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AMERICAN ELECTRONICS ASSOCIATION

ADVANCED MANUFACTURING TECHNOLOGY INITIATIVE
U.S. ELECTRONICS INDUSTRY PRIORITIES

RECOMMENDATION HIGHLIGHTS

If the U.S. is to become a global leader in manufacturing, U.S. industry must regain its competitive edge in a number of strategic electronic components and manufacturing systems. U.S. electronic industries and technologies will have the greatest impact on U.S. manufacturing industry global leadership, and both government and industry have a role in keeping the U.S. globally competitive in these industries and technologies. It is important, however, that representatives from commercial electronic manufacturing industries drive the selection of specific industries and technologies for government support. The U.S. must develop a continuum of basic research, applied research, and system test beds or consortia to restore a competitive U.S. position in electronics manufacturing. To this end, the AEA offers the following recommendations:

INDUSTRY-LED ADVISORY COMMITTEE The AEA recommends that the Administration create a formal industry-led "Electronics Manufacturing Advisory Committee" to help develop and implement a "National Electronics Manufacturing Initiative," and guide federal manufacturing policies and programs throughout the government. Companies represented on the Committee should include electronic equipment manufacturers, electronic component manufacturers, and electronic manufacturing equipment and materials manufacturers. The Committee should coordinate with the broad-based, industry-led "Advanced Manufacturing Committee," which is authorized by S. 4, the "National Competitiveness Act of 1993," and supported by the AEA, and FCCSET committees and workgroups.

ELECTRONICS INDUSTRY FORUMS The AEA intends to work with other industry, academic and labor organizations to create and sponsor two forums of representatives of industries involved in the manufacture, production, and use of 1) strategic electronic components, and 2) electronics manufacturing systems. The forums will provide guidance and recommendations on industry and government actions to improve U.S. electronics component manufacturing and manufacturing systems competitiveness, including roadmaps for the development and application of critical technologies (see roadmap examples in appendix). The forums also could be chartered as a utilized federal advisory committee for all agencies with programs impacting electronics manufacturing, and act as information resources for, and provide detailed input to, the "Electronics Manufacturing Advisory Committee," the "Advanced Manufacturing Committee," and FCCSET.

NATIONAL ELECTRONICS MANUFACTURING INITIATIVE Because key electronics components, manufacturing equipment and computer integrated manufacturing industries and technologies are of major strategic importance, not only to the U.S. electronics industries but to a range of U.S. manufacturing industries, the AEA recommends that coordinated inter-agency efforts be developed in this area. **The Association urges the Administration to initiate a budget "cross-cut" and national initiative in electronics manufacturing -- focusing on strategic electronic components and electronics manufacturing systems.** The AEA recommends that the current FCCSET Electronics Workgroup should be transformed into an Electronics Committee and should include representatives of all agencies with programs and responsibilities that impact electronics manufacturing competitiveness. The Committee should inventory existing federal efforts and work with industry (especially the AEA Electronics Industry Forums) and the Electronics Manufacturing Advisory Committee to develop the proposed "National Electronics Manufacturing Initiative." **The Initiative should focus on directing federal R&D resources to the development and deployment of strategic components and their related material and equipment technologies, and manufacturing systems technologies. Critical areas are outlined below.**

STRATEGIC ELECTRONIC COMPONENTS **The Electronics Industry Forum should develop roadmaps and recommendations for the following electronic components, for which the AEA urges immediate increased research and technology deployment focus on a national level by industry, government and academia:**

1. Integrated Circuits
2 Printed Wiring Boards (PWB), Multi-Chip Module (MCM) Substrates
3. Liquid Crystal Flat Panel Displays
4. Semiconductor Packaging Technology
5. Printed Wiring Board (PWB), Substrate (MCM) Assembly Technology
6. High Density Batteries

ELECTRONICS MANUFACTURING SYSTEMS Funding must be directed and focused for both basic and applied research in process control, process design, system integration, and automation technology. The National Institute of Standards and Technology, the Advanced Research Projects Agency, the National Science Foundation, and other appropriate agencies and national labs, should cooperate to fund R&D aimed at new advances in manufacturing technologies. **The AEA recommends that R&D be immediately focused in the following pre-competitive, strategic, electronic-manufacturing-process technology areas**:

1. Process Modeling and Knowledge Representation
2. Sensor Development
3. Actuator Technology Development

4. Manufacturing Software
5. Micro-Machining and Nano-Fabrication Techniques
6. Flexible Assembly System Technology

EQUIPMENT DEVELOPMENT It is critical that the above technologies are implemented in commercially available products and in process equipment, packaging equipment, and assembly equipment. **At least 50 percent of electronics manufacturing technology funding should be directed at equipment technology transfer to equipment vendors through agencies such as the National Institute of Standards and Technology, and through industry co-funded consortia that are targeted at electronics manufacturing equipment areas.**

SYSTEM INTEGRATION In order to address the many complex issues associated with developing new manufacturing processes where equipment from many vendors must be seemlessly integrated, **the government should co-fund consortia and teaming efforts to develop pilot facilities or model factories which deploy new manufacturing capabilities.** This funding would help reduce the risk of trying out new manufacturing equipment and processes and would be temporary for any one project. After several years, the model factory would be absorbed by team members.

ADVANCED MANUFACTURING TECHNOLOGY INITIATIVE
U.S. ELECTRONICS INDUSTRY PRIORITIES

Recommendations of the American Electronics Association on the Proposed Advanced Manufacturing Technology Initiative

Introduction

Electronics and electro-mechanical manufacturing, the largest manufacturing employer in the U.S., faces serious challenges. **In the next two decades it will be one of the highest growth industries in the world.** Competition on a global level will force rapid changes in methods and strategies. There will be increasing demands for higher skill levels for industry workers. Unfortunately, the ability of the U.S. to compete in this industry at world cost and quality standards has deteriorated significantly over the last several decades. Listed below is a sample of products that can no longer be competitively manufactured in the U.S.:

Table 1

Products we can't make at world cost in the United States

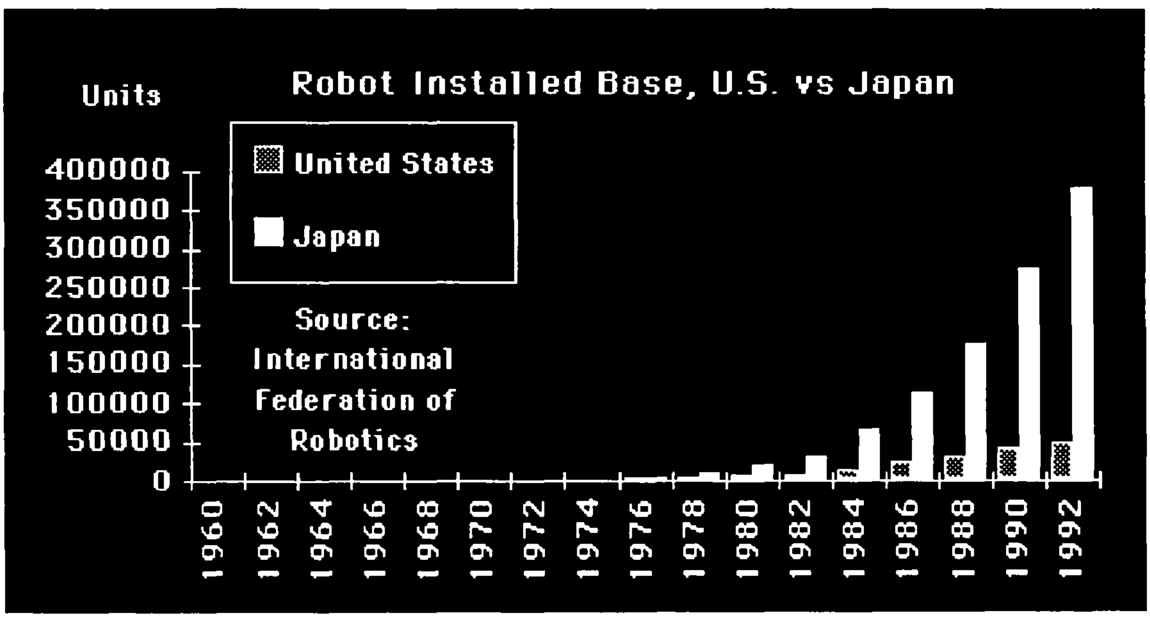
Example Product	U.S. Market ($ billion)
VCRS	10.7
Camcorders	2.8
Portable Audio	2.1
Audio	4.3
Disk Drives	16.0
Total:	$36.0 billion

Common characteristic: Precision electro-mechanical or electro-optical products; require either low-cost, skilled labor or precision automation

For VCRS, camcorders, and audio products, it is estimated that over 95% of the manufacturing is outside the U.S. There is no U.S. company that has the manufacturing knowhow to make a VCR, which contains roughly 2000 parts, and sell it to Sears for less than $100. In the disk drive industry, most manufacturing by U.S. disk drive companies is either done in Singapore by low-cost ($1.50 per hour) labor or subcontracted to Japanese companies such as MKE (which builds disk drives for Quantum, a $2 billion U.S. company). The Japanese cost of labor is similar to that in the U.S. Japan, however, uses precision automation to build all these products at world cost, and is years ahead of the U.S. in the application of automation technology.

The loss of U.S. manufacturing for electronics products has particularly serious implications for the U.S. semiconductor industry. If electronic end-products are all made outside the U.S., our semiconductor companies will continue to see their end-user market shrink. It has been very difficult for the U.S. semiconductor industry to gain market share in Japan.

Paramount to the U.S. regaining manufacturing pre-eminence in electronics, is capturing global leadership in the development and deployment of manufacturing technologies. The U.S. has fallen badly behind our international competitors in adopting new manufacturing technologies. A study by the National Center of Manufacturing Sciences found that, on average, it takes about 55 years for a new manufacturing technology to be fully utilized in the U.S. The average period in Japan is 25 years. This disparity is graphically illustrated by the relative adoption rates in the U.S. and Japan of the industrial robot. The robot is one of several manufacturing technologies that have allowed Japan to control electronics manufacturing. Invented in the U.S. in 1960, the first robot was exported to Japan in 1968.



