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Hold For CNS

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Agenda for the Meeting of the
NSTC COMMITTEE FOR NATIONAL SECURITY

December 15, 1997
1330-1500 Hours
Pentagon, Room 3D1019

I. INTRODUCTION — new members.

II. STATUS OF CURRENT EFFORTS
- International Technology Transfer Interagency Working Group
- NPAC - TWG

III. POSSIBLE NEW EFFORTS
- Infrastructure Assurance Research and Development Issues Interagency Working Group

IV. OTHER BUSINESS

V. CLOSING REMARKS

CNS

Kerri-Ann, 12/2/97

Wes Kitchens sent the attached draft CNS meeting agenda. He would appreciate any comments you have. He is particularly concerned with the time allotted for the presentations. I'm available to talk about it at your convenience.

Steve

Hold for Gansler meeting

OFFICE OF THE DIRECTOR OF
DEFENSE RESEARCH AND ENGINEERING
3040 DEFENSE PENTAGON
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Number of Pages: 3 **(Including Cover Sheet)**

Date 12/2/97

Notes:

Steve,

Am forwarding my first cut of the agenda for the CNS meeting. Please note I have only used 1 hour of the 1-1/2 hours blocked out. I have assumed Kerri-Ann will want to discuss the proposed IWG on Infrastructure Assurance R&D Issues. This will need to go out with read-ahead material on Dec 8th and will need Dr. Jones and Dr. Gansler's approval. Can you please show it to Dr. Jones and get her changes/approval.

Thanks

Wes

DRAFT

Agenda for the Meeting of the
NSTC COMMITTEE FOR NATIONAL SECURITY

December 15, 1997
1330-1500 Hours
Pentagon, Room 3D1019

I. INTRODUCTION

II. STATUS OF CURRENT EFFORTS
- International Technology Transfer Interagency Working Group

III. POSSIBLE NEW EFFORTS
- Infrastructure Assurance Research and Development Issues Interagency Working Group

IV. OTHER BUSINESS

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Annotated DRAFT Agenda

Agenda for the Meeting of the
NSTC COMMITTEE FOR NATIONAL SECURITY

December 15, 1997
1330-1500 Hours
Pentagon, Room 3D1019

I. INTRODUCTION *(5 minutes) Opening comments.*

II. STATUS OF CURRENT EFFORTS

- International Technology Transfer Interagency Working Group *(30 minutes)*

Presentation by Mr. Steve Rinaldi of the Office of Science and Technology Policy, Chairman of the International Technology Transfer Interagency Working Group. This IWG will present a progress report concerning the tasks it was assigned at the CNS meeting on July 17, 1997. There will be read-ahead material.

III. POSSIBLE NEW EFFORTS

- Infrastructure Assurance Research and Development Issues Interagency Working Group *(20 minutes)*

Discussion, led by Dr. Kerri-Ann Jones, of a proposed new CNS Interagency Working Group. This Group will lead Federal efforts to develop and coordinate a comprehensive, focused R&D portfolio to address relevant infrastructure assurance requirements. There will be read-ahead material.

IV. OTHER BUSINESS

I am unaware of any other business.

V. CLOSING REMARKS *(5 minutes)*

December 12, 1997

MEMORANDUM FOR KERRI-ANN JONES

THROUGH: BRUCE MACDONALD

FROM: STEVE RINALDI

SUBJECT: Committee on National Security Meeting - Monday, December 15

You will attend the Committee on National Security (CNS) meeting on Monday, December 15, from 2:00-3:30 p.m. in Room 3D1019 at the Pentagon. I will accompany you to this meeting.

This package provides background information to prepare you for the meeting.

- Meeting Agenda (Tab 1). The meeting will cover two principal topics: activity updates from the two existing working groups and possible new efforts.

- Status of Current Efforts (Tabs 2-3). The briefing from the International Technology Transfer Working Group is at Tab 2. As I have noted to you in previous conversations, there have been a number of problems with this working group. To a large degree, the problems stem from the desire by several members to end the IWG's activites. This is probably reflective of the opinions of the working group members rather than their principals. Tab 3 contains additional observations and explanations of these problems. The Non-Proliferation and Arms Control TWG had no inputs for the read-ahead package.

- New Efforts (Tab 4). As part of the interagency review of the PCCIP report, you proposed that the CNS undertake the task of determining the critical infrastructure assurance R&D agenda, program, and execution plan. You discussed this proposal with Jack Gansler and George Singley on December 8. Tab 4 contains the proposal you submitted to the PCCIP interagency working group. This proposal was sent to the CNS principals as part of their read-ahead package.

- Meeting with Jack Gansler (Tab 5). This tab contains materials from your read-ahead package from your meeting earlier this week with Jack Gansler.

Should you require further information, I will be happy to provide it.

Attachments

CNS Working Group on International Technology Transfer Issues and Policy

Tasks and Deliverables, October 1997 CNS Meeting

TASK	*DESCRIPTION*	*DELIVERABLES*	*REFERENCE* *(Rpt to CNS, 17 July 1997)*
Review existing lists of technologies	• Starting point: National Critical Technologies List, Military Critical Technologies List • Add additional lists as required • Assess lists; determine if they require updating	"List of Lists," with assessments of their validity/currency	Task 1, Subtask 1
Inventory existing government processes for collecting data	• Pattern after Commerce Dept survey • Develop CNS tasking to the appropriate departments and agencies • Compile/assess responses	Inventory of processes, with assessments	Task 1, Subtask 2
Inventory govt. / private sector interfaces on intl. technology	• Pattern after Commerce Dept survey • Include in CNS tasking on data collection processes • Compile/assess responses	Inventory of interfaces with assessments	Task 2, Subtask 1
Assess other studies	• NSF data on international technology, esp. *The Science and Engineering Indicators* • Council on Competitiveness global R&D study	Inventory of studies, with assessments	Task 1, Subtask 2
ICAF study	• Contact ICAF to determine feasibility/interest in performing study (student and/or faculty) • Determine timelines	Recommendation on proceeding with ICAF study	Task 1, Subtask 2

hold for CNS meeting

EXECUTIVE OFFICE OF THE PRESIDENT OF THE UNITED STATES

OFFICE OF SCIENCE AND TECHNOLOGY POLICY

REPORT TO THE CNS:

PROGRESS REPORT
Working Group on
International Technology Transfer Issues and Policy

December 15, 1997

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Overview

- Review of Working Group Activities
- Status of Current Activities
  - Principle Findings
  - Action Items from July 17 CNS Meeting
- Proposed Next Steps and Recommendations

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Review of Activities

- December 1996 - April 1997
  - Working group examined three tasks
    - Describe primary government mechanisms for monitoring, assessing, and controlling international technology transfer
    - Frame interagency issues and differences on international technology transfer and equipment export issues
    - Frame the effect that current export control mechanisms have on technology imports.
  - Conclusions
    - Government controls over *controlled technology* are effective within legal and regulatory guidelines, but license decisions are generally made based on narrow evaluation factors
    - The government does not have a comprehensive understanding of the effects on U.S. national interests of the international flow of controlled and uncontrolled technology
    - Collecting and analyzing data to determine if policy changes are required would be a major undertaking

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Review of Activities

- April 1997 - July 1997
  - CNS tasked working group to examine possibility of contracting new studies
  - Working group developed a list of possible study topics, contractors, costs, time frames

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Actions Assigned by CNS Principals

- July 1997 - Present: CNS principals assigned five actions at the July 17 meeting:
  - Review existing lists of technologies
  - Inventory existing government data collection processes
  - Inventory government/private sector interfaces on international technology
  - Assess other studies of technology transfer and flow
  - Investigate possibility of a project with the National Defense University students/faculty

Findings from Current Baselining Activities

- Considerable amount of data on technology transfer exists
  - Numerous databases, critical technology lists, studies, historical data
  - Key problem - getting the right data to the right policymakers
  - Can provide important inputs into policy decisions ... *but* ...
  - Data can be contradictory or conflicting, and interpretations vary

- Departments and agencies have different guidelines, interpretations, and interests
  - Stems from departmental perceptions of technology transfer and associated issues
  - Reflected in the different interfaces with the private sector, various critical technology lists, and diverse databases

- Participation of the private sector is essential
  - Private sector has the technical expertise, understands future technology and market trends, and faces foreign competition
  - Can provide valuable advice and counsel

Action Item 1: Review Existing Lists of Technologies

- Many lists of "critical technologies" have been developed
  - Different authorities mandate lists: Congress (Military Critical Technologies List), departments/agencies (Air Force Technology Opportunities Overseas List), private sector (precedent and case history), …
  - Purposes and uses of the lists vary: export control, counterproliferation, disclosure, cooperative R&D agreement development, etc.
  - Content and accuracy of the data on the lists vary
    - Data collection processes vary, as do frequencies of list updates
    - Lists become a "snapshot" in time

- RESULT: Lack of coherence due to multiplicity of lists, different purposes, and different content
  - Complicates the decisionmaking process

- IMPACT: Lists do not provide a uniform foundation for policy decisions - no single point of reference

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Action Item 2: Inventory Gov't Data Collection Processes

- Government collects a wide range of technology transfer data
  - Motivations for data collection vary - export control, counterproliferation, international agreement development, policy and regulation development
  - Collection requires significant contact with industry
  - Data often "shared" through various means (e.g., government databases and publications, working groups)
- Potential problems with data:
  - Currency - due to collection time requirements, data becomes a "snapshot" in time
  - Accuracy - quality can vary
  - Dissemination - key decisionmakers and staffs might not know what is available
- RESULT: Wide range of data exists, but appropriate and accurate data might be overlooked in the policy process
- IMPACT: Suggests that data should be used as a guide, not an absolute, in the policy process

Action Item 3: Inventory Gov't/Private Sector Interfaces

- Wide number of interfaces exist at many levels:
  - Formal committees and advisory groups
  - Trade and professional associations
  - Private "networks" of contacts
- Government/private sector contact is important element
  - Private sector has technology expertise, understands levels of foreign expertise
  - Private sector can provide inputs on impacts of controls
- DOD dual use policy require full exposure to, and knowledge of, commercial technology

- RESULT/IMPACT: Extensive government/private sector interfaces exist; government should be encouraged to use private sector expertise in technology transfer issues
  - Caveat: private sector has specific viewpoints that do not necessarily reflect government positions

DRAFT

Action Item 4: Assess Other Studies

- Many organizations have studied international technology transfer issues
  - Not a unique question nor unique policy concern
  - Sponsored by government and private sector
  - Domestic and foreign studies - in some cases, excellent exchanges of data
  - Form a comprehensive knowledge base that could support decision-making processes and policy formulation; could also tap expertise of authors
- Potential limitations:
  - Studies may reflect organizational positions and motivations
  - Dissemination of information to policy makers and their staffs
  - Information overload
- RESULTS/IMPACTS:
  - Studies can provide useful guidance to decision processes
  - Key problem: selecting and disseminating the key studies to the decisionmakers

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Action Item 5: National Defense University Study

- Potential exists for study with Industrial College of the Armed Forces (ICAF)
  - ICAF faculty participating in Working Group meetings
  - Must work closely with ICAF to scope potential student/faculty projects
    - Projects must meet student academic requirements and working group objectives
    - Level of effort equivalent to three or six semester hours of Master's level research; can be one or two semesters in duration
    - Student projects must fit within academic schedule constraints
  - Student projects culminate in publishable papers
- ICAF can be responsive if study areas can be postulated on a 6-12 month time frame
  - ICAF needs time to recruit student researchers
  - Optimal time to begin new projects - Fall

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Action Item 5: National Defense University Study

- Potential student projects:
  - General: Examine almost any adequately defined and limited subject relating to S&T management of national security resources
  - Case Study: Examine a specific technology transfer limited in scope to a particular transfer mode or geographic region/country
  - Metrics: Propose and test metrics to evaluate particular technology transfer control mechanisms
  - Metrics: Develop metrics to assess the value of technology gained and lost through competition and cooperation
  - Process Improvement: Evaluate how well various government agencies work together to enable desirable technology transfer and inhibit undesired transfer for a specific technology or weapon system class. Recommend process improvements

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Next Steps

- Current activities have focused on baselining existing lists, data, studies, and interfaces
- Proposed activities for next quarter:
  - Focus on several specific Terms of Reference tasks during the upcoming quarter
    - Task 8: Characterize the short and long term benefits and risks associated with technology transfer; propose methods to quantify the benefits and risks
    - Task 9: Identify the effects that current mechanisms for controlling the export of technology have on the import of technology
  - Methodology:
    - Examine studies, baseline current understanding
    - Follow-up with other organizations (e.g., NSF, IRI, RAND, etc.)
    - May recommend follow-on, detailed contracted study
  - Encourage and actively support ICAF student research projects
- Long-term activities
  - Examine Tasks 6 and 7 (technology transfer process improvements)
  - Develop guidelines for process improvements

APPENDIX I
WORKING GROUP TASKS
(from Terms of Reference)

Tasks

The working group will identify issues, formulate them in the most useful way, analyze them, present them to the CNS, and make recommendations to the CNS for improving associated policy mechanisms. Specifically, the working group will perform the following tasks (not listed in priority order):

1. Review current mechanisms for monitoring, assessing, and controlling international technology transfer and the export of technology and equipment, including third party sales, identifying both gaps and overlaps;

2. Review U.S. "Buy American" legislation as a barrier to exports;

3. Refine the definitions of critical technologies and related export policies necessary to maintain appropriate national leadership in these areas;

4. Review the actions, practices, and investment strategies of other national governments which affect technology transfer between U.S. industry and foreign industry and governments;

5. Consult with industry to identify their highest priority concerns and to obtain their views regarding policies which restrict their ability to compete in the global marketplace;

6. Detail interagency issues and differences on international technology transfer and equipment export issues;

7. Identify ways to improve interagency cooperation and coordination on technology transfer issues;

8. Characterize the short and long term benefits and risks associated with technology transfer transactions and propose measures to quantify the benefits and risks;

9. Identify the effect that current mechanisms for controlling the export of technology have on the import of technology.

