindless antitrust.

MERRIFIELD: Thank you, Jesse [Markham], for moderating an excellent panel, and thank you, panelists and all the others who have contributed today. It's helpful to remind ourselves that we're in a period of extraordinary change. George Berry, the former Dean of the Harvard Medical School said, "This period in which you and I are now living will be one day recognized as a second great divide in human history, the first being the emergence of civilization 10,000 years ago. More change will occur in the next 10-20 years than has happened in all of history."

You and I have lucked into this moment, and the management of change has got to be our primary understanding. There are tremendous forces operating in world markets. These forces include a technological explosion that is obsoleting our plants and facilities in an increasingly shorter period of time; the targeted industry strategy that the Japanese have modeled and everybody's copying worldwide; the emergence of the less developed countries to take market shares in areas where they have low-cost natural resources or low labor costs. All of these are going to modify our environment.

We have to understand these things clearly, but we still have to understand that we have, by far, the most advantageous set of resources and capabilities anywhere in the world. Let's not forget for a moment, that we have the advanced technology, we have the industrial infrastructure, we have the entrepreneurial character and culture, the capital formation capability, and the world's largest market. All we have to do is get the barriers out of the way, and set up appropriate incentives. That's the role of Government, and that's what we're here to help you with. I would like to challenge each of you to come back to us with ideas that will keep this process going. Thanks very much.

Speakers

Malcolm Baldrige

Malcolm Baldrige is the 26th Secretary of Commerce. He has over 35 years of management and manufacturing experience, most recently as Chairman and Chief Executive Officer of Scovill, Inc. He has served on the board of directors of the Bendix Corporation, ASARCO, Uniroyal, AMF, and the Connecticut Mutual Life Insurance Company. He was active in many business and community organizations, including the Business Council, the International Chamber of Commerce, Easter Seal Society, Red Cross and the YMCA. Mr. Baldrige holds a bachelor's degree from Yale University.

William F. Baxter

William F. Baxter is the Assistant Attorney General of the Antitrust Division, U.S. Department of Justice. He was Professor of Law at Stanford Law School and Visiting Professor of Law at Yale University. Mr. Baxter has served as consultant to private and public sector organizations including Citicorp, The Brookings Institution, the President's Task Force on Communications Policy, VISA, EXXON, American Petroleum Institute, Hoffman La Roche, and Northrop. He has authored publications in the areas of antitrust, regulation, banking, pollution, law and economics, and holds A.B. and J.D. degrees from Stanford University.

John E. Chapoton

John E. Chapoton, Assistant Secretary of the Treasury for Tax Policy, has over 20 years of experience in tax law and legislation. Most recently, he was partner in the law firm of Vinson and Elkins in Houston, Texas. From 1969 to 1972, Mr. Chapoton held various positions at the Treasury Department, including Tax Legislative Counsel. While in private practice from 1961 to 1969, he specialized in Federal tax matters. He holds a Bachelor's degree in business administration from the University of Texas, and an LL.B. degree from the University of Texas School of Law.

Edwin L. Harper

Edwin L. Harper is Assistant to the President for Policy Development. He previously served the Reagan Administration as Deputy Director of the Office of Management and Budget. From 1968-69 Mr. Harper was Special Assistant to the Director for Resources Planning, Bureau of the Budget. From 1969 to 1973, he was a Special Assistant to the President and Assistant Director of the Domestic Council. In 1973, Mr. Harper returned to the private sector where he served as an officer of three Fortune 500 companies and Director of several other companies. Just prior to his return to government, he was a Vice President of the Emerson Electric Company. He received his bachelor's degree from Principia College in 1963 and a doctorate from the University of Virginia in 1968. Mr. Harper has been a guest scholar at the Brookings Institution (1965-66) and lecturer at Rutgers University (1966-68).

George M. Low

George Low is the 14th President of Rensselaer Polytechnic Institute. He was Chief of the Special Projects Branch of the National Advisory Committee for Aeronautics, and became Chief of Manned Space Flight for the National Aeronautics and Space Administration. His positions at NASA included Deputy Associate Administrator for Manned Space Flight, managing the Gemini and Apollo Programs; Deputy Director of the Manned Spacecraft Center; Manager of the Apollo Spacecraft Program; and Deputy Administrator of NASA. As manager of the Apollo Program he directed five manned flights, including Apollo 11, the first manned lunar landing. George Low holds Bachelor and Master of Science Degrees in Aeronautical Engineering from RPI. He has received honorary doctorate degrees in transportation, engineering, science, law and human letters, and received over 15 special honors awards.

