U.S. DEPARTMENT OF COMMERCE

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To : Bruce
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From: Jack

Comments ?

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**EXECUTIVE OFFICE OF THE PRESIDENT**
**COUNCIL OF ECONOMIC ADVISERS**
**WASHINGTON, D.C. 20500**

June 4, 1987

MEMORANDUM FOR EPC WORKING GROUP ON R&D

FROM: THOMAS G. MOORE TGM

SUBJECT: Material for June 5 Meeting

Attached are notes relevant to the Friday, June 5, 1987 meeting of the EPC Working Group on R&D at 2:30 pm.

1) SBIR

2)

ECONOMIC BACKGROUND AND POSSIBLE AREAS FOR
POLICY INITIATIVES RELATED TO SUPERCONDUCTIVITY
June 3, 1987

Recent breakthroughs in research on superconductivity may make possible the development of new products that rely on powerful, lightweight electromagnets or smaller, more powerful electronic circuits. Possible applications include: large savings (5-15%) in electric power transmission; much more efficient storage of electricity; magnetically levitated trains; more efficient motors, electric magnets, and generators; and smaller, more powerful computers. Whether and when these uses materialize will depend on the scientific advances made in superconductivity and a host of other factors.

On the basis of recent developments, it seems likely that high temperature superconductivity may provide great benefits for the economy overall. Consumers (and consuming firms) will benefit from the various applications of the new technology regardless of who manufactures them. However, the success of U.S. firms in developing and commercializing new applications of superconductivity could have major ramifications for U.S. industry, technological leadership, and national security.

International trade allows specialization in production, which in turn permits a country to use its scarce resources more efficiently and thereby improve productivity. The United States

will manufacture and export superconductive products if such a manufacturing industry is more efficient relative to other American industries. Because comparative advantage refers to an internal ranking of productivity, the United States might eventually import superconductive products even if American firms could manufacture the same products at lower absolute cost than could foreign firms.

The U.S. comparative advantage in the production and marketing of any single product utilizing superconductivity depends on the relative costs of capital and labor, the relative skill and education of labor (human capital), the tax structure in the U.S. and other countries, the legal and property rights structure in the U.S. and elsewhere, relative U.S. labor law and policy, R&D policy, and the comparative advantages of other U.S. industries. None of these factors is easy to change. The factors most amenable to government policy are tax structure, the legal and property rights structure, R&D policy, and U.S. labor law and policy.

At present, American scientists and American companies like IBM are responsible for many of the basic scientific breakthroughs in superconductivity. American industry also appears to be cautiously accelerating efforts to develop commercial applications. Yet U.S. industry spokesmen have expressed concern that America's leadership in superconductivity research will not extend to leadership in the commercial

development of products using superconductivity technology and that Japan will surpass the United States in developing these promising new products.

These concerns appear to be based on perceptions that: (1) the prevailing shareholder/investor climate constrains American managers to adopt a more risk-averse and short-term orientation than many of their foreign rivals; (2) the current regulatory environment in America may not be conducive to cooperation in developing new technologies; and (3) foreign governments are likely to directly intervene to coordinate and assist their industries' efforts to commercialize new applications.

The first perception is difficult to assess and does not translate readily into government policies. There may be very little the government can do to change the corporate ethos in America. Nor should the American government adopt policies which interfere with the marketplace in efforts to alter the basic laws of comparative advantage. Superconductivity technology inevitably will be available internationally, through foreign innovation and cross-licensing of U.S. patents and inventions.

International trade will also help diffuse the benefits of superconductive technology to all countries because economies of scale in production allow different countries to manufacture similar products. Consumers value product diversity, and a world market enables many more firms to achieve efficient scales of

production of similar, but differentiated, goods. Thus, products such as computers, automobiles, and cameras are manufactured in several countries, and these products are traded between the countries that produce them. A similar pattern of trade between countries that manufacture superconductive products could emerge as the new technology develops.