To restore U.S. manufacturing global competitiveness, the U.S. government, industry and academia must develop a continuum of basic research, applied research, and system test beds and/or consortia programs focused on critical electronics technologies and processes. If these efforts are to succeed, however, it is imperative that they be guided by representatives from the commercial electronic manufacturing industry. Ultimately, the responsibility for making the U.S. a world leader in manufacturing rests with these companies.

This white paper was developed by senior executives from companies representative of the U.S. electronics industry to provide guidance to the Federal Government on the expenditure of R&D funds, as well as the development of a long-term, national Advanced Manufacturing Technology Initiative. The following text identifies the key R&D-related barriers to, and critical components of, U.S. electronics manufacturing competitiveness. Recommendations for government action focus on industry guidance, strategic electronic components, and electronic manufacturing systems. Due to a lack of time and a complete lack of detailed information on current and past Federal activities related to manufacturing, these recommendations are general in nature. The AEA will continue to with work all appropriate industry and government representatives to provide the Federal Government with detailed guidance and recommendations on activities to improve U.S. electronics manufacturing competitiveness, including roadmaps for the development and application of critical technologies.

Background

This document is the second in a series of submissions by the American Electronics Association (AEA) to the Federal Government to assist with the development and implementation of a successful national "Advanced Manufacturing Technology (AMT) Initiative." On February 22, 1993, President Clinton and Vice President Gore released *Technology for America's Economic Growth, A New Direction to Build Economic Strength*, announcing the Administration's intention to focus national efforts towards advanced manufacturing -- the foundation of the American economy. On April, 1993, Dr. John Gibbons, the Director of the Office of Science and Technology Policy, released *FCCSET Initiatives in the FY 1994 Budget*, a report prepared by the Federal Coordinating Council for Science, Engineering, and Technology (FCCSET) describing the Administration's proposed $1.4 billion FY 1994 Advanced Manufacturing Technology (AMT) Initiative. The Initiative builds on a draft proposal developed by the FCCSET and critiqued by the AEA in 1992. In December, 1992, the AEA submitted to the FCCSET, initial recommendations for the AMT Initiative and an assessment of the U.S. electronics industry's manufacturing needs and directions. The Association's 1992 white paper discussed the main elements of electronics manufacturing, the industry's future direction, and recommendations for re-focusing the proposed Initiative.

The AEA applauds the Administration's pledge to work with industry to re-focus federal resources "to accelerate the development and application of advanced manufacturing technologies to dramatically improve the manufacturing capabilities of a broad spectrum of U.S. industries." This white paper is intended to help guide the Federal Government and industry in the development and implementation of a long-term AMT Initiative that will help the U.S. electronics industry regain global manufacturing competitiveness. By working with U.S. companies to advance and apply the critical technologies outlined in this paper, the Federal Government can help the U.S. electronics industry stimulate economic growth, create high-quality jobs, and protect the environment.

This is especially critical, since the U.S. electronics industry is the nation's largest manufacturing employer, accounting for 2.31 million jobs. That is more than the aerospace, automotive and steel industries combined. In addition, the U.S. electronics industry improves the productivity of virtually every other sector -- from government and education to health care and agriculture. Furthermore, the electronics industry accounts for about one-third of total U.S. manufacturing productivity growth, nearly one-third of U.S. industry's R&D spending, and leads U.S. industry's drive to improve the quality of American products and services. In order for the Administration to accomplish its manufacturing goals, the AMT Initiative must succeed in helping improve the manufacturing capabilities of a broad spectrum of the U.S. electronics industry. Outlined in the following pages are the most critical elements for U.S. electronics manufacturing competitiveness, and how government can work with industry to advance these technologies and processes.

INDUSTRY GUIDANCE

Both government and industry have a role in keeping the U.S. globally competitive in manufacturing and fostering critical manufacturing technologies and processes. It is important, however, that representatives from commercial electronic manufacturing industries drive the selection of the specific industries and technologies for government support. In the past decade, U.S. industry, government and academia have organized and funded many programs aimed at improving America's competitive position in worldwide electronics manufacturing. **Unfortunately, with a few exceptions, such as SEMATECH, little substantive output has found its way to the commercial electronics manufacturing industry.** Instead, we have a host of government-funded R&D and demonstration programs in manufacturing processes, systems, and equipment gathering dust in our universities and government contractor labs throughout the U.S. The AEA submits that this failure is do largely to the lack of participation of the commercial segment of the U.S. electronics manufacturing industry in the planning, organization, and implementation of these programs.

INDUSTRY-LED ADVISORY COMMITTEE The AEA recommends that the Administration create a formal industry-led "Electronics Manufacturing Advisory Committee" to help develop and implement a "National Electronics Manufacturing Initiative," and guide federal manufacturing policies and programs throughout the government. Companies represented on the Committee should include electronic equipment manufacturers, electronic component manufacturers, and electronic manufacturing equipment and materials manufacturers. The Committee should coordinate with the broad-based, industry-led "Advanced Manufacturing Committee," which is authorized by S. 4, the "National Competitiveness Act of 1993," and supported by the AEA, and FCCSET committees and workgroups.

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STRATEGIC ELECTRONIC COMPONENTS

Background

A primary requirement for regaining the U.S. competitive position in the electronic manufacturing industry is the establishment of a strong worldwide competitive advantage in certain strategic electronic components.

The movement of the consumer electronic industry to Japan played a major role in the loss of the U.S. electronic component industry. A number of factors are now converging, however, that may help reverse this trend:

- **Factory automation has become computer hardware and software intensive, which plays to U.S. companies' strengths in information processing.**

- **Increased globalization of both the electronic equipment manufacturing industry and market results in a world market for U.S. made electronic components.**

- **The global market share for U.S.-made electronic equipment in the communication and data processing industries is increasing. Some of these products are approaching consumer volumes.**

Now is the time to take the steps to encourage the re-growth of this important industry. **The U.S. must regain its competitive edge in a number of other strategic components and their related material and equipment technologies, if it is to become the world leader in the electronic manufacturing industry.** Of the many electronic components which could be included in this list, six are widely recognized for having the greatest impact on the U.S. electronics industry:

1. Integrated Circuits
2. Printed Wiring Boards (PWB) and Multichip Module (MCM) Substrates
3. Liquid Crystal, Flat Panel Displays
4. Semiconductor Packaging Technology
5. Printed Wiring and Substrate (MCM) Assembly Technology
6. High Density Batteries

These strategic component technologies and industries are integral to the success of the major electronic equipment growth industries including the portable computer, and wireless and telecommunications sectors.

In order to grow, U.S. electronic equipment industries must have access to the key, best-in-class strategic components. In addition, they must be able to participate in the design of the components concurrent with the design of the final products.

Also, the increased portability of both computing and communications products presents a major challenge to strategic components which impact the interconnection and packaging aspects of electronic equipment.

Even more important than the components themselves, is the infrastructure material and equipment technologies required in the manufacture of each strategic component. This is because the further down on the electronic "food chain" a technology resides, the higher its impact on the entire industry. Also, the manufacture of basic electronic component materials and equipment often requires a greater investment of technical and financial resources than the manufacture of the component itself or even the electronic equipment at the top of the food chain. This results in the technological or capital price of entering the strategic electronic material, equipment and component businesses being so high as to exclude many independent entrepreneurs. In addition, the technical and capital investment required for the U. S. to regain its competitive position in each strategic component is so high that it is important for us to select only those areas with the highest impact and potential for success so as not to fragment the investments to a point where a "critical mass" of effort is not achieved on any of the initiatives.

Integrated Circuits

The most obviously strategic electronic component is the semiconductor integrated circuit. The U. S. is making some progress in regaining its competitive advantage in integrated circuits. This is in part due to Federal Government support of both semiconductor and related material and equipment technologies through joint efforts such as Sematech and the Semiconductor Research Corporation.

The Semiconductor Industry Association (SIA) recently developed a series of technology roadmaps that project their needs out to the year 2007 in the areas of: chip test and design; process integration; lithography; interconnect; materials and bulk processes; environmental, safety, and health; manufacturing systems; manufacturing facilities; process/device/structure CAD packaging; and equipment modeling and design.

These competencies will require increased research and implementation focus on a national level by industry, government and academia. The AEA supports the SIA's recommendations that existing resources should be more effectively utilized and focused through, for example, the use of the Semiconductor Research Corporation and Sematech.

In addition to technology availability issues, the issue of manufacturing technology costs also was addressed by the SIA. This is key to the future affordability of technology under development. The major cost drivers are the wafer processing equipment and its ownership, the manufacturing facilities, and the packaging and test operations. Each of these areas are showing costs that are increasing at a rate faster than the increase of the on-chip functionality and performance. The AEA supports the SIA's recommendations that increased research attention be focused on the technologies that underpin these cost drivers. Approaches should include process understanding and control, alternate facilities and equipment approaches, and integration of packaging and test into the wafer design and manufacturing itself.

Printed Wiring Boards (PWB) and Multichip Module (MCM) Substrates

PWB and MCM substrates are components second only to integrated circuits in importance to the U. S. electronic industry. The fact that the U. S. is fast losing its edge in the PWB industry to Japan, Europe and Southeast Asia makes investment of capital and technical resource in this technology critical.

From a technology standpoint, PWB, MCM substrate and other electronic technologies will increase in importance as they become the limiting technology to advances in integrated circuit speed and density.
For the U. S. to regain global leadership in PW Board and MCM substrate technology, America must also lead in the following supporting infrastructure industries and related technologies:

- PWB Product Materials
- PWB Fabrication Materials
- MCM Substrate Materials
- PWB Fabrication Equipment
- PWB Test and Inspection Equipment
- Flex Circuit Materials
- Flex Circuit Equipment

PWB Product Materials: These include low dielectric constant, low loss, low cost, high temperature, low strain light and thin organic materials, such as tetrafunctional and BT epoxies, cyanate esters, polyimide and PTFE for use in laminate manufacturing.

