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Record Group/Collection: George H.W. Bush Presidential Records
Collection/Office of Origin: Science and Technology Policy, Office of (OSTP)
Series: Bromley, D. Allan, Files
Subseries: International Files - Country Files

OA/ID Number: 62066
Folder ID Number: 62066-001

Folder Title:
International: Japan [1 of 3] [1991]

Stack:

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Position:

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Logged

"Document Control"

TYPE: ACTION DOCUMENT NUMBER: 9200008
 ORIGINATOR: 02 STATUS I DIRECTORATE STATUS

FROM: INAMORI, Kazuo: KYOCERA CORPORATION

TO: DR. D.A. BROMLEY

DATE OF
 CORRESPONDENCE: 12/27/91

SUBJECT: HE IS PROVIDING DR. BROMLEY WITH A COPY OF "BASIC
 PRINCIPLES OF JAPANESE EXTERNAL POLICY". HE WOULD
 WELCOME ANY REMARKS.

 DIRECTORATE STAFF
 ASSIGNED: INTERNATIONAL/POLICY ASSIGNED: SB

ACTION STAFF
 REQUIRED: AS APPROPRIATE ACTION: →

 SENDER'S DUE DATE:
 OSTP DUE DATE: 01/20/92 STAFF DUE DATE: 1/20/92
 DATE COMPLETED: DATE COMPLETED/DEPT:

 COPIES TO: D. Allan Bromley

 WHITE HOUSE TRACKING #: CONTACT PERSON:
 REMARKS: 1/8/92 PHONE: EXT:

No response necessary.
 Sara Bowden

OSTP RECEIVED: 01/02/92 DEPT RECEIVED:
 FILE: P-INTERNATIONAL-JAPAN
 CENTRAL FILES:

CLOSED

THE WHITE HOUSE
WASHINGTON

January 13, 1992

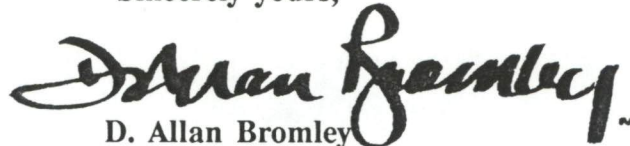
Dear Mr. Inamori:

Many thanks for sending me the book entitled **Basic Principles of Japanese External Policy** which I shall find extremely helpful.

I recall with pleasure your visit here to Washington and look forward to our paths crossing again in the not too distant future.

With all best wishes for the new year,

Sincerely yours,

A handwritten signature in dark ink, reading "D. Allan Bromley". The signature is fluid and cursive, with a small flourish at the end.

D. Allan Bromley
The Assistant to the President
for
Science and Technology

Mr. Kazuo Inamori
Chairman of the Board
Kyocera Corporation
5-22 Kitainoue-cho, Higashino
Yamashina-ku, Kyoto 607
Japan

RECEIVED

92 JAN 2 A 9 : 6 December 27, 1991

OSTP
MAIL ROOM

Dr.D. Allan Bromley
Science Advisor to the President
The White House, Washington, D.C .
U.S.A.

Dear Dr.Bromley :

Please kindly find an enclosed book "BASIC PRINCIPLES OF JAPANESE EXTERNAL POLICY" which was made by a governmental council I belong to. I would like to send this small book for your reference.

This spring, I was appointed as Chairman of the "Subcouncil on Japan and the World" of the Provisional Council for the Promotion of Administrative Reform by Prime Minister Kaifu. The purpose is to make proposals in order to make our public administration worthy of receiving trust and respect from our own people as well as from the international community. I believe Japan is not yet trusted enough even though it has become one of the economic giants in the world because it does not have clear basic, principles of external policy with which people in other countries agree.

Therefore, we decided to initially discuss what principles Japan should have and thereafter to deliberate how public administrative systems should be reformed based on them.

Thus, the Subcouncil made this "BASIC PRINCIPLES OF JAPANESE EXTERNAL POLICY" this June. The Government subsequently made a decision to respect it to the maximum extent possible. Therefore, public administrative organizations in charge of external policies will implement their external policies founded on these basic principles henceforth. As these principles should be understood by as many people as possible in the world, this English version was just published.

Since you have a great insight about Japan and the world, your comments to this small book would be most appreciated. The Subcouncil will keep discussing how to reform our public administrative systems until next June based on these principles.

Yours sincerely,



Kazuo Inamori
Chairman of the Board
Kyocera Corporation

**“BASIC PRINCIPLES OF
JAPANESE EXTERNAL POLICY”**

from the “FIRST REPORT ON ADMINISTRATIVE REFORM”
submitted to the PRIME MINISTER on JULY 4, 1991
by the PROVISIONAL COUNCIL for
the PROMOTION of ADMINISTRATIVE REFORM
approved by the GOVERNMENT on JULY 9, 1991

MANAGEMENT AND COORDINATION AGENCY
PRIME MINISTER'S OFFICE
GOVERNMENT OF JAPAN
NOVEMBER 1991

"Document Control"

TYPE: INFORMATION

DOCUMENT NUMBER: 9200040

ORIGINATOR: 02

STATUS C

DIRECTORATE STATUS

FROM: MURATA, Ryohei:AMBASSADOR OF JAPAN

TO: DR. D.A. BROMLEY

DATE OF
CORRESPONDENCE: 12/27/91

SUBJECT: HE IS FORWARDING A FAREWELL LETTER FROM TARO
NAKAYAMA, THE FORMER MINISTER FOR FORIEGN AFFAIRS OF
JAPAN.

DIRECTORATE STAFF
ASSIGNED: ASSIGNED:

ACTION STAFF
REQUIRED: ACTION:

SENDER'S DUE DATE:
OSTP DUE DATE: STAFF DUE DATE
DATE COMPLETED: DATE COMPLETED/DEPT:

COPIES TO: D. Allan Bromley
INTERNATIONAL/POLICY

WHITE HOUSE TRACKING #: CONTACT PERSON:
REMARKS: PHONE: EXT:

OSTP RECEIVED: 01/07/92 DEPT RECEIVED:
FILE: P-INTERNATIONAL-JAPAN
CENTRAL FILES:



0040 I

RECEIVED

EMBASSY OF JAPAN
WASHINGTON, D. C.

92 JAN 7 P2:35

December 27, 1991

CSTP
MAIL ROOM

Dear Dr. Bromley:

I have the honor to forward to you, enclosed herewith, a letter from Mr. Taro Nakayama, the former Minister for Foreign Affairs of Japan.

Allow me to extend my warmest regards.

Respectfully yours,

Ryohei Murata
Ambassador of Japan

The Honorable
D. Allan Bromley
Assistant to the President
for Science and Technology
The White House
Washington, D.C. 20500

Translation

MINISTRY OF FOREIGN AFFAIRS
TOKYO, JAPAN

November 5, 1991

Dear Dr. Bromley,

I would like to express my sincere appreciation for the friendship and support you and your government have extended to me during my tenure as Foreign Minister.

The political and economic structure of the international society is fundamentally changing from one based on East-West confrontation to that of harmony and coexistence. It is very pleasing for me to witness this structural change for I have visited many countries and maintained close dialogues with their leaders and people concerned for the cause of peace and prosperity of the world. I think we should all welcome this movement.

Looking back over the period of my tenure, it is particularly satisfying that we have been able to further enhance our cooperation in science and technology with your country, as cochairmen of the Joint High Level Committee established by the Japan-U.S. Agreement on Cooperation in Research and Development in Science and Technology. I hope you will extend the same kindness and understanding to my successor.

I

The Honourable D. Allan Bromley
Assistant to the President
for Science and Technology

I will continue to endeavor for the advancement of Japan's foreign policy objectives and for further strengthening of the friendship with your country, including in the field of science and technology, even after I leave my post as Foreign Minister.

Wishing you continued good health and success,
I remain,

Sincerely yours,

/s/

Taro Nakayama
Former Minister
for Foreign Affairs of Japan

科学技術面を含む貴国との友好関係が更に確固たるものとなるよう尽力して参る
所存であります。

閣下の御健康と益々の御活躍をお祈り致します。

敬具

平成三年十一月五日

日本国外務大臣

中山太郎

科学技術担当大統領補佐官

D・アラン・ブロムレー 閣下



閣下

外務大臣退任にあたり、私は閣下はじめ貴国政府より賜わった御厚情と御支援に対し、深甚なる謝意を表明致します。

国際社会の政治・経済構造は大きく変化し、今や東西対立から融和・共存の時代へと着実に進行しております。このことは、世界各国を訪問し、各国首脳はじめ関係者各位と世界の平和と繁栄のための対話を続けてまいりました私にとりまして大きな喜びであり、また、大変歓迎すべきことと思っております。

顧みますに、私の外務大臣在任中の二年余の間、日米科学技術協力協定合同高級委員会の共同議長として閣下の御協力を得て貴国との科学技術協力関係に更なる進展を見ましたことは私の大きな喜びとするところであります。今後私の後任が私と同様の御厚誼と御理解を賜わりますことを希望しております。

私としましては、外務大臣の職を退いた後も我が国外交の発展のため、また、

THE WHITE HOUSE
WASHINGTON

January 13, 1992

Dear Mr. Minister:

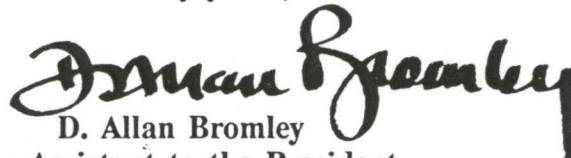
I much appreciate your letter of November 5 that has just been passed along to me by the Japanese Embassy here in Washington.

As you look back on your tenure as Minister of Foreign Affairs you have every reason to be proud of what you have accomplished. It has been a great privilege working with you as co-chairman of the Joint High Level Committee in Science and Technology and I shall certainly look forward to continuing the high level of friendship and cooperation that we have established when your successor takes over. I believe that our discussions have contributed in significant fashion to improving the understanding between our two peoples and to establishing channels of communications that have importance far beyond the explicit matters of science and of technology.

Let me then take this occasion to wish you every success in your new ventures and may 1992 be a year of health and happiness to you and all your family.

With warmest best wishes,

Sincerely yours,

A handwritten signature in dark ink, appearing to read "D. Allan Bromley", written in a cursive style.

D. Allan Bromley
The Assistant to the President
for
Science and Technology

His Excellency
Taro Nakayama
Former Minister of Foreign Affairs
Tokyo, Japan

ENVIRONMENTAL, SCIENTIFIC AND TECHNOLOGICAL AFFAIRS

Dr. Bromley

United States Embassy
Tokyo, Japan

TEL (81) (3) 3224-5500 FAX (81) (3) 3505-1002

Fax

No. of Pages: 2

DATE: November 26, 1991

TO: Mr. Tom Ratchford, OSTP

FAX: (202) 395-3719

Ms. Linda Staheli, OES/SCT

FROM: FAX: (202) 647-0773

FROM: Dr. Edward M. Malloy, Counselor

The attached article appeared in the 11/23 Nikkei.

Government restudies global R&D contributions

(NIKKEI
11/23/91)

U.S. PRESSURE NUDGES JAPAN TOWARD GREATER FUNDING FOR RESEARCH

BY KIYOSHI ANDO
Staff writer

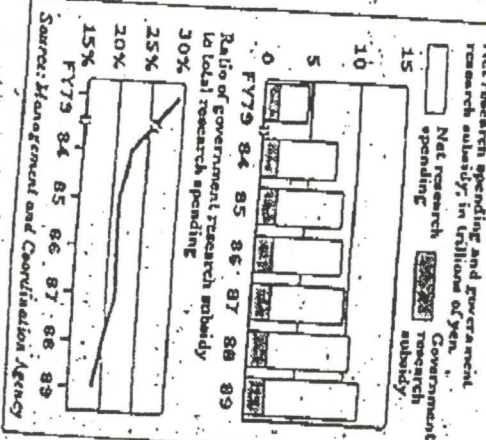
The Japanese government has put its science and technology policy under the microscope, as three high-level bodies undertake reviews of various aspects of the policy.

The overall rationale of the policy review is to help improve research facilities at universities and expand Japan's contribution to international basic research. But one specific outcome may be to reverse Tokyo's initial resistance to U.S. requests for Japan to contribute \$1.5-2 billion in research and development funds and equipment to the \$8.2 billion superconducting super collider project in Texas.

With particular focus on R&D expenditure, the policy review is being approached on three fronts — first, by the government's Provisional Council for the Promotion of Administrative Reform, which has been asked to recommend reform measures. Meanwhile, the Science Council of Japan has begun discussing policy problems and the ruling Liberal Democratic Party (LDP) has also set up a special committee in its Policy Research Council. The committee will study reform proposals such as abolition of the budget ceiling on government-backed R&D. The ceiling currently applies to all ministries and government agencies.

Among other issues being examined

GROWTH OF NON-GOVERNMENT R&D FUNDING



by both the provisional administrative reform council and the LDP is the provision of funding outside of the annual national R&D budget, and the introduction of official development assistance (ODA) for R&D activities overseas. There are proposals that ODA funds, to cover areas such as technology transfers to developing countries and joint international projects, be incorporated into the fiscal 1993 budget.

U.S. pressure

Until recently, the government virtually ignored pleas to respond to growing criticism over the deteriorating research environment at Japanese univer-

sities. This was before the U.S. began urging Japan to contribute to international basic research programs and other large projects — in particular the super collider project.

In the face of Japan's evident reluctance, Washington suggested Tokyo create a special research budget including funds for international projects, so any contribution to the super collider project would not siphon money away from Japan's basic research.

Japanese authorities concerned have complained the American request for a portion of Japan's R&D budget is tantamount to interference in its internal affairs.

However, one reason the government has such high hopes over the recently launched policy review is that ongoing U.S. pressure over the super collider is likely to force some sort of action, according to Japanese officials.

The sheer size of the American demand itself rules out budgets of ministries and agencies, which are traditionally used for such international contributions. The only way to enable such specialized R&D funding would come through modifications to the science and technology policy, say researchers.

The urgency of boosting Japan's basic research and the need to expand government budgets were previously argued by the Council for Science and Technology, which is chaired by the prime minister, and the Science Council, an advisory organ to the minister of education. But neither body was able to come up with concrete proposals, due to fundamental disagreements.

The situation has changed now, say government officials. Even in senior circles of government, there are strong

criticisms of the inconsistency and absence of an underlying philosophy in Japan's science and technology policy. There is also growing acknowledgement that the makeshift measures resorted to in the past to deflect international criticism will no longer suffice.

Duty to lead

The abolition of the budget ceiling and the establishment of R&D ODA are both regarded as controversial proposals which are certain to meet with opposition from the Ministry of Finance. The provision of international projects, also, is not expected to make recommendations which would sharply swell government spending. But both bodies may be in for some nudging from the LDP's policy review committee.

"It is our duty to lead them vigorously," says one member of the LDP's special committee.

The special committee comprises influential members of other LDP panels which oversee science and technology, education, and commerce and industry. At the committee's first meeting, held Oct. 23, members heard presentations by representatives of the Science and Technology Agency, the Ministry of Education and the Ministry of International Trade and Industry. It was then decided that all parties concerned will cooperate to achieve a sharp increase in the R&D budget for fiscal 1993.

Researchers, who have long hoped R&D funding would gain enough interest to be taken up in the Diet, regard this as a significant development in itself, since problems relating to scientific research have traditionally been seen as non-political issues with minimal impact on the ballot box.

THE WHITE HOUSE

WASHINGTON

December 18, 1991

Dear Ed:

This is a belated note to express to you my appreciation for all your help while I was in Japan in October and let me also thank you for keeping us up to date with clippings from Japanese newspapers and other pertinent pieces of information since that time.

I was pleased by the resolution passed by the Science Council of Japan and, just this past week, by the announced decision of the LDP to support participation in the SSC. I note, however, that they have not stated the extent of their participation or how they would propose to go about it, but at least it points in the right direction. We have made it rather clear here that it is our belief that unless we receive 1.5 billion dollars from the Japanese it is highly probable that the SSC project will in fact be cancelled.

According to present planning I will be accompanying the President when he visits Seoul and Tokyo in early January and so look forward to seeing you at that time.

Please convey my warmest regards to Mike Armacost and let me wish you and your family a very happy Christmas and a healthy and rewarding 1992.

With warmest regards,

Sincerely yours,



D. Allan Bromley
The Assistant to the President
for
Science and Technology

Dr. Edward M. Malloy, Counselor
Environmental, Scientific and Technological Affairs
United States Embassy
Tokyo, Japan

"Document Control"

TYPE: INFORMATION DOCUMENT NUMBER: 9125011
ORIGINATOR: 02 STATUS C DIRECTORATE STATUS

FROM: BOIDOCK, John K.: TEXAS INSTRUMENTS

TO: DR. D.A. BROMLEY

DATE OF
CORRESPONDENCE: 11/25/91

SUBJECT: RE: AMERICAN HIGH-TECH MANUFACTURERS EFFORTS IN
JAPAN.