APPENDIX II
BACKGROUND MATERIAL

Action Item 1: Review Existing Lists of Technologies

National Critical Technologies List

- **ORIGIN:** Congressionally mandated (1989), biennial report from OSTP. Contractor - RAND
- **SCOPE:** Tasked to identify 30 critical technologies
  - Critical technology - defined by Congress as a product or process technology that is "essential for the United States to develop to further the long-term national security or economic prosperity of the United States"
  - Last report dated March 1995; 1997 report nearing completion. Interviewing 60 persons from broad spectrum of industry
- **DIFFICULTIES/LIMITATIONS:**
  - No common definition of "critical technology" - list lacks boundaries
  - Without boundaries, list is difficult to apply to policy process
  - List inflation
  - Quick technology "turnover" in some sectors
    - Future lists will be "moving target lists"
    - Traditional survey methods are insufficient, given time scales

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Action Item 1: Review Existing Lists of Technologies

Military Critical Technologies List

- **ORIGIN:** Export Administration Act of 1979; DOD develops list. Contractor - IDA
- **SCOPE:** Secretary of Defense assigned responsibility for providing assessments and judgments on militarily critical technologies and equipment
  - Critical technology: a technology "whose performance parameters are at or above the minimum level necessary to ensure continuing superior performance of US military systems."
  - Process strives to update list within technology lifecycles. 60 subgroups from DOD, industry, and academia meet as required to update lists
- **DIFFICULTIES/LIMITATIONS**:
  - MCTL is a reference document -- it is not an export control list
  - There are items on the MCTL that are not on export control lists, and vice-versa
  - However: Departments of State and Commerce use MCTL as a reference document

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Action Item 1: Review Existing Lists of Technologies

Commerce Control List

- **ORIGIN:** Export Administration Act of 1979, as amended (provisions continued by International Emergency Economic Powers Act)
- **SCOPE:** Includes commodities, software, and technology
  - Should take into consideration multilateral regime lists: Wassenaar Arrangement, Nuclear Suppliers Group, Missile Technology Control Regime, Australia Group
  - Should not take into consideration foreign policy lists: U.S. controls for anti-terrorism, crime control (human rights), encryption items, regional stability, short supply reasons, and other foreign policy controls
  - List developed in consultation with industry, especially Technical Advisory Committees
- **DIFFICULTIES/LIMITATIONS:**
  - Obtaining U.S. interagency and international agreement on changes can be a lengthy process
  - Technology moves quickly

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Action Item 2: Inventory Gov't Data Collection Processes

Data Collection Examples

- State Department
  - Chairs and/or participates in several interagency working groups that review and interpret data
    - Dual use, nuclear, biological, chemical, missile, and other defense articles not covered under the various regimes
  - Four offices collect and analyze data and formulate Department positions on dual-use license requests and specific export cases
    - Chemical and biological equipment and technologies, missile technologies
    - Database with licensing information, enforcement cases, criminal/civil actions, watch lists

- Defense Department
  - Foreign Disclosure and Technical Information System (FORDTIS)
    - Data on disclosure and export licenses

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Action Item 2: Inventory Gov't Data Collection Processes

Data Collection Examples, con't

- Commerce Department
  - Significant data collected by the Census Bureau
    - Exports/imports and other trade indicators
    - Economic and statistical data

- Some data collection cuts across multiple departments and agencies
  - Data may vary, due to different deparmental motivations and uses

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Action Item 3: Inventory Gov't/Private Sector Interfaces

Examples, Government/Private Sector Interfaces

- Formal Committees and Advisory Groups
  - President's Committee of Advisors on Science and Technology
  - President's National Security Telecommunications Advisory Council
  - Department of Commerce advisory groups
  - Depart of Defense: Defense Science Board, service science boards, Defense Policy Advisory Group
- Various working groups, such as those involved in developing critical technology lists
  - May include government, industry, and academia

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Action Item 4: Assess Other Studies

National Science Foundation

- Science and Engineering Indicators
  - **ORIGIN**: Required by National Science Foundation Act of 1950
  - **SCOPE:** Biennial report; next report due in 1998. Comprehensive summary of statistical data:
    - Investments, national trends, international comparisons, patent information, education, demographics, ...
    - Have historical data, contacts with database owners/maintainers
  - **OBSERVATION:** Significant portion of this data is directly relevant to technology transfer questions, especially on uncontrolled technologies

- NSF has produced other studies with relevant data, including:
    - "Human Resources for Science and Technology" - by global region
    - "Asia's New High-Tech Competitors"

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Action Item 4: Assess Other Studies

Industrial Research Institute

- Association of 278 companies with R&D facilities in the U.S.
  - Mission: "To enhance the effectiveness of technological innovation in industry"
  - Member companies employ over 500,000 scientists and engineers, have annual R&D expenditures from $1 million to $9 billion
  - Maintains linkages to similar foreign institutes in Europe, Japan, Canada, Australia, and Korea
- Federal Science and Technology Committee - IRI's liaison to federal government on policies and programs of national interest
  - Provides advice to government agencies
  - Issues position statements and advisory letters on government policies and programs affecting R&D
- Performs various studies on aspects of the research process
  - R&D Trends Forecast -- annual outlook on R&D based on industry surveys
  - Forecasts similar trends in foreign nations

Potential DOJ membership on CNS

September 19, 1996

MEMORANDUM FOR KERRI-ANN JONES

FROM: GERALD EPSTEIN

SUBJECT: National Institute of Justice

The National Institute of Justice is located in the Justice Department's Office of Justice Programs, headed by Assistant Attorney General Laurie Robinson. She reports to Associate Attorney General John Schmidt. (These names are from the on-line federal directory, current as of January/February 1996.) The FY96 appropriation for NIJ was $30,000,000; in addition, it received $20,000,000 from the Local Law Enforcement Block Grant to assist local governments to identify, select, develop, modernize, and purchase new technologies for use by law enforcement. The relevant House appropriations subcommittee's FY97 report describes NIJ as "the nation's primary source of research and development in the field of criminal justice. NIJ fosters innovation in law enforcement technologies, investigates causes and patterns of crime, and informs the public of research and development findings."

The FY97 Commerce, State, and Justice Appropriations bill has not been through conference yet, but the House subcommittee report language provides funds for the following projects. (It is not clear whether these are a few of NIJ's activities that are of particular interest to the Committee, or whether this is all that NIJ is doing.)

1) *Defense Technology* -- work with DoD to convert non-lethal technology to law enforcement use *(another argument for putting Justice on NSTC and CNS).*

2) *Southwest Border States Anti-Drug Information System* -- in conjunction with DoD, development of a system to allow law enforcement officers in one state to access criminal and intelligence databases of other states quickly and securely.

3) *National Study on Correctional Health Care* -- a national study on health care services currently available in jails, prisons, and juvenile facilities.

NIJ is also pursuing a number of technology initiatives: a program on automated facial recognition technology and another, with funds to be transferred to the FBI, on a Center of Advanced Support in Technology for Law Enforcement (whatever that is - it sounds redundant with NIJ's own mission from its name).

From this appropriations report, it does not appear that the money authorized for counterterrorism technology development has indeed been appropriated.

Treasury

~~Do~~ Undersecretary for Enforcement

2/97

- Secret Service
- Customs
- ATF
- Financial investigations

Paul Brown – 622-1354

Epstein was on a trip w/ the Gore Commission on Air Secur w/ Brown & has met Kelly, who was a Commissioner

NIJ - Jeremy Travis 10/31/96

Created 1970 by Congress. In Justice within Office of Justice Programs, w/ Bureau of Justice Statistics + 3 other agencies. Mission: conduct R&D on criminal justice issues. Travis been director 2 years.

- Budget growth, these are "good times": Attorney General support
- 1994 Anticrime Act, which set up programs, each of which evaluation will be a major component. 1-5% of each program's funds go to NIJ for evaluation + research. Amount set by negotiation w/ program office; rough costing out. 1% of $1.4 billion Community Policing Act (Office of Research Evaluation)
- Congressional support, esp. in hard science area.

David (Office of Science + Technology) out of defense industry. NIJ traditionally had minor forensics, technology role: soft body armor, DNA, product testing. Has grown from $4-$5 million to $60-70 million.

What happened? VP MOU betw. DoD + DoJ to work law enforcement applications of defense technology. No money. Then Pat Schroeder put money in DoD under MOU to fund NIJ priorities.

Technology is a program area under the Comm. Policing Act (COPS) AD ~$8 mill for things like concealed weapon detection.

Congress allocated a percent of Crime Act money for state + local support, but then earmarked it.

NIJ budget $94.5 million, not including DoD contribution -
Period of major growth,

Recommended Technology Policy Council be set up w/in DOJ - Chaired by Jamie Gorelick, but in effect NIJ is secretariat -
Have invited Treasury agencies & ONDCP; w/ DoD and Transportation (FAA)

Created a research council w/in Justice, esp. social science side. Bulnisar

Interagency Working Group on Violence Research
joint w/ NIH,
$5 million or so

Strategic direction: building international contacts. Joined international network of criminology institutions. Proposing comparative research study. New work on research demonstration, hypothesis testing

Will take on more long-term studies; create infrastructure on crime research. Chicago program -

FY98 budget request: 3 year program for Arrestee Drug Abuse Monitoring System

Intramural - mostly social science.

NIJ

10/31/96

Congress has set up a $40 mil Counterterrorism program

NIJ contact w/ Police Scientific Development Branch in the UK.
NIJ has annual conferences in law enforcement technology

Infrastructure - means 2 things
- Acorns system - dealing w/ independent entities all over the country. Number of institutions doing research/evaluation
- Chicago program. Ideas originate in house, get submitted to NIJ. Chicago program joint between NIJ & MacArthur Foundation, follow 100,000 kids for 8 years. > $4 million. Has had contact w/ one office in NSF. But criminology always seen as "bastard child" of sociological research.

Size 42 people when Travis arrived; now 73, going to 87.

NIJ working w/ FAA (Adm. Pluta, John Daly)
- concealed weapons detection
- explosives detection

9-11 technologies underway. COPS money at first. Then DARPA transferred money to Rome center

TERMS OF REFERENCE
FOR THE
CNS WORKING GROUP
ON
INTERNATIONAL TECHNOLOGY TRANSFER ISSUES AND POLICY

Background

Technology developed in the United States is transferred to other countries in a variety of ways. In some cases, the transfer is purposeful and intended to serve the broad national interest; in others it is a byproduct of legitimate transactions; in still others it is the result of illicit activity. The U.S. also has an interest in gaining access to technologies developed abroad. Numerous policy mechanisms are in place to balance the benefits and risks of technology transfer with regard to national and economic security. However, improvements in the unity of national policy may be needed. The Committee for National Security (CNS) of the National Science and Technology Council will examine international technology transfer issues and seek to identify opportunities for improving policy mechanisms while recognizing that the mechanisms we use to control the release of technology will affect our ability to acquire foreign-developed technology.

Approach

The Committee for National Security will establish a working group to identify international technology transfer policy issues and to make recommendations to the CNS for improving associated policy mechanisms. The working group will focus on transfers of technology which affect U.S. national and economic security, and will address the following areas of global trade and technology transfer:

- Sales and contracts with foreign buyers which impose mandatory requirements for technology transfer as a condition of sale;

- Joint commercial ventures with foreign partners involving technology sharing and next generation development;

- Government-to-government agreements on the cooperative development and production of defense equipment, to include the impacts of such agreements on the private sector.

Participants

The working group will include representatives from Departments of Commerce, Defense, State, Energy, NASA, the Arms Control and Disarmament Agency, and the Office of Science and Technology Policy.

December 23, 1996

ACTION PLAN
FOR AN
INTERNATIONAL TECHNOLOGY TRANSFER POLICY INITIATIVE

Committee for National Security

Task	*Action Step*	*Schedule*
Phase 1		
Review current mechanisms for monitoring, assessing, and controlling international technology transfer and the export of technology and equipment, including third party sales, identifying both gaps and overlaps.	Develop a briefing for CNS which describes the primary government approval mechanisms for: • sales and contracts with foreign buyers • joint ventures with foreign partners • government-to-government agreements on the cooperative development and production of defense equipment.	Distribute briefing charts prior to first 1997 CNS meeting.
Detail interagency issues and differences on international technology transfer and equipment export issues.	Develop a briefing for CNS which frames interagency issues and differences.	Distribute briefing charts prior to first 1997 CNS meeting.
	Identify initial opportunities for improved coordination.	First quarter 1997.
Identify the effect that current mechanisms for controlling the export of technology have on the import of technology.	Develop a briefing for CNS which frames the issues.	Distribute briefing charts prior to first 1997 CNS meeting.
	Develop and analyze information.	First quarter 1997.

January 9, 1997

Tasks

The working group will identify issues, formulate them in the most useful way, analyze them, present them to the CNS, and make recommendations to the CNS for improving associated policy mechanisms. Specifically, the working group will perform the following tasks (not listed in priority order):

1. Review current mechanisms for monitoring, assessing, and controlling international technology transfer and the export of technology and equipment, including third party sales, identifying both gaps and overlaps;

2. Review U.S. "Buy American" legislation as a barrier to exports;

3. Refine the definitions of critical technologies and related export policies necessary to maintain appropriate national leadership in these areas;

4. Review the actions, practices, and investment strategies of other national governments which affect technology transfer between U.S. industry and foreign industry and governments;

5. Consult with industry to identify their highest priority concerns and to obtain their views regarding policies which restrict their ability to compete in the global marketplace;

6. Detail interagency issues and differences on international technology transfer and equipment export issues;

7. Identify ways to improve interagency cooperation and coordination on technology transfer issues;

8. Characterize the short and long term benefits and risks associated with technology transfer transactions and propose measures to quantify the benefits and risks;

9. Identify the effect that current mechanisms for controlling the export of technology have on the import of technology.