However, industry concerns with domestic regulatory environment raise issues for U.S. government policy. We need carefully to review the current regulatory climate and seek appropriate modifications to ensure that U.S. firms have maximum freedom to acquire information, conduct research, develop applications, and invest in manufacturing capacity to bring their innovations to market. Areas to examine include tax structure, antitrust policy, protection of intellectual property rights, R&D policy, and U.S. labor law and policy.

Foreign governemnts may intervene in their markets to farther superconductivity developments. We should carefully monitor such "industrial policies" to ensure that trade remains free and fair. However, whether such policies will be successful is questionable. First, MITI has not been notably successful in its targeting policies. It tried to dictate design to Japanese auto companies and to discourage Honda. MITI apparently did not target VCRs; in fact at least four competitive technologies were developed independently by Japanese companies. MITI has targeted mainframe computers since the early 1960l's, but without

appreciable success. It targeted commercial airlines without appreciable success. It targeted commercial airlines without appreciable effect. On the other hand, MITI did target semiconductors, in which they have become a major factor.

Moreover, this Administration has always viewed competitive markets as more efficient, progressive, and innovative than government controlled or guided firms. Economic theory indicates that competitive markets perform better than less competitive. Industrial policy has not been viewed by this Administration as desirable or likely to produce as good economic performance as the market.

SUPERCONDUCTIVITY COMPETITIVENESS INITIATIVES FOR REEMPHASIS

Earlier this year the Administration sent to Congress a competitiveness package which, among other things, dealt wtih policies designed to further the transfer of technology from the laboratory to production. We would recommend that the Administration reiterate the President's proposals that are most relevant to superconductivity. They include:

- The President's proposal to further improve worker training and assist the PIC/JTPA (Private Industry Councils/Job Training and Partnership Act) program which is focused on preparing and retraining workers for the future. The PIC/JTPA programs were established to ensure

that workers were being trained and retrained for the needs of a growing, future economy -- not one that has passed by a decade or two ago. This is particularly important in the case of industry's efforts to "be there firstest with the mostest" with good, high-quality superconductivity engineering and products.

- The establishment of new university science and technology centers. Whether one or more of these centers will deal with needed superconductivity breakthroughs is being examined by the Technical Sub-working Group.

- Double the budget of the National Science Foundation to accelerate the development of new knowledge in advanced technologies and expand the nation's talent in science and technologies such as superconductivity.

- NSF has been directed to work with the Department of Education and state and local governments to improve basic scientific literacy.

- Enact laws to protect intellectual property to help ensure that American firms which are the first and the best R&D achievers will also be sufficiently protected from unfair and unethical pirating of results as these become manufacturing-worthy. In particular, as the President has recommended to Congress, we should strengthen the

protection of process patents and encourage the efficient use of intellectual property created by American firms, by ensuring that the procompetitive licensing of technologies is not unreasonably discouraged by either the antitrust laws or the "patent misuse" doctrine.

- o Executive Order 12591 (Facilitating Access to Science and Technology): The Executive Order and the associated Federal Technology Transfer Act of 1986 (P.L. 99-502) provide sweeping guidance and new provisions for transfer of technology from government to the private sector. Special efforts should be made to alert senior agency managers and laboratory managers to the potential for commercialization of superconductivity breakthroughs.

As outlined above, the market will provide incentives to develop and commerecialize products utilizing superconductivity. Comparative advantage will determine where the manufacture of these products is carried out. Nevertheless, the Administration may wish to encourage U. S. development and production. Some other steps that might be taken to further development of superconductivity are listed below.

POLICY OPTIONS:

A. THE ROLE OF FEDERAL SUPPORT IN SUPERCONDUCTOR RESEARCH

1. Increasing Research Support

Total Federal government budget authority for research and development for FY 1987 is $57,996 million. Of this, approximately $45 million, or .07 percent, is budgeted for research on superconductors. In addition, private industry is requested to be spending $100 million on superconductor research and applications.