DIRECTORATE STAFF
ASSIGNED: ASSIGNED:

ACTION STAFF
REQUIRED: ACTION:

SENDER'S DUE DATE:
OSTP DUE DATE: STAFF DUE DATE
DATE COMPLETED: DATE COMPLETED/DEPT:

COPIES TO: D. Allan Bromley
INTERNATIONAL/POLICY
INDUSTRIAL

WHITE HOUSE TRACKING #: CONTACT PERSON:
REMARKS: PHONE: EXT:

OSTP RECEIVED: 12/04/91 DEPT RECEIVED:
FILE: P-INTERNATIONAL-JAPAN*INDUSTRIAL-MANUFACTURING
CENTRAL FILES:

5011

TEXAS INSTRUMENTS



RECEIVED

31 DEC 4 9:44

OSTP
MAIL ROOM

November 25, 1991

Mr. D. Allan Bromley
Assistant to the President
for Science and Technology
Office of Science and Technology Policy
Old Executive Office Building
Washington, DC 20506

Dear Mr. Bromley:

We are now five months into the New Semiconductor Agreement and the foreign share of Japan's semiconductor market has remained unchanged. To affirm in your mind the fact that American high-tech manufacturers are expending significant effort in Japan, I am sending you the attached material describing one of Texas Instruments' recently announced programs to enhance sales of semiconductors in Japan.

The enclosed brochure and press release describe TI's new research and development center in Tsukuba, Japan which opened in October. This facility is an important example of TI's commitment to gain a significant share of the Japanese electronics market, which represents more than half the world demand for semiconductors. With the establishment of the Tsukuba center, TI is the first U.S. based commercial semiconductor company with facilities in Japan capable of serving customers over the complete lifecycle of a product, from concept to application.

I have also enclosed a recent press release describing TI's strategy for competing throughout the globe. Texas Instruments has been in Japan since 1962 and, as the enclosed materials illustrate, we intend to be a presence in this market for years to come.

Thank you for your continued support of the objectives of the U.S./Japan Semiconductor Agreement. I look forward to working with you over the next year to assure these objectives are met.

Sincerely,

John K. Boidock
Vice President, Corporate Staff &
Manager, Government Relationships

TEXAS INSTRUMENTS



Backgrounder C-134

MEDIA CONTACT:

Stan Victor, 214/995-2984

PLEASE DO NOT PUBLISH THIS NUMBER

TI PREPARES FOR DEMANDS OF THE 1990S WITH GLOBAL SEMICONDUCTOR STRATEGY

DALLAS (October 1, 1991) -- In the late 1980s, TI management began a process to review where the world was going, where growth was occurring, and what changes TI would have to make in order to increase its competitiveness and serve customers globally. This process -- called TI 2000 -- led to a vision, backed up by substantial capital and research and development investments. From TI's new research center in Tsukuba (Science City), Japan, to its new submicron CMOS global factory network, to key customer alliances in targeted markets, TI's vision is becoming a reality.

TI's semiconductor vision anticipates a \$200 billion semiconductor industry, driving an estimated \$2 trillion electronics industry, by the year 2000. TI investments over the past five years will transition TI's semiconductor capacity from 8 percent CMOS processes in 1986 to approximately 70 percent by 1992 -- roughly equivalent to the market -- with more capacity under construction. Submicron CMOS processes will form the basis for most next-generation integrated circuit products during this decade.

The submicron CMOS capacity available to TI will increase by a factor of about eight over the next five years, with facilities strategically located in the world's four major markets for semiconductors -- Japan, the U.S., Europe and the Asia-Pacific region. Currently, TI manufactures semiconductors in 27 locations and 12 countries around the world.

- more -

Pat Weber, TI executive vice president and president of the Semiconductor Group, summarized TI's strategy: "TI has been developing and executing an integrated global strategy to meet the semiconductor demands of tomorrow's electronic systems. Key elements of that strategy are customer focus, leadership processes, manufacturing capacity additions at a lower cost of capital, a broad portfolio of standard and differentiated products, global deployment of resources, and market-driven strategies."

According to Mr. Weber, TI has invested at a higher rate of capital expenditures as a percentage of revenues than either the U.S. or Japanese industry since 1989. "We stayed with our investment decisions despite a semiconductor industry recession. We believe these investments will put us in a much stronger position to serve the needs of our customers worldwide."

'Flexible' capacity

A key factor in TI's expansion strategy is flexibility, something TI managers say is absolutely critical to meet changing market needs. Each submicron wafer manufacturing facility -- valued at approximately \$300 million each -- is built around standardized materials, equipment and processes that are "harmonized" around the world for productivity and flexibility.

Dr. Pallab Chatterjee, TI vice president, Corporate Staff, and manager of TI's semiconductor research and development efforts, says TI's vision of harmonization means that the equipment, tooling and recipes will have a high degree of commonality between TI fabs around the world.

"This makes it possible to shift back and forth between product mixes to respond to customer demand," said Dr. Chatterjee. "The standardized approach also helps to extend the life of the fabs and increase plant efficiency -- all of which translates to lower product costs."

Integrated by one of the world's most extensive computer and communications networks, this harmonization and communications linkage creates what TI calls a "global, seamless factory."

TI's harmonized fabs typically begin production using the latest generation dynamic random access memory (DRAM) chip, used for memory storage. "In essence," says Dr. Chatterjee, "we use DRAMS to develop the fine geometry processing capabilities — 0.5-micron range and below — that we then use to produce our broad product portfolio. All this helps us bring products to market faster — a key concern of today's customer — and to be more responsive to customer needs."

TI's harmonized fabs will produce current-generation 4-megabit (0.8 micron design) and later-generation 16-megabit (0.5 micron) DRAMs, which prepare the way for logic, Flash-EPROMs (specialized memories) and other products. Development is also well underway on the 64-megabit DRAM, at the 0.35-micron level, with industry production expected in the 1994 time frame.

Equalizing cost of capital

Mr. Weber explains that TI's strategy called for increased capacity at a lower cost of capital: "By sharing investment costs with customers, governments and other businesses that wanted to diversify, TI is reducing its cash requirements by more than \$1.0 billion over several years and achieving a cost-of-capital rate roughly equivalent with the Japanese, thereby enhancing our competitiveness."

TI has engaged in multiple ventures with customers and governments to jointly fund wafer fabs. These include joint ventures with Acer Incorporated in Taiwan (initial production expected late 1991), Kobe Steel in Japan (initial production 1992), a cooperative agreement with Hewlett-Packard, Canon and the government of Singapore (initial production mid-1993), and support by the Italian government on TI's wholly owned fab in Avezzano (in 4-megabit production).

In tandem with the fab strategy is R&D. "Since 1984 we have also increased our research and development investments at a company level by nearly two

percentage points," said Mr. Weber. "We've put almost \$3 billion dollars into new products and processes, building upon our harmonization strategy."

TI has established a dedicated R&D facility in Tsukuba (Science City), Ibaraki Prefecture in Japan. This center will be involved in research and development of advanced materials, devices and integrated circuits. TI will draw on the creative talent of the Japanese research community, allowing its scientists to engage in collaborative research with customers, universities and research consortia. TI expects this R&D center to strengthen its technology base in areas that are growing in Japan and the Asia-Pacific region.

To further ensure harmonized equipment and processes, TI is also participating in another program called Microelectronics Manufacturing Science and Technology (MMST), jointly funded with the United States Air Force and the Defense Advanced Research Projects Agency (DARPA). Now three years into this five-year program, MMST is based on industry-accepted semi-modular equipment standards. Embedded into MMST is a computer-integrated manufacturing environment that makes full use of the modularity approach.

Customers drive capacity on time

Customers are the driving force behind TI's efforts to build the needed capacity on time, with collaborative efforts ongoing between TI and the first users of next-generation products. TI calls these "teacher-customer" engagements, and depends on the systems expertise of the equipment manufacturer to define next-generation and subsequent process characteristics.

"Our new technologies are continuously coming onboard every two-and-a-half to three years, but development to customer qualification is actually a five-year cycle," Dr. Chatterjee explains. "That just means you have to begin working very, very early with key customers if you want to be on time for the rest of the industry."

Dr. Wally Rhines, executive vice president, Semiconductor Group, said:

"Companies like Sony in Japan, Sun Microsystems in the United States and Ericsson in Europe are working closely with us on new products. For example, we just announced our participation with three Japanese semiconductor manufacturers to develop chip sets for the Japanese MUSE high-definition television standard. Our submicron CMOS capacity additions give us a large pool of product capacity to support their new product needs."

Dr. Rhines emphasizes that this is especially critical to customers today because the customized nature of the products often creates a sole source situation, at least during initial production. "For customers who are dependent upon a semiconductor supplier for a sole-source product, it's important to have substantial capacity worldwide."

Not coincidentally, he adds that when an upside for one customer occurs, it almost always does so for others. "Traditionally, the electronics industry has been capacity limited at the peak of every cycle. By having flexible and harmonized fabs, we can shift capacity from commodity products to customized customer products quickly and cost-effectively."

#####

テキサス インスツルメンツ

筑波研究開発センター



"Document Control"

TYPE: INFORMATION DOCUMENT NUMBER: 9124775
ORIGINATOR: 02 STATUS C DIRECTORATE STATUS

FROM: SCHNABEL, Rockwell A.: DEPUTY SECRETARY OF COMMERCE

TO: DR. D.A. BROMLEY

DATE OF
CORRESPONDENCE: 11/08/91

SUBJECT: A CONGRATULATORY LETTER TO DR. BROMLEY FOR HIS
EFFORTS AT THE U.S.-JAPAN SCIENCE AND TECHNOLOGY
AGREEMENT MEETING.

DIRECTORATE STAFF
ASSIGNED: ASSIGNED:

ACTION STAFF
REQUIRED: ACTION:

SENDER'S DUE DATE:
OSTP DUE DATE: STAFF DUE DATE
DATE COMPLETED: DATE COMPLETED/DEPT:

COPIES TO: D. Allan Bromley
INTERNATIONAL/POLICY

WHITE HOUSE TRACKING #: CONTACT PERSON:
REMARKS: PHONE: EXT:

OSTP RECEIVED: 11/14/91 DEPT RECEIVED:
FILE: P-INTERNATIONAL-JAPAN
CENTRAL FILES:



4775
THE DEPUTY SECRETARY OF COMMERCE

Washington, D.C. 20230

November 8, 1991

RECEIVED

91 NOV 14 A10:34

OSTP
MAIL ROOM

Honorable D. Allan Bromley
Assistant to the President for
Science and Technology
Office of Science and Technology Policy
Old Executive Office Building
Washington, D.C. 20506

Dear Allan:

Congratulations on the progress achieved at the Joint High Level Committee meeting of the U.S.-Japan Science and Technology (S&T) Agreement.

Assistant Secretary Wince-Smith briefed me on the meeting and on the status of our response to Japan's various proposals for international collaborative R&D projects. We appreciate and support the strong message you conveyed that early dialogue under the framework of the S&T Agreement is essential when Japan anticipates issuing an invitation for foreign participation in such projects.

Newspaper accounts of the meetings reported that the U.S. was offering to participate in Japanese R&D programs if the Japanese participated in certain U.S. programs. I understand from Ms. Wince-Smith that the press reports were incorrect and that you reinforced yet again that possible U.S. participation in Japanese proposed R&D initiatives should be considered on a case-by-case basis to ensure mutual and equitable benefits for all participants.

As always, Commerce supports your efforts.

Sincerely,

Rockwell A. Schnabel

"Document Control"

TYPE: INFORMATION

ORIGINATOR: 02

STATUS C

DOCUMENT NUMBER: 9124765

DIRECTORATE STATUS

FROM: STUCK, Elizabeth: UNIVERSITY OF MINNESOTA

TO: DR. D.A. BROMLEY

DATE OF
CORRESPONDENCE: 11/06/91

SUBJECT: A THANK YOU LETTER TO DR. BROMLEY FOR HIS ROLE IN
MAKING THE SUMMER INSTITUTE IN JAPAN PROGRAM
POSSIBLE.

DIRECTORATE
ASSIGNED: STAFF
ASSIGNED:

ACTION
REQUIRED: STAFF
ACTION:

SENDER'S DUE DATE:
OSTP DUE DATE: STAFF DUE DATE
DATE COMPLETED: DATE COMPLETED/DEPT:

COPIES TO: D. Allan Bromley
INTERNATIONAL/POLICY

WHITE HOUSE TRACKING #: CONTACT PERSON:
REMARKS: PHONE: EXT:

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UNIVERSITY OF MINNESOTA

4765
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Computer Science Department
4-192 EE/CScl Building
200 Union Street S.E.
Minneapolis, MN 55455-0159

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P12:34

Office: (612) 625-4002
FAX: (612) 625-0572

OSTP
MAIL ROOM

November 6, 1991

Dr. D. Allan Bromley
Science Advisor to the President and Director
Office of Science and Technology Policy
New Executive Office Building
Washington, D.C. 20506

Dr. Bromley:

This summer I was supported as a participant in the Summer Institute in Japan program sponsored by the U.S. National Science Foundation, the Science and Technology Agency of Japan, and the Japan Foundation's Center for Global Partnership. This program provided me with an invaluable opportunity to participate in research activities with Japanese scientists; observe research at Japanese laboratories in industry, government agencies, and universities; and experience Japanese culture.

I would like to thank you for your role in making this opportunity possible. My experiences in the Summer Institute in Japan have produced several important results. I have built ties and several friendships with Japanese scientists which will facilitate future collaborations with other Japanese scientists. It is likely that I will collaborate again with the scientists I worked with this past summer. Also important, I now better understand the Japanese people and their culture.

These results will clearly benefit my career as a scientist. In addition, I believe that continuing to provide such an opportunity to other young scientists will play an important role in an improved relationship between the U.S. and Japan in the future.

Sincerely,

Elizabeth Stuck

Elizabeth Stuck

"Document Control"

TYPE: INFORMATION

DOCUMENT NUMBER: 9124780

ORIGINATOR: 02

STATUS C

DIRECTORATE STATUS

FROM: MORI, Wataru: PRIME MINISTER'S COUNCIL FOR SCIENCE &
TECHNOLOGY, JAPAN

TO: DR. D.A. BROMLEY

DATE OF
CORRESPONDENCE: 11/06/91

SUBJECT: RE: HIS SATISFACTION WITH THE CARNEGIE GROUP MEETING
AND A THANK YOU TO DR. BROMLEY FOR FOR HIS KINDNESS.
PHOTOGRAPHS ARE ENCLOSED.

DIRECTORATE STAFF
ASSIGNED: ASSIGNED:

ACTION STAFF
REQUIRED: ACTION:

SENDER'S DUE DATE:

OSTP DUE DATE: STAFF DUE DATE
DATE COMPLETED: DATE COMPLETED/DEPT:

COPIES TO: D. Allan Bromley
INTERNATIONAL/POLICY

WHITE HOUSE TRACKING #: CONTACT PERSON:
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CENTRAL FILES:

4780

PRIME MINISTER'S
COUNCIL FOR SCIENCE AND TECHNOLOGY

Kasumigaseki 2/2/1, Chiyoda-ku, Tokyo, 100 JAPAN

Phone:(81)(3) 3581 1357, Fax:(81)(3) 3581 3079

RECL

CSTP
MAILED

November 6, 1991

Dr. D. Allan Bromley
Assistant to the President
for Science and Technology
Old Executive Office Building
17th Street & Pennsylvania Avenue, NW
Washington, D.C., USA

Dear Dr. Bromely:

It was very fruitful and enjoyable, for me, to join the second Carnegie Group Meeting. I believe our frank exchanges of views on science and technology policy made us progress our understanding each other. I do appreciate your every kindness shown to me during the meeting.

Please find several pictures at the meeting. They may remind you the pleasant time at Mount Kisco. Concerning the "family picture", I am sending a negative film to Dr. Beckler, from whom, I hope, will receive enlarged one in near future.

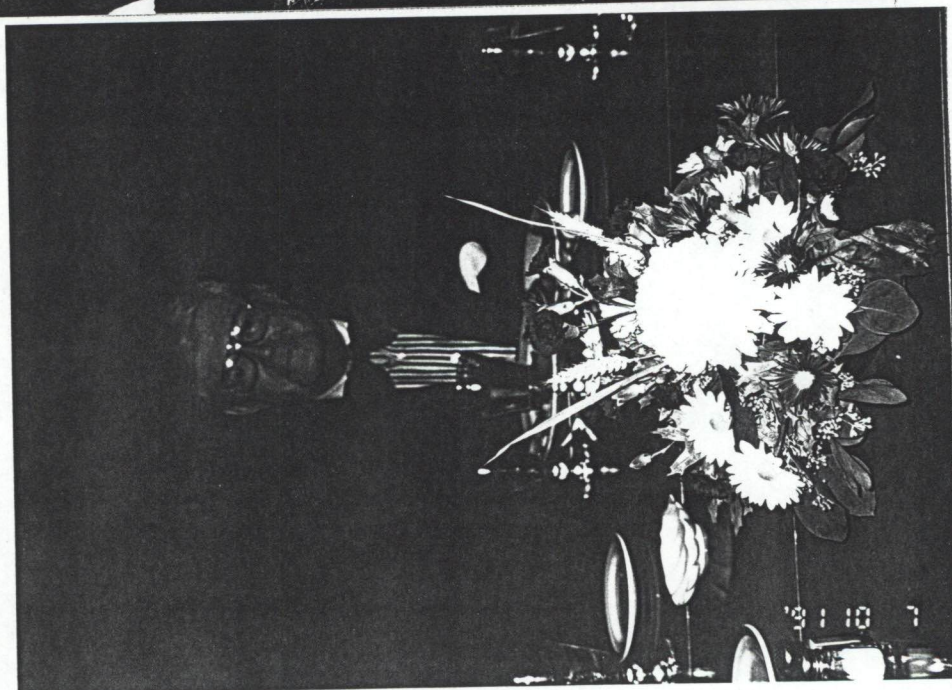
you

I am looking forward to seeing you at the next meeting.