Phase 2		
Review U.S. "Buy American" legislation as a barrier to exports.	Identify relevant legislation. Analyze legislation.	First quarter 1997. Second quarter 1997
Refine the definitions of critical technologies and related export policies necessary to maintain appropriate national leadership in these areas.	Compile existing definitions. Recommend revised definitions to CNS.	First quarter 1997. Second quarter 1997.
Phase 3		
Characterize the short and long term benefits and risks associated with technology transfer transactions and propose measures to quantify the benefits and risks.	Build on results of previous analysis.	Third quarter 1997.
Identify ways to improve interagency cooperation and coordination on technology transfer issues.	Analyze opportunities and make recommendations to CNS.	Third quarter 1997.
All Phases		
Review the actions, practices, and investment strategies of other national governments which affect technology transfer between U.S. industry and foreign industry and governments.	Utilize existing reporting processes of the intelligence community, as well as reports and other information from open sources.	Ongoing
Consult with industry to identify their highest priority concerns and to obtain their views regarding policies which restrict their ability to compete in the global marketplace.	Identify appropriate channels through which dialogue with industry can be established.	Second quarter 1997.

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Number of Pages: 3 **(Including Cover Sheet)**

Date 12/2/97

Notes:

Steve,

Am forwarding my first cut at the agenda for the CNS meeting. Please note I have only used 1 hour of the 1-1/2 hours blocked out. I have assumed Kerri-Ann will want to discuss the proposed IWG on Infrastructure Assurance R&D Issues. This will need to go out with read-ahead material on Dec 8th and will need Dr. Jones and Dr. Gansler's approval. Can you please show it to Dr. Jones and get her changes/approval.

Thanks

Wes

Future Challenges

By the year 2000, 65 percent of all jobs in America will require some education beyond high school. However, even in professional and technical jobs—the largest single occupational category[53]—70 percent of the jobs will not require a college degree. This explains the growing interest in the German apprenticeship program for post–high school education.

About half of all service workers will be involved in collecting, analyzing, synthesizing, structuring, storing, or retrieving information as a basis of knowledge.[54] This will require far greater skills than the vast majority of today's service workers possess..

For both factory and service workers, computer skills will clearly be a basic requirement. The fastest growing employment sector in the economy will undoubtedly be in the software area—the engine that basically drives the information era.

Demographics in the twenty-first century will also change significantly, and both women and minorities will play an increasing role throughout the various levels of the work place. In fact, over the remainder of the decade, 85 percent of those entering the work force will be non-whites, women, and immigrants (with the native white male representing only 15 percent of the new entrants).[55]

The role of union leaders will also change. Rather than fighting technology, they must be involved in technology policy in a positive way. Indeed, labor and education policies must be integrated. Critical to this is the creation of a learning economy, which requires the support of industry, labor, government, and the educational establishment. Life-long learning means that the education market extends from preschoolers up to, and often beyond, retirement. In addition, as the world becomes more global, a significant part of life-long learning is foreign study. If we are to compete in the global marketplace, we must be able to speak other languages and understand other cultures.

America must become a high-skills/high-wage economy in the twenty-first century. A low-skills/high-wage economy will not be competitive; and a low-skills/low-wage economy will not achieve our objectives of a strong national security posture, economic growth, and a better life for the work force.

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Achieving Civil/Military Integration

Survey data show that close to 85 percent of Americans simply are against change—on almost any issue. The changes required to achieve civil/military integration are in some cases major; the resistance, accordingly, can be expected to be severe. One must recall Machiavelli's warning on the difficulty of introducing change in government: ". . . it ought to be remembered that there is nothing more difficult to take in hand, more perilous to conduct, or more uncertain in its success, than to take the lead in the introduction of a new order of things. Because the innovator has for enemies all those who have done well under the old conditions, and lukewarm defenders in those who may do well under the new. This coolness arises partly from fear of the opponents, who have the laws on their side, and partly from the incredulity of men, who do not readily believe in new things until they have had a long experience of them. . . . Thus it happens that whenever those who are hostile have the opportunity to attack they do it like partisans, whilst the others defend lukewarmly. . . ."[1]

Yet the restructuring of the U.S. defense industrial base has to happen, for three basic reasons. *First,* the restructured military forces of the post–cold war era have to be equipped with the weapons to fight twenty-first century conflicts, but with far fewer dollars than in the past. *Second,* the U.S. needs to create an innovative, responsive, efficient, and effective domestic defense industrial base with lower costs, smaller quantity weapons production, and greatly reduced dependence on foreign military sales. *Third,* the tens of billions of dollars of annual defense R & D and production expenditures have to go beyond uniquely military applications to help overall U.S. economic growth and international industrial competitiveness (for DoD and the nation's mutual benefit).

In the same way that American industry has the primary responsibility for America's industrial competitiveness, it also has the dominant responsibility for coming up with an overall integration/conversion plan—and for taking initial actions—if it expects to get any government short-term help in making the transition. It is essential for American industry to apply the most advanced management techniques and the best technology toward improving U.S. competitiveness. In addition, it must help assure that America's greatest asset, its work force, is not only well educated and trained, but also fully challenged and utilized to its potential capacity.

Today individual firms and industry associations ask the federal government for help with foreign military sales, with weapons' production, loan payments, depreciation for capital investments, research and development funding, worker training, and so on. In the future, in exchange for such assistance the government must insist on specific integration/conversion plans and actions from the industry, lest the industry become more and more defense dependent and fail to take the lead in bringing about the desired restructured industrial base.

America's labor unions also have a leading role to play in pushing for new training and education of the labor force, not in lobbying for subsidies to maintain the current structure. The major responsibility of the federal government is to create an overall environment favorable to long-term national economic growth. It must create incentives for long-term investments (by firms, pension funds, and individuals); reduce the national deficit; and redraft current industrial policies. A reallocation of resources is required, from subsidies to agriculture, home building, small restaurants, and similar areas to sectors with the potential opportunity for rapid economic growth, increased exports, and the creation of whole new industries. Obviously, this shift is made far more difficult by the fact that new industries have very few voters, while old and decaying industries have enormous political power. Thus the restructuring strategy must explicitly address the issue of work force transition to the new structure.

Improved management of existing resources includes improved management of people. Since the growth industries are clearly going to be information intensive, a high-skill domestic work force is required. If resources are not spent on training local labor, U.S. industry will be forced to move offshore to find its workers.

The most immediate, government actions, however, relate to removing existing barriers to civil/military integration. As noted, between 60 and 75 percent[2] of the current barriers can be removed by the executive branch (largely the DoD) without legislative changes, although many require at least the passive cooperation of the Congress. The remaining barriers are primarily driven by legislation—and must be addressed by the Congress. The two most difficult obstacles to transition are the cost-based contracting process and the procurement process (both made worse by the DoD's often extreme interpretations and applications of the laws in these areas). In the future, the Congress must be willing to step down from its position of imperial rule maker, in which any legislator—without study or advice—can simply implement a bill that he or she feels will improve ("reform") the defense procurement system. It will be necessary for the Congress to allow defense procurement to be done in a fashion similar to that of the commercial world. For this to be achieved, each proposed piece of legislation must be subjected to independent analysis of its likely cost and structural impact. The same procedure of course must apply to executive branch regulations.

To better understand the reason for study and negotiation prior to implementation, consider the following example:[3] On April 17, 1992, the government's Cost Accounting Standards (CAS) Board published a "Recodification of Cost Accounting Standards Board Rules and Regulations" in the Federal Register. The board issued the recodification even though, at that time, there was a presidentially directed federal government moratorium on new regulations. The announced logic was that, "The economic impact on contracts resulting from this recodification is expected to be minor . . . [and] regulatory impact analysis is not required."

Commenting on this, the accounting firm Arthur Anderson stated: "In our view, the recodification is probably the most significant piece of regulation to impact non-DoD contractors in the last 20 years or more. We believe that the government made a serious error in extending full CAS coverage to non-defense contracts. It will result in fewer suppliers willing to do business with the government and then only at higher prices."

Thus a seemingly minor regulatory change intended only to "recodify," resulted in significantly higher prices and less competition for government business. But the regulator never analyzed the cost impacts prior to the action.

Congress will have to have better control over its own actions. A major boost toward these required changes was provided in 1993 by Vice President Gore's task force on "reinventing government." Its highest priority government procurement recommendation was to "shift from a set of rigid rules to a set of guiding principles"[4]—supplying detailed explanations and guidance but allowing government procurement personnel and program managers to be empowered to make management decisions in the government's best interest—the same concept that is applied in the commercial sector with the Uniform Commercial Code.

Sixteen Specific Government Actions

The restructuring of the defense industrial base is, above all, a cultural change, in many ways similar to that which U.S. and foreign companies have been forced to go through in order to remain competitive. From them, there are useful lessons to be learned.[5]

1. The first step in successful transformations has been a clear "vision statement"—in this case, of an integrated defense industrial base. This must be accompanied by a strategy for achieving that vision—in this case, technological leadership, human resource development, and removal of the barriers to integration. It is essential that these objectives be reinforced repeatedly—by the president as well as by the leaders of Congress—and eventually elaborated on. For example, one elaboration would be a clear statement of the strong American preference for private sector operations whenever possible.

In the same way, it will be necessary to continuously emphasize the three aspects of civil/military integration that have been highlighted throughout this book: dual-use R & D; integrated facilities; and the purchase of commercial parts, subsystems, and equipment. It is important to counter the tendency to simply say "we'll buy a few commercial items and that will take care of integrating the industrial base." Rather, what is needed is a full transformation that must focus on dual-use R & D and factory-floor integration.

2. Once the vision and strategy are set—and continuously repeated—the second step is to achieve some early successes. The best way is to build on initiatives that have already been started, for example, by recognizing the positive contribution of an individual weapon system program manager who took bold steps to streamline operations.

Another initiative that can be expanded immediately is to dramatically increase the DoD's purchases of commercial items. With the passage of the National Defense Authorization Act for FY91, Congress declared that the time had come to start the process of rationalizing, codifying, and streamlining the defense acquisition process. An advisory panel was established that made recommendations[6] for consolidating and simplifying current laws and, particularly, for allowing the government to buy commercial items. But even these changes immediately ran into special-interest barriers, for example, the long-standing requirement that all small items (anything under $25,000) be "set aside" for procurement from small businesses. This restriction on size immediately limits procurement and takes a purchase out of the normal commercial world and puts it back into the tortuous world of defense-unique procurements.

To prevent this, greater rationalization of procurement guidelines and an expanded definition of what encompasses commercial items (for example, modifications of commercial items and items intended for commercial use but not yet sold to the general public) are needed. The procurement reforms approved by Congress in 1994 move in this direction.

3. Then the definition of "commercial" needs to be expanded still further, specifically to encompass commercial facilities—as an important step toward integration. Initially, one could define a defense-unique item that came from a largely commercial facility (one with 80 percent of its sales going to commercial markets) as being a "commercial item." Then one could waive all of the special provisions that would otherwise apply to the defense-unique item. Public trust would be assured by the normal market forces that drive the operation of that commercial facility in terms of product cost and quality. Trust could be further increased by government-performed, independent market (price) analyses of the value of the DoD goods being purchased.

4. An expanded definition of "commercial" would still not include the major weapon systems area, where the overwhelming majority of defense dollars are spent. Here it is essential to make a weapon's price a part of the military requirement—similar to a weapon's performance. This single step would explicitly create the incentives for introducing all of the other efficiency-oriented changes. It would force economic considerations to take an equal priority with the historic, cultural/political/operational considerations that have almost exclusively driven both domestic and international defense programs in the past.

The impact of price considerations can be most easily seen in the case of future joint international weapons development. In the past, each country insisted on its own technology developments and production lines, regardless of duplication. Each country also insisted on its "just return" (getting back the share of the business that it invested in the program), rather than having the design or production work go to the country that is most competitive on a given product. Using cost as a driving consideration on these multinational programs would have enormous economic benefits for each of the countries involved. However, it would require an approach based on affordability, rather than on politics.

Affordability and effectiveness must similarly be put ahead of special interests in the United States. Consistent with making costs—specifically future production and support costs—a weapon's requirement would be to evaluate the adverse cost impacts of each and every law, regulation, specification, and standard currently imposed on a weapon's program—as well as those proposed in the future.

5. The next step is to recognize that each sector of the defense industrial base (ships, aircraft, electronics, munitions, vehicles, services, etc.) is dramatically different. Detailed sectoral analyses are therefore required, matching likely DoD demands in each sector (for R & D, production, and logistics support) against existing private and public capacities and capabilities. In some sectors, significant downsizing will occur; in others, preservation, or even initiation of new efforts, will be required. For example, the next tank and its engine may be made from materials like composite armor and a ceramic engine, so new facilities may be needed—and they should be planned as dual-use facilities.

An essential requirement of these sectoral analyses will be determining the desired structure in each sector, not picking winning and losing firms but deciding how many plants should remain in the XYZ sector, what the mix of private and public plants should be, and so on. The desired results will be achieved through the use of competitive market forces—assuming competition is present or can be created—and implemented through DoD contract awards. In the future, industrial base considerations will have to be a significant element in DoD's resource allocations and program decisions.[7]

6. The next step is that the DoD must establish a true preference for commercial specifications and standards in all DoD designs and manufacturing operations. Initial steps in this direction were taken—through Defense Secretary Perry's leadership—in 1994.[8] To implement this change the Defense Department would have to redirect its normal military specification and standards writers to either find equivalent commercial specs and standards or, together with the relevant industrial representatives, establish new ones. Maintenance of these dual-use specs and standards should be handled by national and preferably international standards groups that exist in the private sector—the DoD would simply be one of the organizations represented.

7. Since over 50 percent of the cost of defense weapon systems is at the lower tiers of the defense industry (supplier and parts) where transition to commercial items is most easily accomplished, there must be an immediate prohibition against passing down defense-unique rules to these suppliers. Today the prime contractor must pass down over eighty specific clauses to its suppliers,[9] and the primes often choose to add many more of their own. In a few cases, stopping this pass-down practice will require some legislative changes; in most cases, it will simply require the DoD to do some greater risk sharing with its prime contractors. They will be reluctant since the primes have the responsibility of meeting the government's unique requirements. The long-term solution is to remove defense-unique requirements from prime contractors as well.

8. Then there will have to be significant changes in the DoD's research and development practices, specifically, providing manufacturing-oriented efforts far greater resource support. Existing programs, such as

the manufacturing technology (ManTech) program, help stimulate process design and lower-cost technology development, but the greatest impact comes from actual weapon systems' lower-cost manufacturing and support. The R & D resources must be particularly shifted toward design-for-manufacturing and support (on weapons development programs). Thus a key element of the new R & D practices must involve a requirement for, and the funding of, the use of concurrent engineering on all new programs and major system modifications.