Federal funding for research and development for superconductors and other activities is divided among agencies as follows:

| Agency | Superconductor Funds ($ millions) | All Funds ($ millions) | As Percent Of All Funds |
|---|---|---|---|
| DOE | 25.0 | 4,837 | 0.5 |
| DOD | 10.0 | 37,865 | 0.03 |
| NSF | 6.6 | 1,440 | 0.5 |
| Other | 2.8 | 13,854 | 0.0 |
| Total | 44.4 | 57,996 | |

SBIR Program-Special provision for superconductor

The low percentage of research funds suggests that it may be possible to reallocate funds in the short term towards superconductor research. In fact, some agencies have reallocated funds since the 1988 budget came out. This is only a short-term solution, however, because it is important to keep up research in other areas of science, so that we do not find ourselves at a disadvantage in the future. Moreover, it is unclear whether in the short run more funds could be usefully absorbed in superconductor research.

2. Increasing Incentives for Talented Students to Enter Superconductivity Research

Funding for graduate students is one method for attracting talent to a field. Attracting more talent to the field of superconductivity could be done either through increased NSF funding of graduate fellowships or funding of projects in universities utilizing such students. The NSF awarded 560 new graduate fellowships for the 1987 fiscal year, divided as follows:

| Field | Number of Awards |
|---|---|
| Engineering | 125 |
| Math Sciences | 77 |
| Physical Sciences | 95 |
| Life/Medicine | 147 |

| | |
|---|---|
| Psychology | 34 |
| Social Sciences | 82 |

Each fellowship costs NSF $18,300 per year. In addition, many graduate students are employed by professors who receive funds for research. The Division of Material Sciences at NSF, which has a budget of $100 million, funded projects that employ 1500 graduate students. Of these, 100 are working on superconductivity. To the extent that funding for materials research on superconductivity is increased, more graduate students will be attracted to the field.

3. Technology Transfer

Government laboratories currently spend about $17 billion in research and development, generating some of the world's most advanced scientific knowledge. They could be a major resource for accelerating superconductivity developments. However, effective use of the resource has been limited recently, because government laboratories are intended to specialize in basic research not application. For example, 28,000 government patents have been issued, but only about 4 percent ever have been licensed.

The problem has been that authorizations for licensing of government funded technology have been lacking or badly encumbered with bureaucratic procedures. The Technology Transfer

Act of 1986 and EO 12591 have provided the required authorization and hopefully removed much of the bureaucratic process involved in transfer. Moreover, important incentives such as royalty sharing with federal scientists and agencies have been provided for government labs both to pro-actively patent and license their technology and also to enter into cooperative ventures with private sector organizations.

However, implementation of the law and of the President's directive may still face barriers. These barriers might include:

(1) A lack of understanding of the marketplace by government lab personnel to adequately identify technology that might have significant commercial potential.

(2) A lack of understanding of how to prepare adequate patents, market segment analyses, and business plans for approaching private sector companies.

(3) A lack of knowledge of the process for identifying potential licensees and effecting the marriage brokering process.

(4) A lack of awareness in the private sector of the potential that may exist in government labs.

A possible solution to these barriers lies in a government funded, but industry managed process in which experienced industrial scientists who have managed the innovation process are hired or under contract spend time in each laboratory to develop and/or school indigenous scientists in the necessary procedures, and pro-actively search out licensees and joint venture partners in the industrial community.

OPTION

Require each major federal laboratory to fund a small office of industrial scientists who have had extensive management experience, to inventory, and screen ongoing laboratory developments for commercial potential, and to pro-actively search out licensees for identified technology. The office, if successful, would be self-funding from royalties within a few years.

Smaller laboratories that cannot justify full-time offices might be serviced either from the large laboratories of the same agency or by experienced consultants who are accessible through the DOC data base

PROS

The rate of implementation might be accelerated; the ratio of successes to failures might be increased; the royalty stream to the laboratories to further its mission could be significant, and the utilization of tax

dollars would be maximized. Exclusive capture for U.S. companies of some of the world's most advanced technology will be achieved for the first time.

CONS

Anxieties will be higher, and be expressed in terms of loss of central control, distortion of mission, and escape of sensitive information.

These offices may fail to generate significant licensing of technology at the cost of a rise in bureaucracy and additional budget costs.

B. TAX AND REGULATORY PROPOSALS

1. Investment Tax Credit (ITC)

R&D Tax credit.