Sincerely yours,

Wataru Mori

Wataru Mori







THE WHITE HOUSE
WASHINGTON

December 4, 1991

Dear Wataru:

It was a great pleasure to see you recently in Japan and I very much appreciated the information that you were good enough to provide.

I have not forgotten my commitment to provide a number of reports and documents to the members of the Carnegie Group and am in the process of collecting those documents at the present time. I will send you a first shipment in the very near future with the remainder to follow probably late this year or early next year as soon as the reports of the FCCSET crosscuts, developed to accompany the President's budget submission to the Congress, come off the press. This year there will be five of them in the areas of global change, high performance computing, mathematics and science education, material science and technology, and biotechnology, respectively. I believe that you will find them interesting.

I was pleased by the resolution of the Science Council of Japan following my presentation to the Executive Committee of that Council, and indeed, by the general response of everyone with whom I discussed the possible Japanese participation in the SSC.

I recognize quite clearly that it is unrealistic for us to anticipate any such participation unless we can help to develop the new funding at the highest political levels that will make it possible to have a substantial transfusion of new support into the basic research and university structure of Japan at the domestic level. This was the proposal that I made to everyone with whom I had the pleasure of meeting, and I am hopeful that when President Bush meets Prime Minister Miyazawa in mid-January, that this can be brought to a successful conclusion. I anticipate that I will be accompanying the President on that travel and will look forward to the pleasure of seeing you then.

In the meantime, let me extend my warmest best wishes that the upcoming New Year will bring you health, happiness, and every satisfaction.

Sincerely yours,

A handwritten signature in dark ink, appearing to read "Allan", with a stylized, cursive script.

D. Allan Bromley
The Assistant to the President
for
Science and Technology

Dr. Wataru Mori
Prime Minister's Council
for Science and Technology
Kasumaigaseki 2/2/1
Chiyoda-ku, Tokyo 100
Japan

"Document Control"

TYPE: INFORMATION DOCUMENT NUMBER: 9124645
ORIGINATOR: 02 STATUS C DIRECTORATE STATUS

FROM: WINCE-SMITH, Deborah: DEPARTMENT OF COMMERCE

TO: DR. D.A. BROMLEY

DATE OF
CORRESPONDENCE: 10/31/91

SUBJECT: PROVIDING DR. BROMLEY WITH A COPY OF AN ARTICLE
CONCERNING JAPAN'S RESEARCH BUDGET.

DIRECTORATE STAFF
ASSIGNED: ASSIGNED:

ACTION STAFF
REQUIRED: ACTION:

SENDER'S DUE DATE:
OSTP DUE DATE: STAFF DUE DATE
DATE COMPLETED: DATE COMPLETED/DEPT:

COPIES TO: D. Allan Bromley
INTERNATIONAL/POLICY

WHITE HOUSE TRACKING #: CONTACT PERSON:
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OSTP RECEIVED: 11/04/91 DEPT RECEIVED:
FILE: P-INTERNATIONAL-JAPAN
CENTRAL FILES:



4645

**Assistant Secretary
for Technology Policy**

DATE:

10-31-91

NOV 4 AM 43

FROM THE DESK OF:

OFFICE OF THE
DIRECTOR
Deborah L. Wince-Smith

TO: Dr. Bromley

- ☐ Per our conversation.
- ☒ For your information.
- ☐ For appropriate action.
- ☐ For draft of an appropriate reply for my signature.
- ☐ Please answer directly.
- ☐ Let's discuss.
- ☐ Please return with your comments.

Ministry calls for increase in academic research funds

The research budgets at Japan's universities should be increased to avoid a decline in the country's future vitality, the Education Ministry said Friday.

It also called for institutionalized systems in which universities can more easily utilize private-sector funds.

In the latest edition of its annual white paper on education, the ministry warned that national budgets for science and academic research were becoming inadequate to keep up with advances of recent years.

Education Minister Yutaka Inoue submitted the paper to a meeting of the Cabinet, which approved it the same

day.

The white paper, entitled "Our Educational Policy — Academic Research Contributing to the World," also says Japan needs to improve conditions for academic research in order to promote creativity and contribute to mankind's body of knowledge.

It also calls for measures to improve the quality of post-graduate education and to further strengthen fellowship systems for researchers. In addition, it urges facilitating personnel exchanges, making research organizations more flexible and mobile and promoting research cooperation between academic and industrial circles.

In order to foster international cooperation, Japan's researchers must continue contributing scientifically to the world, the report notes.

The paper also reports the findings of a survey covering more than 1,000 professors at both private and national universities throughout the country in March.

The survey indicates that the average university-affiliated research organization received ¥3.81 million for liberal arts studies and ¥10.91 million for natural science studies in 1990.

The bulk of the research funds were provided by university authorities and the Education Ministry.

Supercollider fails to garner support

Japan is continuing to decline to contribute to a multibillion-dollar U.S. project for a high-energy research supercollider. Its standoffish attitude is likely to develop into a political matter when President George Bush visits Japan in late November.

Akiko Santo, director general of the Science and Technology Agency, told a news conference Friday that the Japanese government made it clear during two days of science talks with U.S. officials that financial help is difficult at this moment because of budgetary constraints.

"We are now preoccupied with cementing the basis for Japan's basic science research," she said.

While expressing understanding of the difficulties facing Japan, the U.S. team, headed by Allan Bromley, a science adviser to Bush, commented that the project is certain to be high on the agenda during the Japanese-U.S. summit, Japanese officials said.

The U.S. side proposed the creation of a special fund in Japan to finance the Superconducting Super Collider facility now being built in Texas for \$8.2 billion.

But the Japanese team rejected the proposal, arguing that such a big outlay would constrain other projects in Japan.

The supercollider project, scheduled to be completed in

1999, involves construction of an 87 km circular tunnel, where protons would hurtle in opposite directions at near the speed of light, eventually colliding to recreate the forces present at the origin of the universe, scientists say.

Santo said the U.S. delegation did not specify the scale of funding it wants from Japan, but Japanese government sources said earlier in the week that Bush, during his November tour to Japan, could seek up to \$1.6 billion in aid.

The law that established the supercollider project requires that at least one-third of the funds come from sources outside the federal government. The state of Texas has already promised \$1 billion.

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Nov-5-91

Dear Deborah:

Thanks for the Japanese article. Things may not be so bleak, however. The Japanese Science Council has voted formally to support the concept I proposed in my talk to it in which a package deal would provide funding both for the

Japanese basic researchers in the universities and for SSC.

It would be very difficult for Miyazawa to say no to the President and the LDP has set up a formal committee to consider the SSC buy-in.

Thanks again Allan

PRIVATE

158 Donegan Avenue
E. Patchogue, NY 11772

October 28, 1991

Dr. D. Allan Bromley
Science Advisor to the President
The White House
Washington, DC 20506

Dear Allan:

I am taking the liberty of sending you a few clippings from two Japanese dailies, Asahi and Nihon Keizai Shinbun (Nikkei), re your recent trip to Tokyo and SSC. I am tempted to make a few critical comments on remarks attributed to you by David Sanger of the New York Times. However, knowing that you already have enough problems in your own backyard, it would appear prudent not to further burden you with my remarks.

After dispatching to you my letter of October 1, 1991, a MITI document "Tentative NIPT Schedule" was received. An English summary of this document, however, has not been prepared since an unreturned telephone call to Eugene Wong suggests that he now has all the information he needs on NIPT. Thus, I will suspend this part of my activities to be of service to you. If there is any other area in which I can be of use, please let me know.

With best wishes.

Sincerely yours,


Yoshio Shimamoto

YS:mck
Encl.

大型加速器の建設協力

米大統領の 訪日時協議

報道官語る

【ワシントン18日電】米大統領が、約八十二億一千萬圓の費用を要する大型加速器の建設に協力する計画を、約十八日、米政府が日本に提出している。加速器は、原子力、宇宙、医療、産業の発展に重要な役割を果す。米政府は、加速器の建設に協力する計画を、約十八日、米政府が日本に提出している。加速器は、原子力、宇宙、医療、産業の発展に重要な役割を果す。

米政府は、加速器の建設に協力する計画を、約十八日、米政府が日本に提出している。加速器は、原子力、宇宙、医療、産業の発展に重要な役割を果す。

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米政府は、加速器の建設に協力する計画を、約十八日、米政府が日本に提出している。加速器は、原子力、宇宙、医療、産業の発展に重要な役割を果す。

日経 10/19

NIKKEI

ており、米政府は日本に十五億一千萬圓の協力を期待している。プロムリー米大統領が、加速器を中心とする代表団が、米政府と、加速器の建設に協力する計画を、約十八日、米政府が日本に提出している。加速器は、原子力、宇宙、医療、産業の発展に重要な役割を果す。

加速器の運営 日米共同で

大統領補佐官が表明

日米科学技術協力協定の合同高級委員会に出席するため、米中のプロムリー米大統領補佐官は十五日、日本学術会議を訪れ、最大の懸案である加速器の建設、大型加速器（SSC）建設への日本の協力を求めた。同補佐官は「SSC運営を日本と共有に近い形で進めていきたい」と表明、資金面だけでなく、運営面でも日本側の大規模な関与を受け入れる姿勢を示した。十六日以降、関係官庁を訪れ協力を訴える。

米SSCのために 特別予算を提出 米国の米補佐官

日米科学技術協力協定の合同高級委員会のため、米中のプロムリー米大統領補佐官は十六日、在米の大統領補佐官と記者会見し、「日本政府は加速器の建設に特別な予算を提出し、一部を日本の大学研究に振り向け、残りを米国の超伝導大型加速器（SSC）計画に充てたい」と述べた。同補佐官は「SSC運営を日本と共有に近い形で進めていきたい」と表明、資金面だけでなく、運営面でも日本側の大規模な関与を受け入れる姿勢を示した。十六日以降、関係官庁を訪れ協力を訴える。

SSC資金 協力は困難

政府、米に表明へ

米政府は、加速器の建設に協力する計画を、約十八日、米政府が日本に提出している。加速器は、原子力、宇宙、医療、産業の発展に重要な役割を果す。

問題としてSSC協力をもちかけてくるのは必至。

朝日 10/12

ASAHI

朝日 10/16

ASAHI

朝日 10/19

ASAHI

史上最大の実験施設といわれる英国の超電導超大型粒子加速器(SSC)、十月初めに来日

した米國エナルギー社(ORE)代表團は日本に対し、関連施設の提供をこれまでになく強く求めた。日本の産業界の技術力を高く評価するとともに、建設資金の一部を提携提供する以外にも協力の道があることを示唆したものだ。すでに日本のメーカの中には契約をめざして車輪を磨いたところもあるが、はたして操縦があらうかが疑問視する所もある。

日本の“実績”評価

「日本には資金よりも産業界の優れた技術や装置の提供を求めたい」――米自したDOEのW・ハッパ・エメルギー研究局長は、日本関係者との会談で繰り返し訴えた。

同局長の発言の背景は二つある。SSCに関する日本企業の高い関心を評価したこと、米国のプロジェクトに多数の

米、資金協力求める

超電導大型
加速器の開発

来週に日米科技協委

日米科学技術協力協定に基づく閣僚級の第三回合同通商委員会の十七、十八日外務省で開かれる。日本から山梨科学技術庁長官ら、米国からフロリダ科学技術担当大統領補佐官らが出席する。米国側はテキサス州に建設中の超超導超大型粒子加速器

図(200)へ、日本が資金や施設の提供で協力するよう懇ねて強く求めたことだ。

委員会ではまず、基礎科学的研究をいわゆる「サイエンス」分野と応用技術など、科学技術協力により相互に力を話し合う。米国は従来から基礎科学の巨大研究プロジェクトでも800への日本の参加を求めており、協力要請は強まっている。一方、日本側は「ヒューマン・フロンティア・サイエンス・プログラム」へ米国の参加するよう要請する見込み。

2017. 10. 10

電磁石などで協力要請

政府は「無償供与」を警戒

十七億、余りを日本などからの協力でまかなうとしている。

すでに米のSCC研究所は稲の
導管中の糖液成分などの調査を

備を進めている。装束の心臓部ともいえる超常導線材の開発に参加を希望する企業を世界各国から募集し、今年に入って候補

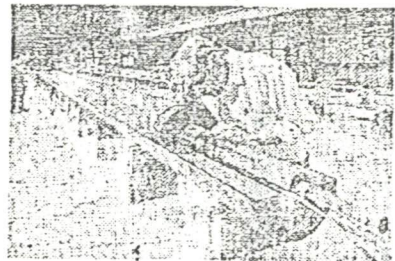
技術的波及に期待も
米国の期待も大きいわけだ

三言と云ふの材料が必要となる。試験問題を終え、九四年ころから試験問題を作成するの段

を中心になたてきえる強い政
府の科学研究費を「道する」と
協力に慎重論も強い。これまで

たいして
ている。

S.S.C.は、原子が約八十七億年という巨大なナナオツ草の実験室で、リングに浮いて数千金の太陽の超電導磁石を並べて水素の原子核である陽子を加速して、速度を加えて、物質を構成する基本単位の素粒子の研究をするものだ。物理学の基本原理の解明にもつながる。一九九九年まで、ぼてサス州に建設、総額は八十二億ドル(約一兆一千万円)強というビッグプロジェクト。米国、ただでは資金が不足するため、



米国立ブルックヘブン研究所で
試作中のSSC用超電導電磁石

が、日本のメーカーも「十分価値のある技術開発テーマ」(森田国尚・日立富城越電機技術推進本部長兼技術部部長)と取り交す。また「必要なら材料の調査も行う。これら」の品質のばらつきを拘束するには高い生産技術が必要(二宮同電工・藤本路博機務部長)と、

の日本實業會議にて、その中心への協力問題に取り付けられたが、日本は明瞭な回答を返して置た。

関係省庁も慎重

そこで今回はDOEは二日本一の科学研究を以つてつづもりはなく、確かな協力が大前提と強調した。しかし結局は政府予算にしたがふせがくることゝある文部省が、科学技術庁と関係省庁の一致を要する。

DOEの代表団に付きアダム
リ上陸が計画、十一月には
ブッシュ大統領が来日する。S
S計師への協力要請は一層強
まるみられる。最終的に協力
可能な額としては「五億」程
度、「十億」が限度」などの説
があるが、千億なら「(大統領
の)領地がつかえるだろう」と
ハッパー局長は言う。米国の「正
力」を前に「無用な摩擦も避け
たいし……」と政府は頭を抱え
ている。

基礎研究費増額を

米国立科学財団
前理事長会見

SSC、政治解決も



ブロック前理事長

だ。国の豊かさに見合う予算措置を講じているとはいえない。大学の研究にもっと投資すべきだと思う。米国の大学より日本の状況はよくない。SSCにつ

いては、こうした日本の国内事情とのバランスを判断して決めたいのではないか。一、基礎研究でも重要な課題について、政治解決の道をめぐ

ることはよくある。SSCについは計画をこなさないように配慮することが最も大切だ。ただ日本は貿易黒字の額に比べて(外国のプロジェクトへの)費用負担は少ないと思う。今後広範囲な分野で努力を払うことが求められるだろう。

一、競争力委員会は先端技術分野での米国の優位維持を訴えて三月に競争力強化のための報告書をまとめたが、これは米国内向けで、(日本など)他の国界は過去四十年間、世界のリーダーの地位を保ってきたが、今な技術について提言したわけでもない。米国の産業はそうではない。そこで、競争力強化に向け、包括的で戦略的な技術について提言したわけだ。

国際会議出席のため来日した米国立科学財団(NSF)のエリック・ブロック前理事長は日本経済新聞記者との会見に際し、日本は経済力に見合った形で基礎研究費を増額する必要があると強調した。また日米間で懸案となっている米国の超電導超大型粒子加速器(SSC)建設計画への日本の協力について、来月開かれる日米首脳会談で政治解決する可能性が大きいことを示唆した。同氏は現在、ホワイトハウスの競争力委員会特別顧問を務めている。会見要旨は次の通り。

一、日本に注ぎたいのは、まず基礎研究費を増やすこと

THE WHITE HOUSE
WASHINGTON

December 2, 1991

Dear Yoshio:

Many thanks for continuing to keep us up to date on what is happening vis-a-vis activities in Japan.

I have learned to develop a very thick skin with respect to anything said about me in the *New York Times* or, indeed, in the media anywhere. I am more and more convinced that most of these people write their stories well before they ever contact any of us in Washington and then simply listen to see whether we say anything that can be taken out of context that will support the main thrust of their already established story. A few words of support are always, however, most welcome.