In addition, it is important that all production planning be done with the assumption of small-quantity production, which will most likely lead to the requirement for flexible manufacturing and multiproduct production on a common line. Ideally, this would mean all defense products integrated with commercial items, but—in the few cases where this is not possible—a least multiple defense products on the same production lines.

As with many of the other proposed changes, not all of the critical R & D changes require legislative revisions for their achievement. Nonetheless, they will be difficult cultural changes—requiring strong and sustained DoD leadership.

9. The next change would require that contractor support of logistics activities (sparing, repairs, and upgrades) should be assumed as the norm. Organic capability by the DoD should only be justified under special circumstances—such as on the front lines. Contractors should be given incentives to continuously redesign and upgrade their equipment for improved reliability. If firms chose to stop production of an old item, the drawings should go to the government to ensure a life-long supply of the item.

The move from organic maintenance to contractor maintenance would result in the reduction of large numbers of government civilian workers and large inventories of spare parts. It would shift DoD logistics support to the modern, "lean" approach, where the parts would almost all come directly from the factory, and where maintenance would be done largely at the contractor's expense, thereby ensuring greater initial reliability and continued product improvements. With modern communications and transportation techniques, inventories could be greatly reduced and parts could arrive "just-in-time."

10. Defense industry overheads must be dramatically reduced, probably through the use of activities-based costing. This modern management approach provides detailed visibility into the resources and time devoted to each activity within an industrial facility and highlights non-value-added functions. Thus the data for more efficient management would be immediately available, so the defense industry could direct its attention to reducing costs instead of simply justifying them. This should also reduce the need for excessive auditing and oversight by the government.

If activities-based costing is used in a dual-use facility, it will make the added costs associated with defense-unique requirements and their impact on each activity immediately clear. Where uniqueness is necessary, it will result in proper allocation of those costs. Thus a commercial item in an integrated plant will not be unduly burdened by the additional defense requirements as is often the case today.

11. Incentives must be created for firms to move to integrated facilities. For example, once activities-based costing has been introduced into integrated (largely commercial) facilities, these companies should be excluded from any unique defense procurement laws. This step would create an enormous incentive for defense plants to move in the direction of dual use, since all they would need to achieve "commercial" status would be to generate (for example) 20 percent of commercial sales out of the integrated facility, in return for which they would receive waivers from all of the unique requirements they previously struggled to live with. Public trust would be maintained through the management visibility provided by activities-based costing.

A complement to this, and an added incentive for factory integration, would be for the DoD to examine the quality of a manufacturing process, instead of exclusively the quality of the product produced. The modern factory management concept is to control the production process to remove all variability. When this is achieved, the process is responsive to any changing set of conditions and continuously yields high quality products. A supplier certification process can be set up to identify these world-class vendors, all of which can then be suppliers to the DoD.

It is important to emphasize that these processes will not be identical from firm to firm. Nor does the certification process become a fairness constraint on who can be a DoD supplier; it is totally open to anyone who can qualify. But it does restrict suppliers to only those who are quality producers. In 1986 the Presidential Blue Ribbon Commission on Acquisition (known as the Packard Commission) attempted to introduce statistical quality control as a requirement for achieving high quality in the semiconductor manufacturing process. Many DoD suppliers objected that this would be an "unfair" practice, even though it was common practice in most commercial semiconductor firms. Such hurdles will have to be overcome this time.

12. It is necessary to revise many of the Justice Department and Federal Trade Commission antitrust rules if the downsizing process is to be rational. As noted, there will be instances in which only two facilities in any given sector are all that are affordable, and yet provide adequate competition. Current antitrust laws would greatly discourage such consolidation if there were only three or four firms in that sector today. In some sectors it may be necessary to allow consolidation even below two, but here great effort should be made by the DoD to assure an expanded market definition—to include firms in related businesses that could potentially enter the market and to encourage firms that are not already making products in that area, but that have competitive technologies to consider developing their capabilities in the needed military arena.[10] Perhaps small DoD R & D contracts to these new defense suppliers would provide sufficient incentives to bring them in, once the current barriers to integration have been removed.

A related area in the antitrust regime is to encourage R & D consortia and other cooperative ventures. Industry (both defense and commercial), government laboratories, and universities should be allowed to work together, especially in the early development of new products that have market potential (the so-called precompetitive phases). The participants would share risks, costs, and know-how. Industry gains access to government technology and talent, and the government gains a better sense of market needs.

13. Advanced capital equipment, including information technology, is extremely expensive, particularly for small and medium-sized firms. The government therefore must give some consideration to the special financial problems associated with the capital investment situation in the defense industrial base. As a result of the large investments in new plant and equipment made in the 1980s, many defense firms are saddled with a heavy burden. Since they are required by DoD accounting rules to charge off this equipment on any commercial work they might do (as well as on their defense business), it gives them a very severe competitive handicap—in fact, creating a significant disincentive to plant integration. Many small and medium-sized defense firms simply do not have the resources to invest in the equipment needed to be competitive in the commercial world. Thus the government must find a means to encourage conversion by these firms, either through rapid write-offs on current and new equipment, or through the availability of long-term, low-cost capital. One recommendation[11] is to set up a private-sector bank (one proponent called it the "Corporation for Defense Conversion") for investments in firms that need help in making the transition. The condition for receiving funds would be that the only constraint on the firm's success was a lack of capital. Other options, including government-guaranteed loans or even government-furnished equipment, are also possible.

14. There must be a widespread shift from today's lengthy and cumbersome government contract award process to a modern, electronic-data-exchange procurement system. This "lean" system would shorten a process that now takes nine to eighteen months (or longer for major weapon systems) to one that takes a few months or less. It is a necessary move toward facilitating increased efficiency and effectiveness in performing government business.

15. There must be a government civilian manpower reduction plan for the DoD. This would include reduced government oversight, management, and acquisition people, as well as the government (and quasi-government) workers in the depots, labs, arsenals, and federally funded research and development centers. Fewer workers will be needed to staff and supervise the few remaining unique government requirements. But to assure a smooth downsizing, there needs to be a specific manpower phase-down plan. Part of this could be satisfied through base closures, attrition, and other such techniques; but the overall master plan needs to be made explicit and then to be monitored on a quarterly basis. Without the deliberate removal of government people who are no longer required, there will simply be a shifting of personnel from one function to another; where

regulation and excessive oversight is removed in one area it will increase someplace else. Thus the only way to assure successful implementation is to reduce in-house staffing, thereby decreasing the civilian work force by 30 percent to 50 percent.

Vice President Gore's 1993 task force on "reinventing government" recommended an overall civilian government work force reduction of 252,000 people over a five-year period.[12] (President Clinton had run on a platform of at least a 100,000 cut.) Were this reduction to be achieved and the process continued as changes evolved, there would clearly be a significant gain in government efficiency.

16. The last and perhaps most critical of the actions—besides the need for establishing a clear vision and strategy—is to have explicit institutional mechanisms to monitor the progress of the cultural transformation. A system based on output measures has to be established to evaluate all aspects of integration—facilities, operations, costs, shorter development and production cycles, higher reliability, and so on. There will be a need for flexibility and mid-course corrections but not for alterations in the objectives.

A senior, independent group of outsiders (former congressional leaders and defense industry executives, academics, etc.) should be set up by DoD officials to help them monitor progress. Because many of the transition issues necessarily involve other departments of the executive branch (Treasury, Commerce) it may be useful to also have a separate interagency organization assisting with the implementation (discussed below). The outside advisory group could help them too. But this outside group should not have an authority of its own (such as a congressional or a presidential commission) to avoid the danger of developing two sets of initiatives (one from the DoD leadership and one from the commission). All prior successful cultural transformations have clearly shown the need for a single coherent leadership and direction.

Two suggestions that have considerable merit relate to the issue of how to get congressional support for the required cutbacks and essential legislative changes. The public sector of the defense industry (depots, labs, arsenals) have such strong congressional influence that it may be impossible to close them down one-by-one. Thus it has been proposed[13] that a "Commission on Rational Downsizing of the Public Sector of the Defense Industry" be established. Modeled on the independence of the Base Closure Commission and chartered by the Congress, its objective would be privatizing the defense industrial base in all areas except for those functions that are inherently governmental. It would periodically submit an all-or-nothing list of balanced cutbacks for administration and congressional approvals, as the Base Closure Commission now does. (Or, as an alternative, the Base Closure Commission itself could be used to achieve this objective.)

Similarly, it may be necessary to approach many of the required legislative changes in an all-or-nothing fashion. This is a recommendation that was explicitly endorsed in an independent Carnegie Commission study[14] on defense acquisition reform. Some such technique may be required simply to get the Congress to do what they know is necessary, but that they cannot bring themselves to do on their own.

One way to greatly speed up the transformation process is to take maximum advantage of existing legislation wherever it can be used—and thus avoid going through the Congress to begin the changes. As can be seen from table 12.1, many of the proposed sixteen changes do not require congressional action. In fact, on a number of them, the DoD has already begun to take initial steps.

The Defense Production Act

One law that was explicitly set up for strengthening the defense industrial base and moving it toward a dual-use model was the Defense Production Act (DPA); specifically, the 1992 Reauthorization of the Defense Production Act.

In the past, Title III of this act was used chiefly to create incentives to spur domestic development of new capacity for advanced materials required by the DoD, but only available offshore. In most cases, government help was required to overcome industry reluctance to invest because of the uncertainty of the demand and/or the threat of foreign competition entering the market. To counter this concern, a two-phase program was established. The first phase typically gives a contractor a fixed sum to produce small quantities of material and make it available for compliance testing. In the second phase, the contractor reaches quantity production

Table 12.1
Sixteen specific government actions

1. Issue and continuously reiterate a strong statement of the new vision and strategy, that is, civil/military integration and the three-part strategy;
2. Encourage the buying of commercial items; specifically, fully implement the Panel 800 recommendations;
3. Immediately expand the definition of "commercial" to include defense-unique items produced in a largely commercial facility;
4. Make costs (production and support) an essential requirement for weapons' design—at a level comparable to performance;
5. Perform sector-by-sector analyses of the desired future structures—both private and public—of each critical defense industrial sector, and identify the paths and actions leading to achievement of the new structures;
6. Require the use of commercial/industrial specifications and standards—unless written waivers are obtained;
7. Prohibit flow-down of any defense-unique requirements to the lower tiers—unless written waivers are obtained;
8. Shift R & D resources—generic and, particularly, programmatic—to focus on process technologies, concurrent engineering, and dual-use applicability;
9. Shift logistics support to industry (from organic), and use "lean" (just-in-time) concepts;
10. Shift to activities-based costing to reduce industry overheads and, correspondingly, government oversight and auditing;
11. Create incentives for defense plants to move to dual-use operations—for example, by providing waivers from defense-unique requirements if a plant achieves 20 percent commercial sales and gets its quality and activities-based costing processes certified;
12. Revise antitrust rules to allow efficient and effective defense industry downsizing;
13. Explicitly address defense firms' capital needs—especially the small and medium-sized firms—for low-cost capital and rapid write-offs;
14. Rapidly shift the defense procurement process to a "lean," electronic system, to reduce the procurement period from many months to weeks, but still preserve public trust;
15. Implement and monitor a government (civilian) work force reduction plan to reduce government overhead and assure acquisition process streamlining; and
16. Establish an outside senior advisory group to help the DoD leadership (and perhaps other executive departments) monitor implementation and assure achievement of the envisioned changes.

under a purchase commitment that establishes the government as the buyer of last resort, with the expectation that there will actually be an adequate commercial market to absorb the production.

Today the Title III program's mission is changing rapidly. The reductions in DoD's procurement budget and Congress's 1992 decision to give the program an explicit mandate to foster civil/military integration has shifted its emphasis to dual-use products. Thus Title III could become an important tool in the conversion efforts. For example, as an alternative and/or addition to its prior focus, Title III funds may be used for product development, testing, and qualification without continuing on to production. This approach was recently used for open architecture, numerically controlled, machine tool controllers. The government supported the development of an "industry standard" prototype by a joint venture of controls manufacturers and ensured that the system would be fully tested, and the results made available for use in future product marketing. The actual production and marketing of the controllers are the responsibility of the individual firms that will compete for the business.

The Title III program has historically been limited by administrative action to purchases and purchase commitments. But grants, loans, and loan guarantees are also authorized and could provide a broader range of conversion assistance. Since the current prohibition is based on an interagency agreement between the Office of Management and Budget and the DoD, it could easily be changed to meet conversion objectives.

The overall purpose of Title III of the DPA is to ensure the viability of an industrial source that is critical to DoD, while increasing that company's ability to operate profitably in the commercial marketplace. This objective is obviously closely aligned with the conversion needs of the defense industry, as well as with the objectives of the DoD's required future defense industrial base.

Complementary Broad Government Actions

There are a few significant areas in which the government could facilitate a more rapid evolution to a new defense industrial structure. One of these is for the Congress to shift to a multiyear resource allocation process. The current one-year fiscal cycle—and often even less than that, since continuing resolutions are frequently used—greatly hampers efficiency.

No other developed country operates on a one-year fiscal plan. Most of them use a rolling five-year plan, where they annually debate the sixth year and simply approve a budget for the current year based on the first year of the prior multiyear plan. The United States could move to a rolling three-year budget; the current congressional budget process is geared to that.[15] A simple two-year budget would not likely achieve the required stability because of the uncertainty at the end of the second year, including the significant incremental changes that would likely occur at that time.

Another area in which the government can have a significant impact is in its international dealings, particularly with Japan and Europe. The United States must take a far more integrated view, linking its trade policies, export-control policies, joint-development programs, and others to the objectives for a restructured defense industrial base.

The export control of critical defense technologies has traditionally been under government management. In the future, the list of items that are controlled can be greatly reduced because in most cases economic competitiveness is more of a concern than national security. What needs to be done is to develop a very limited list of items that are critical for both commercial and military reasons. For example, the DoD for years has successfully controlled foreign access to the design of advanced versions of the critical hot-section of aircraft jet engines—an obvious dual-use product. A short list of controlled exports—that will vary from sector to sector—will also provide the required guidance to industry.