An important new PWB material area is deposited dielectrics capable of lithographically-formed features and vias. These materials will allow for very high density signal line interconnect and high resolution solder resists.

As integrated circuit packages increase in input/output density and direct chip attach approaches (such as TAB on Board and Flip Chip on Board) become more prevalent, companies will need high resolution, low cost materials for pre-application of solder onto PWB. These materials will include improved lead-free solder plating baths and screenable, no clean, pastes for use at a PWB fabrication level.

Although passive elements continue to be integrated into silicon integrated circuits, the need for passive components will remain. Materials which will allow for low cost, high density integration of passive components into the PWB, such as resistors and capacitors, will provide for density and cost demands of future electronic equipment.

PWB Fabrication Materials: Industry will require Improved capability in dry film and liquid photo resists and environmentally 'friendly' etching solutions.

MCM Substrate Materials: MCM's will play a role in achievement of interconnect densities and speed and power performance beyond the PWB capability. Basic material requirements include: low dielectric constant, high power dissipation, and low strain substrate materials. For the most part, these are inorganic materials, like alumina, aluminum nitride and silicon carbide. Organic laminates, however, are also being considered, along with high performance deposited organic and inorganic dielectric materials, like polyimide, BCB, and also composite inorganic and organic materials.

PWB Fabrication Equipment: The PWB equipment industry is another critical technology area in which Japan and Europe have made major in-roads and which the U. S. is in danger of losing. The most strategic of this equipment includes:

- Large Area Precision Lithography Systems with capability down to 50µ
- Precision Drilling Systems with 100µ to 250µ, low cost locating and drilling capability
- Automatic Inspection Equipment
- Precision Test Equipment (Flying Probe)
- Large Area Reactive Ion Etching Equipment

Flex Circuit Materials and Equipment: Flex circuits are seeing increasing application in high volume, low cost, low profile consumer products, like electronic watches and thin module cards. The application will require low cost, high electrical performance film materials with improvements over the current polyimide and mylar materials. These films will be processed on high volume reel to reel lithographic systems.

Flat Panel Displays

Electronic flat panel displays are fast emerging as the primary human interface of future electronic equipment. Of the numerous flat panel approaches, liquid crystal displays (LCDs), both active and passive matrix, currently dominate the commercial market. This market has challenging requirements for size, resolution, speed, color content and low cost, placed on it by modern, high function, portable equipment.

As with of our other strategic components, the LCD technology was invented in the U.S. but commercialization (volume manufacturing), especially of active matrix displays, has taken place primarily in Japan. One of the reasons for this is the similarity in process, materials and equipment technology between the

LCD and the semiconductor wafer fab technology in which the Japanese also have excelled.

Another aspect of this strategic component which must be considered is that as products become more portable and smaller, the display becomes a greater physical portion of the product. This places major demands on interconnection and packaging integration with the LCD, and will result in improved integrated circuit-to-display assembly technology, such as chip on glass.

Also, as with other strategic components, product and fabrication material and equipment will play an important role in the success of this important industry. Fortunately, the LCD process technology is related to both wafer fabrication and printed circuit board process technologies, so that in some cases the infrastructure technologies supporting those industries could be extended to support the LCD industry.

LCD Product Materials: The most critical of the LCD materials are the liquid crystal backfill materials currently consisting of super twisted nematic, and more recent ferroelectric, crystal materials. Structural materials include glass, and research is underway on the use of plastic LCDs. Thin film transistor materials are primarily inorganic sputtered and chemically vapor deposited metals, metal oxides and semiconducting materials. For color LCDs, organic color filter materials are important.

LCD Fabrication Materials: These are also similar to semiconductor process materials but with an emphasis on much larger area (10" X 12") and somewhat larger feature (5 μ) defect reduction. These will include large area, low defect photo resists and low environmental impact cleaning and etching materials.

LCD Equipment: As mentioned earlier, much of the equipment is a hybrid between semiconductor wafer fab equipment and high performance printed circuit board equipment. The two most critical LCD equipment areas, with the greatest impact on solution of the current industry yield problems are the large area lithography systems and chemical vapor deposition systems. The lithography systems are still dominated by the Japanese wafer fabrication equipment companies that are producing scanning, reflective lens, large area lithographic systems capable of down to 1μ resolution over 10" X 20" areas. The U. S. still retains "best-in-class" manufacturing of CVD and sputtering systems, but the customers are primarily Japanese companies.

Semiconductor Packaging Technology

Semiconductor device performance, as it relates to product speed, size and function, is quickly becoming limited by semiconductor packaging

technologies. An even more important trend taking place in the industry is the integration of semiconductor packaging with technologies on both sides of the "electronic food chain". TAB and Flip Chip bumping, as well as improved die passivation at the wafer level, will perform much of the current packaging function. At the higher end, are multichip modules and board level direct chip attach, including wire bonded chip on board, tab on board and flip chip on board, which accomplish a great deal of the semiconductor packaging function. Also, electronic displays are integrating more of the semiconductor packaging function with chip on glass technology.

Semiconductor Packaging Materials: Important semiconductor packaging material areas include wafer bumping and passivation materials, such as high purity, no lead solder bumping, vacuum deposition sources, plating baths and gold plating baths. Other wafer passivation materials, include organic, such as polyimide and BCB, and inorganic, such as quartz, deposited quartz, silicon nitride and various doped glasses. Plastic quad flat pacs will continue to be the dominant packaging type for the foreseeable future. Materials to support this packaging include low stress, high purity molding compounds and fine pitch low cost lead frame materials. PQFP advances also will require improved die bonding and die passivation materials. In addition, thermo plastic fast cure die bond materials will be required for modern short cycle manufacturing, while the lead die bond alloys for high power semiconductor devices will no longer be needed.

A third class of packages - ceramic and plastic land (ball) grid arrays are also being used for high I/O applications. This package will require unique materials including high purity lead-free solder spheres, as well as high purity, low stress molding compounds and liquid encapsulants.

Semiconductor Packaging Equipment: The center of gravity of semiconductor packaging equipment also has moved to Japan, including wire and die bond equipment, as well as tab and flip chip equipment.

Future die bond equipment requirements include higher speed, and accommodation of fast cure bonding materials. Chip on board die bonders also will be increasingly used by industry.

Wire bond equipment has seen major advances in speed and bond pitch. These will increase to speeds of a few tenths of a second/bond and high yield bond pitch capabilities of less the 50μ.

Japanese advances in the TAB inner lead bond equipment includes higher yields achieved through improved alignment and pressure control. Work has taken place in laser ILB, but there is no wide spread use at this point.

Outer lead bond equipment has had problems in yield and bond cycle time. Outer lead bonding will merge with fine pitch QFP package bonding, where a major equipment effort is taking place at PWB assembly equipment manufacturers.

Semiconductor Test Handling Equipment: The move toward direct chip attach at the MCM, PWB and FPD levels will place major demands on wafer and chip level test and burn-in (known as good die). Equipment required for this includes array test probe equipment capable of high speed electrical measurement, and equipment for wafer level burn-in.

PWB and MCM Assembly Technology

Perhaps no electronic manufacturing technology has undergone as much technical change as PWB assembly. The move from mostly manual/automatic through hole board assembly to fully automatic surface mount assembly has caused major shifts in the electronic industry.

Forced automation has resulted in significant productivity improvements, as well as significant increases in capital and technology cost of entry into the business. The latter has spawned an entire contract assembly industry. The next major shift will be a move toward unpackaged integrated circuit chip assembly onto both the final mother boards or onto multichip modules.

The continuing move toward finer pitch and smaller surface mount components, combined with environmental regulations and the move to direct chip attach will define future process, material and equipment requirements for PWB and MCM assembly technology.

PWB/MCM Assembly Material: Materials for future surface mount and direct chip attach shifts will include:

- High Resolution, No Clean, Lead-Free Solder Pastes
- Ozone Depletion Substance Free Cleaning Materials
- High Conductivity, High Resolution, Isotropic and Anisotropic Conducting Organic Adhesives, such as Conductive Epoxies.
- Low Stress, Low Ionic, Direct Chip Attach Encapsulants

PWB/MCM Assembly Equipment: The chip placement machine has been pivotal in advancing the shift to surface mount technology in the worldwide electronic industry. This machine evolved from U. S.-developed automatic PC through hole insertion machines. Japanese electronic firms improved the technology and eventually took over the through hole insertion machine industry. They then evolved into the chip placement machine industry, which

Japan now dominates. Fortunately for the U. S. electronic industry, the Japanese "chip shooter" equipment manufacturers are anxious to sell their equipment worldwide.

A second area of important assembly equipment technology is the flexible robotic cells used to place active and other non-R&C chip components. As this technology advances, the requirement for this equipment to place finer pitch QFP and flip chip direct attach will be crucial.

As the component pitch and components themselves continue to decrease in size and as defect levels, and new package introduction cycle time decrease, in-line automated laser and X-ray inspection equipment will become even more prevalent.

The requirement for improved process control also will result in adaptive controlled, improved ambient control reflow furnaces. Improved solder paste printing systems will evolve into solder jet printing systems.

High Density Battery Cell Technology

The current major limitation to the move to portability of future electronic equipment is battery cell technology. Although major advances are being made in reduced power consumption through semiconductor and circuit design advances, a great deal of opportunity still exists for the U. S. to make power density and environmental improvements in battery cell technology. This industry segment also is dominated by the Japanese. This is predominately a material technology with the following areas now receiving the most attention:

- Nickel Metal Hydride
- Rechargeable Lithium - Solid State Polymers, Ceramic Glass Electrolytes
- Pseudo Capacitor
- Miniature Fuel Cells
- Redox Couples
- Metal Air Systems

Recommendations

Electronics Initiative Because strategic electronic component manufacturing and technologies are of major critical importance -- economically and militarily -- the AEA recommends that a coordinated inter-agency effort be developed in this area. Strategic electronic components are vital dual-use technologies that should also receive focus under the Administration's defense conversion initiatives. T**he Association urges the Administration to initiate a budget "cross-cut" and Federal initiative in electronics manufacturing, which includes a focus on strategic electronic components and their related material and equipment**

technologies.