You should certainly not conclude from the fact that you did not receive a return phone call from Gene Wong that your activities on our behalf are not appreciated. Gene was out of the country and has been running ragged with his new responsibilities as Associate Director for Industrial Technology, a position that he took over when Bill Phillips' health deteriorated to the point where he felt that he had to resign. I can assure you that we very much welcome your input and assistance and this is certainly true with respect to the NIPT. What we have done here is to go back to the Japanese with a very specific proposal that, instead of some kind of vague collaboration over the entire field of information technology, we focus specifically on opto electronics and mount a closely focused joint program in that area as something of a pilot activity under NIPT. This is now in the Japanese court but when I was in Japan a few weeks ago I found that the suggestion had been well received and, from all I could gather, the Japanese are prepared to take us up on our proposal.

We are, however, very much in need of the kind of input that we simply do not have that appears in Japanese publications, so I would really urge you to continue to contact us, and me in particular, whenever you run across something that you feel we might have missed.

I deeply appreciate your willingness to help and can assure you that your efforts are anything but unappreciated.

With warmest best wishes,

Sincerely yours,

A stylized, handwritten signature in black ink, appearing to read 'D. Allan Bromley'.

D. Allan Bromley
The Assistant to the President
for
Science and Technology

Dr. Yoshio Shimamoto
158 Donegan Avenue
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IN SCIENCE AND TECHNOLOGY AND AN ENCLOSED PAPER ON
THE SAME SUBJECT.

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HARVARD UNIVERSITY

CENTER FOR SCIENCE AND INTERNATIONAL AFFAIRS

Professor Lewis M. Branscomb
Director, Science Technology and Public Policy Program
Albert Pratt Public Service Professor
(617) 495-1853

91 NOV 1 11:42

John F. Kennedy School of Government
79 J.F.K. Street
Cambridge, Massachusetts 02138
Fax: (617) 495-5776

OFFICE OF THE
DIRECTOR

The Hon. D. Allan Bromley
Assistant to the President
Executive Office of the President
Old Executive Office Building
Washington, DC 20506

Dear Allan,

I will not be able to attend the meeting of the Council of Foreign Relations at which you will be speaking on U.S.-Japan relations in science and technology. If your remarks are prepared I would much appreciate a copy I could share with my students.

Perhaps you would like to see the enclosed paper on this subject that I will present Nov. 7 in Tokyo at the 100th anniversary of the Electrotechnical Laboratory, Japan's most famous national laboratory.

Best wishes,

October 28, 1991

Lewis Branscomb

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Lewis Branscomb

**100th Anniversary of Electrotechnical Laboratory
International Symposium
Technology for Humanity 21**

Asahi Hall, Yuraku-cho, Tokyo, Nov. 7 1991

**The Road from Resentment to Understanding
in U.S.-Japan Science and Technology Relations**

Lewis M. Branscomb

Center for Science and International Affairs
John F. Kennedy School of Government, Harvard University
Cambridge, MA 02138

In March of this year the United States National Institute for Standards and Technology, for its first 89 years known as the National Bureau of Standards, celebrated its 90th year of service to science and economic progress. As former Director of the still young National Bureau of Standards, it is an honor for me to salute our senior colleague -- the ETL -- for 100 years of equally distinguished service. For almost a century, these two laboratories have played a central part in each nation's most remarkable achievement: the maturing of science as an instrument of human progress.

On this ceremonial occasion it is fitting that we should celebrate the achievements of Japanese science and technology and look ahead to the leadership role Japan will play in international science. As noted by Prof. Kikuchi, our panel coordinator, international harmony in science and technology depends on mutual respect and the elimination of sources of misunderstanding and friction. I have never experienced friction or mistrust among scientists in our two countries, nor have I heard Japanese scientists suggest difficulties in scholarly relationships with their peers in the U.S.

But we all know that the press reports and political speeches are often filled with recriminations about the other country -- recriminations that I believe are largely ill-founded and reflect a lack of understanding on each side about the other's history, culture, and achievements. With the end of the Cold War, Americans are beginning to redefine their notion of national security along economic and environmental lines. The 50th anniversary of Pearl Harbor in December will provide an opportunity to put militarism and hostility behind us and engage the new world order -- in which Japan plays a strong international role -- with optimism and confidence. This symposium can help direct history in that direction.

It is unnecessary to describe to this audience how information technology has accelerated the international diffusion of technology and created a global economy.¹ No nation should attempt to be technologically self sufficient; that is no longer a sensible goal. It must be possible for nations to cooperate and compete simultaneously; this requires a degree of

harmony and acceptance of a common set of rules of behavior in trade has not yet been achieved.² It is against that background that technology friction becomes a serious practical obstacle to progress, as well as a source of political disharmony.

The first step in addressing technology friction is an informed and constructive discussion. There have been many excellent contributions to this dialogue from both sides of the Pacific.³ If my comments are too direct or too frank for this ceremonial occasion, I ask your forgiveness in advance. Take it as another illustration of the need for sensitivity to another nation's culture.

Revolutionary change in the science, engineering, and innovation.

For most of the century, the power of science to explain the behavior of matter was limited to the simplest forms and processes. It was not until the second half of the century that the atomic and molecular structure of matter was understood, and for many years after its discovery, the quantum theory of matter could not give exact results for any atoms more complex than atomic hydrogen. The structure of chemical elements and the concept of valency were known, but chemical kinetics remained highly empirical until well after World War II. Biological knowledge remained largely descriptive until molecular biologists unravelled the genome and revolutionized understanding of the nature of life processes.⁴

Engineering became quantitative and capable of predicable results only after it acquired a science base, and science had to mature first. Even today, large domains of engineering still depend on "imbedded" knowledge, gained through experience. But the maturing of science, the development of computers, and the appearance of better ways to manage innovation have made possible extraordinary advances in the ability to put science to work for humanity.

These advances rest on the contributions of the people of many nations, and have accumulated over many centuries. Historically, we acknowledge Europe as the source of modern physics, which led to the industrial revolution. But looking further back in history we acknowledge the contributions of Babylon and of Islamic culture to mathematics. Today scholars are gaining new respect for the technical innovations of early Chinese society. In the post world war II period, however, Japan and the U.S.A. have led the way to the new knowledge-based economy, with Europe close behind.

The post-war American science and technology pipeline.

It is not surprising that after the war the U.S. dominated the free world's science and technology. It was the only major industrial nation on either side of the war whose homeland was not devastated. The source of America's post-war achievements in science were: a huge domestic market, few serious competitors in the commercial application of the new technologies, a military threat from the Soviet Union which drove U.S. defense technology to the limits of scientific capability, an influx of talent from both Europe and

Asia, and a culture that rewards individual creativity and initiative.

Driven by these forces and a strong economy, the U.S. science and technology investments exceeded the sum of those of its principle economic competitors. In 1960 fully one third of all the R&D, public and private, invested by all of the industrial democracies, came from a single source: the United States Defense Department. With little high-tech commercial competition until the middle 1960's, U.S. firms could patiently wait for the fruits of public research to find their way into new industries.

Given the high level of science and technology investment, and the strong economy that it sustained until the mid-1980's, there was no reason for government to question its *laissez-faire* attitude toward the promotion of commercial industry, or its reliance on the "pipe-line" model of innovation. The "pipeline model" assumes that science is the primary driver of innovation, and that the process is sequential from research, to development, to pilot production, to manufacturing. It became the paradigm that justified public investments in academic basic science and restricted government development of technology to the requirements of government missions only.⁵

On the positive side, this policy allowed the U.S. to develop its universities into extraordinarily productive sources of pure and "engineering science," and of what is now being called "generic" (non-product specific) technology. American universities, with strong encouragement from government, have developed a wide range of mechanisms for collaboration with industry and for spinning off new companies that accelerate the commercialization of new science.⁶

But American industry was too slow to capitalize on science-based engineering to modernize production processes. As a result, the high tech component of the U.S. economy began losing market share to Japan as early as the late 1960's⁷. U.S. industry has not lost the capacity to innovate; it has too often failed to apply its best technical skills to the "down stream" technologies that assure low cost, high quality, and rapid response to market signals. Japanese manufacturing engineers make incremental product improvements in the factory; in most U.S. firms changes in requirements go back to development for another time-consuming trip through the pipeline.⁸

Japanese innovations in technology and industrial innovation.

Thus, Japanese industry has shown the world a better way.

The Kanban production system, for example, is now widely emulated in the U.S. In many Japanese firms some of the most talented engineers working on process development and production systems; in U.S. firms the best talent is usually found in the research laboratory, thinking about new products.

Japanese industry also shed itself of the mass production paradigm that dominated U.S.

business and engineering schools from the 1930's to the 1970's. Called "Taylorism," after Frederick W. Taylor, the founder of "scientific industrial management" in the 1890's, it emphasized the disaggregation of tasks into elemental units, and maximization of the efficiency of each.⁹ Japanese production management methods are far better suited to the world of flexible manufacturing automation, to assuring quality through process control rather than testing, and to using the skills of a well educated and motivated workforce.

Another innovation from Japanese industry is what I call the strategy of "trickle-up" technology development. This is the introduction of new technology first into consumer products, mastering their production in high volumes for applications that demand only modest performance. Then, by following a "functional learning curve," rather than a cost-driven learning curve, the technology is introduced to more demanding and more profitable applications. For example, liquid crystal displays and low power CMOS circuits found their first growth markets in wrist watches; today they are dominant in segments of the computer industry. This approach can result in much lower costs and more rapid production scale up than the "trickle down" approach common in the U.S. and Europe.

Prof. Fumio Kodama has analyzed in some detail a number of indigenous Japanese innovations, such as "demand articulation," "technology fusion," "thinking organization," and "technology diversification."¹⁰ In Kodama's view many of them were not consciously invented by management experts, but rather represent the codification of practices that arose naturally out of a serendipitous fit of Japanese cultural attributes to the emerging capabilities of science and engineering. Nevertheless, they constitute as great a gift to industrial progress as does the American developing universities as sources of technical knowledge, or the mastery of complex systems analysis and management. Both Americans and Japanese should hold each other's innovations in high esteem.

Unfortunately, and despite the complementary character of Japanese and American contributions to scientific and technological progress, the press of each country reports recriminations where admiration would be more appropriate. While both sides should realize that the friction is discussed more in news rooms and political bodies than in board rooms or laboratories, it continues to impede the mutual respect that is required for the coexistence of cooperation and competition. The world's two preeminent technological and industrial powers, together with Germany and other industrial democracies have much to contribute to sustainable, international development, and to the maintenance of peace and harmony.

Sources of misunderstanding in U.S.-Japan S&T relations.

What might be the sources of these misunderstandings?

First, we should recognize the rapidity with which circumstances have changed. Every nation views the present through the perspective of the past. Japanese remember the hardships of post-war reconstruction, and properly see their industrial success as an

extraordinary triumph of national will and hard work. It must be painful to hear foreigners call this achievement "free riding." It must be equally annoying that foreigners often fail to acknowledge the progress Japan has made in opening its markets and reducing the role of government in managing trade.

Americans, on the other hand, remember the years after the War when its science was treated as a national asset to be shared with our friends in the interest of political solidarity. In the 1950's and 1960's, "Atoms for Peace" and "Green Revolution" were central to government science policy; few were concerned about the possible loss of competitive advantage in commerce. Nevertheless, once U.S. firms were seriously challenged by Japanese competitors, politicians who viewed the science "pipeline" as a source of industrial competitiveness easily came to see the openness of American science as an unreciprocated act of economic generosity.

In the last decade the U.S. has gone from the world's banker to its largest debtor. Whether this fact was due to politically encouraged self-indulgence and unwillingness to pay taxes, or was due to the accumulated burdens of Cold War security, it is a fact that most Americans now believe that Japan has fully recovered from the War and is America's equal -- if not her superior -- in economic power. It is easy for those Americans to resent restrictions on entry to Japanese markets that persist long after they are justified. Finally, let me admit that many Americans are prone to a quite common human failing: looking for someone else to blame for one's own shortcomings.

These sources of misunderstanding and resentment on both sides are, unfortunately, compounded by failures on each side to understand how public decisions are arrived at in the other country. This cultural barrier to understanding is best illustrated by the regrettable controversy over the FS-X aircraft.

Many Americans fail to appreciate the strains and complexity of the processes through which Japanese society arrives at national consensus. Because Japanese do not display their differences publicly, Americans may assume that consensus is easily achieved in Japan, and that conflicting views are not strongly held or vigorously defended. On seeing a widely-held consensus finally emerge, those Americans may also assume that the consensus can just as easily be changed. Thus Americans unfamiliar with Japanese ways were ill-prepared for the distress felt in Japan when the Commerce Department, under pressure from Congress, asked Japan to renegotiate an FS-X agreement they had already renegotiated once with the U.S. Department of Defense.

On their side, many Japanese who are unfamiliar with the U.S. political institutions may have seen the Commerce Department objections to the agreement already made by Defense as the behavior of an unreliable friend whose word cannot be trusted. But they may not understand that in the U.S. government "no one has the last word."¹¹ Only a treaty, signed by the President, ratified by the Senate, and ruled constitutional by the Courts, can be said to be truly binding.

Furthermore, much of the American exaggeration of the role of MITI as the source of industrial achievements in Japan is actually a reflection of envy, not of resentment. For pointing to Japanese government policy is often a tactic American economic liberals use to put pressure on their conservative politicians to address U.S. competitiveness issues with more enthusiasm. This effort to get U.S. policy to look more Japanese simply elevates political pressure against those same policies in Japan.

The truth is that most Americans admire Japanese achievements, as I believe Japanese admire many things American – if not our politicians, at least our many golf courses, and perhaps other features of American life. Virtually every American business executive has studied Japan's management innovations, and thousands of firms have been working hard at emulating them. The Baldrige Award is given by the U.S. government to firms that most successfully adopt Japanese strategies for quality assurance. It has attracted at least as much attention in America as the Deming Award does in Japan. Japanese should also take note that more U.S. state Governors have offices in Tokyo to encourage trade than have offices in Washington to seek trade protection.

Sources of strength in U.S.-Japan S&T relations.

Trade disputes are not an appropriate way to work out differences over matters of science and technology. Trade matters must be dealt with, but trade negotiations deal with perceptions of power and the quest for economic advantage. These are not the coin of discourse about relations in science and engineering. I believe it is time to look ahead to find the sources of strength in U.S. - Japan relations in science and technology. Improved relations can draw strength from four sources:

- 1) A growing complexity of strategic alliances and market relationships between U.S. and Japanese firms, reflecting the globalization of technology and the leverage of specific technological comparative advantage. Soon products made in every country will include components and ideas drawn from international sources.
- 2) There is increasing recognition that national treatment of industrial firms should be based on their acceptance of the obligations of good citizenship in the country of location, and not based only on the location of the corporate headquarters or ownership.¹² Honda Corporation is preparing to export automobiles manufactured in Marysville, Ohio, to France. The picture of U.S. government officials insisting that the French government accept these cars as American products puts an entirely different cast on U.S.- Japan trade frictions.
- 3) Japanese firms are building new industrial research laboratories in the U.S. This is a sound move on several grounds, and its positive contribution to good relations will soon become evident. Americans will welcome this reinvestment in the U.S. technical knowledge base. Technology is a driver of good science, as well as a beneficiary of scientific discovery. Japanese firms that bring their excellent technology to their U.S. research laboratories will help expand opportunities for American scientists and engineers, and contribute to cultural

as well as technical interchange.

4) At the heart of good relations lies the traditionally international ethos of science. All nations benefit when non-proprietary science research flows freely, and scientists are able to travel to one another's laboratories and collaborate whenever they wish. The value of interchange at the level of basic science goes far beyond the sharing of the responsibility for contributing to the advance of human knowledge about the natural world. The experience at collaboration and the mutual respect that these relationships engender will facilitate understanding in many ways.

These transoceanic linkages in basic science have existed for 70 years across the Atlantic. They have created channels of communication and mutual respect that have enabled Ministers of Science and Technology who grew up in this world of international science to deal with the science and technology dimensions of trans-Atlantic trade friction. Political differences are not eliminated as a result, but they do not spill over into the world of science and technology as much as they otherwise might.

When American scientists express the hope that the Japanese government will be more liberal with financial support to science research in Japanese universities, their motive is respect for Japanese intellectual ability and the desire to expand the opportunities for collaboration. It has little to do with trade issues. As noted before, the pipeline that takes new science to market is quite long. American scientists do not see Japanese university science as inaccessible, except to the extent that Americans have not mastered the Japanese language. They do recognize that the balance of emphasis on engineering and on science is quite different in Japan and the U.S. The ratio of doctorates in physics and in engineering is almost 10 times higher in the U.S. than in Japan.

"Symmetrical Access"

In my view the debates over "symmetrical access" have not been very helpful in the quest for understanding the imbalances that tend to destabilize science and technology relations. While I am sure that the officials who discuss symmetrical access in bilateral meetings understand the issues, the public is undoubtedly confused.

There are few barriers to access within universities in either country. But the benefits of access are not symmetrical if one side chooses to invest substantially less than the other. There are, of course, strong proprietary barriers to access in commercial firms in all countries. Neither government should, in my view, interfere in the decisions of private firms about what to share and what to hold closely. But it is appropriate for both countries to commit themselves to the removal of inappropriate and unnecessary barriers to exchange of technical knowledge. This, it seems to me, is what symmetrical access should mean.