Critical technologies management should be expanded to include the gathering and dissemination of information from other countries. Since the United States is no longer the leader in many critical areas, it is essential to take advantage of the available data, often in foreign languages. Historically the United States has taken a very narrow view of such international data gathering—primarily because America was usually ahead—so the only interest was in intelligence gathering on potential military adversaries. Unlike most U.S. economic competitors, American engineers do not take full advantage of what is available from foreign sources. The U.S. government must help sponsor foreign study, foreign data gathering, foreign language programs, exchange programs with foreign industry, etc., to improve the data gathering and benchmarking on

international competitors in areas of critical technology. Again, tracking of such data can be part of the required sectoral analyses.

The government can also greatly facilitate the conversion effort by encouraging high-technology civilian investments, primarily in R & D. There are enormous overlaps with defense technology in such areas as information, communications, transportation, law enforcement, domestic security, medicine, health care, energy, education and training, environment, civilian space applications, and manufacturing technologies. In areas where there are mission applications that are controlled by other government agencies (e.g., transportation, energy, environment), it is up to the government to stimulate the long-term, high-risk research and development; in some cases, this may mean becoming the guaranteed first production purchaser. The government must actively create an attractive nondefense market for many defense firms.

Finally, the government can make significant investments in public sector infrastructure that can have a dramatic impact on economic growth, as well as help in defense conversion. For example, investments in the infrastructure associated with air traffic management, national information networks, and smart highways could stimulate new markets and new domestic industries. At the same time, they would provide business opportunities for high-tech defense firms.

Overcoming the Resistance to Change

This book could not possibly end without addressing the obvious question of "why is this defense procurement reform likely to succeed when all of the other attempts over the past decades have failed?"

The first, and easiest, answer to this question is that, today, things are different. In the past, no matter what people said, there was always the firm conviction that the defense budget would remain high—because the communist threat was still there and growing. In the post–cold war era, there is a general acknowledgment that the world has changed. There is no question that defense dollars will stay down for some time. Yet there is still the need to maintain a strong defense posture—especially in view of the worldwide instabilities, conflicts, and spread of arms. So, with high and rising weapon system costs, a declining defense budget, an inefficient and rapidly deteriorating defense industry, and a requirement for new weapons, a Defense Department crisis is at hand!

Prior successful cultural changes—such as those in some state and local government agencies, as well as those in U.S. industry—all began with the recognition of a crisis. This is a necessary, but not sufficient, condition for achieving a cultural change of the magnitude being considered here.

The defense industry recognizes a crisis. With its market disappearing and the current isolation of the industry, there are few directions for the vast majority of the defense industrial managers to turn. A few will choose to dramatically shrink down and form the basis of the remaining defense-unique facilities. But the overwhelming majority will either diversify or disappear. This recognition of the industrial crisis is different today than it was in the past, when most firms felt they could simply weather the storm.

Another reason for believing that it might be possible to make the change this time is that many of the nation's leaders—in both the executive and legislative branches—recognize the need for this change and are in agreement about the direction in which it should go. In the Defense Department (initially led by Clinton appointee William Perry, as deputy secretary of defense and then as secretary), the integrated, civil/military industrial base model is increasingly being accepted as the desired future direction. It is also being accepted throughout other major portions of the government. President Clinton, Vice President Gore, and many other members of the first post–cold war administration (from the Commerce Department, the Labor Department, and, particularly, the new National Economic Council) have all advocated a similar direction. Naturally, there is still strong opposition—both in portions of the executive branch and particularly on Capitol Hill from those representing the various special interests that would be affected by such a change. Nonetheless, the leadership is sufficiently aligned and motivated to achieve dramatic changes. This is a condition that has not been true in the past when many in the DoD and in the White House argued that things were fine as is.

Some important lessons can be learned from looking at specific reasons why prior major recommendations for change in the DoD have failed.[16] Specifically, there were seven principal impediments:

1. The goal of the recommendation was not fully accepted by the implementing organization and/or by the top-level management.

2. There were threats to jobs, and/or a perceived conflict of interest in implementing the recommendation.
3. There was poor communication of the intent of the recommendation.
4. There were no incentives to change, and change represented a risk to a basically risk-adverse group.
5. Inadequate resources were provided to make the change. Savings were projected and people were told to reduce the resources and implement change—but there was no recognition that the change costs money and that it would take time to realize the eventual benefits.
6. There was no sustained supported for the change from the leadership, and often not even sustained leadership. The time required for full and effective implementation was often longer than the time that political appointees were in their jobs.
7. In all cases there were no output measures of improvement.

Each of these issues must be addressed in attempting to change the way the DoD does business. Actions taken to start an effort—a reorganization or the issuance of a directive—cannot be considered the measure of accomplishment. The improvements required must be viewed as a process change, not just as a rewriting of rules or a redirection of programs. And the implementations must be carried through until they produce the intended results. This is a particularly critical point; the type of change recommended here will take at least five years, and perhaps three years to even begin to see the impact in any measurably significant way. There will be visible qualitative changes along the way, however, and these must be highlighted and built upon.

To overcome the anticipated resistance to change, there must be an excess of communication. A coherent and simple message, easily understood, must be reiterated again and again. People must be assured that their concerns have been addressed and that they are being dealt with fairly.

Because of the relatively short time that most political appointees are in office—typically an average of two and one-half years or less—it is essential that an institutional mechanism be established for helping to make defense conversion happen, to measure its progress, and to make midcourse changes as needed. At the beginning of the Clinton administration, an Interagency Conversion Committee was set up, co-chaired by the deputy director of the National Economic Council and the under secretary of defense for acquisition. It included representatives of all of the relevant agencies. This committee could serve as the basis for such a more permanent interagency institution.

One of the main functions of both the interagency committee and the external advisory board will be to help establish output measures of effectiveness (of the change) and to report on them over time. These obviously include longer-term cost and schedule trends in weapon system developments, as well as some intermediate measures affecting the transformation of various systems (specifications and standards, cost accounting, auditing, procurement) and, from the industrial side, the actual achievement of plant integration, commercial component, subsystem and system acquisitions, and the implementation of modern electronic information technology within the industrial structure.

Other functions of an advisory committee can include:

- identification of the critical product and process technologies that will provide long-term technological leadership for security and economic growth;
- adequate, efficient, and effective government and industry stimulation of research, engineering, and manufacturing efforts in the identified critical areas;
- assurance of coordinated civil/military integration of both government efforts and particularly domestic industrial activities;
- adequate consideration of public trust and fairness issues;
- necessary antitrust revisions to allow appropriate downsizing and consortia in both the engineering and manufacturing areas;
- incentives for the stimulation of capital investments by industry;
- assistance in access to foreign technology;
- export control over critical dual-use technologies;
- support for the necessary infrastructures; and
- assurance of adequate international benchmarking data on critical technology areas.

Conclusion

By the mid-1990s, U.S. commercial industry was starting to turn the corner, significantly enhancing its productivity in many sectors. The macroeconomic conditions were not yet favorable for greater gains, however, and many in the Congress had not yet recognized the need for introducing

serious institutional changes. Certainly, the United States was not well on its way to restructuring its defense industrial base or the DoD weapons acquisition process. On the positive side, a number of lower-level organizations within the DoD were initiating changes in the desired direction, and numerous top-level policy changes were being instituted. Yet policy changes are not enough—careful attention must be paid to the details of implementation.

Successful change of the magnitude envisioned here requires a six-step process:[17]

1. Preparation: establish the vision and the strategy;
2. Commitment: high priority of leadership time and team-building;
3. Deployment: communication and training to gain widespread alignment;
4. Action: slow at first, but accelerating as it spreads;
5. Reinforcement: team rewards and widespread recognition of successes; and,
6. Results measurement and feedback: output measures and adjustments as required.

The benefits of the proposed change can be extremely significant. Literally, tens of *billions* of dollars of increased efficiency and effectiveness can be realized in the defense weapons acquisition arena alone. The United States will have a defense industrial base capable of providing for its peacetime and crisis demands at a dramatically lower cost. And, U.S. economic growth and international industrial competitiveness will be aided by the large defense R & D and production investments that will, and must, be made for the nation's long-term security.

The alternative is to continue on the present path and end up with a small, highly subsidized, inefficient, ineffective, noncompetitive, and technologically obsolete defense industrial base, with an absence of either a surge capability for crisis demands or any civilian benefits to the nation from defense R & D and procurement expenditures.

ıbining the three broad areas of potential cost savings, we find:

ced inefficiencies in program definition ($15 billion per year).
ced inefficiencies in program execution ($20 billion per year).
ced inefficiencies in maintaining the defense industrial base ($10 per year).

in, because these categories overlap and therefore cannot be added, ıt possible to estimate easily the total potential savings. From this, er, it should be possible to conclude that *the potential savings is ıly in the tens of billions of dollars annually,* or well over 20 percent total acquisition dollars spent by the Defense Department.

ıdd additional credibility to this estimate, in 1994 a very significant ınvestigated the regulatory cost impacts (of doing government busi-vithin representative design and manufacturing plants. The objec-ıs to determine the difference in doing a given task between defense es and best commercial practices.[11] After months of analyzing a ant number of defense supplier facilities, the study concluded that ulatory impacts alone represented approximately 18 percent of the ıdded cost in an individual plant. The detailed analysis was done ı prime contractor and lower-tier facilities; therefore the numbers extrapolated across the overall defense acquisition budget. Thus, ıt considering many of the other inefficiencies noted above (the ns' requirements process, added government employees, and the lant industrial base), the study found that, solely due to regulatory s, the costs to the government were 18 percent greater than they be if best commercial practices (by high-quality, world-class firms) tilized. The study also found that the more engineering-intensive ı technology-based the activities were, the greater the regulatory ıpacts became (going well over 25 percent). The combination of ctivities-based costing plant analyses and the numerous case stud-ıilitary and commercial equipment clearly indicates that the poten-ings, as a result of moving from government practices to world-ommercial practices, can be extremely significant and fully justifies orts required to implement the actions recommended in this book.

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Technological Leadership

Research and development fuel the engine that drives the U.S. economy. In the civilian arena, new products and new manufacturing processes yield competitive advantage, resulting in the creation of new jobs and national economic growth. In the military, R & D help sustain its strategy of technological superiority. Both civilian and military R & D are therefore critical; and wherever possible the nation should benefit from the coupling of the two.

* Dual use (P)

The payoff from this coupling—and from increased civilian R & D investment—could be huge. Economic studies suggest that the rate of return on effective R & D spending runs as high as 50 percent a year, including indirect benefits to the economy.[1] R & D requires three sets of complementary investments: capital equipment, infrastructure, and skilled labor.

First, incentives must be created for capital investment, if the United States is to fully realize the gains from its R & D leadership. Increasingly, the nation that "wins" is not the one that carried out the original R & D but the one that gets the new products to the market most rapidly. This is true in both the economic and security spheres.

Second, there are huge benefits to be gained from national infrastructure investments. In the last generation, it was highway building (justified on the basis of national security) that stimulated the U.S. auto industry. Today, in the information age, these investments must be made in the national information infrastructure. Since this infrastructure is a public good, it is unlikely that private sector investments will be adequate. Government incentives and investments will be required.

Third, technological leadership requires a skilled labor force. Again, this is a public good in which it will be necessary to make significant public sector investments.

Thus there are four areas that require significant investment: R & D, capital equipment, infrastructure, and education and training. Since there are often inadequate long-term incentives for the U.S. private sector to make large enough investments in these areas, it is imperative that the government step in and help. American firms will often underinvest in R & D for one of the following reasons: they are not in a position to capitalize on the payoff (there may be richer, or faster, competition); the project is too risky; the benefits will accrue more to the public than to the firm; or, particularly, there may be a negative short-term profit impact. For these reasons, the United States may continue to lose its leadership position in many critical technology areas without government involvement in R & D—both in the creation of incentives through public policy and in selected direct investments.

When resources are constrained, as they certainly are for the federal government, programs must be justified on economic, quality of life, and/or security arguments. Federal projects such as the $120 billion space station become increasingly difficult to defend. As one European observer commented, "I can't understand your country putting billions into placing a man in orbit when your highways and railroads don't work."[2] Although this may be an exaggeration, it highlights the disparity between research levels on ground- and air-based transportation versus other projects.

The point is that it is not solely a question of how much money a nation devotes to R & D, but rather what it is spent on and how efficiently and effectively it is used. It also matters where it is spent; if manufacturing goes offshore, engineering will soon follow.[3] Therefore the nation must not just increase the amount spent on R & D but must assess the particulars of the funding. These become critical public policy questions.

Some general guidelines can be established. For example, a good deal of evidence shows that multiple smaller projects have a higher payoff than one or two "big science" projects. Similarly, it is possible to identify several industries/technologies where R & D investment by the government makes the most sense: (1) those essential to long-term economic growth and security; (2) those where investment will speed up their competitive advancement, that is, industries with high rates of change of technology and high barriers to entry or reentry; (3) those where industrial technologies are closely linked (in a "food chain"), so progress in one will rapidly carry over to others, for example, the semiconductor, computer, and telecommunications industries; (4) those areas in which reasonable levels of government investment can truly make a difference (where it would not be swamped by the current levels of alternative investments); and (5) those areas that are vulnerable to the loss of rapid access (the foreign dependency/vulnerability issue). These five key measures (critical, fast-changing, linked, leveraged, and vulnerable) describe areas for government targeting, either through private sector incentives and/or public R & D investments.

Critical R & D investment decisions can be made only by individuals who are technologically literate. Unfortunately, most U.S. industry, government, and labor leaders are technologically illiterate, often with a background in law, finance, or marketing. The decisions are made even more difficult because there are no good models to follow. It is easy to calculate the equations for return on investment once the likely market is defined. It is much harder to know the likely market created by a new-technology R & D investment; and judgments cannot easily be tested in the short term, since these investments are aimed at returns over many years.

Recent conflict-of-interest legislation greatly discourages people from high-technology industrial management positions to enter the government. Yet most senior government officials do not traditionally have a high-technology management background or experience in making high-risk investment decisions. As we will discuss in the next chapter, this lack of experienced government leaders may be a fatal flaw—unless corrected in the near term—in view of the very significant impact that the federal government has on R & D in the United States.