To assist with the Initiative, the U.S. electronics industry will create a Forum on Strategic Components, which is expected to create sub-groups for each strategic components area:

1. **Integrated Circuits**
2. **Printed Wiring Boards (PWB) and Multichip Module (MCM) Substrates**
3. **Liquid Crystal, Flat Panel Displays**
4. **Semiconductor Packaging Technology**
5. **Printed Wiring and Substrate (MCM) Assembly Technology**
6. **High Density Batteries**

The Forum will provide the Federal Government with needed information and recommendations on:

1. **Specific strategic component industries whose growth is crucial to the rebirth of the U.S. electronic industry.**
2. **Roadmaps on strategic component technologies required by each of those industries (see examples in appendix).**
3. **Specific electronic materials industries and technologies required to support the selected strategic component industries.**
4. **Specific electronic manufacturing equipment and computer integration industries and technologies required to support the selected strategic component industries.**

A FCCSET Electronics Committee should be formed, which includes representatives of all agencies with programs and responsibilities that impact electronics manufacturing competitiveness. The Committee should inventory existing federal efforts and work with the Electronics Industry Forums and the Electronics Manufacturing Advisory Committee to develop the proposed Initiative. **The Initiative should focus on directing federal R&D resources to the development of strategic electronic components technologies as outlined above.**

ELECTRONICS MANUFACTURING SYSTEMS

Trends

In addition to the semiconductor packaging equipment described earlier, process equipment needs for the electronics industry also include advanced

material handling and flexible assembly cells (intelligent work cells). The U.S. is lagging far behind Japan in the adoption of flexible manufacturing technology. Further, the U.S. does not have the capability to build entire classes of electronic products at competitive world costs. Table 1 lists $36 billion worth of products that are built either in Japan with precision automation or in south-east Asia with low-cost skilled labor. If the U.S. wants to retain electronics factories we must dramatically increase our understanding and use of flexible automation. There is almost no U.S. applied research funding in this area. In addition, there are very few training facilities available to industry in the U.S., and we have a very poorly trained manufacturing engineering infrastructure relative to Japan and Germany. Furthermore, there are no financial incentives to encourage the adoption of this technology. U.S. Government and industry must address each of these areas or the U.S. will fall further behind our international competitors. Both Singapore and Taiwan, for example, have announced national programs to provide training in the use of robots. Funding in each of these small countries is approximately $200 million over a three year period.

The U.S. needs to develop flexible assembly lines that can be set up and in production in a few weeks instead of the 12-18 months typical today. One key technology to enable this to occur is the development of flexible part feeding systems that can feed generic classes of parts. Part feeders in use today typically are customized for each part shape -- either in the form of nests machined into pallets, or vibratory bowl feeders which use a series of mechanical "filters" to orient parts. These mechanical filters must be designed and adjusted for each part and are unique to that part. As a result, even assembly lines using reprogrammable robots are not very flexible if they incorporate part-specific feeders. To change over the line, the feeders must be removed, and new feeders designed and installed. This lack of flexibility is a tremendous impediment to the adoption of assembly automation, especially in industries such as the electronics industry where product lives have contracted to as little as one year. Part feeders typically represent between 30 percent and 50 percent of the cost of installing an automated assembly line. Hard-tooled feeders must be discarded or re-tooled to change over the line. A second important technology in assembly automation is simulation technology that can model system configuration and throughput, as well as provide the information necessary to program the assembly system. This technology is within our grasp if we choose to apply resources to its development, and offers the opportunity to provide design engineers an accurate model of the assembly process as well as a means to dramatically compress the time to design an assembly system.

Other important technologies include communication standards for sensors and controllers, and object-oriented application software for assembly and

material handling that can be used by non-programmers.

Common to both packaging equipment and flexible assembly equipment are several technological trends which are listed below:

Increasing miniaturization: Most electronic component packaging is now at a state of miniaturization where it can no longer be done by people. This is also becoming increasingly true for integrated-system products, such as 1.5 in disk drives, portable audio products, camcorders, etc. Japan leads the world in miniaturization technology and processes.

Increased use of advanced sensors: Today's surface mount circuit boards cannot be assembled without the use of machine vision. Both laser-based sensors and X-rays are now being used for on-line process control applications. Most advanced sensors have been developed in the U.S. Japan has been buying machine vision from U.S. vendors, but is now developing domestic machine vision capability.

Increased speed: High-volume component placement rates are now at 15,000 chips per hour, three times faster than ten years ago. Even lower volume, highly flexible lines using robots have tripled their speeds over the last ten years. Japan leads the world in high-volume assembly equipment.

Increased flexibility: Both packaging equipment and final system assembly lines can be changed over in just a few minutes to make a different (albeit similar) product. Japan leads the world in the use of robots, although advanced robot technology is available in both the U.S. and Europe.

Automatic programming: Circuit board assembly machines are now driven directly from CAD data bases. This trend will extend to process machinery and final system assembly machinery in the future. The U.S. is ahead in this area.

Environmental constraints: Eliminating ozone-depleting chemicals from soldering and other processes is requiring major investments by certain equipment manufacturers. The ability to provide essentially zero-particle environments for semiconductor fabrication will determine what countries will make the circuits with the highest densities. The U.S. and Europe are leading in environmental legislation which is driving their equipment suppliers. Japan has the lead in developing equipment to work in very-low particle environments, including actuators, bearings, and robots for high-vacuum applications.

Improved yield and quality: Japan has been instrumental in setting new world standards for yield and quality. Failure rates of 1 part per million are now standard in several industries. Automation combined with statistical process control has been a key factor in achieving these low defect rates.

Japan leads the U.S. in almost every one of these areas, except the development of advanced sensors and automatic programming. If the U.S. is to regain a competitive manufacturing infrastructure we must fund applied research to strengthen these areas.

Technology Needs

Process Modeling: **Process control and process design technology will play a major role in the future of electronics manufacturing worldwide.** Both basic and applied research are needed in process modeling; while we have static geometric modeling systems developed as design tools, we do not have modeling systems which can easily represent geometric and chemical changes and the associated physical laws of transformation. Process modeling systems should be able to incorporate process knowledge, be updated by sensor input, and be fast enough to be used in real-time process control loops. Future controllers will be "smart" controllers with built-in process knowledge. Process models may also be used in simulations which make process capabilities available to product designers; designers can work with a "virtual factory" on their terminals to verify the produceability of designs prior to production. This capability is critical in continuing to reduce product design cycles.

Sensors: **To date, process control systems have made limited use of sensor technology.** Sensors have tended to be simple and low-bandwidth such as temperature and pressure sensors. Process control is often done at the end of a line, through inspection. Current and future process controllers will make increasing use of high-bandwidth sensors such as machine vision, laser range scanners, and possibly techniques such as x-ray imaging to determine non-surface material properties. Experimenting with advanced sensing techniques for process control is beyond the scope of most process equipment companies and may be appropriate for public funding or consortia.

Machine-control software: **Advanced manufacturing software for machine control will be a crucial competitive technology.** Japan has proposed a program called the Intelligent Manufacturing System to develop advanced manufacturing software. Many useful products have already been developed by U.S. companies. For example, in the U.S. robotics industry software is available which incorporates machine vision, motion control, force control, process control, real-time database management, and object-oriented application packages with icon interfaces. However, many useful manufacturing software packages are not widely understood or widely applied. Commercially-available manufacturing software technology could be benchmarked by national labs or consortia for use in related equipment in the electronics industry. While we have institutions which benchmark manufacturing hardware such as machine tools and lasers, we have few methods to evaluate and publicize manufacturing software. As a result, rather than a few standard programs gaining wide acceptance, almost every manufacturing equipment company writes its software from scratch. With no standards, there is little portability, and due to the small customer base of most packages, less reliability than with high volume programs. At the moment, the national labs are a detriment to this process as they tend to also create their own software packages which are not commercial products and are not supported (e.g. NIST, Sandia, and JPL have all created their own robot programming languages).

Actuators: **The U.S. has lost tremendous ground to Japan and Germany in the area of precision motion control. Most U.S. equipment companies buy precision ball screws, actuators and position sensors from Japan.** New developments are typically available two years earlier in Japan than in the U.S. This gives Japanese equipment developers a built-in advantage over U.S. companies. In the U.S. we appear to have a preoccupation with developing computer and software technology to the exclusion of advanced mechanical technologies. We have under-funded both basic and applied research in commercially useful motion actuators and sensors.

Micro-machines: An emerging technology that will have a significant impact on electronics in the future is the area of micromachining -- the fabrication of miniature components having microscopic features. This technology is now being referred to as High-Aspect-Ratio Micro-Electro-Magnetic-Mechanical-Systems. **The idea is to build sensors, actuators, and even machines from microscopic components using techniques similar to those used for semiconductor fabrication.** One commercial product, a micro-accelerometer, has already been developed for use as an air-bag crash detection sensor. Fabrication processes for these devices can be enabling technologies for next generation manufacturing. Commercialization of one of these technologies, a lithographic technique known as LIGA, is underway in Germany. Japan's MITI has identified these technologies as critical for R&D and future business, and has organized a Micromachine Center in Tokyo to conduct a ten year program of over $100 million of focused research in this area. In contrast, the U.S. has a few small projects. A coordinated effort is needed to develop these technologies in a timely manner to support R&D nationwide and to build a basis for commercialization. This coordinated effort should be based on industry pull and government push.