To take a few examples, Americans should give up the attempt to control the diffusion of unclassified, dual use (civil and military) knowledge, even when it is thought to be "sensitive"

in relation to possible defense applications. The Japanese government might recognize more clearly that Americans, having recognized the shortcomings of the pipeline model of commercialization, are eager to capture the benefits of applied technology. They will not be happy to accept a division of labor in which Americans do the science and Japanese develop its industrial applications.¹³

There is, however, one remaining source of strain in how the concept of "symmetrical access" is interpreted. This is in the grey area between pure science on the one hand and proprietary knowledge on the other. A great deal of ambiguity attaches to the words "basic research." There is a large body of industrially useful technical knowledge that shares with basic research the properties that economists attribute to a "public good." Examples of such knowledge would include characterization of new materials, advanced test methods, concepts for automated design, and scientific instrumentation. Research in these areas is often performed at public expense in universities and national laboratories, such as ETL and NIST. The knowledge is often published, for, as economists would say, its appropriability is low and the social returns from its use large. But similar work is done in industry, where it may be kept proprietary, and in universities where it is a means to the end of exploring more basic scientific questions.

Since there is no general agreement on such "generic" or "infrastructural" knowledge, and how it should be treated in international relationships, there is ample opportunity for differences to arise. It is important, I believe, to try to distinguish the types of technical knowledge as they relate to national interests in economic competition and in scientific cooperation. Attempts to do so have been made, but the ideas are at an early stage and have not yet won general acceptance.¹⁴ Universities will generally publish all their work, and industrial firms will make their own decisions on what to release. But if governments have significant differences in what they consider "basic" and what they consider "strategic" friction between the countries is sure to result.

An even more fruitful approach than symmetrical access, however, is to focus on stronger mechanisms for collaboration, emphasizing those mechanisms that depend least on participation by governments.

A few years ago I suggested in an address to the Engineering Academy of Japan that both sides would benefit from a collaboration of two U.S. and two Japanese schools of engineering in research on the manufacturing systems of the future.¹⁵ The opportunity to build on the best practical experience with new conceptual approaches, now being studied by Prof. Yoshikawa at Tokyo University and by his counterparts in the U.S., could be of fundamental importance to economic efficiency and to engineering education everywhere.

The IMS project that was advanced by Japan is responsive to this opportunity. The U.S. government apparently felt that the proposal should have been discussed first in government channels before private universities or firms were approached. In my experience the most effective forms of technical collaboration arise from the initiative of the parties that wish

to work together, without the need for government participation. Projects initiated or coordinated by governments are often burdened by extraneous political and bureaucratic baggage.

But unless the governments on both sides are prepared to provide generous financial support for such projects, without insisting on managing the negotiations, it is impossible for researcher-based initiatives to advance. Given the political sensitivities of U.S. - Japan technical relationships today, that may be a lot to ask. But it is the pattern of U.S. bilateral relations with virtually all the industrial democracies, and it should be the goal of U.S.-Japan relations. Americans have only to compare U.S. - U.S.S.R cooperation in science in the past with U.S.- European projects to know what a profound difference scientist-based initiatives can make.

This brings me to my final point, which concerns those large science and engineering projects that cannot be managed by scientists without direct government involvement. I have in mind high energy physics facilities, space research, fusion energy, oceanography, and Antarctic projects as examples. Here Europe, Japan, and North America, as well as the smaller nations, share a desire for access to the best facilities for scientific research and none can easily afford the total cost.

One approach is the multinational consortium, of which the European Center for Nuclear Research (CERN) is the best known and perhaps the most successful. Creation of such institutions requires long and tedious negotiation, but it is sometimes necessary when the critical requirement is scale rather than diversity of scientific approaches.

Prof. Kodama has proposed an "option sharing" approach.¹⁶ In the early phase of the development of large projects, scientists in each nation would pursue a scientific approach of their own choosing, to be explored on an affordable scale. International agreement on two points would be sought in advance. First, all information about each approach would be open to the scientists pursuing complementary projects in other countries. And second, as each project matures, scientists could elect to work in the project of their choice, regardless of national location.

This idea combines the need for scientific autonomy and decentralization with the virtues of sharing and avoidance of unnecessary duplication. The idea needs only one addition: In the case of projects like the super collider, where the scientific value of scale outweighs the merits of diversity of options, prior agreement would be sought for sharing costs and tasks to implement the technical principles of the most successful option as a truly international facility.

With the collapse of Cold War, and now the collapse of communism, the Japan, the United States, and Europe must shift their attention to economic growth in the third World, to the reconstruction of the USSR and Eastern Europe, and to the preservation of the Earth's environment. For these tasks, the best industrial performance and the best science and

technology must be mobilized.

The U.S. and Japan must see each other's skills and assets as different but complementary. As Harold Brown has noted, "Japanese move slowly in a consistent direction; Americans move quickly in all directions at once. But we often arrive at about the same place." Rather than disparaging one another, and viewing our trade competition as a "zero sum game," we need to think about how we and other nations can work together to achieve these new objectives. In my view the scientific communities of Japan and the U.S. are more than ready to work together to that end. Harmonious relations in science and technology must ultimately rest on cooperative initiatives by scientists and engineers themselves, with government support but minimal interference. But governments must create the conditions that make that possible.

ENDNOTES

1. L. M. Branscomb, "Technological Change and Its International Diffusion", *Global Structural Change*, Mark Perlman, ed., Washington DC: American Enterprise Institute, 1987.
2. Sylvia Ostrey, Governments and Corporations in a Shrinking World, New York: Council on Foreign Relations Press, 1990.
3. See for example, Kiichi Saeki and Shigetaka Seki, Cooperation and Conflict: Thoughts on U.S.-Japan Science and Technology Relations, (Tokyo: International Institute for Global Peace, IIGP Policy Paper 62E, May 1991.)
4. A summary of the evolution of science and engineering from descriptive to predictive during this century is given in a "tongue in cheek" paper by L.M. Branscomb, "Science in 2006", American Scientist November-December, 1986, pp 650-658.
5. L. M. Branscomb, "Toward a U.S. Technology Policy," ISSUES in Science and Technology, volume 7, Number 4, pp 50-55, Summer 1991.
6. L.M. Branscomb, "IBM and U.S. Universities -- An Evolving Partnership," IEEE Transactions on Education, Vol. E-29, No. 2, Pp. 69-77 (May 1986).
7. R. Gilpin, Joint Economic Committee Report, Washington DC: U.S. Government Printing Office, 1972.
8. Ralph Gomory, Harvard Business Review
9. The late John E. Gibson, Department of Systems Engineering, University of Virginia has written on this subject.
10. Fumio Kodama, Analyzing Japanese High Technologies, London: Pinter Press, 1991.
11. Prof. Raymond Vernon of Harvard's Kennedy School of Government insists that one cannot refer to "the U.S. government policy." He notes that the separation of powers inherent in the U.S. Constitution was designed to prevent any of the three branches of government from dominating either of the other two. Thus the Administration can adopt a policy in all sincerity, only to see the Congress pass laws contravening the policy, or see the Supreme Court ruling the policy contrary to constitutional law.
12. R. Reich, "Who's Us?" Harvard Business Review, Jan-Feb., 1990, pp. 306-307.

13. Suggestions to that effect are reported to have been made informally in discussions of the New Earth 21 project.

14. J. Alic, L.M. Branscomb, H. Brooks, A. Carter, and G. Epstein, Beyond Spinoff: Military and Commercial Technologies in a Changing World, Boston MA: Harvard Business School Press, to appear early 1992.

15. Can I find a reference to my talk and its date?

16. Fumio Kodama, The Japan Economic Journal, Feb. 3, 1990.

THE WHITE HOUSE

Nov. 4, 91

Dear Leo:-
Concerning the talk I gave to the
Science Council in Japan, I was
delighted to learn recently that the
Council has passed a resolution
in support of my proposal on page 9.
I will go with the President back

D. ALLAN BROMLEY

Assistant to the President for Science and Technology

Executive Office of the President

Science Council of Japan

October 15, 1991

Tokyo

BAKER, WORTHINGTON, CROSSLEY, STANSBERRY & WOOLF

ATTORNEYS AT LAW

601 PENNSYLVANIA AVENUE, N.W., SUITE 600
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KNOXVILLE, TENNESSEE
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JOHNSON CITY, TENNESSEE
HENDERSONVILLE, TENNESSEE

VIA FAX

October 18, 1991

Dr. Allan Bromley
Assistant to the President
for Science and Technology
Office of Science and Technology Policy
Old Executive Office Building
17th Street & Pennsylvania Avenue, N.W.
Washington, D.C. 20506

Dear Dr. Bromley:

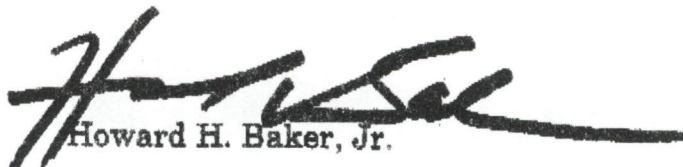
I understand that your office will soon select those institutions that will participate in the conference on the development of a New Information Processing Technology (NIPT) sponsored by Japan's Ministry of International Trade and Industry. This is to ask that you consider the selection of the University of Tennessee to participate in this conference.

As you can see from the attached, the University's Department of Computer Science has been active in establishing research and development relationships with Japanese laboratories. In particular, the University believes that their research of "emergent computation" pursued by Professor Bruce J. MacLennan would be a most appropriate inclusion in the NIPT program.

I would be most grateful if you would give to this proposal your favorable consideration.

With very best wishes,

Sincerely,


Howard H. Baker, Jr.

Attachment

THE UNIVERSITY OF TENNESSEE



October 3, 1991

Office of the President
800 Andy Holt Tower
Knoxville 37996-0180
Telephone (615) 974-2241
Fax (615) 974-3753

Senator Howard Baker
c/o Baker, Worthington, Crossley,
Stansberry & Woolf
900 South Gay Street
Knoxville, TN 37902

Dear Howard:

The Department of Computer Science at UT Knoxville is attempting to establish research and development relationships with Japanese laboratories. Through our discussions with Japanese officials, we have learned that we have a strong mutual interest in the New Information Processing Technology (NIPT) program. We believe that your experience and business relationships with the Japanese and your knowledge of the cognizant federal offices of our government could be of significant help as we seek to participate in NIPT-funded activities.

Specifically, we seek to have included in the NIPT program the research on "emergent computation" pursued by UT Professor Bruce J. MacLennan. It is our understanding that OSTP soon will be appointing a working team to visit Japan November 5-8, 1991, for the purpose of discussing and determining the joint venture research proposals that may be funded by NIPT. Any assistance you might provide in securing the appointment of Professor MacLennan to this team would be valuable to us.

Thank you so much for your continuing support of UT.

Sincerely,

A handwritten signature in dark ink, appearing to read "Joe".

Joseph E. Johnson
President

This memo summarizes participation by the Computer Science Department at the University of Tennessee, Knoxville, in the MITI-sponsored project to develop a New Information Processing Technology (NIPT):

1. Prof. MacLennan was invited to be a panalist at the *International Symposium on New Information Processing Technologies '91*, or *NIPT '91*, in Tokyo, March 13-14, 1991. (Abstract, text of talk and transparencies attached.)
2. While in Tokyo Prof. MacLennan discussed the NIPT project and his own research with scientists and administrators at Mitsubishi Electric, Toshiba, Hitachi Central Research Laboratory, MITI, and the Institute for Supercomputing Research. (See attached trip report for details.)
3. In May 1991 Prof. MacLennan met with three representatives of Toshiba (Yano, Kadoya, Ishihara) and described his research.
4. In May 1991 Prof. MacLennan submitted a draft proposal, "Foundations of Flexible Information Processing" (attached), to MITI for their comments.
5. In June 1991 Prof. MacLennan submitted essentially identical draft proposals to Toshiba, Hitachi, Mitsubishi Electric and Canon.
6. In August 1991 Prof. MacLennan developed a draft proposal for \$20M (over five years) to fund an *Emergent Computation Research Laboratory* at UTK to pursue basic research required for NIPT. (See "Concept Paper" and "Proposal," attached.)
7. Prof. MacLennan was invited to write an article (attached) for publication in *Vector Register*, the journal of the Institute for Supercomputing Research (Tokyo). It will appear this year.
8. On September 30 Prof. MacLennan will attend the NEDO/UT sponsored symposium and workshop, *The United States and Japan: Exploring New Initiatives in Research and Technology Development and Applications*.
9. On October 7 Prof. MacLennan will host Dr. M. Arai, Chief Research Scientist, Toshiba Systems and Software Engineering Lab. to discuss NIPT-related research.
10. Prof. MacLennan will give an invited talk (abstract attached) on his NIPT-related research at the *Fifth ISR Workshop* (December 10-12, 1991) of the Institute for Supercomputing Research (Tokyo).

Bruce MacLennan
Associate Professor
Computer Science Department
University of Tennessee, Knoxville
September 25, 1991

NIPT '91 Secretariat
Japan Information Processing
Development Center
Kikai-Shinko Bldg.
3-5-8 Shibakoen, Minato-ku
Tokyo 106 Japan
Phone: (03) 3432-5405
Fax: (03) 3431-4324

March 27, 1991

Dear Professor MacLennan:

Thank you for joining us as a panelist in the "International Symposium On New Information Processing Technologies '91" held in Tokyo on March 13 and 14. We very much appreciate that you accepted our invitation despite your busy schedule. The Symposium was very successful - more than 450 people participated from Japan and overseas.

This Symposium was planned during the Gulf crisis and the war that broke out eventually. When thinking of the seriousness of the situation, we cannot express how fortunate it was that the war ended early and the Symposium was held in joy amidst restored peace.

The results of our research and survey reported at the Symposium will be the base of further studies in an international program expected to begin in the near future for the development of new information processing technologies. We hope you will also be interested in this program and anticipate your suggestions and future cooperation.

Thank you and sincerely,



Kinko Yamamoto
Managing Director

OSTP STAFFING SHEET

Response to ltr from former Sen Howard Baker

SUBJECT:

ORIGINATOR: DAB probably asked Dr. Wong to draft a response

ORIGINATOR:

PHONE: _____ 3902

DATE ORIGINATED: Oct 18, 1991 BY FAX from Baker DATE DUE

to be assigned

DATE ORIGINATED: _____ DATE DUE: _____

CORR TRACKING NO.:

EXTERNAL COORDINATION: none required

			COMMENTS	DATE
DIRECTOR				
CHIEF OF STAFF				
GENERAL COUNSEL			<i>Ky Is this letter responsive? Should we refer the Senator on to someone who has the responsibility of selecting?</i>	<i>10-23-91</i>
EXEC. ASST.			<i>looks great!</i>	<i>10-24-91</i>

ACTION REQUESTED:

DAB signature; return to Sally Sherman for
dispatch and logging into correspondence system

10/25 Mary Smit: I faxed ltr. to Sen. Baker as well as making hard copy. Sally Shern

[illegible]

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF SCIENCE AND TECHNOLOGY POLICY
WASHINGTON, D.C. 20506

October 24, 1991

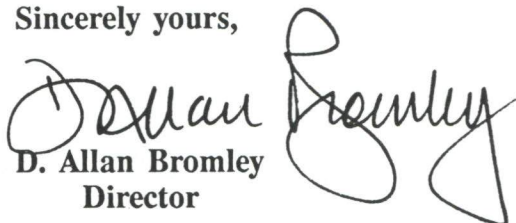
Dear Senator Baker:

Thank you for your letter of October 18, 1991, concerning the participation of the University of Tennessee at a MITI workshop in Japan.

MITI has made it clear that NIPT is a domestic Japanese program, but one with a significant international component. Based on this understanding, an inter-agency group led by Eugene Wong of my office is developing with MITI a suitable model for the international component of NIPT, and good progress has been made. We consider the workshops scheduled for November 5-8 to be part of the domestic portion of NIPT, and MITI will decide whom to invite. However, we think that any substantial participation by American researchers in the workshops will undermine the effort to jointly develop an international component and be consistent with the oft-stated claim by MITI that NIPT is a domestic program, and we have made our views known to MITI. Under the circumstances, I regret that I am not able to help in securing an invitation for the University of Tennessee to participate in the NIPT workshops.

With best wishes,

Sincerely yours,


D. Allan Bromley
Director

The Honorable Howard H. Baker, Jr.
Baker, Worthington, Crossley, Stansberry and Woolf
801 Pennsylvania Avenue, N.W.
Suite 800
Washington, D.C. 20004

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF SCIENCE AND TECHNOLOGY POLICY
WASHINGTON, D.C. 20506

October 24, 1991

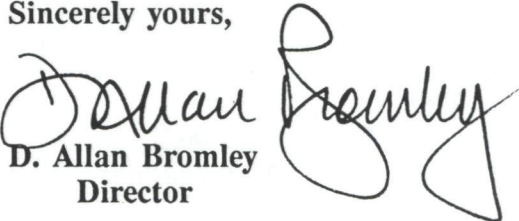
Dear Senator Baker:

Thank you for your letter of October 18, 1991, concerning the participation of the University of Tennessee at a MITI workshop in Japan.