Government Role

The U.S. federal government funds approximately 50 percent of the nation's R & D. In fiscal year 1994, government R & D spending totaled

$75.5 billion, of which 56 percent ($42.5 billion) was for military R & D. There has been a significant rise in nonmilitary R & D in the last few years, and that trend is expected to continue. Overall, the intent of the government investments is threefold: to act as a catalyst in stimulating economic growth through investments in areas such as transportation, energy, and agriculture; to help improve the quality of life through investments in health, safety, and the environment; and to assure national security.

The government should act as a wise investor in areas that have a large public benefit either directly, for example, for national security, or through the stimulation of economic growth. In addition, the government has responsibility for assuring harmonization of both public and private interests and for creating incentives for private investment that are consistent with these.

This government role (in civilian R & D) is not new. In 1836 Congress appropriated $30,000 to Samuel Morse for the experimental telegraph line from Washington, D.C., to Baltimore, Maryland. But most U.S. government investments have been in basic science and defense, whereas many of the nation's economic competitors have emphasized nondefense R & D. As a percent of GNP in 1990, nondefense R & D was: Japan, 3.0 percent, Germany, 2.75 percent, United States, 1.9 percent.[4]

The U.S. government has often treated science and technology as if they were separable entities. In 1945, Vannevar Bush's report to President Truman, *Science: The Endless Frontier,* put in place this country's first federal science policy but assigned the government no role in technology development. At the time, America's industrial technology base was very strong, but its science base was relatively weak. Today, the opposite is true—America's science, basic research, and higher education systems are world leaders; its civilian technology base is faltering.

For nearly forty years after World War II, strategic technology in American was developed mainly in the context of military and space programs. This gave the United States world leadership in integrated circuits, advanced computers, aerospace, lasers, nuclear energy, polymers, and many other fields. Today the world is very different. The emergence of the civilian sector as the precursor of new technology developments (supplanting the military sector); the end of the cold war and the dramatic decline in defense expenditures; and the aggressive investment by foreign competitors in coordinated, public-private sector initiatives for technology development, are all typical of the new environment. As a result, the traditional U.S. approach to supporting strategic technology development and utilization through military and space programs has become less effective than it was in the past.[5]

The need for America to transfer some of its R & D focus from research to technology, and from defense to the civilian sector, is exacerbated by two significant shifts: first, the obvious decline in overall defense expenditures, which is bound to have an impact on defense R & D expenditures over the long term; and second, the increasingly short-term perspective of the private sector, resulting in cutbacks on high-risk, long-term industrial R & D investments in the interest of boosting quarterly financial reports.

Increased R & D investments in commercial and dual-use (civil and military) technologies must take two forms: greater government incentives for industry investments, and far larger direct government investments. The risk in the latter recommendation is that government investments frequently are not sufficiently market-driven. Also, there is a very real possibility—given industry and Wall Street's short-term perspectives—that government money would simply be a replacement for industry money—and thus not a net gain. For both reasons, it is critical that government support for civilian R & D be only in highly selected areas. Lewis Branscomb of Harvard has suggested the following three guidelines for the government's civilian sector investments:

- Support pathbreaking technologies that are long-range and high-risk, but promise to stimulate large new industries;
- Support infrastructural technologies that are public goods; and
- Support nationally vital technologies where they involve significant commitments on the part of the subsidized industry.

Civilian sector R & D investments by the government must be based on industry-led market analyses and indications of areas of long-term high payoff. Their expected value must be explicitly identified prior to making the investment. Where the payoff would be dual, with significant benefits to both U.S. economic growth and to national security, funding could come through either the DoD or the relevant civilian mission agency. In fact, the Departments of Transportation, Energy, Labor, Education, Environment, and Commerce all have significant mission-oriented, long-term, high-risk R & D that needs to be done, much of which would be relevant to defense. For example, there is a $200 billion environmental cleanup program required for the U.S. nuclear weapons plants over the next thirty years. R & D in this area that is focused on reducing costs and/or time could potentially have enormous payoffs.

In view of the potential for government/industry conflict in areas of dual use, it is essential that government-funded civilian R & D have very explicit guidelines. One set that appears credible includes:

- cost sharing between government and industry;
- industry involvement in project initiation and design;
- diversification of investments;
- project selection removed from the political process; and
- a rigorous project evaluation program.

Civilian sector technology investments will also require new institutional structures within government departments. The National Science Foundation historically has done an outstanding job of coordinating long-term science investments, and the Department of Defense has achieved a similar coordination function through its director of Defense Research and Engineering (in the Office of the Secretary of Defense). As the nation begins to emphasize technology investments in transportation, communications, environment, and so on, there will need to be similarly strong R & D organizations within the relevant agencies. Most important is that high-quality people with industrial technology experience be recruited to fill these jobs, and that they are able to receive expert outside opinion to guide them—as the Defense Department has historically done with its Defense Science Board.[6]

A first step toward addressing the institutional questions associated with civilian and dual-use technology investments was taken at the end of the Bush administration. A Federal Coordinating Council for Science, Engineering, and Technology (FCCSET, and pronounced "fix it") was established under the Office of Science and Technology Policy in the White House. Although this is an interagency committee, not an operational organization—and thus does not control either budgets or projects—it

did initiate a series of steps that were carried into the Clinton administration. It was renamed the National Science and Technology Council; elevated to the level of the National Security Council and the National Economic Council; and is now headed by the president.[7] All of its initiatives are to be funded by the relevant agencies, but the council can have a very strong influence on integration and direction. By identifying specific areas and integrating the resources from the separate agencies, the council can provide guidance for private sector long-term investments and can make sure that the nation is getting the maximum benefit from the government's R & D investments.

The six specific areas initially selected (and the level of investment in FY93) were: advanced manufacturing ($1.4 billion); high-performance computing and communications ($1.0 billion); global change research ($1.5 billion); advanced materials and processing ($2.0 billion); biotechnology research ($4.3 billion); and science, math, engineering, and technology education ($2.3 billion). On an annual basis, these are clearly significant funding levels; and the interagency coordination should help to enhance their effectiveness.

Other civilian R & D initiatives that began in the early 1990s included the Advanced Technology Program started by Congress to provide grants for the development of "precompetitive, generic technologies." The National Institute for Standards and Technology (NIST) in the Department of Commerce was designated as the lead agency. Although initial funding was modest, it has been growing rapidly and requires cost sharing by industry. In 1993, Congress created the Technology Reinvestment Program, also a cost sharing effort, but this one was aimed at dual-use R & D and was to be administered through the Advanced Research Projects Agency (ARPA) in the Department of Defense. Its initial funding was $500 million, and it immediately generated enormous interest around the country (almost 3,000 proposals were submitted). It planned a wide range of dual-use areas for stimulation, including technology development for: information, electronics, machine tools and robotics, materials and structures, health care, training, the environment, aeronautics, vehicles, shipbuilding, and advanced batteries.

Another major initiative that got started in the early 1990s was a significant R & D program funded by the Department of Transportation. It included R & D on intelligent vehicle/highway systems, high-speed rail systems, magnetic levitation, and environmentally clean vehicles.

At the beginning of the Clinton administration, the president announced a new U.S. technology policy aimed specifically at economic growth. It had four key elements:

- directly supporting the development, commercialization, and deployment of new technology;
- fiscal and regulatory policies that indirectly promote these activities—from R & D tax credits to dramatic changes in government procurement policy;
- investments in scientific and technical education and training; and,
- support for critical transportation and communication infrastructures.

As shown in table 10.1, there are a wide range of methods available to the government to implement this policy. At one end are incentives that encourage industry, allowing them full responsibility for project selection (tax incentives, university support, and permitting corporate independent research and development (IR & D) as an overhead expense on government contracts). At the other end are government-sponsored R & D projects, funded by project-specific authorizations and appropriations. The most appealing options are those that create incentives for industry to invest in areas with the greatest market return.

The independent research and development (IR & D) program in 1990, along with bid and proposal dollars, had a level of $3.6 billion. This is a fully reimbursed expense under defense contracts and in recent years was changed to encourage its application for dual-use R & D. The contractor selects the areas for investment; and these have often been extremely successful, in many cases leading to products that significantly advanced the state of the art. The debate is over whether government-funded R & D support (direct or indirect) should be based on government decisions or industry decisions. In areas such as defense, the government will claim to know its mission needs better; industry will claim greater technical expertise and will assert that the government should let market forces pick the best technologies. In general, the data appear to favor the industry arguments, especially in the civilian mission areas. Nonetheless, there is a definite catalytic role for the government that must be present to stimulate investment in new high-risk areas.

Table 10.1
Some potential government policy instruments

- Protection of domestic market until producers mature
- Advanced degree support for engineers/scientists
- Exemption from antitrust laws
- Investment funds provided through special mechanisms
- Procurement assistance (and/or guarantees) from government agencies
- Preferential interest rates on loans
- Special incentives to attract foreign firms
- Rebates of indirect taxes
- Raw materials subsidies
- Loans to exporters
- Export targeting
- Export financing programs
- Providing R & D funds
- Technical assistance for smaller firms (from national technology institutes)
- Support for skill upgrading for scientists and engineers
- Selection of technologies of "critical importance"
- Support primarily for precompetitive R & D
- Tax incentives/special privileges for private research institutes
- Setting standards well in advance of current levels
- Incentives for R & D cooperatives for smaller firms
- Joint efforts between government and private R & D labs
- Government labs take on high-risk, large-externality, long-time-horizon R & D
- Tax credits for R & D investment and commercialization of locally developed technology
- Corporate set-asides of profits for R & D in coming years

Consistent with this is the belief that the overwhelming majority of even government-funded R & D should be done in the private sector rather than in government laboratories. The arguments here relate directly to the competitive nature of the private sector marketplace, as well as to the far closer coupling that exists within firms between R & D and the manufacturing and marketing areas. The example here is the difference between the way ARPA does its government-sponsored research within the Department of Defense versus the way it is done in the large government laboratories (either in the defense or energy laboratories). In ARPA, a few government project directors are responsible for the selection and review of areas to be funded and for monitoring how well the contractors are doing in their research. The critical element is the selection of project directors and the freedom they are given in selecting and working with contractors. The execution is 100 percent outside of the government (either in industry or universities). It is usually awarded through "best ideas" competitions, not on proposed costs, and contracts are given to more than one researcher so competition continues to drive the programs and costs are controlled.

This ARPA approach has received universal recognition for its success in funding nontraditional areas and in starting up whole new industries. By contrast, the alternative of setting up a government laboratory (or utilizing an existing one) to research a given area—essentially in competition with industry—has had a far less positive effect and should be discouraged, particularly in any future civilian R & D work to be done by nondefense government agencies. Unfortunately, recent congressional legislation has significantly favored the use of the government laboratories.

Government R & D tax credits to industry would also encourage long-term technology investments. Current tax laws actually penalize an American firm that sells internationally but does its research in the United States.[8] The portion of R & D that is tax deductible is only equal to the U.S. share of a company's worldwide sales. Thus, if a company does all of its research in the United States but registers only half its sales in the domestic market, it can deduct only half of its R & D expenditures. The Treasury Department insists that the balance must be deducted from income earned abroad. Foreign governments, however, refuse to recognize these expenditures for their tax purposes, unless the firm actually conducts the research within their borders. Therefore the American companies must either forgo the U.S. tax deduction or move part of their R & D investments from American universities and labs to other nations. Indeed, many have. The firms most directly affected are the large companies that finance most of America's privately sponsored research. Since they already have international operations, it is relatively easy for them to shift research from the United States to overseas facilities. The consequences of this policy have repeatedly been brought to the attention of Treasury officials, who respond that they need the tax collections to relieve the deficit. Yet this inflexible shortsightedness will inevitably harm the national interest. It gives other nations access to some of America's most advanced technology. It takes funds away from American universities that are training the next generation of scientists and engineers. And it develops state-of-the-art engineers in other countries, instead of in the United States. Certainly, this appears to be a policy worthy of review.

Another policy worth reviewing is the government's role in technology data gathering, such as advanced technology forecasting and international benchmarking. Traditionally, the U.S. intelligence community closely monitored both classified and unclassified trends in military technology around the world, particularly in the former Soviet Union. The data was not applied in the area of economic competition, and in fact was rarely available to those outside of the defense community. By contrast, many other nations (especially France and Japan) believe the government's role should be in civilian technology as much as in military technology. Japan provides technology forecasting data for its industry and university researchers. For example, in September 1988 the Japanese Science and Technology Agency published an impressive report entitled "Future Technology in Japan: Forecast to the Year 2015." Japanese government-furnished data also covers foreign technology and intelligence data. The Japan External Trade Organization (JETRO) is considered "the intelligence arm" of MITI. It was set up in 1957 as a trade promotion group and serves the dual function of lobbying (in the United States and elsewhere) as well as data gathering. JETRO has over 300 government officials working in Japan's embassy and consulates in America and is assisted by 200 Japanese journalists. The data collected is widely shared among Japan's various industrial sectors, with MITI acting as distributor.[9]

Any national industrial or technology policy needs long-term investment financing. The government can back private capital for critical technology areas, or it can supply that capital. Small Business Administration loans, targeted to high technology rather than to the restaurant business—as they now primarily are—would make a great deal of sense. The Small Business Independent Research (SBIR) program, in which a percentage of each government agency's R & D is set aside for small business ventures, is another form of direct financing that would be more effective if targeted to critical technology areas. As noted, when direct government financing is involved in civilian R & D, there should be some industrial cost sharing, assuming the commercial potential warrants it, to prevent the taking of government money from becoming a business unto itself. Still, indirect financial incentives that are market-driven are the preferred route.