Harald B. Malmgren

Harald Malmgren is President of Malmgren, Inc., Washington, D.C., and Director of Malmgren, Golt, Kingston, & Company, Ltd., London. He is also Adjunct Professor at Georgetown University; and a Director of the Atlantic Council of the U.S., the Overseas Development Council, the Council on Science and Technology for Development, and the Trade Policy Research Centre in London. Malmgren was Deputy Special Representative for Trade Negotiations in the Executive Office of the President, with the rank of Ambassador. He also headed the Economics Group of the Institute for Defense Analyses. He has been adviser and consultant in recent years to the Senate and various Presidential commissions, and to a number of domestic and international industrial associations. He holds a B.S. summa cum laude from Yale University (1957), and a Doctor of Philosophy in economics from Oxford University (1961).

Jesse William Markham

Jesse W. Markham is Professor Emeritus of Harvard University and Resident Professor, Law and Economics Center, Emory University. His 35 years experience in the academic, private and public sectors includes professorial positions at Vanderbilt, Princeton, Harvard, Columbia and Emory Universities; Chief Economist at the Federal Trade Commission; advisor on various governmental commissions; and Economics Editor for Houghton Mifflin Company. Among his numerous publications are *The American Economy, The European Common Market: Friend or Competitor,* and *Conglomerate Enterprise and Public Policy.* He holds an A.B. degree from the University of Richmond, and M.A. and Ph.D. degrees from Harvard University, with postgraduate work at the Johns Hopkins University.

Charles McC. Mathias, Jr.

Charles McC. Mathias, Jr. is U.S. Senator from Maryland, and chairs the State's congressional delegation. After practicing law in Frederick, Maryland, Senator Mathias became Assistant Attorney General of Maryland, and City Attorney of Frederick. He served as a delegate to the Maryland General Assembly, and was elected to the U.S. House of Representatives for four terms. Now in his third term as Senior Senator from Maryland, he serves on four Senate committees: Rules and Administration, Foreign Relations, Judiciary and Governmental Affairs. He chairs the Committee on Rules and Administration, is Chairman of the Subcommittee on International Economic Policy, the Subcommittee on Patents, Copyrights and Trademarks, the Subcommittee on Governmental Efficiency and the District of Columbia and the Subcommittee on International Economic Policy. Senator Mathias holds a bachelor's degree from Haverford College, and an LL.B. from the University of Maryland.

Peter F. McCloskey

Peter F. McCloskey, President and Chief Executive Officer of the Electronic Industries Association, is responsible for the activities of the national trade organization representing U.S. manufacturers in the $114 billion electronics industry. He was formerly President of the Computer and Business Equipment Manufacturers Association, and President and Chairman of the Board of Farrington Manufacturing Company. A member of the President's Peace Corps Advisory Council, his professional experience has also included managerial positions with IBM, private law practice and service as a First Lieutenant in the U.S. Marine Corps.

D. Bruce Merrifield

D. Bruce Merrifield is currently Assistant Secretary of Commerce for Productivity, Technology and Innovation. Most recently, he was Vice President of Technology and Venture Management for the Continental Group. He is a former Director and president-elect of The Industrial Research Institute; he also has been Chairman of the Board of the IRI Research Corporation and is a former Trustee and Chair-

man of the Research Council of The American Management Association. Currently, he is a member of The Directors of Industrial Research, and a Fellow of both The American Association for Advancement of Science and of The Institute of Chemists.

Dr. Merrifield also has been a member of the Advisory Board for the Binational Research and Development Foundation with Israel and of the U.S. Department of Commerce's Trade Mission to the People's Republic of China. He has served as a Science Advisor to the Jordanian government and as a member of the Department of Defense transition teams. Dr. Merrifield is a graduate of Princeton University and holds Master and Doctoral degrees in Physical Organic Chemistry from the University of Chicago.

Nicholas G. Moore

Nicholas Moore is Managing Partner of the San Jose office of Coopers & Lybrand and Partner In Charge of the San Jose and Palo Alto offices' tax departments. He graduated from St. Mary's College with a B.S. in accounting, and the University of California's Hastings College of Law with a J.D. and is both a Certified Public Accountant and a member of the California Bar Association. He has had substantial experience dealing with small and medium-sized high technology companies and with venture capital firms, and in the analysis of tax motivated investments for clients. As a member of the Financial Accounting Standards Board Advisory Group on Research and Development Arrangements, he is actively involved with the development of proper accounting treatment for R & D financings. Mr. Moore has authored two major technical articles on research and development partnerships, and has spoken before professional and high technology trade association groups on a wide range of subjects including research and development financing.

John M. Mutz

As Lieutenant Governor of Indiana, John Mutz' duties include President of the Indiana Senate, Director of the Department of Commerce, and Commissioner of Agriculture. Working with Governor Orr, Lt. Governor Mutz has written, helped pass, and is now implementing the largest package of job development programs ever passed by any state legislature. As a member of the State House of Representatives and State Senate for over 12 years, he became recognized as an expert on state finance issues: he chaired the State Budget Committee and participated in drafting the Property Tax Control Program. In the private sector, he founded Fast Food Management, which owned and managed 70 franchise operations; was Vice President of Circle Leasing; and developed several other companies. Lt. Governor Mutz holds a Bachelor of Science degree in advertising and business management and a Masters Degree from Northwestern University.