MITI has made it clear that NIPT is a domestic Japanese program, but one with a significant international component. Based on this understanding, an inter-agency group led by Eugene Wong of my office is developing with MITI a suitable model for the international component of NIPT, and good progress has been made. We consider the workshops scheduled for November 5-8 to be part of the domestic portion of NIPT, and MITI will decide whom to invite. However, we think that any substantial participation by American researchers in the workshops will undermine the effort to jointly develop an international component and be consistent with the oft-stated claim by MITI that NIPT is a domestic program, and we have made our views known to MITI. Under the circumstances, I regret that I am not able to help in securing an invitation for the University of Tennessee to participate in the NIPT workshops.

With best wishes,

Sincerely yours,


D. Allan Bromley
Director

The Honorable Howard H. Baker, Jr.
Baker, Worthington, Crossley, Stansberry and Woolf
801 Pennsylvania Avenue, N.W.
Suite 800
Washington, D.C. 20004

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF SCIENCE AND TECHNOLOGY POLICY
WASHINGTON, D.C. 20506

October 24, 1991

Dear Senator Baker:

Thank you for your letter of October 18, 1991, concerning the participation of the University of Tennessee at a MITI workshop in Japan.

There has been some confusion on the role of my Office in determining who should be invited to the workshop. One of my colleagues, Dr. Eugene Wong, has coordinated an effort to select four U.S. government officials as observers at the workshop, but we have not been involved in selecting the attendees in any other way.

With best wishes,

Sincerely yours,

D. Allan Bromley
Director

The Honorable Howard H. Baker, Jr.
Baker, Worthington, Crossley, Stansberry and Woolf
801 Pennsylvania Avenue, N.W.
Suite 800
Washington, D.C. 20004

MITI has made it clear that NIPT is a domestic program, but one with a significant international component. Under the auspices of the U.S.-Japan S+T Agreement, we have been engaged in discussion about developing

"Document Control"

TYPE: INFORMATION

DOCUMENT NUMBER: 9124419

ORIGINATOR: 02

STATUS C

DIRECTORATE STATUS

FROM: TOLL, John S.: UNIVERSITY OF MARYLAND

TO: DR. D.A. BROMLEY

DATE OF
CORRESPONDENCE: 10/12/91

SUBJECT: A LETTER ADVISING DR. BROMLEY TO MEET WITH ICHIRO
OZAWA WHILE IN JAPAN.

DIRECTORATE
ASSIGNED:

STAFF
ASSIGNED:

ACTION
REQUIRED:

STAFF
ACTION:

SENDER'S DUE DATE:

OSTP DUE DATE:
DATE COMPLETED:

STAFF DUE DATE
DATE COMPLETED/DEPT:

COPIES TO: D. Allan Bromley
INTERNATIONAL/POLICY

WHITE HOUSE TRACKING #:

CONTACT PERSON:

PHONE:

EXT:

REMARKS: LETTER WAS ORIGINALLY FAXED TO DR. BROMLEY ON 10/12/91.

OSTP RECEIVED: 10/16/91
FILE: P-INTERNATIONAL-JAPAN

DEPT RECEIVED:

UNIVERSITY OF MARYLAND SYSTEM

DEPARTMENT OF PHYSICS & ASTRONOMY

College Park, Maryland 20742-4111

Chancellor Emeritus
Professor of Physics



OFFICE OF THE
DIRECTOR

4419
91 OCT 16 A 8:39

RECEIVED
(301) 405-6051

October 12, 1991

Dr. Allan Bromley
Science Advisor to the President and
Director, Office of Science and Technology Policy
Old Executive Office Building
Washington, D. C. 20506

Dear Allan:

I hope that this message reaches you before you leave for Japan. Your strong advocacy of Japanese contributions of key components for the Superconducting Super Collider can be the crucial step in persuading Japan to make a substantial commitment, and this in turn can be extremely effective in ensuring strong Congressional support next year. We are grateful to you for featuring the SSC as a key part of your visit to Japan.

The specific purpose of this letter is to relay to you that my Japanese contacts have just told me it is extremely important that you and Henson Moore get an appointment to see Ichiro Ozawa while you are in Japan, even if it is only for ten minutes. Ozawa was a key supporter in the recent selection of Miyazawa to become the next Prime Minister of Japan. Furthermore, Ozawa is chairman of the LDP Global Participation Committee. The LDP is the leading party which controls the Japanese diet and selects from among its members the Prime Ministers. Ozawa has long been a key figure in the LDP but now is in a particularly important position. You may see him anyway in a group but you might not because the transition in government will not occur until after your visit. It is really important in any case that you try to arrange a personal visit with him.

I hope that this suggestion reaches you in time. With many thanks for all that you do,

As ever,

John S. Toll
Chancellor Emeritus and
Professor of Physics and
President, Universities Research Association

JST:mmr
cc: Dr. Ratchford

Confirmation - Letter originally sent by FAX - (202-395-3261) October 12, 1991

"Document Control"

TYPE: INFORMATION DOCUMENT NUMBER: 9124322
ORIGINATOR: 02 STATUS C DIRECTORATE STATUS

FROM: WHITE, Robert M.

TO: DR. D.A. BROMLEY

DATE OF
CORRESPONDENCE: 10/04/91

SUBJECT: THANK YOU LETTER FOR INVITATION TO THIRD HIGH LEVEL
JOINT COMMITTEE MEETING ON 10/17/91-10/18/91. DR.
WHITE IS SENDING ASSISTANT SECRETARY DEBORAH
WINCE-SMITH.

DIRECTORATE STAFF
ASSIGNED: ASSIGNED:

ACTION STAFF
REQUIRED: ACTION:

SENDER'S DUE DATE: STAFF DUE DATE
OSTP DUE DATE: STAFF DUE DATE
DATE COMPLETED: DATE COMPLETED/DEPT:

COPIES TO: D. Allan Bromley
INTERNATIONAL/POLICY

WHITE HOUSE TRACKING #: CONTACT PERSON:
REMARKS: PHONE: EXT:

OSTP RECEIVED: 10/07/91 DEPT RECEIVED:
FILE: P-INTERNATIONAL-JAPAN



4322
UNITED STATES DEPARTMENT OF COMMERCE
The Under Secretary for Technology
Washington, D.C. 20230

RECEIVED

91 OCT 7 AM : 42

OFFICE OF THE
DIRECTOR

October 4, 1991

The Honorable D. Allan Bromley
Assistant to the President
for Science and Technology
Office of Science and Technology Policy
The White House
Old Executive Office Building
Washington, D. C. 20506

Dear Allan,

Thank you for your letter of September 4, inviting me to participate in the Third Joint High Level Committee meeting in Tokyo on October 17 and 18.

I have asked Assistant Secretary Deborah Wince-Smith to represent the Technology Administration. Deborah is not only very familiar with the status of the IMS and NIPT programs, but has a great deal of historical involvement with the S&T Agreement itself that should prove invaluable for its continuity.

I would, however, like to attend your "pre-meeting" on October 9, to keep informed.

Sincerely,

Bob

Robert M. White, Ph.D.

cc: Deborah Wince-Smith
Phyllis Genter

"Document Control"

TYPE: INFORMATION DOCUMENT NUMBER: 9124312
ORIGINATOR: 02 STATUS C DIRECTORATE STATUS

FROM: BROWN, Harold and Erich Bloch:OFFICE OF JAPAN AFFAIRS, NATIONAL
RESEARCH COUNCIL

TO: DR. D.A. BROMLEY

DATE OF
CORRESPONDENCE: 10/04/91

SUBJECT: SOME OBSERVATIONS OF KEY ISSUES AND AREAS OF
POTENTIAL COOPERATION WHICH MAY ASSIST IN
PREPARATION OF DISCUSSIONS IN JAPAN CONCERNING
SCIENTIFIC AND TECHNOLOGICAL RELATIONS.

DIRECTORATE STAFF
ASSIGNED: ASSIGNED:

ACTION STAFF
REQUIRED: ACTION:

SENDER'S DUE DATE:
OSTP DUE DATE: STAFF DUE DATE
DATE COMPLETED: DATE COMPLETED/DEPT:

COPIES TO: D. Allan Bromley
INTERNATIONAL/POLICY
Steve Olson

WHITE HOUSE TRACKING #: CONTACT PERSON:
REMARKS: PHONE: EXT:

OSTP RECEIVED: 10/07/91 DEPT RECEIVED:
FILE: P-INTERNATIONAL-JAPAN

4312

OFFICE OF JAPAN AFFAIRS
NATIONAL RESEARCH COUNCIL

OFFICE OF INTERNATIONAL AFFAIRS
2101 Constitution Avenue Washington, D.C. 20418

TELEPHONE: (202) 334-2815
FAX: (202) 334-1748/3094

October 4, 1991

OFFICE LOCATION
Foundry Building
Suite 2045
1055 Thomas Jefferson Street, N.W.
Washington, D.C. 20007

RECEIVED
91 OCT 7 10:47
OFFICE OF THE DIRECTOR

Dr. D. Allan Bromley
Assistant to the President for Science and Technology
Executive Office of the President
The White House
Washington, D.C. 20500

Dear Dr. Bromley:

Realizing that you are preparing for discussions in Japan concerning scientific and technological relations, we would like to share some observations of key issues and areas for potential cooperation.

As chairman and vice chairman of the National Research Council's Committee on Japan, we are working to develop better ways to both compete and cooperate with Japan as a technological superpower. The Committee's agenda includes two tracks. One set of activities (workshops, briefings, studies) is designed to contribute to the policy debate within the United States on key issues in U.S.-Japan scientific and technological relations. The other is a series of ongoing, private sector discussions with the Japanese science and technology community.

As you know, representatives of the National Academies of Sciences and Engineering met with a group of science, technology and business leaders most recently in August, 1991. The topic of the two-day meeting was "Scientific and Technological Interdependence: New Challenges for the United States and Japan." The observations here are based on those discussions.

First, the Japanese are worried about the state of their university research system. Those from the academic community, in particular, say that the only way to correct the asymmetries in researcher exchange is for Japan to make its university-based research system stronger. There is even a concern that Japanese industry attention on U.S. universities will be coupled with a neglect of the Japanese university community.

These concerns are valid, and they may stimulate reorganization, rethinking and new funding to build university research in Japan. It would be our observation, however, that at present Japan's new push into basic research is driven by Japanese industry, and they concentrate their work in corporate laboratories. Since this research is by its nature part of a profit-making effort, it is not a close parallel to basic research in the United States which is easily accessible. Another issue for attention is whether the Japanese are aware of the serious strains that U.S. universities face in terms of budget constraints and other problems that will affect their long-term status as world-class teaching and research institutions. In view of public support for American universities, it may be necessary for them to develop guidelines for their interactions with foreign corporations to ensure that these interactions contribute to the welfare of the United States as well as to international research.

Second, Japanese companies are worried about what they perceive to be criticism of their expanding global presence (and they should be worried). The biggest and best companies are developing careful strategies to become better global citizens. But our observation would be that there is a real need to define "rules of the road" that encourage Japanese companies that do business in the United States to transfer technology, provide technical training, and improve the U.S. manufacturing base.

Another theme emphasized by the Japanese is their interest in promoting international R&D collaboration, not only in basic science but also in advanced manufacturing. The Intelligent Manufacturing System project is a case in point. The question is whether this and other international projects in advanced manufacturing can be structured to feature technology transfer from Japan. To do so, it will be necessary to build in mechanisms to provide access for U.S. technical personnel to Japan's corporate laboratories and manufacturing facilities.

On another subject, there is a real need for discussions with the Japanese on technology and security issues. If the historic changes in the Soviet Union lead to a return to Japan of the Northern Islands, the foundation for the U.S.-Japan security alliance will need to be redefined. In any event, the growing importance of dual-use technologies and components built in Japan and other Asian countries for U.S. military systems highlight problems of interdependence. Networks of high technology development and trade in Asia create a new context for economic and security policies and suggest the need for informal discussions that involve not only the defense community, but also the business and science communities in both countries. The challenge is to define the role that technology can play in enhancing "security" in this new era.

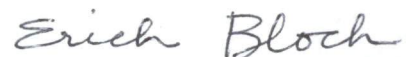
Finally, leaders from the Japanese private sector appear interested in taking up global problems. Promoting development in the third world, disaster mitigation, and efforts to address environmental concerns are good examples. Finding synergies between U.S. and Japanese efforts will not be easy, however. The Japanese government and private sector have launched a number of ambitious environmental programs in the past year, and meaningful cooperation will have to mean much more than a combination of Japanese yen and U.S. ideas.

While our discussions with the Japanese are informal and non-governmental, we hope that insights from them may be useful to you. We on the Committee on Japan welcome opportunities to share our expertise and provide assistance to the Executive Branch when appropriate. Please feel free to call on us.

Sincerely,



Harold Brown
Chairman



Erich Bloch
Vice Chairman

"Document Control"

TYPE: INFORMATION

DOCUMENT NUMBER: 9124281

ORIGINATOR: 02

STATUS C

DIRECTORATE STATUS

FROM: SHIMAMOTO, Y.

TO: DR. D.A. BROMLEY

DATE OF
CORRESPONDENCE: 10/01/91

SUBJECT: RE: RECENTLY ACQUIRED NEWS ON MITI

DIRECTORATE STAFF
ASSIGNED: ASSIGNED:

ACTION STAFF
REQUIRED: ACTION:

SENDER'S DUE DATE: STAFF DUE DATE
OSTP DUE DATE: DATE COMPLETED/DEPT:
DATE COMPLETED:

COPIES TO: INTERNATIONAL/POLICY
D. Allan Bromley
INDUSTRIAL

WHITE HOUSE TRACKING #: CONTACT PERSON:
REMARKS: PHONE: EXT:

OSTP RECEIVED: 10/04/91 DEPT RECEIVED:
FILE: P-INTERNATIONAL-JAPAN

4281
158 Donegan Avenue
East Patchogue, NY 11772
RECEIVED
October 1, 1991

Dr. D. Allan Bromley
Science Advisor to the President
The White House
Washington, DC 20506

91 OCT 4 A 9:27

OFFICE OF THE
DIRECTOR

Dear Allan:

The purpose of this letter is to pass along some recently acquired news on MITI.

(1) NIPT

- (a) In order to avoid the perception of linkage with the 5th Generation Computer Project, the computer to be developed under the NIPT-plan is now called the "4-Dimensional Computer".
- (b) At long last the NIPT Feasibility Study Committee, chaired by Prof. Takemochi Ishida, now at the Keio University and who also served as the Chair of the Research Committee on NIPT, has been organized. The first meeting of this committee is scheduled to take place on October 15, 1991.
- (c) The first International Workshop on NIPT will be held on November 5-8, 1991. It was erroneously reported in the Nikkei Sangyo Shinbun of August 28, 1991, that the Workshop will be held in October. The article states that approximately ten individuals from ERCIM ("European Research Consortium for Information Science and Mathematic"?) and others from EC will participate. The article also states that "In contrast, the American points of contact, the Departments of State and Commerce, are fearful of technology drain and are cautious about participating."
- (d) MITI's budget request submission for FY 1992 contains approximately 900 M¥ for NIPT R&D. (Nikkei Sangyo Shinbun, September 2, 1991.)

(2) IMS

- (a) According to the reference cited in (1)(d) above, MITI's budget request for IMS for 1992 is 813M¥ (up from 273M¥ for FY 1991).
- (b) It is reported that 15 American organizations (including United Technologies, IBM, Rockwell, DEC, EDS, TI, ATT, Motorola, Honeywell, MIT, Purdue, Lehigh, and NIST) will participate (Nihon Kogyo Shinbun, September 20, 1991).

It was good seeing you two weeks ago. Part 7 of the FUET '91 Series is enclosed.