System Integration Technology: **The largest impediment to deploying advanced manufacturing technologies and equipment in the U.S. has been the lack of opportunities to test the integration of this equipment in production**

lines. No single vendor can supply the full range of equipment needed for modern factories. No single vendor can afford to build pilot factories to test the integration of his equipment with that of other vendors. As a result, end users are often faced with the decision to perform very expensive integration experiments in developing new factories. The risk associated with system integration and the lack of trained automation engineers in the U.S. is limiting the adoption of advanced manufacturing equipment in the U.S. Integrating diverse pieces of equipment from multiple vendors into a smoothly operating system is difficult, risky, and time-consuming. Unlike Japan, where companies tend to maintain large production engineering groups, most U.S. companies do not have internal capability to design and install complex production systems. Most automation systems are contracted out to external "system integration companies." These companies are often small and thinly capitalized, and it is difficult for them to raise working capital. They typically must purchase the automation equipment, perform the integration, and wait until the end user accepts the line before they get paid. One unhappy customer who refuses to pay can put them out of business, and this frequently happens. The current trend towards "concurrent engineering" has meant that production system design is often started before the product design is completed. This results in a continuing stream of production system specification changes while the system is being designed. This trend exacerbates the risk and cost of system integration. U.S. industry needs ways to reduce the risk of developing CIM systems and new manufacturing processes, and technologies to lower the risk of integrating automation lines. These technologies include the ability to simulate complex lines, sensor and actuator communication standards, better design rules for manufacturability, and better ways for production system designers to share information with product designers.

<u>Technology Transfer:</u> A significant gap exists in getting basic research from our universities and applied research from our national labs into commercial products. Most of the U.S. companies making equipment for electronics manufacturing are small businesses. These companies often cannot afford to send employees to universities or national labs for extended periods of time to absorb new technology.

Recommendations

<u>National Electronics Initiative</u> We need to develop a continuum of basic research, applied research, and system test beds or consortia to restore a competitive U.S. position in electronics manufacturing systems. We must direct and focus funding for both basic and applied research in process control, process design, system integration, and automation technology. **The AEA urges the Administration to initiate a budget "cross-cut" and Federal initiative in electronics manufacturing, which includes a focus on electronics**

manufacturing systems.

To assist with the Initiative, the U.S. electronics industry will create a Forum on Electronics Manufacturing Systems to help guide these efforts. The Forum is expected to form sub-groups for each of the technology areas outlined below.

The National Institute of Standards and Technology, the Advanced Research Projects Agency, the National Science Foundation, and other appropriate agencies and national labs, should cooperate to fund R&D aimed at new advances in manufacturing technologies. **The AEA recommends that R&D be immediately focused in the following pre-competitive, strategic, electronic-manufacturing-process technology areas:**

Process modeling and knowledge representation: modeling physical and chemical transformations over time, and the process parameters controlling these transformations; using process knowledge in real-time control systems; and simulation of manufacturing processes and systems.

Sensor development: various imaging approaches, including machine vision (2D and 3D), laser and X-ray imaging; thermal imaging; position and velocity sensors for actuators, especially high-resolution sensors with absolute position information; nano sensors; and vision-based flexible part feeders.

Actuator technology development: high-speed zero backlash actuators; miniature actuators; high-resolution actuators; high power-to-weight-ratio actuators; advanced speed reducers with long life and zero backlash; smart actuators with built-in sensing and power control; and lightweight magnetic materials.

Manufacturing software: open architectures, standards, and test beds for manufacturing software; communication standards for factory networks and distributed control; and automatic manufacturing process programming from product CAD data bases.

Micro-machining and nano-fabrication techniques: micro-actuators; micro-sensors; micro-power systems such as batteries, and micro-controllers; and application development for micro-machines.

Flexible assembly system technology: flexible part feeding technology; assembly system simulation; design rules for assembly; assembly process modeling; assembly systems driven from design data bases; error representation, detection and recovery; design rules for dissassembly and recycling; dissassembly systems; low-cost assembly systems; and rapid set-up and changeover systems.

Equipment Development
It is critical that the above technologies are implemented in commercially available products and in process equipment, packaging equipment, and assembly equipment. At least 50 percent of electronics manufacturing technology funding should be directed at equipment technology transfer to equipment vendors through agencies such as the National Institute of Standards and Technology, and through industry co-funded consortia that are targeted at electronics manufacturing equipment areas.

System Integration
In order to address the many complex issues associated with developing new manufacturing processes where equipment from many vendors must be seemlessly integrated, **the government should co-fund consortia and teaming efforts to develop pilot facilities or model factories which deploy new manufacturing capabilities.** This funding would help reduce the risk of trying out new manufacturing equipment and processes and would be temporary for any one project. After several years, the model factory should be absorbed by team members.

ADDITIONAL ACTIVITIES

In addition to coordinating and focusing Federal R&D on strategic electronic components and manufacturing systems, government activities in procurement, education and training, technology dissemination, and benchmarking and information gathering also should be directed towards advancing U.S. manufacturing competitiveness.

The U. S. electronics industry cannot be self-sustaining unless it can make a profit in the domestic market. To improve the worldwide competitive position of the U.S. electronics industry, major national, state, and local projects must rely on electronics products manufactured by U.S. companies. Government agencies can significantly boost the U.S. electronics industry by promoting the use of electronics devices and systems made by U.S. companies into ongoing and future infrastructure projects in areas like communications, energy, transportation, education and health care. If planned to satisfy a real public need, such projects can help with the strengthening and resurgence of U.S. manufacturing.

A highly-skilled workforce is a cornerstone of a competitive manufacturing industry. Broadly speaking, in order to create the highly skilled workforce America needs to be competitive in manufacturing, five key areas need attention:

* developing national K-12 education standards that clearly reflect the skill

requirements of employers operating in the Technology and Information Age;

* strengthening the transition from school to work, especially for the 70 percent or more of high school students that will not complete baccalaureate degrees;
* strengthening the incentives and opportunities for employers of all sizes to invest in quality workforce training, and creating cost-effective ways for employers to provide -- and the current workforce to use -- remedial training;
* study and dissemination of manufacturing industry "work re-engineering best practices" from product design to distribution; and
* continued government cooperation with and support for electronics industry efforts to develop "voluntary worker standards" which will identify and disseminate workforce skill requirements to current and future workers, workforce trainers, and K-12 educators.

Also important to the success of the Advanced Manufacturing Technology Initiative and Electronics Manufacturing Initiative is the effectiveness of government's deployment and application efforts. The Initiatives should emphasize the need to focus on improving U.S. industry's competitiveness in manufacturing leading edge technologies rather than simply creating more leading edge technologies for our international competitors to copy and commercialize. With this mind, the AEA supports the expansion of Federal deployment and application programs, especially the Manufacturing Extension Partnership Program at NIST.

An additional element to advancing U.S. global manufacturing leadership is effective benchmarking and information gathering. It is difficult for the U.S. electronics industry to evaluate its worldwide competitive status without authoritative and timely data. The AEA urges the Federal Government to undertake a comprehensive annual review of the health and international competitive position of each sector of the U.S. electronics industry. The analysis should also include assessment of the U.S. strength in the critical technologies identified by industry and government. In addition, the AEA supports greater government involvement in technology and product monitoring. U.S. companies have great difficulty obtaining timely information to make decisions more quickly than our foreign competitors. It would be helpful for companies to have access to a wide variety of information and analysis of foreign R&D activities and technical capabilities.

The AEA's member company executives look forward to discussing this white paper in detail with the members of the Administration, the FCCSET Manufacturing Subcommittee and Electronics Working Group, Congress and other industry sectors. The AEA is eager to work with the Administration, Congress and other industries to develop and implement a long-term national Advanced Manufacturing Technology Initiative and Electronics Manufacturing Initiative that will help U.S industry increase economic growth and create jobs.

Appendix I

DETAILED POTENTIAL SOLUTIONS	1992	1995	1998	2001	2004	2007
Line width / Hole Dia. (µm)	150 / 300	125 / 175	100 / 125	50 / 75	25 / 50	
Mfg. Cost ($ / cm.^{2} / Layer)	$.020/cm^2	$.020/cm^2	$.020/cm^2	$.020/cm^2	$.020/cm^2	
(Def./10^6 lin. in.)	40	35	25	15	5	
Frequency (Ghz.)	0.25	0.50	1.0	2.5	5.0	

Product Materials	Multifunctional & BT Epoxies, PI, Cyanate Esters, Aramides, LCP's, Controlled TCE, Fluoropolymer, high K Composites
	High performance glass reinforced Laminates
	Polymer films/unreinforced Laminates
	Deposited Dielectrics
Process Materials	Advanced Dry Film and Liquid Photoresists, Electrophoretic Resist
	Environmentally Conscious Chemistries
Fabrication Equip.	Large Area Lithography Systems-25µ Resolution Over 500 mm
	Precision Drilling Systems - 125µ Hole Diameter, Dry Metal Deposition
	Large Area Dry Via Processing Equipment
	High Resolution, High Volume Automatic Inspection Equipment
	Automated Panel Probe Test Equipment, Fine Pitch Flying Head Test Equipment

AEA STRATEGIC COMPONENT ROADMAP P.W. BOARDS (commercial)

DETAILED POTENTIAL SOLUTIONS	1992–1995	1995–1998	1998–2001	2001–2004	2004–2007
POWER DENSITY (WH / In^3)	2.0	3.5	5.0	9.0	> 10.0
ENERGY DENSITY (WH / Lb.)	25	50	90	200	> 220
COST ($ / WH)	0.85	0.50	0.25	0.10	< 0.10
USEFUL LIFE (Cycles)	750	750	3000	> 3000	>3000
FAILURE RATE (% Capacity loss / yr.)		80	15	5	5

DRAFT COPY

PRODUCT MATERIALS

- Nickel Powder, Cd. Hydroxide
- Lithium metal / salt
- Ceramic Oxides
- Carbon
- Conductive polymers
- Organic Fuels

FABRICATION EQUIPMENT

- High speed winding and crimping eq
- Laminating equipment
- Thin film deposition equipment
- Specialized chemical processing equipment

AEA STRATEGIC COMPONENT ROADMAP -HIGH DENSITY BATTERY CELLS

Electronic Equipment Assembly

Computer equipment , Communications equipment , Aerospace and defense equipment , Industrial equipment

↑

Printed Wiring Board Assembly

Surface mount assembly,Unpackaged chip assembly

↑

Strategic Component Assembly and Packaging

Integrated Circuit. assembly & packaging, Multichip Module assembly & packaging, Liquid Crystal Display Module assembly and packaging, Battery assembly and packaging.