A national technology policy is often associated with a trade policy. Clearly, these must be integrated, but an R & D-oriented policy that stimulates competitiveness would be far more effective than a protectionist trade policy. In fact, protectionism is probably one of the least effective stimulation policies. Mike Scherer of Harvard found that when U.S. firms are given protection against high-tech imports, they actually cut back on their R & D investments in the area being protected.[10]

Protectionism is inherently a "beggar thy neighbor" policy. It is a negative-net-sum game, which is very bad public policy. To make it worse, as Raymond Vernon (also of Harvard) has observed, "One key reason for the striking protectionist sentiment in Congress and in the public press is that a coalition of protectionist interests in the United States has succeeded in a strategy that they have pursued persistently over the past thirty-five years. Fundamentally, the strategy has been to ensure that the problems associated with increased international trade are always addressed on a case-by-case basis rather than systematically. That result has been achieved by a succession of statutory measures that have given aggrieved domestic industries increasing power to initiate individual proposals for trade restrictions. As long as such issues arise case by case, the atmosphere surrounding discussions of trade policy is bound to be protectionist, and the costs of imposing import restrictions on the economy at large—costs such as the impact on consumers and the risk of retaliation—are likely to play a secondary role in the decisionmaking process."[11]

In a few selected cases it might make sense to have an infant-industry trade protection policy for a short time. Most of the legislation in this area, however, has been for protecting dying industries and is more political than constructive and has not been based on economic growth initiatives.

What is missing from U.S. government economic policy is the recognition that the primary markets have now shifted from internal domestic competition (where the government was reluctant to get involved lest it favor one firm over another) to an international competition in which U.S. firms are competing with foreign firms (and where the foreign firms have government support). As electronics expert Michael Borrus of the Berkeley Roundtable for the International Economy put it, "There is a growing conviction that competition in high tech, once between companies, is now between countries and their governments."

In recognition of this change, the Congress loosened the antitrust laws and began (with the National Cooperative Research Act of 1984) to allow "consortia to be established by U.S. firms to assist in the critical phase between pure research and production competition between firms"—known as the precompetitive research phase. More than one hundred consortia were formed in the first five years after 1984. By 1989 the legislation was further expanded, and such partnerships were extending their efforts into production, often with the government serving as banker.[12]

Companies participate in consortia when the benefits of the inventions that result could probably not be retained by a single company or when the investment required cannot be justified on a single-firm basis.

A number of initial consortia involved major defense contractors (eleven of them established a Software Productivity Consortium).[13] Politically, consortia appeal to the conservative right by overcoming the complaint that antitrust rules prevent American companies from cooperating on any project. They appeal to calls from the left for better planning—and because they suggest less government control and more coordination of industrial policy.

When should consortia be sponsored by the government? As a general guideline, the National Academy of Engineering recommended[14] that U.S. consortia be established only: (1) in areas where the United States lags behind foreign competitors; (2) for a specific narrow purpose; (3) for a lifetime determined at their formation; and (4) to promote competitive horizontal and cooperative vertical relationships among a company and its suppliers and its customers (there are no internal competitors).

Closely related to the industrial consortia are consortia between government research labs and industry. This initiative was pushed by Congress to help diffuse government research to industry and to help in the conversion of the defense and nuclear weapons labs to civilian R & D. The Stevenson-Wydler Technology Innovation Act of 1980 (Public Law

96-480) for the first time made technology transfer a formal part of the mission of all federal agencies carrying out research and development.[15] Specifically, it states that "it is the continuing responsibility of the federal government to ensure the full use of the results of the nation's federal investment in research and development. To this end the federal government shall strive where appropriate to transfer federally owned or originated technology to state and local governments and to the private sector."[16]

The Federal Technology Transfer Act of 1986 (Public Law 99-502) expanded this policy across agencies by authorizing government-operated laboratories to enter into cooperative research and development agreements (CRDAs) with other agencies, nonprofit organizations, state and local governments, and private industry (extended in 1989 to government-owned, contractor-operated labs as well).[17] Since then, CRDAs have grown like wildflowers.

* One final significant role that the government can play in accelerating new products into the marketplace is through the development of standards. Traditionally, private sector groups, usually made up of representatives from the firms in a given industry, develop either national or international standards via a very slow and poorly funded process, and the standards do not apply to defense-unique products. The government can supply the needed resources to accelerate the process, and it can support and encourage the development of dual-use standards. The Commerce Department's National Institute of Standards and Technology has traditionally played a significant coordination role in the standards area; but there is no reason why the DoD could not also fund some private * sector efforts. Without the existence of such standards, there is a tendency for a great deal of duplicative effort on nonconforming products. The governments of many of America's international economic competitors have helped their industries accelerate their standards developments. The United States needs to get involved on an equal level.

Lewis Branscomb of Harvard has suggested five requirements for an * emerging (international) U.S. technology strategy:

- its benefits should accrue largely to the United States;
- it should avoid conflicts of interest, and the appearance thereof;

- it should expect, and be able to shut off, projects that fail or are no longer useful;
- it should be informed by (even led by) competent advice, particularly from the private sector; and
- it should take into account the global marketplace and answer the question "who is us?"

In addition, it should provide the one thing that has clearly been missing from U.S. technology strategy, namely, any form of rigorous, independent evaluation of past policies. Not knowing when to stop government-sponsored R & D poses a real danger. Once a project gets started, there is a strong tendency to continue it, even though any good research analysis will show that the right thing to do is to start multiple approaches and continue only those that make sense. Politics and institutional biases must not stand in the way of terminating unsuccessful research projects. And there must be no penalty for failure.

Defense Needs

The Department of Defense today has a crying need nor just for technological superiority but for high performance at an affordable price. The addition of this cost requirement dramatically changes the R & D agenda for the department. The DoD still must push the edge of the performance envelope outward, but instead of paying more and more for each new system, it now has to use advanced technology—in new products as well as in manufacturing and support—to dramatically reverse the historic cost-growth curves.

There are two ways that the DoD can achieve this. The first, and by far the more difficult, is by focusing on breakthrough technologies and "nontraditional" approaches. The second is to pursue the traditional weapon systems acquisition route but focus on achieving much lower-cost weapons in the next generation. * *

An increased emphasis on the search for breakthroughs entails a much greater willingness to accept occasional technical failures than America has evidenced in recent years.[18] The idea is to pursue totally nontraditional approaches that can result in orders-of-magnitude improvement in performance but can still do this at significantly lower cost. For example, replacing the bomber with a cruise missile is a different way of doing the same job; by applying new technologies, the result is dramatically lower costs to do the same mission.

The problem of course is that the army, navy, and air force have built-in institutional resistance to such nontraditional approaches. The solution may be to set up totally new organizations. After the Soviet Union launched *Sputnik*—clearly, a nontraditional item up to that point—DoD reacted by establishing ARPA.[19] At the time, Secretary of Defense Neil McElroy stated, "I want an agency that makes sure no important thing remains undone because it doesn't fit somebody's mission." Since that time, ARPA has in fact created many new technologies and many new capabilities that were not likely to have come, and certainly not come as rapidly, out of traditional ways of addressing military problems. The challenge for the DoD is to establish new institutional structures to pursue nontraditional approaches.

In the more traditional R & D arena an "upgraded" approach to weapons design involves the use of "concurrent engineering," where manufacturing and support people are brought into the design process at the preliminary design stage. Four typical examples of the benefits of concurrent engineering (for military and commercial applications) include:[20]

- Boeing's Ballistic Systems Division, which realized 30 percent cost savings and 67 percent inspection ratio reduction;
- McDonnell-Douglas's TAV-8B, which found 68 percent fewer drawing changes and 58 percent scrap reduction;
- Hewlett Packard's Instruments, which had 35 percent less development time and 60 percent lower field failure rates;
- John Deere & Company, which realized 30 percent development cost savings and 60 percent development time reduction.

Since the largest portion of the life-cycle costs of a weapon system are often in the support area, improved quality has a double cost benefit: it reduces support costs dramatically, and it requires the procurement of significantly fewer systems, because more equipment will be working when needed.

As to time savings, although it is generally recognized how important it is to rapidly get a new product into the field in the commercial world, there has been some question of whether this is still an important requirement in the defense arena. It is. For example, during Desert Storm it became clear that the United States badly needed a technique for identifying vehicles on the ground as being either friend or foe. ARPA designed and delivered a brand new identification system in sixteen days (by totally bypassing all of the required DoD procedures). In contrast, the average time for new product realization cycles in defense is over sixteen years—and even under acceleration (crisis) conditions is still measured in years, not days or months.

The DoD not only has to focus on developing rapid new product realization cycles, but also has to plan for ongoing upgrades as newer technology becomes available. This requires initial planning for relatively small quantities of production and for the use of the most advanced manufacturing equipment and management techniques to achieve efficient production in small quantities. It also requires a dramatic shift in the investment resource balance between new product technologies and new process technologies.

Today, the DoD devotes almost all of its $38 billion of annual R & D to generate maximum performance from new product developments, leaving a trivial amount to investigating advanced manufacturing (process) developments—aimed at lowering costs and improving quality. Yet in many products, such as next-generation semiconductors, the product and process changes must go together to achieve state-of-the art performance—and certainly to achieve it at lower costs.

One of the biggest benefits in the manufacturing technology area comes (again) from taking a relatively nontraditional approach. Until recently, the focus in the process area has been on robotics and other forms of machine automation. Although this clearly will remain the focus in the next generation, two additional technologies are becoming very significant. First is that of information technology; second is simulation and modeling. Data systems and electronic networks throughout the factory linked directly into the engineering operation will allow simultaneous computer-assisted design and manufacturing. Essentially, the engineer designs the product on a computer and simultaneously programs the robots that control the production process. The data system then monitors the production results (statistically) and highlights areas that need process or product improvements. In simulation and modeling, the production process itself is modeled in detail and simulated on digital computers. Major changes can easily be tried on the computer and implemented at low risk to yield great benefits in both cost and time. The purpose is not simply to simulate the current production processes, but rather to develop totally new processes as a result of the availability of advanced information technology ("reengineering").

Finally, new accounting systems are being developed for factory operations to measure the cost and time of each activity, including the engineering and management functions. These systems, known as "activities-based costing," or when used as a management tool, "activities-based management," can be used to empirically validate the process simulations, as well as to measure the effectiveness of process improvements as they are introduced. To achieve the dramatic savings that are projected for these various techniques, however, far more research and development—including prototyping—on advanced manufacturing processes are also required. Today funding for such activities is minimal.

When these techniques are applied across a wide variety of products, the United States will become far more competitive in many dual-use areas. For example, the United States is basically out of the commercial shipbuilding industry. Yet because shipbuilding is so important to the U.S. Navy, if some of the new techniques can result in dramatic savings, it is conceivable that the United States could profitably get back into shipbuilding. (Germany currently designs and builds ships in an average of sixteen months; while the United States takes an average of thirty months.)

Apart from reentering an old commercial industry, there are other major advantages to dual-use R & D. The DoD would gain the benefit of the higher quality and lower cost that comes from the greater commercial volume. In addition, it would speed up the development cycle and reduce the cost for defense R & D to design future weapon systems, based on the use of existing commercial components and even subsystems. As noted, when this was done for a secure phone (by the National Security Agency) it cut the development time by a factor of five to one, and the production cost by ten to one.

The traditional front-end emphasis on new product technologies and prototyping has relegated manufacturing considerations to secondary importance, usually put off until production or—at the very earliest—full-

scale weapons development. In the future, process technology should be considered just as critical as product technology.

There will always be a few very expensive investments required for new weapons production on systems that are essential for military needs. For example, the multibillion-dollar development and production of an advanced antiballistic missile system was found to be needed in the Persian Gulf conflict. The problem with these next-generation systems is the incredible cost for both the products themselves as well as the manufacturing equipment on which they are built. The R & D alone for a new aircraft is in the range of \$2–\$4 billion and for a new jet engine or even a new semiconductor facility, over \$1 billion each. On projects of this magnitude, it is essential that the DoD fully utilize every technique for reducing cost and time. Needless to say, many of these new concepts represent a cultural change in the way DoD does business. For example, the apparently simple concept of activities-based costing was tried in the early 1990s by a number of defense firms. The voluntary participation between 1991 and 1993 dropped from eleven active participants to only two,[21] clearly not evidence of strong support. Thus it will take active and continuous leadership for the DoD to implement any new systems for continuous performance improvements with continuous reductions of cost.

To maintain technological leadership in the twenty-first century, it is clear that continuing high levels of defense R & D investments will be required; that these investments should focus on dual-use applicability; and that they should be driven as much by cost considerations as by performance. Finally, one other action that would greatly enhance defense R & D is simply speeding up the procurement process. By using electronic information systems between the government and industry, the award cycle can be cut down from two years to a few weeks or, at worst, a few months. The approach has been demonstrated but not widely applied. In this area as in others, the DoD can capitalize on the true benefits of rapidly changing advanced information technology.

Manufacturing

The manufacturing problems of the U.S. weapons acquisition process deal with figuring out the best way to achieve mass production efficiencies in small quantities. The solution has been referred to as "lean," "agile," or "flexible" manufacturing. It incorporates many of the ideas that have been developing over the last decade, such as "just-in-time inventory," "integrated product and process development," "total quality management," "enterprise integration," and particularly "worker empowerment."

The concept—largely developed by the Japanese—is to strive for a process that allows the customer to tailor each product to his unique desires and yet have the total volume in the factory be high enough so that, through the multiple use of flexible manufacturing equipment and information systems that control the factory, each item can be produced rapidly with high quality and at low cost. The key to success in this process is to drastically reduce setup times on machines (transferring from one product to another), thus allowing efficient operation on much smaller batches of goods. At the same time, the work force in the factory is constantly striving to improve both process and product, an approach that can be tolerated by a flexible manufacturing system that accepts continuous changes and continuous improvements.

Under ideal conditions (always the objective) the system has no failures and virtually no maintenance costs. It is continuously restructured to remove all non-value-added elements, and there is little or no inventory kept around. The parts and material arrive "just in time" to be used in the production process; each item produced has been ordered, for immediate delivery, by a particular customer. The large costs of carrying inventory (including the plant space and warehouses) are largely eliminated. In fact, inventory turnover, which may have been three of four times a year, now is twenty-five to thirty times a year.

In this process, "good enough" is not acceptable. There is a constant quest for "better." You continuously have to try harder just to maintain your share of the market because someone else is trying harder still. Since all workers feel part of the process and are empowered to improve it, there is much higher employee motivation. In addition, workers are rewarded when the whole team does a better job. Obviously, it takes a highly skilled and intelligent work force to operate within a flexible system, so training and education become key elements of this process.