With best wishes,

Sincerely yours,



Y. Shimamoto

YS:mck
Enclosure

講演

次世代電子基礎技術国際シンポジウム (FUET'91)報告⑦

三菱電機㈱ 中央研究所電子エレクトロニクス研究部
第1グループマネージャ 久間 和生

ニューラルネットワークの概要と その工学的意義

ただいまご紹介にあずかりました三菱電機中央研究所の久間です。私の話の内容は、"Artificial Neural Networks Based on Optoelectronic Technologies"です。講演内容を簡単にご説明したいのですが、まずニューラル・ネットワークの概要とその工学的意義を述べたいと思います。次に、ニューラル・ネットワークのハードウェアについてご紹介します。電子技術からのアプローチと光技術からのアプローチとを比較して、それぞれの現状について紹介します。

次に私どものグループでやっている研究を例に取って、光ニューラル・ネットワークの詳細についてご紹介します。とくにシナプス荷重に要求される精度、光ニューロ・デバイスの現状、システムを大規模化、統合化する時の概念といったことについて議論します。最後にまとめとして、今後必要な研究テーマを検討して終わりにしたいと思います。

この図1は皆さんよくご存じのニューラル・ネットワークの基本構造を示したものです。ニューラル・ネットワークは多くのニューロンと呼ばれる素子とシナプスと呼ばれる素子で構成されています。ニューロンの機能は積和演算機能と非線形な入出力特性を与える一種の演算素

子です。一方シナプスはニューロン間の結合の強さを与える一種の分散記憶素子で、その結合の強さは一般的に学習によって与えられます。

それをシナプス荷重と呼んでいます。これはアナログ量で表され、正の値のものと負の値のものがあります。こういったネットワークを構成して何らかの入力信号を与えると、そのシナプス荷重とニューロンの作用によって何らかのパターンの出力信号が得られます。その時に望ましい入出力関係が得られるように、シナプスの値を決めていこうというのが学習にはなりません。

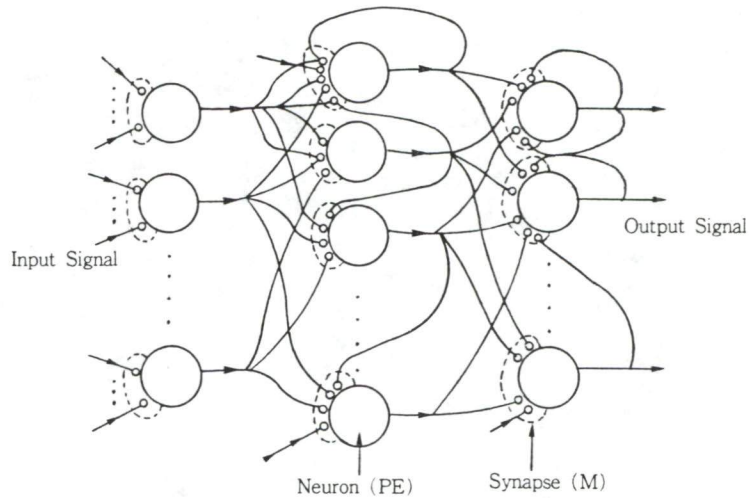
こういったニューラル・ネットワークの工学的意義を考えると、図1の下方に書かれているように、ソフトウェア的には学習によって知識



久間 和生氏

を獲得できる分散記憶方式にな
ストになって
です。

ニューラル・
は非常に多岐に
ノイマン型コン
くのが非常に難



- Advantages of Neural Networks**
- (1) S/W : Knowledge Acquisition through LEARNING (Self-Organization)
 - (2) H/W : ROBUST and FAIL-SAFE system

図1 Schematic Model of Neural Networks

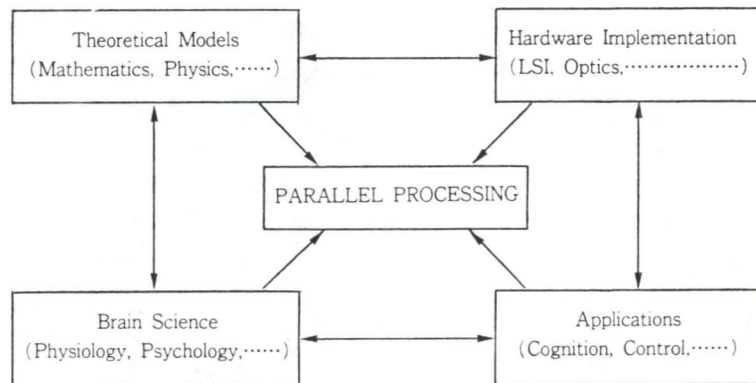


図2 Research Area of Neural Networks

を獲得できることです。ハードウェア的には分散記憶方式になっているので、システムがロバストになってフェイルセーフであるということです。

ニューラル・ネットワークに期待される応用は非常に多岐にわたっています。その1つは、ノイマン型コンピュータでは、プログラムを書くのが非常に難しい、あるいは不可能であると

いうような問題、たとえばパターン認識とか特徴抽出、ロボットなどの制御、それから予測といった分野への応用が期待されています。2つ目は、データ量が多くなって、場合の数が非常に多くなるような組合わせ最適化問題というような分野があります。

ニューラル・ネットワークの研究は図2に示されているように、ニューラル・ネットワーク

の理論モデルを中心にして、脳科学、ハードウェア、アプリケーションに関する研究分野が、いわゆる超並列計算という名のもとに協力して研究が進められています。今日お話しさせていただくのは、このハードウェアに関するところ

です。たとえば1000個のニューロンがお互いに結合しているネットワークを考えると、ニューロン間を結合するシナプスの数は最大1000の2乗、つまり100万個にもなります。したがってハードウェアを開発しようという時には、この膨大な数のシナプス結合をいかに実現するかが問題になります。

ニューラル・ネットワークのハードウェアの現状

ニューラル・ネットワークのハードウェアは、先ほど申し上げましたように電子技術による方法と、光技術による方法があります。表1はそれぞれの利点と問題点をまとめたものです。光技術の1つ目の利点は、表に示されているように、空間並列性を利用した3次元アーキテクチャに適していることです。2つ目は潜在的な能力ですが、非常に配線の密度が高くなることがあげられます。3つ目に並列の入力、並列の処理、並列の出力という情報処理の形態が可能で

あることです。したがって画像処理等を高速にできる可能性があるわけです。4つ目は、基本的に光デバイスは高速に動作する可能性があります。

ところが問題は、まだ技術が未成熟であるということです。たとえば非線形デバイスとか、光のメモリ素子とか、光デバイスの集積化技術といったところがまだこれからの研究テーマであることです。それからたぶん将来問題になるのが、光デバイスは開発されても、エレクトロニクス素子とのインタフェースを実際にどうするかということが問題になるように思います。

一方エレクトロニクスのほうは基本的には2次元のアーキテクチャに適しているわけですが、LSI技術を中心に非常に技術が成熟していて、洗練されています。しかもエレクトロニクスは非常にフレキシブルで、汎用性および融通性に優れている点があります。ただし将来の問題点としては、配線による限界、キャパシタンスによる限界、ニューラル・ネットワークに本質的なアナログ技術が未熟なことなどが問題ではないかと思っています。

専用ハードウェアを実現する場合に、現在3つの方式のアプローチがあります。1つは既存のLSIのチップ、たとえばマイクロプロセッサとかDSPチップを複数個用いてニューラル・

ネットワークの演算
を作る方式です。
セラレータと呼ばれ
の素子構造そのもの
の方式を模倣しよ
チップ、それから光
つの方法があるわけ
図3は横軸にシナ
タコネクションの数
ネットワークの処理速
のために1ギガフロ

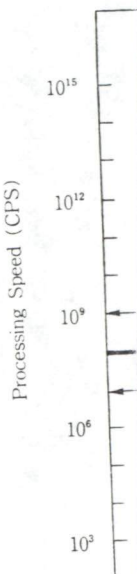


表1 Comparison between Optics and Electronics

	OPTICS	ELECTRONICS
ADVANTAGES	● 3-D Architecture (Inherent Parallelism) ● High Density Connectivity ● 2-D Parallel I/O Channels (direct image processing) ● Poten. High Speed Processing	● 2-D Architecture ● Technologies Highly Matured (nonlinear devices, logical & memory devices, LSI...) ● Great Flexible Processing ● High Speed Processing
PROBLEMS	● Technologies Immatured (nonlinear devices, memories, integration technol. ...) ● Interface with Electronics	● Limitation by Connectivity ● Limitation by Capacitance ● Analog Technologies Immatured

Hardware
Neuro-Accel
Digital C
Analogue

ネットワークの演算に向けた並列アーキテクチャを作る方式です。この方式はニューロ・アクセラレータと呼ばれています。2つ目は、実際の素子構造そのものをニューラル・ネットワークの方式を模倣しようというLSIのニューロチップ、それから光エレクトロニクスという3つの方法があるわけです。

図3は横軸にシナプス結合数、すなわちインタコネクションの数を、縦軸にニューラル・ネットワークの処理速度を示したものです。参考のために1ギガフロップスのスーパーコンピュ

ータで処理した時の速度と、2000年に開発されるであろう100ギガフロップスのスーパーコンピュータを利用した時の処理速度も示されています。したがってスーパーコンピュータといえども、あいまいな情報処理の分野では人間に比べると非常に遅いことがわかります。それで、ニューラル・ネットワークによる情報処理を行うには、どうしても専用の高速に動作するハードウェアが必要になってくるだろうと思います。

この領域は0.2 μ mのプロセスを用いたLSIで実現可能なニューロチップの予測領域です。

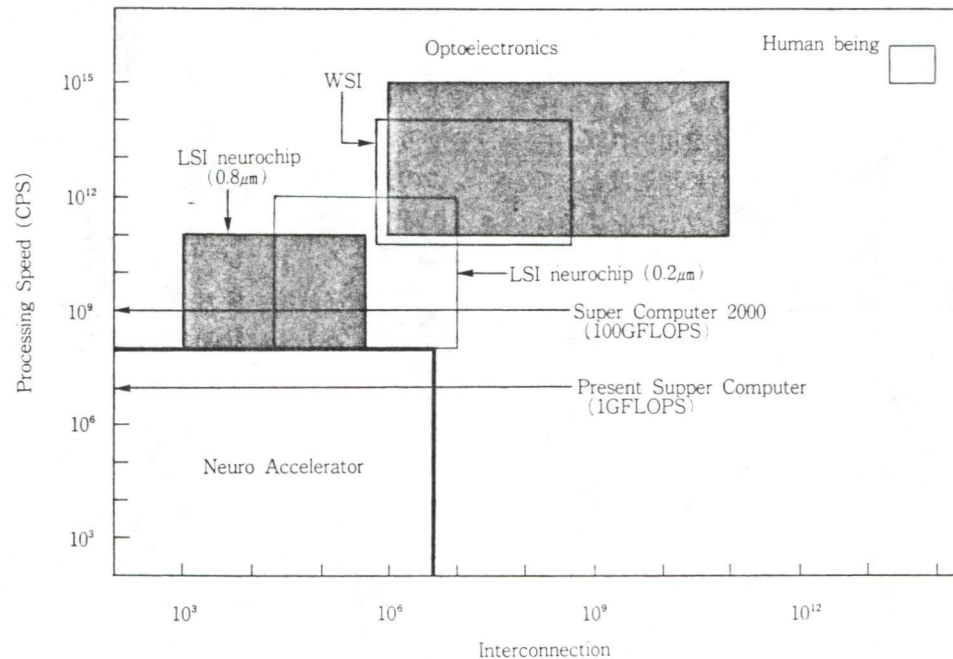


図3 Potential Abilities of Various Artificial Neural Networks

表2 Typical Examples of VLSI Neurochips

Hardware	No. Neurons	Proc. Speed	Learn. Speed	Remarks
Neuro-Accelerator	512DSP Chips	1.6 GCPS	1.9 GCUPS	ASI, 8 VLSI Chips Flex. for Many Models
Digital Chip	1152 Neurons (0.8 μ m)		2.3 GCUPS	Hitachi, 8 WSI's Back-Propagation Chip
Analogue Chip	336 Neurons (1.0 μ m)	1.0 TCPS	28 GCUPS	Mitsubishi, 2 VLSI Chips Boltzmann Machine Chip

LSI でもかなりのことができるわけですが、より大規模で高速のネットワークを構成していくには、ウェーハ・スケール・インテグレーションとかオプトエレクトロニクスといった技術が必要になるのではないかと予測しています。

表2は電子技術を用いたニューロアクセラレータ、デジタル方式のニューロ・チップ、アナログ方式のニューロ・チップに対するいままでのトップデータをまとめたものです。ニューロ・アクセラレータに関しては、アメリカのASI社で開発されたものが優れた特性を示しています。1つのLSIチップの中に64個のDSPを集積化して、そういったチップを8個用いて、したがって全体として512個のDSPで1種の並列計算機を作っているわけです。

このニューロアクセラレータを用いれば、ニューラル・ネットワークの実行処理速度として1.6GCPS、学習速度、すなわちラーニングスピードとして1.9GCPSという特性が得られています。しかも並列計算機方式ですので、さまざまなニューラル・ネットワーク・モデルに対して適応できるという特徴もあります。

一方、デジタル方式のニューロ・チップに関しては、皆さんご存じだと思いますが、日立製作所がウェーハ・スケール・インテグレーション(WSI)を用いたチップの開発を進めています。0.8 μ mプロセス、CMOSプロセスを用いた8枚のウェーハを用いて、ニューロン数1152個を実現しています。現状では、バックプロパゲーションモデルに限定されていますが、2.3GCPSの学習速度が得られています。

またアナログのシリコンチップに関しては、われわれ三菱電機においてキャパシタンスに蓄積される電荷量をシナプス荷重に相当させる方式で開発を進めています。2つのVLSIチップを組み合わせると1 TCPS、学習も28GCPSという性能が得られています。応用がボルツマン・マシンに限られているわけですが、ここまでチップができているというのが現状です。

このように現在の先端のLSI技術を用いると、ウェーハ・インテグレーションにしても、アナログ・チップにしても、だいたい1チップ当たり数十個から200個程度までのニューロンを集積化させることが可能です。

次に光のほうの現状はどうかをご紹介します。図4の(a)は光電子共存型のニューラル・ネットワークのアーキテクチャを示したもので、基本的には左側に発光アレイ、真ん中に空間光変調素子、右側に受光素子アレイの3層構造で構成されたものです。この発光素子アレイの出力がニューロンの興奮状態に相当して、この空間光変調素子は2次元のアレイデバイスで、その1個1個がシナプスのひとつに相当します。ここで光の透過率をシナプス荷重に対応させようという方式です。

この方式はニューラル・ネットワークの膨大な配線の部分だけに光を適用して、非線形処理を行うところ、およびフィードバックを行うところには電子技術を使おうという方式です。この方式で、たとえば1000 $\times$ 1000程度の2次元のアレイを作っておいて、この発光素子アレイをたとえば10MHz程度で駆動してやると、全体の処理速度として10TCPSという非常に高速な演算が達成できることになります。

一方、下のほうの図4(b)は、実時間ホログラムと言われる材料を用いたものです。普通クレジットカード等の右上についているホログラムは書き換えができないわけですが、最近チタン酸バリウム等の書き換えができるホログラム材料の技術が著しく進歩しています。

こういう実時間ホログラムを使って、図4(b)では点線で書いてありますが、その中に形成される干渉縞のひとつをシナプス荷重に相当させると、1cm²の実時間ホログラムには計算上1T個のシナプスが実装できることになります。1T個ということは、ニューロンの数にすると100万個以上ということになります。このような材料はなかなか使いにくいのですが、もし実現で

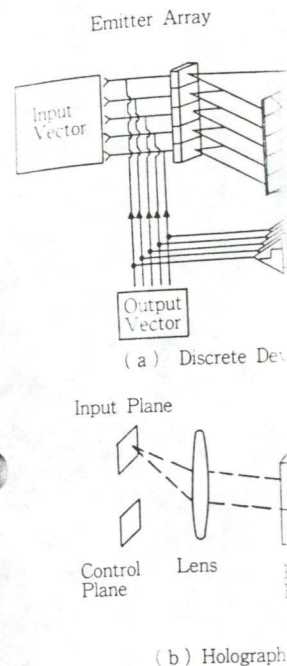


図4 Typical Architectures of Neural Networks

できれば非常に大規模なネットワークが作れることになり、ただし光アーキテクチャで報告されているニューロン数は100個程度で、たとえば1000個程度です。これは光ニューラル・ネットワークですが、どちらの数にして100個、200個あります。

ところが単にデバイス例が多くて、それなれたニューロンの数、性能の報告が少ないように、とくにアナログデバイス、と思います。その原因は、値に対してソフトウェアでも高精度な演算ソフトウェアではどうし

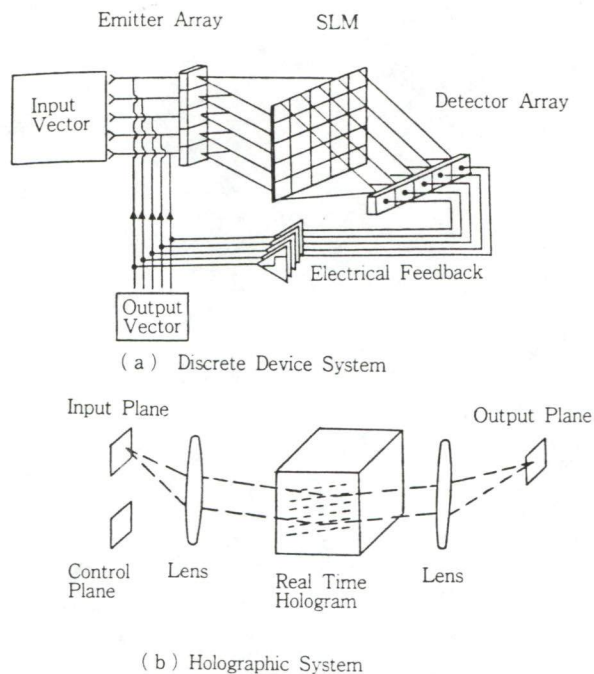


図4 Typical Architectures of Optical Neural Networks

きれば非常に大規模なニューラル・ネットワークが作れることになります。

ただし光アーキテクチャに関しても、現在まで報告されているニューロンの数はせいぜい100個程度で、たとえば処理できるパターンも50個程度です。これまでLSIニューロ・チップと光ニューラル・ネットワークの現状を述べたわけですが、どちらの場合もだいたいニューロン数にして100個、200個程度のものは試作されています。

ところが単にデバイスを試作したという報告例が多くて、それなりの機能、たとえば実装されたニューロンの数に相当する実力を持った機能の報告が少ないように思います。この傾向はとくにアナログデバイスに関して顕著なように思います。その原因のひとつは、シナプス荷重値に対してソフトウェア・シミュレータではいくらかでも高精度な演算が可能なのですが、ハードウェアではどうしてもデバイスの精度で制限