William C. Norris

William C. Norris, Chairman and Chief Executive Officer of Control Data Corporation, founded the company in 1957. He holds a degree in electrical engineering from the University of Nebraska, and as a founder of Engineering Research Associates, made substantial contributions to the development of digital computer technology. He headed the Univac Division of Sperry Rand and, under his direction, Control Data has became the leading company in large-scale scientific and engineering computers.

Mr. Norris has helped found two consortium organizations, City Venture and Rural Venture, which are engaged in the revitalization of inner cities and redevelopment of rural areas. Control Data has also spent over 20 years developing the PLATO computer-based education system. He is a member of various professional, business, and academic groups, as well as the President's Task Force on Private Sector Initiatives. He has authored a series of booklets addressing the use of technology to solve society's problems called the "Tireless Servant."

Participants

John M. Albertine
President
American Business Conference

Richard Alberts
Deputy Director
Semiconductor Research Cooperative

Robert S. Ames
Executive Vice President
Textron, Inc.

Honorable Betsy Ancker-Johnson
Vice President
General Motors Corporation

Jesse I. Aweida
Chairman
Storage Technology Corporation

Honorable Malcolm Baldrige
Secretary of Commerce

Honorable William F. Baxter
Assistant Attorney General for Antitrust
U.S. Department of Justice

Erich Bloch
Vice President
IBM Corporation

Bruce R. Bockmann
Managing Director
Morgan Stanley & Company, Inc.

F. Peter Boer
President, Corporate Research Division
W. R. Grace and Company

Honorable John E. Chapoton
Assistant Secretary for Tax Policy
U.S. Department of the Treasury

Robert C. Forney
Executive Vice President
E. I. Du Pont de Nemours

Richard N. Foster
Director
McKinsey & Company

David Gatton
Director of Development Programs
U.S. Conference of Mayors

James A. Gray
President
National Machine Tool Builders Association

Honorable Edwin L. Harper
Assistant to the President for Policy Development
The White House

Karl G. Harr, Jr.
President
Aerospace Industries Association of Amercia

Robert Holland
President
Committee for Economic Development

E. E. Hood, Jr.
Vice Chairman of the Board
General Electric Company

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Director, Corporate Research
Westinghouse Research and Development Center

Admiral Bobby Ray Inman
President and Chief Operating Officer
Microelectronics and Computer Technology Corporation

Howard W. Johnson
Chairman of the Corporation
Massachusetts Institute of Technology

Paul Jorgensen
Senior Vice President for the Sciences Group
SRI International

Charles R. Kokesh
President
Technology Funding, Inc.

Lloyd K. Lauderdale
Vice President, Research and Engineering
E-Systems, Inc.

George M. Low
President
Rensselaer Polytechnic Institute

Ambassador Harald B. Malmgren
President
Malmgren, Inc.

Jesse W. Markham
Professor
Law and Economics Center
Emory University

Honorable Charles McC. Mathias, Jr.
United States Senate

Peter F. McCloskey
President
Electronic Industries Association

Peter F. McNeish
Executive Vice President
National Association of Small Business Investment Companies

D. Bruce Merrifield
Assistant Secretary for Productivity, Technology and Innovation
U.S. Department of Commerce

Egils Milbergs
Director, Office of Productivity, Technology and Innovation
U.S. Department of Commerce

Nicholas G. Moore
Managing Partner
Coopers and Lybrand

Honorable John Mutz
Lt. Governor of Indiana

William C. Norris
Chairman & Chief Executive Officer
Control Data Corporation

Douglas Pewitt
Assistant Director for General Science
Office of Science and Technology Policy

William C. Purple
Executive Vice President
The Bendix Corporation

David E. Sanders
Director of Corporate Development
Hewlett-Packard Company, Inc.

Paul T. Santilli
Vice President and General Counsel
Battelle Memorial Institute

George M. Scalise
Senior Vice President
Advanced Micro Devices

Roland W. Schmitt
Senior Vice President
General Electric Company
(Representing Industrial Research Institute)

Richard Seibert
Vice President, Resources and Technology Department
National Association of Manufacturers

Robert H. Sorensen
Chairman
Perkins-Elmer Corporation

Richard A. Stimson
Director, Standardization and Acquisition Support
Office of the Under Secretary of Defense for Research and Engineering
U. S. Department of Defense

Robert H. Wertheim
Senior Vice President, Science and Engineering
Lockheed Corporation

Peter E. Wilkniss
Deputy Assistant Director
Scientific, Technological and International Affairs Directorate
National Science Foundation

Honorable Edwin V. W. Zschau
U.S. House of Representatives

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