To take advantage of the potential benefits from manufacturing technologies, Japanese world-class firms devote about 64 percent of their total

R & D dollars to these processes; top U.S. firms allocate about 32 percent;[22] the DoD allocates between 1 and 2 percent! Of a defense R & D budget of approximately $38 billion, the only clearly identified process-technology funding is approximately $350 million, for the so-called ManTech program (for a variety of small, manufacturing technology efforts) and the Sematech program (for semiconductor manufacturing technology). Because the Department of Defense historically has had such an extreme focus on the design of new missiles, aircraft, and tanks, it will be extremely difficult to reallocate resources to manufacturing. Nonetheless, this is an essential step.

This resource shift must be complemented by a change in the type of people who are involved in the early design process, specifically bringing in people familiar with manufacturing. The post–cold war DoD shift toward more emphasis on weapons' prototypes and advanced technology demonstrations (rather than large quantities of production or even full-scale development of major weapon systems) in no way changes the need for a manufacturing perspective. It does, however, change the nature of what the prototypes are intended to demonstrate. Now, it is equally important to determine whether a low-cost weapon could be developed, as it was before to focus on a high-performance weapon. This makes prototypes more expensive because engineers will have to consider future production costs while designing them, but it makes the prototypes far more useful. If one wanted to subsequently produce them, they could be manufactured relatively quickly and at much lower cost.

One DoD success story in manufacturing technology was Sematech. Here, the DoD shared R & D investments fifty-fifty with an industry consortia. The objective was to reverse Japan's lead in semiconductor manufacturing equipment. Because the Defense Department believed microelectronics were so critical to future defense needs, and because the DoD was becoming increasingly dependent on Japanese chips for their weapon systems, it decided to make a significant investment in the area. It focused on the manufacturing tools that make the chips, since that was the key limiting factor in advancing the state of the art. It was recognized that defense needs were a trivial portion of the overall semiconductor industry, so for the DoD to be able to buy its chips domestically meant revitalizing the entire domestic commercial semiconductor industry. The only constraint placed on the DoD investment was that firms that took part had to agree to initially use the equipment only in their domestic plants.

The arrangement eventually worked out by the industry itself was that a consortia of twelve semiconductor firms—that became known as Sematech—would put in $100 million per year for five years, and this would be matched by the DoD. Although the Bush administration tried to back out at one point—claiming they did not want to support "industrial policy"—the program was successful in reversing Japan's leadership in the semiconductor equipment field. At the end of the five years, not only did the Clinton administration continue the funding, but it added a commitment by the Department of Energy of around $20 million per year for five years to have the Sandia National Laboratory (DoE) match funds (again fifty-fifty) with Sematech to conduct further research.

The Sematech model has subsequently been used to set up other public/private manufacturing efforts, and it has been suggested for electro-optics, superconductivity, high-definition television, and advanced transport aircraft. But this approach may not be suitable for every sector of the industrial base. Alternatives could include: having industry do the work on its own in an individual plant; having a consortia of industry members or a consortia between industry and government; or having a totally funded effort by the government, either to an individual firm or a consortia; or any one of the above, but including university linkages. What is clear is that there are significant benefits to having the DoD focus on manufacturing technology leadership.

Dual-Use Critical Technologies

Since the beginning of the cold war, the U.S. government, and particularly the DoD, have been deciding which technologies are critical for national security and which are not, as evidenced by their funding choices. The issue now is whether there should be a greater role for the government in helping to stimulate those areas it deems critical to the economy as well. The argument for greater involvement emphasizes the importance of technology leadership to future economic growth and international competitiveness. This means using the R & D dollars that are provided by the DoD and focusing them as much as possible in dual-use areas. It also

means increasing the government's R & D activities in other essential civilian areas such as transportation, education, the environment, and energy.

These resources should come from a redirection of current expenditures. For example, the United States now spends billions of dollars to benefit the real estate and construction industries through tax subsidization; yet neither of these industries has a big export market, nor do they utilize rapidly changing technologies that require such government subsidization. In the same way, the Small Business Administration makes the largest share of its loans to small restaurants, which have an extremely limited export market and certainly are not considered high-technology growth industries. In addition, the United States provides an annual farm subsidy of $91 billion,[23] primarily to large agribusinesses that could do very well without it.

The government must also begin to think of using cost-effective new technologies in solving some of its more traditional problems. For example, in the massive highway construction arena, switching to intelligent vehicle/highway systems (using advanced information technology to make better use of existing highways) instead of traditional "more asphalt" solutions that cost between $1 million and $100 million per mile, depending on whether one is in a rural area or in downtown Los Angeles.

Experts who are asked to list "critical technologies" tend to identify a relatively common set of areas. The lists of the Department of Defense, the Commerce Department, and the Office of Science and Technology Policy have an amazingly high level of overlap. Even comparing these lists with those put out by the Japanese or the Europeans reveals an extremely high overlap. Typical of the items almost universally agreed to are:

- electronics technologies;
- biotechnologies;
- information technologies;
- manufacturing and process technologies;
- advanced materials technologies; and
- software.

These critical areas have a wide spectrum of future markets and are often referred to as "generic." They are critical for both defense needs and commercial competitiveness; many represent areas in which the United States has been losing its leadership position.

As American industry has become more and more short-term (profit) oriented, DoD funds for basic research have become more and more critical for developing the nation's future competitive and security positions. Unfortunately, in the second half of the 1980s, even though its budget remained high, the DoD reduced its basic research allocations by 43 percent.[24] This is something that the nation cannot afford. Fortunately, basic research and applied technology are incredibly inexpensive, compared to the full-scale development, production, and support of weapon systems that DoD has been funding. With savings of tens of billions of dollars anticipated in weapons systems, there are large numbers of prototypes and advanced technology demonstrations, as well as basic research, that can be undertaken while still dramatically reducing the total funding requirements. Equally important, this front-end R & D lends itself to a dual-use focus.

Yet as the budget is cut back, the military services have been tending to focus more and more of their resources on some of the truly defense-unique areas—for example, the air force focusing on stealthy, high-acceleration fighter aircraft or the army on enhanced armored vehicles. Although essential to the long-term missions of the services, these foci cause most of the resources to be expended in a more traditional fashion and do not place the appropriate emphasis on the quantum leaps that are possible when one focuses on the more basic, and generic, technologies listed above. Thus much of the funding for some of this basic and applied technology has been coming from ARPA. These areas should be receiving increased funding from the services as well.

If performed using the ARPA model, defense R & D can be extremely effective. With a $1.5 billion budget, ARPA accounts for only 4 percent of Pentagon research but has produced a rich harvest for U.S. industry (commercial and military). Technologies nurtured by ARPA are now used in robotics, advanced aircraft, artificial intelligence, and supercomputing. ARPA currently funds research in ceramics, advanced memory chips, and parallel-processing computer software[25]—all dual use and critical. ARPA has shown that by operating with a small, highly qualified team and by funding out all of its R & D budget, a great deal can be done with limited funds. World-class computer labs at MIT, Stanford, and Carnegie Mellon were developed with funds from ARPA. As John Gage (of Sun Microsystems) stated, "Everything America has [in advanced computers] came out of a small group of dreamers supported by ARPA."[26]

With the shift in private sector industrial research toward more short-term objectives, ARPA is one of the few places still left that significantly funds long-term research. What is particularly important about the ARPA effort is that it is explicitly geared toward breakthrough technologies. Not aimed at just making a percentage improvement in conventional areas, ARPA goes for nontraditional areas and quantum changes that would totally affect the way things are done, creating completely new industries and new ways of overcoming society's problems—including increased security—if the research is successful.

Essentially, ARPA's strategy is completely consistent with the Schumpeterian notion[27] of "gales of creative destruction"—wherein a new technology or product can make a qualitative difference. This has been the case with stealth, numerically controlled machine tools, and virtual reality. It is these technological breakthroughs that really spur a nation's growth. Without such major qualitative advances, even doubling net investment in plant and equipment only raises the growth rate of real income by less than half a percentage point a year.[28] If this new plant and equipment, however, is devoted to the development of a rapidly expanding, totally new industry—such as portable computers; handheld position locating devices (using navigation satellites); or secure portable communications equipment—devices that create their own new markets and that frequently have application for both commercial and military users—then the impacts of the added plant and equipment investments can be far more dramatic.

The problem in these breakthrough areas is in creating the initial market. In fact, this can be a bigger problem that creating the technology itself. Consumers often do not know quite what to do with the new device or how to use it to take advantage of it, since it never existed before. Often it actually changes the way people do things, so they cannot see its advantage until there has been considerable experience with it. Thus one of the greatest roles that government can play is as an initial purchaser of dual-use products. This is exactly the role that ARPA played in the supercomputer field. By buying the early units and demonstrating their capabilities in a wide variety of fields—from nuclear weapons design through meteorology and oceanography—the world began to buy them, and other firms entered the market as suppliers, thus driving the costs down and improving the performance. Interestingly, although the government is not normally allowed to make guaranteed purchases of items that take more than a year to develop—because that extends beyond its one-year budget constraints—there is an exception made through Title III of the Defense Production Act that allows guaranteed purchases for "defense industrial base reasons." In recent revisions of this act, the Congress has become increasingly lenient in its definition of the industrial base, expanding the interpretation into areas involving dual-use technologies and the general area of "economic security."

Other branches of the federal government could also use the initial-buyer stimulation of new technologies to help move along a critical industry. For example, were the U.S. Post Office to guarantee the purchase of large quantities of electric-powered vehicles for their next-generation mail delivery cars, this could provide a very significant stimulus to the industry. In the same way, a U.S. Army initial purchase of hybrid (conventionally fueled/electric-powered) vehicles could be a stimulant for that technology.

A Technology Strategy

The only way for America to achieve technological leadership in either the military or commercial arenas is to continue to strive to stay ahead. Although perhaps self-evident, this is by no means an easy task. In the first place, it is impossible to do it in every area, so the nation must be selective in which areas it is going to focus. Then in each of the selected critical technologies, it must have some overall integrated effort and make best use of its total resources—both public and private. The clear objective must be to achieve the desired leadership position against extremely competent worldwide competitors, who have every intention of establishing a leadership position themselves. * (1)

From the above discussion, certain key points stand out. The U.S. technology strategy—and associated actions and funding—must have year-to-year consistency. On the other hand, the policy must allow for

flexibility and a good deal of diversity; and, in the most critical areas, multiple options should be pursued. In fact, if the strategy does not build in various forms of competition, it is unlikely to be successful. Competition is not duplicative; it represents a way to both manage risk and achieve rapid results for the lowest possible cost.[29]

Most important, the technology policies must be market-driven— (2) * whether this market be in the defense or the commercial arena, or preferably both.

To achieve the military's needed cost and cycle time objectives, the tech- * (3) nology strategy must achieve a far greater balance between product and process technologies than has been true in the past, with perhaps even an overemphasis on process to counter over forty yeas of exclusive focus on performance. Part of this increased emphasis on process would include the acquisition and dissemination of benchmarking data from abroad. It would also include the creation of incentives for capital investments. Finally, it would shift the overwhelming balance of the government's R & D expenditures to the private sector because of the links between engineering, manufacturing, and markets—links that do not exist in government laboratories.

As with ARPA, the government's investment strategy must focus on *(4) high-risk breakthrough technologies. (Industry is more likely to use its own R & D funds to pursue low-risk incremental improvements in the current technologies.) Breakthroughs can come in either performance or in cost; the latter are becoming increasingly important for both the DoD and the commercial world. Thus a new product that has an order-of-magnitude lower cost is as much a breakthrough as one that has an order-of-magnitude higher performance.

The vast majority of the government-funded efforts should be dual use. *(5) Since new products will be designed using concurrent engineering, early consideration of the production and even the support phases of these systems is a critical portion of the technology strategy and must be explicitly stated.

Another key element of the technology strategy must be the continuous *(6) tracking (benchmarking) of best practices throughout the world. One way of gaining access to new developments is through joint programs with other countries. Another way is through a significant U.S. presence in these countries. Today, Sweden has 17 technology attachés in Detroit and 147 worldwide. The United States has almost none. A sole exception, and yet a very important example case, is the recent establishment of an office by the American Electronics Association in Japan. It receives support from the Commerce Department and gathers technology data for the U.S. electronics industry. Its representative also sits on a number of advisory boards within the Japanese Ministry of International Trade and Industry.

A 1992 Carnegie Commission report noted that "very few talented career foreign service officers have had experience with science or technology, and there are very few science officers abroad." France, Germany, and the United Kingdom have a total of thirty-four experts in science and technology staffing their diplomatic missions in Washington, D.C. By contrast, the State Department has only two foreign service science and technology positions in France, one in Germany, and one in the United Kingdom, for a total of four.[30] Some people argue that it would be hard to disseminate this data to only U.S. firms. In fact, it would be hard to even define what is a U.S. firm. That should be a secondary consideration, however. The data must be broadly disseminated once it has been obtained. The United States should have a diffusion-oriented R & D policy, extending all the way to small and mid-sized manufacturers. This is especially significant, since larger firms usually operate on a worldwide basis and have their own capability to gather benchmark data. It is the smaller and mid-sized firms that need help in gathering that data and understanding it.

* (7)

Ignores EOARD, ONREUR, RDO's, etc.

* (8)

Benchmark data may come not from an identical industry but from other industries in other fields that are using new techniques in a different way. Although each sector has unique characteristics, there is an important lesson in the fusion of multiple disciplines and technologies that may represent the greatest opportunities for rapid advancement in new directions.

Prior to becoming Secretary of Labor in the Clinton administration, Robert Reich proposed six steps to return to technological preeminence:[31]

- scan the globe for new insights (technology absorption);
- integrate government-funded research and development with commercial production (dual use);

- integrate corporate research and development with commercial production (concurrent engineering);
- establish technological standards (benchmarks);
- invest in technological learning; and
- provide a good basic education to all citizens.

Although the above discussion covered the first four of these points in detail, the last two stress the obvious fact that technology policy is critically dependent on a high-skill work force. Thus we now turn to a consideration of America's greatest asset—its work force.