↑

Strategic Component Fabrication

Integrated circuit wafer fabrication, Printed wiring board / Multi chip module substrate fabrication, Liquid Crystal Display fabrication, Battery cell fabrication

↑

Strategic Material Manufacturing

Semiconductor wafer and dielectric material, Printed wiring board laminate materials, Multi Chip Module substrate and dielectric materials, Battery cell electrode materials, cleaning, etching and lithography materials

AEA ELECTRONIC MANUFACTURING FOOD CHAIN

Generic Electronic Manufacturing Systems

- Actuator (Robotics)
- Micro-machining
- Process sensors
- Flexible assembly systems
- Automatic inspection systems
- Process modeling software
- Manufacturing control and communication software

Specific Food Chain Process Systems

- **Equipment Assy. Process Systems** - Automated, flexible product assembly stations
- **Printed Wiring Board Assy. Process Systems** - Component placement systems, Flexible robotic workcells, Reflow furnaces, Deposition systems and Inspection systems.
- **Component Assembly and Packaging Systems** - I.C. bonding and molding systems, Robotic placement and Assembly systems, Test systems
- **Component Fabrication Systems** - Lithography systems, Deposition systems, Etching systems.

AEA ELECTRONIC MANUFACTURING FOOD CHAIN

	1992	1995	1998	2001	2004	2007
Small Thin Plastics (Perimeter I/O)						
Thickness (mm)	1.4	1	Bare Chips/ MCM-L			
Lead Count	<80	<208				
Pitch (mm)	0.3–0.5	0.3–0.5				
Lead Count	<1W	<2W				
High Performance/High Pin (Perimeter I/O)						
Lead Count	200–300	300–400	Bare Chips/ MCM-L			
Perimeter Lead Pitch (mm)	0.5	0.4				
Maximum Power (W)	2–5W	5–10W				
(Area I/O)						
Lead Count	200–300	500–600	750	2000	3000	5000
Area Pad Pitch (mm)	0.2–1.5	0.2–1.0	0.15–0.8	0.1–0.5		
Maximum Power (W)	2–5W	5–10W	10–15	40	120	200
Memory (TSOP/USOP)						
Thickness (mm)	1mm	0.5mm	Goes to 3D Short Stack			
Lead Count	30	50				
(3D "Short Stacks")						
Thickness (mm)		1mm				
Number of Die		4 die				

Packaging Roadmap: Highest Volume Products (>80% of development effort)

Date Rec'd 1-5-94
ACTION to OIDS
INFO to Gibbons
Kelly Gwin
Gillman Newell
Nelson.
SIG of
SIGNATORY

FAX

U.S. DEPARTMENT OF COMMERCE

To : Jack Gibbons

From: Mary Good

these are the two "report cards" we have received so far. They look good! However they also raise expectations and we will need to follow through.

Mary

American Electronics Association

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CLINTON PROGRESS REPORT

TECHNOLOGY

↑ *Department of Commerce given the lead role in civilian technology; budget increased 16%.*

↑ *Formed the National Science and Technology Council to put technology at equal footing with defense and economic security.*

↑ *Initiated effort to establish a National Information Infrastructure, the "Information Highway" which will move the U.S. to world leadership in information technology.*

↑ *Clarified anti-trust rules for joint manufacturing ventures.*

↑ *Actively sought out private sector input to increase inter-agency cooperation and coordination.*

TAX

↓ *Increased taxes on all businesses, especially Sub S corporations.*

↓ *Abandoned the Investment Tax Credit during the budget bill battle.*

↑ *Passed a targeted capital gains differential.*

↑ *Extended the research and development tax credit retroactive for two years.*

INTERNATIONAL

↑ *Successfully passed the North American Free Trade Agreement.*

↑ *Reduced Cold War government controls on over $35 billion worth of computer exports.*

↔ *Mixed results from GATT negotiations.*

↔ *Need to achieve a results-oriented agreement to improve trade with Japan.*

GOVERNMENT/OTHER

↑ *Excellent technology appointments.*

↑ *Initial Administration commitment to work with industry to defeat the Financial Accounting Standards Board (FASB) stock options proposal; still needs to develop official Administration position.*

↔ *Good start on "reinventing government" (Gore initiative); but long-term follow-up unclear.*

↔ *Health care bill will have uncertain and massive impact, especially on small business.*

AEA is the oldest, largest, and most active technology trade association in the country. It represents over 3,000 U.S.-based technology companies.

COUNCIL ON COMPETITIVENESS

★ ★ ★

TECHNOLOGY POLICY IMPLEMENTATION ASSESSMENT 1993

FOREWORD

The Clinton Administration came to office emphasizing the importance of technology to America's economic growth and outlining a series of policies designed to stimulate U.S. competitiveness. As the Administration nears its first year in office, it is appropriate to benchmark these policy pronouncements against progress. This report, which is a joint product of the Council's members and its National Affiliates, attempts to determine how well the Administration and Congress have succeeded in implementing eleven longstanding policy recommendations that enjoy wide, bipartisan support in both the public and private sectors. Individually, these recommendations are neither very costly nor especially controversial; combined, they can have a major impact on U.S. competitiveness.

The recommendations fall into four categories: 1) tax policy; 2) Federal R&D; 3) coordination and cooperation; and 4) U.S. manufacturing. Many of them can be traced to the Council's 1991 report, *Gaining New Ground: Technology Priorities for America's Future*. In some areas, such as refocusing the Federal R&D budget, real progress has been made, and both the Administration and Congress should be congratulated for their contributions. In others areas, such as tax policy, deficit reduction and other priorities took precedence during this year's budget negotiations, and as a result, we still need to do much more.

It is essential that the Administration convey the importance of technology investment programs in a tight budget climate. Congress also has a responsibility. It cannot allow issues of agency jurisdiction, committee control and special interest politics to delay passage of bills that define new roles for government support of civilian R&D. The culture and bureaucracies of many Federal agencies must also change. The United States needs a streamlined, coordinated Federal government to meet the global economic challenges of the next century.

The seeds of a national technology policy were planted in the 1980's. During the past year, we have witnessed renewed emphasis on this critical policy agenda. In the future, technology policy must be integrated with the other policies that collectively determine industry's ability to compete at home and abroad, including tax, regulatory, trade and human resource policy. The Council looks forward to working with the Administration and Congress to implement fully a national policy agenda that advances U.S. economic competitiveness.

Sincerely,

George Fisher

George M.C. Fisher
Council Chairman
Chairman, President and Chief Executive Officer
Eastman Kodak Company

HIGHLIGHTS

Tax policies for U.S. investment in R&D and technology surfaced as the weak link in an otherwise commendable effort to implement a national technology policy. This is primarily the result of other priorities, such as deficit reduction, taking precedence in the FY1993 budget negotiations. The Administration and Congress have demonstrated a strong commitment to refocusing the federal R&D budget on industrial competitiveness and have begun putting in place programs that promote industry-government cooperation and better coordination of Federal R&D. However, government also has a critical role in implementating a tax policy that encourages more *private-sector* investment in R&D and manufacturing. Essential components of such a policy, including a permant Research and Experimentation (R&E) tax credit and an investment tax credit for small businesses, are broadly supported and should be fully implemented.

TAX POLICY: The Congress again failed to enact a permanent R&E tax credit and a permanent solution to Treasury Regulation 1.861-8, opting for three-year extensions (two future years plus one year retroactive) in the 1993 Budget Reconciliation Act. A targeted capital gains tax cut was also included for stock held in small businesses for at least five years. The investment tax credit included early on in the tax bill was dropped altogether, partly because of divisions within industry. ***The lack of progress in this area indicates a need for a more in-depth understanding of the impact that tax policy has on private industry's ability to acquire patient capital and make long-term investments in R&D and equipment. Implementing tax policies that promote private sector investment should be a higher priority in the future.***

FEDERAL R&D: The President's FY1994 budget submission included significant increases for the National Science Foundation's (NSF) R&D budget and the National Institute of Standards and Technology's (NIST) Advanced Technology Program (ATP), both of which support civilian R&D and technology development. Congress appropriated NSF's Research and Related Activities at $1.998 billion, which is below the President's request of $2.2 billion, but still an 8% increase over FY1993 levels. ATP was appropriated at the President's budget request of $199 million, a three-fold increase over last year. ***The Administration and Congress significantly increased funding for civilian technology programs in the FY1994 budget. It is critical that this trend continue in future budget cycles. Moreover, as programs such as the ATP grow, it is important that their organization and management evolve accordingly and that metrics be developed to evaluate performance. Discussion is currently underway on how to reorganize ATP to fund and manage groups of projects in specific program areas so as to allow the program to focus its budget strategically and have a more targeted impact on technologies that drive U.S. economic performance.***

COORDINATION AND COOPERATION: The Clinton Administration has introduced several new plans to coordinate federal R&D across agencies and to promote industry-government cooperation. The National Science and Technology Council (NSTC), to be chaired by the President and made up of cabinet-level representatives, was established recently to help coordinate R&D and technology programs across the federal government. The Council's nine R&D coordinating committees, each to be overseen by an interagency standing committee of science and technology representatives, will replace the Federal Coordinating Council on Science, Engineering and Technology (FCCSET). The President's Council of Advisors on Science and Technology (PCAST) has been revived to serve as the primary private-sector advisory group for the President and the NSTC. The advisory council will be co-chaired by the Director of the Office of Science and Technology Policy (OSTP) and a private-sector appointee. Energy Secretary Hazel O'Leary has also released the Department of Energy's draft strategy for refocusing the Federal labs on industrial competitiveness. The corresponding DOE lab bills (S.473 and H.R. 1432) authorizing reallocation of 10-20% of the labs' budgets to joint projects with industry have been delayed in Congress due to debate over committee jurisdiction and agency missions. ***The plans and strategies of the Administration are still in the developmental stages. As a result, it is difficult to determine how rapidly they will be implemented or how effective they will be. We urge the Administration to articulate and justify these programs and to involve the private sector in their detailed development.***