Reinstating the ITC could increase investment in superconductor technology, but it would violate principles of tax reform. Taxes should be neutral with regard to alternative types of investments and production processes. Investments yield higher economic returns when they are driven by market and not tax incentives. The ITC has come and gone over the past 20 years. It was just repealed as as part of tax reform on the grounds that it encouraged investment in equipment over other forms of capital. A tax credit for research and development already exists. The Administration believes that this tax credit

should be made permanent in order to give stability and certainty to business planning.

2. Restriction of Foreign Investment or Joint Ventures With Foreign Firms

Restrictions on foreign investment in U.S. superconductor technology are unlikely to increase our relative technical advantage or to prevent U.S. technology from being copied by foreigners. Such restrictions are more likely to retard U.S. superconductor advances by impeding the flow of investment funds. In addition, restricting foreign investments would invite retaliation by other countries against U.S. investors. The U.S. generally has an open investment policy, with exceptions in certain defense-related, high technology areas.

3. Antitrust Reform

The National Cooperative Research and Development Act (NCRA) of 1984 provides that R&D joint ventures which are notified to Justice will not be considered per se antitrust violations. Instead, they will be subject to the "rule of reason" (allowing consideration of pro-competitive effects); will be liable only for single rather than treble damages; and will allow defendants to collect costs and reasonable attorneys' fees from private party plaintiffs if the plaintiffs' suit is found "unreasonable."

However, the NCRA currently covers only R&D, extending to the production of models and prototypes. The Act explicitly excludes joint production. Yet the ordinary process of commercializing new technologies entails a substantial amount of risk (and learning) in the "early production" stage. U.S. firms commercialization efforts could substantially benefit from extending the NCRA to cover limited joint production in "prototype" or "pilot" plants of a commercial scale. This change would facilitate cooperation without providing blanket immunity.

4. Restrictions on Exports and Transfer of Technology

Restricting or licensing exports that embody superconductor technology would protect foreign markets from U.S. competition. Such restrictions are unlikely to prevent copying by foreigners, which can be done in the U.S. Export restrictions would limit the output and profits of firms that use superconductor applications, and thus are likely to have the perverse effect of slowing investment and commercial advances.

C. REWARDING COMMERCIAL ADVANCES

American scientists are in the forefront of recent developments relating to basic research in superconductivity. Private sector initiatives to commercialize this new technology are underway. However, government involvement may be needed to induce more rapid development. This raises the policy question

of how to encourage the development of commercial applications of superconductors while avoiding the creation of economic distortions and the need for large federal expenditures.

One possibility would be to award on an annual basis, prizes for scientific and engineering accomplishments in superconductor technology in the following categories: 1) Automotive Transportation, 2) Other Transportation, 3) Energy Generation and Motors, 4) Energy Transmission, 5) Medicine, 6) Communications, 7) Computers, 8) Other Applications, 9) Basic Research, and 10) Foreign Contribution.

Each year the government could recognize scientists and engineers who make a significant contribution in each of these areas at an awards ceremony. With the exception of the Basic Research category, only applied research or development would eligible. To be considered, a working prototype must exist, blueprints alone would not be acceptable.

A panel of experts would determine the winning technological applications in each area and the winners would receive an appreciable honorarium (perhaps $10 million). The award should be high enough to be meaningful in terms of developing the technology and providing public recognition to the recipient. The winners would retain all proprietary rights to their inventions. Prizes would only be awarded, when in the opinion of the panel, a significant advancement has been submitted.

Since the objective of these annual prizes is to encourage U.S. commercialization, eligibility should be restricted to permanent residents of the United States and to U.S. corporations.

PROS

- o A program of this sort would cost less than subsidizing all superconductor research.

- o Avoid the need to modify the tax code; induce our best scientists in both the corporate sector and in universities to engage in applied research;

- o Maintain a high profile for superconductivity research while making visible the government's commitment to the development of this technology.

CONS

- o The incentives may be weaker than those provided by direct subsidies.

- o Might create economic distortions by altering the allocation of resources.