U.S. MANUFACTURING: Passage of the National Cooperative Production Amendments this summer marked a successful end to a five-year campaign to limit antitrust liability for joint production ventures. The Administration and Congress have also begun to deliver on their intention to support a national manufacturing technology deployment program. Largely through the Technology Reinvestment Project (TRP), the national budget for manufacturing technology deployment rose from $17 million in FY1992 to over $200 million in FY1993. However, instead of continuing this upward trend in FY1994, appropriations for manufacturing technology deployment dropped to $30 million. A recent Congressional promise to reinstate manufacturing technology deployment funding in the TRP would demonstrate a real commitment to building a nationwide deployment system. Legislation authorizing NIST to support a national network of manufacturing technology deployment centers, having passed the House, was delayed in the Senate at the closing moments of the first session of the 103rd Congress. ***As the national manufacturing technology agenda develops, it is critical that the Administration and the Congress fully fund advanced manufacturing programs and actively involve industry in the selection, coordination and control of advanced manufacturing technology development, commercialization and deployment activities.***

TECHNOLOGY POLICY IMPLEMENTATION ASSESSMENT 1993

	Major Progress	Moderate Progress	Insufficient Progress
Tax Policy			
Establish a Permanent and Improved R&E Tax Credit			✓
Enact a Permanent Solution to Treasury Regulation 1.861-8			✓
Establish a Capital Gains Tax Credit			✓
Establish an Investment Tax Credit for Small Business			✓
Federal R&D			
Expand the Advanced Technology Program	✓		
Increase R&D Funding at NSF	✓		
Coordination & Cooperation			
Improve Coordination and Managment of FCCSET, especially Initiatives in HPCC, biotechnology, materials and manufacturing		✓	
Establish a Permanent Private Sector Advisory Group		✓	
Refocus the National Labs on Industry Needs		✓	
U.S. Manufacturing			
Establish a National Manufacturing Development & Deployment Program		✓	
Limit Antitrust Liability for Joint production ventures	✓		

The Under Secretary for Technology

TECHNOLOGY ADMINISTRATION

FACSIMILE TRANSMITTAL SHEET

Number of Pages (including cover sheet) 8

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Date: 1/5/94

To: Dr. Jack Gibbons

Agency/Company: OSTP

FAX Number: 395-3261 Telephone Number: 456-7116

Date Rec'd 1/5/94
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From: Dr. Mary Good
Under Secretary for Technology

Telephone: 202/482-1575

Special Instructions/Message:

U.S. Department of Commerce
Room 4824
14th & Constitution Avenue, NW
Washington, DC 20230

AMERICAN ELECTRONIC

Jon Englund
DIRECTOR, TECHNOLOGY AND
GOVERNMENT BUSINESS POLICY
SOFTWARE ISSUES

AEA

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SKIP FYI

Best, Jon

January, 1994
American Electronics Association

Technology Policy Review -- 1993

Prologue

Below is a year-end status report on some of the key technology policy issues upon which AEA has been working. In many respects, the review reflects the paradigm shift in technology policy from the more "laissez-faire" approach of the Bush Administation to the activist approach taken by the Clinton Presidency.

AEA's Technology, Manufacturing and Infrastructure Committee (TMI) and its members have testified on many of these issues; participated in numerous meetings with Administration officials, Members of Congress and their staffs; and drafted many position papers and letters in support of AEA's positions.

We hope that the TMI will find this retrospective useful as we enter 1994. We are also distributing this review to both the Advanced Technology Coalition (ATC) and the High-Performance Computing and Communications Consortium (HPCCC). It has been a busy year, and 1994 promises to be even more active and challenging!

1. Creation of National Science and Technology Council

The White House has created the National Science and Technology Council (NSTC) which will be on a par with the National Security Council and National Economic Council. The President will chair the Council. Nine committees will fall under the NSTC:

- Communications and Information R&D (Chair: Anita Jones, DoD)
- Civilian Industrial Technology (Chair: Mary Good, Commerce)
- National Security (Chair: Bill Perry, DoD)
- Food, Health and Safety (Chair: Phil Lee, HHS)
- Fundamental Science and Research (Chair: Neil Lane, NSF)
- Environment and Natural Resources
- Education and Training R&D
- Transportation R&D
- International Science, Engineering and Technology.

The private sector will provide input to the NSTC through the President's Committee of Advisors on Science and Technology and through individual advisory panels that tie into each of the above committees. Rep. Rick Boucher (D-VA) has drafted legislation (HR 3476) which would codify the NSTC's mandate.

Impact: This is a long-term structural elevation for science and technology issues. The success of this Council will depend on its ability to make hard choices on technology funding and the degree to which the private sector has input -- and influence -- into the process.

AEA Role: AEA will lobby to ensure that electronics-related issues are priorities for the NSTC, despite the fact that there is not a separate Electronics Committee. AEA's initiatives on advanced manufacturing and the National Information Infrastructure will be priorities. AEA will nominate member executives to serve on the advisory groups providing input to these NSTC Committees.

2. National Competitiveness Act (including Title VI related to NII) and DoE Bills

While the House passed its version of the National Competitiveness Act (HR 820), the Senate failed to pass S.4. There was still a chance right up until the final hours of the Congressional session, but the holds of several Republican on the bill ultimately prevented its passage.

There were negotiations throughout the session on controversial aspects of these two bills, including:

- Title VI (S. 4) related to NII demonstration projects and networking provisions;
- The Manton Amendment (HR 820), which would place restrictions on foreign entities and their U.S. subsidiaries in tapping U.S. government R&D programs (the Senate did not plan to include the Manton Amendment in its bill but the House appeared willing to fight for it in conference);
- The plan to set up a venture capital fund for small businesses (ultimately Senator Bumpers and others were able to work out a compromise in which a joint Commerce/SBA committee would manage the program);
- White House concerns about HR 1757 (the House counterpart of Title VI of S.4 which authorizes funding for NII demonstration projects) being too restrictive and detailed on which agencies should be involved in which NII demonstration projects and the level of funding of these projects;
- Issues related to the role of the Department of Energy and Sen. Bennett Johnston's conviction that the DoE must be able to operate networks for scientific purposes when necessary (the networks should not exclusively be operated by the private sector).

While there continue to be a few outstanding issues for industry (Manton, NSA's role in software encryption), by the end of the session most of these issues had been resolved. On Title VI, the private sector ultimately had a seat at the table in reaching a compromise on the thorny networking issue. However, resolution of the provisions of "Gore II" remain open and potentially troublesome.

Legislation on the Department of Energy research laboratories has been delayed until next year. S. 1298, sponsored by Sen. Bennett Johnston (which included provisions from S.473; the House counterpart is H.R. 1432) will force an extensive debate on the future role of the national laboratories.

AEA Role: AEA will support passage of the National Competitiveness Act and continue to propose improvements to various elements of the bill.

3. Funding Levels for Commerce Department Programs and High-Performance Computing

A. Department of Commerce/NSF Programs

Funding for DoC programs was robust in 1993. A defining moment came when President Clinton sent a letter to key Members of Congress asking for full funding for a number of Commerce Department programs. His public commitment to these programs played a major role in protecting them from the budget ax. Below is a summary of FY'94 funding levels in major DoC programs:

- Full funding for the Advanced Technology Program ($199.5 million for FY '94, up from $67.9 million in FY 93).

- The Manufacturing Extention Partnerships funding levels were increased from $18 million to $30 million in FY 94. However, manufacturing extension funding was dropped from the FY 94 appropriations for the Technology Reinvestment Project (TRP) and so there may have been a net reduction in this program.

- Over $20 million has been given to the National Telecommunications and Information Administration at Commerce for NII pilot projects related to data networking.

- Funding for National Science Foundation R&D funding was up to $1.9 billion, an 8% increase over the previous year. The Administration had asked for 18% more than last year, however.

B. High-Performance Computing/NII

- $326 million was appropriated through the Defense Appropriations Bill for high-performance computing and communications projects. While this was an 18.5% increase over FY 93, it was $42 million less than the $368 million that was requested. This is an improvement from the $100 million cut by the House, and the $53 million by the Senate going into the Conference.

- After some full-court pressure from NSF and the White House, the NSF's High Performance Computing program was cut by only $12.5 million from the original request (the program will expand by 30% to $272 million).

- DoD's supercomputer modernization budget request was increased. The Administration had requested $122.8 million; $46.1 million went into supercomputer modernization R&D; $100 million into procurement.

AEA Role: AEA will continue to lobby on behalf of robust funding for these programs. AEA will also work through the ATC and the HPCCC towards this end. An AEA letter was sent in the last 3 weeks to the Director of OMB, Leon Panetta, to support the DoC programs such as ATP as the Administration considers its technology funding priorities. It was announced last week that the Administration's ATP request for FY 1995 will be $450 million, close to the full planned increase in funding.

4. New Models for Government-Industry Cooperation

New models for cooperation between government and industry in technology emerged in 1993 with the election of the Clinton Administration. Examples include:

- The effort by Dr. Lance Glasser and the Electronics Working Group to partner with the private sector through a proposed Electronics Partnership Project. The EWG has selected low-cost compact electronics as its initial focus.

- The efforts to include private sector input in major Administration decisions on technology policy and funding. Examples include:

  - The President's Committee of Advisors on Science and Technology;
  - The soon-to-be named National Information Infrastructure Advisory Council and High-Performance Computing Advisory Board;
  - The efforts by the Director of NIST to involve the private sector more heavily in where the Advanced Technology Program focuses its efforts (criteria for the program now includes: broad-based benefit for the U.S. economy, good technical content, strong industry commitment and an opportunity for ATP funding to make a major difference);
  - Private sector involvement in a new joint Commerce-DoD advisory panel on technology and procurement.

AEA Role: We will propose nominees for these various advisory councils and seek to ensure that industry's recommendations have a substantive impact as these new models develop.

5. **GATT and R&D Subsidies**

This was a "sleeper" issue that got a lot of attention as the deadline of December 15 for completing the GATT negotiations neared. The provision, which is part of the Dunkel draft, would have:

- capped government contributions at 25% for applied research;
- capped government contributions at 50% for basic research; and,
- required the government and industry to submit notification reports on such proposals.

Such a provision would have a significant negative impact upon this Administration's technology programs such as the ATP, TRP and the Clean Car initiative. The issue is yet another example of the growing overlap between technology and trade issues.

Update: A compromise was reached recently on the provision. Government funding of applied research or "pre-competitive development activity" will be limited to 50%; government assistance in the case of basic research or "industrial assistance" will be limited to 75%. Definitions accompany the GATT language for both these categories (give Jon Englund at AEA a call at 202-682-4454 if you need these specific definitions).

AEA Role: AEA's TMI and Trade Committees will continue to work together to influence our Administration's positions on issues where technology and trade intersect.

6. **Technology Reinvestment Project**

Over 160 awards have been made totalling $415 million of the total $472 million appropriated for the TRP this year. Two of the three rounds of the awards are now complete. While $404 million has been appropriated for the TRP in FY 94, they zeroed out funding for two manufacturing technology programs. Also, $104 million in TRP funding and dual-use partnership programs was earmarked by Congress (ARPA has pledged to eliminate the earmarks). Rep. George Brown created a cause celebre in waging battle against these earmarks at the end of the session.

AEA Role: While it was a good first start for the TRP, AEA has a series of proposals on the table on how to improve the process, including:

- more private sector input into the selection process;
- including a product development -- not just technology development -- element to the TRP; and,
- encouraging a larger number of medium and small-sized companies to participate in the process and succeed in winning awards (a very small number of these companies have won awards this year -- most of the awards have gone

to big companies).

7. Next Year's Challenges

Many challenges remain for next year. These include (the responsible AEA subcommittee or affiliated organization is in parentheses):

ELECTRONICS MANUFACTURING INITIATIVES (AEA ELECTRONICS MANUFACTURING SUBCOMMITTEE)

- Soliciting input from other organizations on AEA's Advanced Electronics Manufacturing White Paper through participation in several industry fora;

- Using the White Paper, continue to educate decision-makers in Government and Congress on gaps in the U.S. electronics manufacturing food chain in support of the Administration's AMTI (Advanced Manufacturing Technology Initiative). In particular, work through NSTC's Civilian Industrial Technology Committee (chair: Mary Good, undersecretary of commerce for technology), the Electronics Working Group (chair: Lance Glasser, ARPA), and NIST programs (Director: Arati Prabhakar).

DEVELOPING THE NII AND HIGH-PERFORMANCE COMPUTING (AEA NII TASK FORCE AND HPCCC)

- Making the case for the high performance computing program and NII to ensure robust funding levels and projects;

- Providing a user's perspective to the Administration on NII;

- Lobbying for improvements to Title VI of S.4 (related to NII demonstration projects)

- Providing input and possible support to the Administration's telecommunications legislative package due out early this year.

TECHNOLOGY POLICY (TMI FEDERAL AFFAIRS WORKING GROUP and ATC)

- Ensuring that the growing opportunities for private sector input as part of the new models for government-industry cooperation are substantive and have a real impact (and are not just pro forma);

- Achieving some improvements in S.4 and getting it passed early in the session and out of conference without the Manton Amendment;

- Ensuring that key industry technology programs -- such as ATP which ramps up to $450 million from $199 million this year -- are protected in next year's budget; and,

- Playing a role in redefining the mission of the laboratories.

It is going to be a busy year and we look forward to working with you in 1994!

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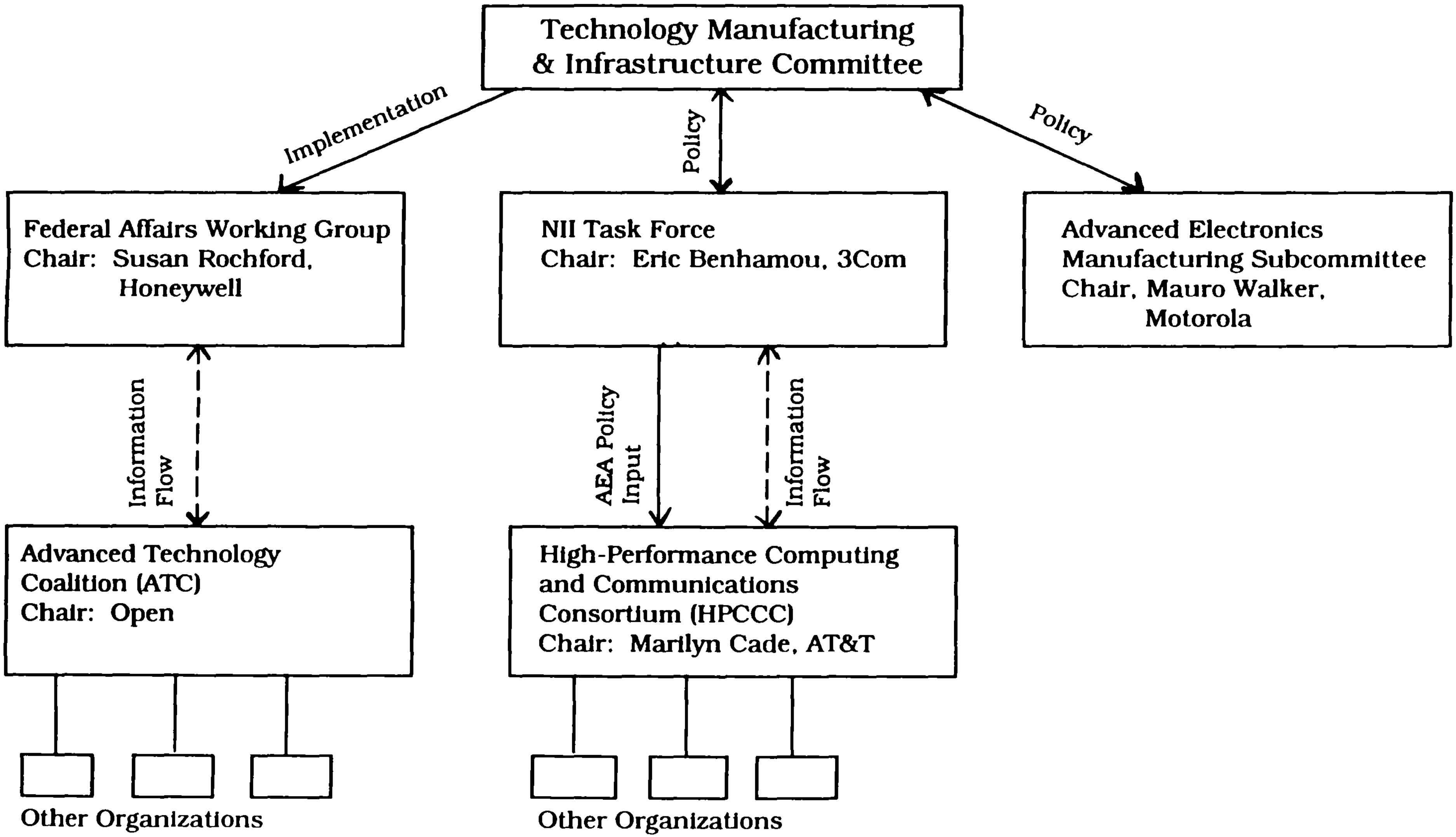
AEA Technology, Manufacturing and Infrastructure Committee

Mission: To advocate a national technology and manufacturing policy -- developed and implemented collaboratively by industry, government and academia -- that provides a long-term, industry-led strategy for U.S. leadership in the global electronics marketplace.

Chair: Dick Knight, Tektronix

AEA Staff: Jon Englund (202-682-4454)



American Electronics Association AEA

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NO. Action item for Dr. Gibbons & Sec. Brown. A

May 13, 1993

The Honorable Albert Gore
Vice President of the United States
Old Executive Office Building
Washington, DC 20500

Dear Mr. Vice President:

The American Electronics Association appreciates the Clinton Administration's commitment to U.S. high technology export competitiveness, as evidenced by the recent decision to continue applying pressure to open the Japanese supercomputer procurement market.

However, we are dismayed that this commitment has not also been directed toward other important foreign markets by relaxing the U.S. export control stranglehold on supercomputers and general purpose computers. Since AEA's March 16 letter to you on this subject, a U.S. government decision has been pending to revise the definition and conditions for sale of a "supercomputer" for export control purposes. A review was in fact supposed to have been completed almost one year ago. This decision must not be permitted to languish any longer. It is because of such delays in this review and U.S. export licensing procedures in general that U.S. high performance computer manufacturers have suffered the loss of customers and the creation of foreign competitors.

We are writing once again to renew our March 16 request for a CEO-level meeting with you to discuss immediate resolution to this long festering problem. We will be in touch with your office soon to arrange a meeting.

Sincerely,

Dick Iverson

J. Richard Iverson
President and CEO

cc: The Honorable Anthony Lake

lets set up meeting

Johns
Nelson
Kalil
(WAKES as she can)

TK
FRI 1:00
8/24 left voicemail

AEA 50 Celebrating Years

ROUTING SLIP

FROM: Greg Simon
Office of the Vice President

DATE: 8/10/93

TO:

Dennis Alpert		Katie McGinty	
Todd Campbell		Beth Prichard	
Leon Fuerth		Jack Quinn	
Skila Harris		Marla Romash	
Elaine Kamarck		Tony Wilson	X
Goody Marshall		Other	Jack Gibbons

FOR YOUR:

Action	X
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Date Rec'd 8-11-93
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Nelson

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DATE DUE 8-25-93