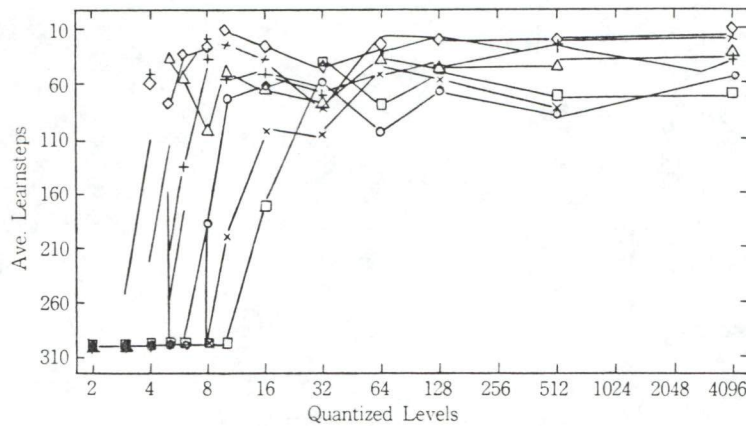
されている。そういったことが原因ではないかと思っています。

したがって、たとえばニューラル・ネットワークのモデルを選択する場合には、そのモデルがどういう問題に適しているか、その処理能力や学習速度はどうかといったことを選択基準とするのは当然なのですが、それとともにニューロンの出力値に対する精度とかシナプス荷重値に対する精度を考慮しなければいけないということになります。

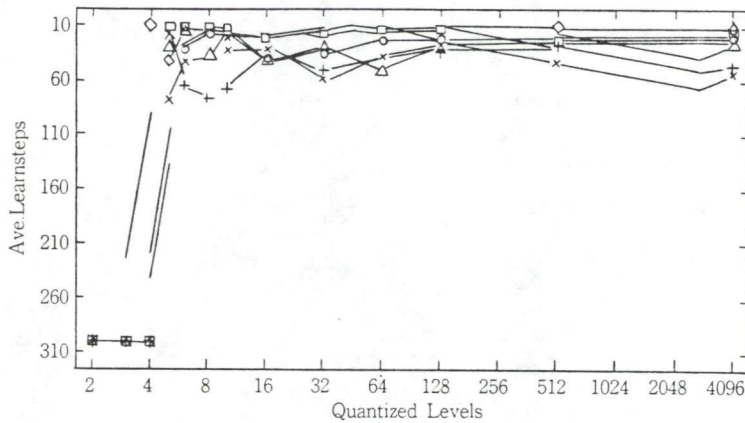
たとえばソフトウェア・シミュレータでよく使われているバックプロパゲーションモデルというのがありますが、このモデルでは少なくとも8ビット程度の精度がシナプス荷重値に要求されます。8ビットというのは階調として数百以上になるわけです。それに対してボルツマン・マシンという別のモデルを使うと、3ビットや4ビットの精度で十分演算ができるということになります。

図5はそれをシミュレーションで実証したものです。横軸がシナプス荷重の階調を示したもので、縦軸に学習に必要な回数を示したものです。これはボルツマン・マシンに対するものです。パラメータはボルツマン・マシンの隠れ層のニューロンの数です。図5でわかるようにだいたい階調として16個とか8個程度取っておけば十分です。ですからハードウェアに適したモデルとソフトウェア・シミュレータに適したモデルは違うのではないかという感覚をわれわれは持っています。

それでははじめから高精度なデジタルニューロ・チップを作っていけばいいではないかという議論になるのですが、デジタルニューロ・チップの泣きどころは、1シナプス当たり要求される素子数が非常に多くなるということで、単位面積あたりに実装できるニューロン数が制限されることです。たとえば $0.8\mu\text{m}$ のCMOSプロセスを利用しても、 1cm^2 当たり10個程度しかニューロンを集積化できません。デジタルの場

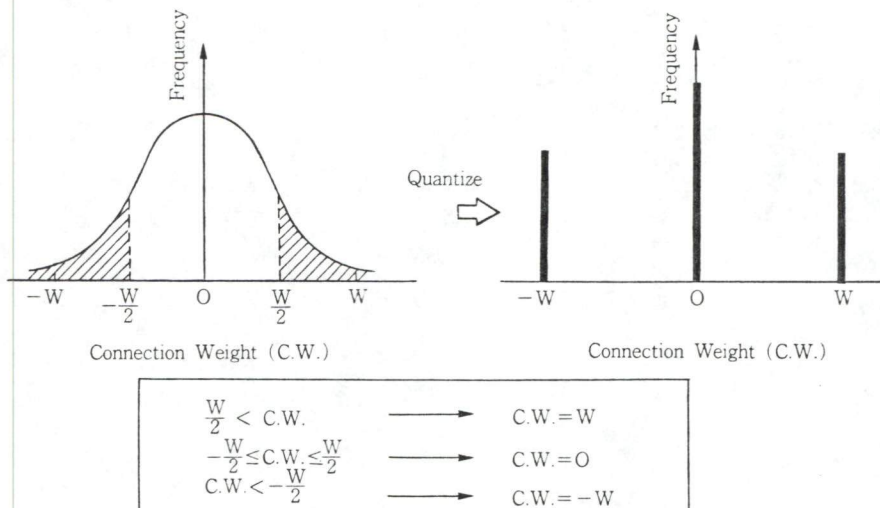


(a) Random Recognition Problem



(b) Parity Checker Problem

図5 Accuracy Requirements for Synaptic Weight(Boltzmann Machine)



Conversion of the Continuous Weight into the Quantized One

図6 Quantized Model with Second Weight Memory(Suitable for Digital Architecture)

合でもいいモデルを選
ウェア化のためにモチ
必要になります。

ここで1つ例として
る量子化モデルを紹介
デルという難しい名前
に簡単な方法で、シ
W/2以上の場合にはW
ートなシナプス荷重
以下の時には-Wとい
う。それ以外の真ん中
しまう。たとえば3つ
まおうということであ

1. E
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out
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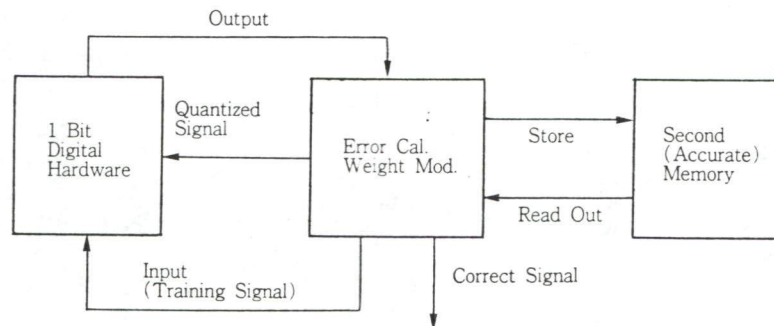
図7

合でもいいモデルを選択するとともに、ハードウェア化のためにモデルを改良していくことが必要になります。

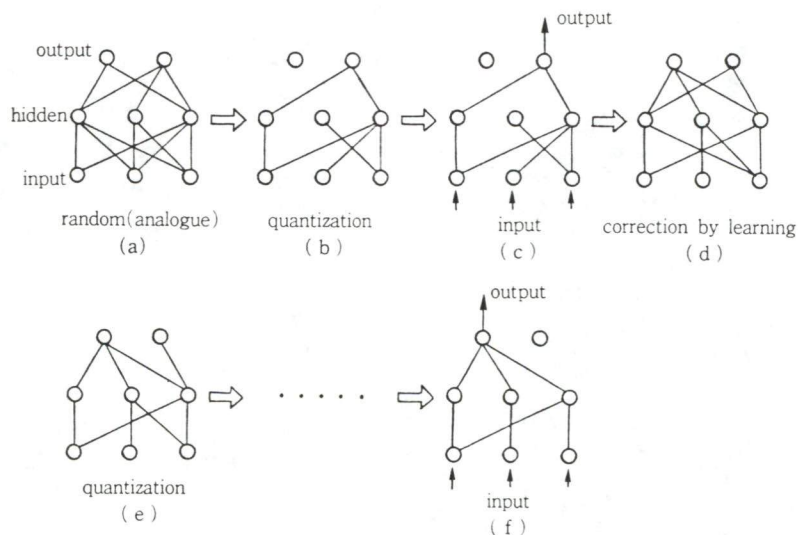
ここで1つ例としてわれわれが研究をしている量子化モデルを紹介します(図6)。量子化モデルという難しい名前ですが、基本的には非常に簡単な方法で、シナプス荷重値がたとえば $W/2$ 以上の場合は W に置き換える。ディスクリートなシナプス荷重値に置き換えます。 $-W/2$ 以下の時には $-W$ というふうに置き換えてしまう。それ以外の真ん中にある時にはゼロにしてしまう。たとえば3つのレベルに離散化してしまうということなのです。

ただこんな無茶なことをやってそのまま学習アルゴリズムを作っていくとうまくいきません。

それでこの図7の上のほうに示されているようなアーキテクチャを考えてみます。すなわち量子化された情報量の少ない荷重値を実際のニューラル・ネットワークのハードウェアに提示してやろう。それから精度の高いシナプス荷重値はセカンドメモリというところに記憶しておこうという方法です。具体的な話をしますと、バックプロパゲーションの3層構造の演算は、こういう簡易的なハードウェアでしてしまっ、その結果得られた値でエラーを検出するわけです。すなわち、先生の記号と比較して、どの程



(a) System Configuration



(b) Learning Process

図7 Principle of Quantized Learning Model with Second Memory

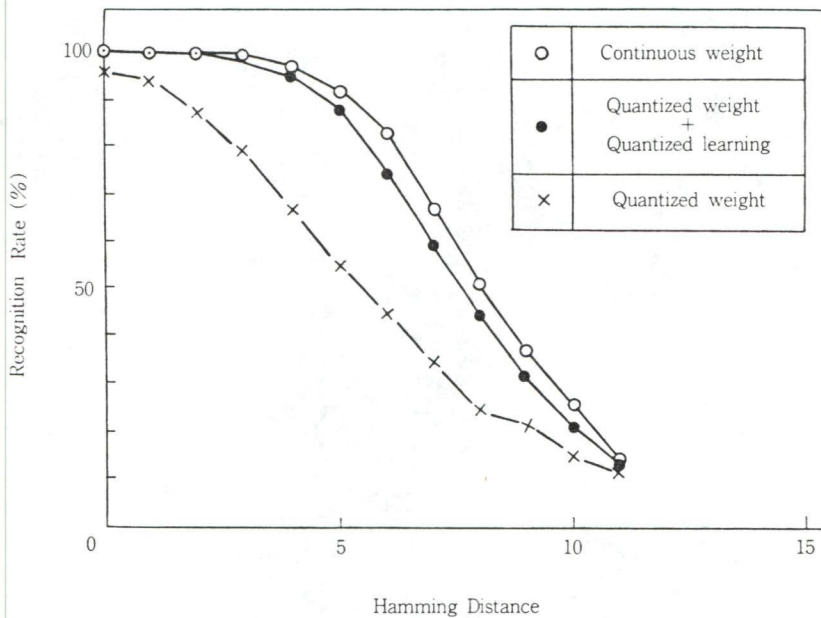


図8 Computer Simulation & Experimental Results of Quantized Learning(Back-Propagation)

度違っているかエラーの計算をします。それでシナプス荷重を修正するわけですが、その時のみセカンドメモリから高精度な情報を呼び出してきて、それで再度シナプス荷重値を更新して、また提示するというアーキテクチャを考えました。

このように工夫することによって、デジタル回路で作ってもハードウェアの規模は非常に小さくなります。同時に演算時間が縮小できるメリットがあります。図8の黒丸が今お話した量子化学学習、バックプロパゲーションで学習した26文字の認識曲線を表すもので、縦軸は認識率で、横軸はその曖昧度を示すものです。白丸は従来の非常に高精度な、8ビット以上のシナプス荷重値を持ったバックプロパゲーションで学習した結果です。このように、ほとんど性能の変わらない結果が得られています。しかもハードウェアに対する負担が非常に軽くなってくるという特徴があります。

これからは、われわれデバイス屋もモデルそのものに目を向けないとなかなかデバイスの進

歩がないということで、その例としてわれわれの研究例を紹介しました。

光ニューラル・ネットワークの現状と将来像

次に光ニューラル・ネットワークの現状と将来像をもう少し詳細に述べたいと思います。われわれ人間は画像情報として膨大な視覚情報を受けているわけですが、それを実時間処理する能力があります。それは2次元の情報をそのままのかたちで並列に入力して、並列に前処理して、並列に出力する網膜によって圧縮された情報を大脳に送り、過去の経験とか学習によって蓄積された記憶を利用して並列処理する網膜と脳によって階層化された情報処理系によるものです。したがって、そういった情報処理の原理が解明されればいいのですが、現状ではまず脳のアーキテクチャをマクロスコピックに見直して、そういったシステムを実現するのに必要なデバイスを開発して、将来動画像等も実時間処理できるシステムができないかというのがわれ

われの夢です。

そのようなシステムを2つご紹介しましょう。一つで開発している光デバイスをご紹介します。先ほどの変調器が定盤の上に置かれたが、図9はそれを製造の集積素子としてシリコンと素の基板の上にレーザと、空間変調器からやはり線状の受光素子と線状の発光素子と受光素子配置されています。アップ・ボンディングでスタック状に集積されています。それぞれのウェーハに搭載されています。ニューロLEDの発光強度と入力力としてベクトルとします。

こうしたニューロが固定の方式と可変

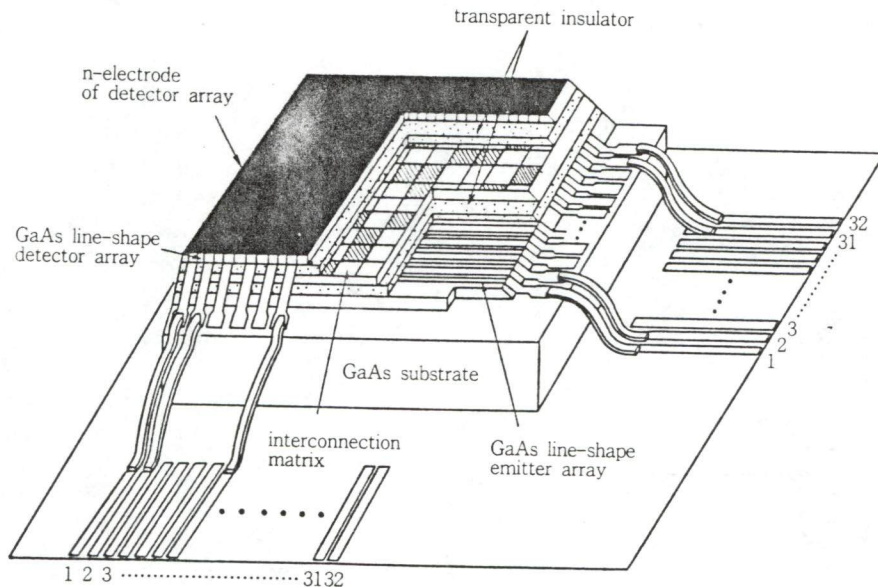


図9 Basic Structure of Optical Neurochip

われの夢です。

そのようなシステムの実現を目指したデバイスを2つご紹介します。最初にわれわれのグループで開発している光ニューロ・チップをご紹介します。先ほどの発光素子と受光素子と空間変調器が定盤の上に載っている図を紹介しましたが、図9はそれをぐっと押し縮めて3次元構造の集積素子として実現したものです。ガリウムヒ素の基板の上に線状の発光ダイオードのアレイと、空間変調器としての光学マスク、それからやはり線状の受光素子で構成されており、線状の発光素子と受光素子はクロスバー構造で配置されています。そういった素子をリップチップ・ボンディングの技術を使って3次元構造にスタック状に集積化したものです。

それぞれのウェーハの成長にはMBE法を用いています。ニューロンのベクトルの状態をLEDの発光強度として与えると、受光素子の出力としてベクトルとマトリックスの積が得られます。

こうしたニューロ・チップにはシナプス荷重が固定の方式と可変の方式があります。次に、

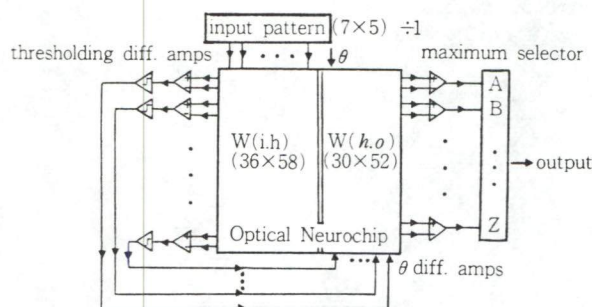
どういったデバイスをい今まで開発してきたかをご紹介します。まずシナプス荷重が固定の方式ですが、い今まで2種類のチップを試作しました(表3)。1つはフィードバック型モデルに基づく連想メモリチップです。この場合はニューロン数32個、シナプス数1024個、このチップに3つのレター、A、J、Eを記憶させて、連想機能を実証したものです。これは数年前のデータですが、それでも数GCPS以上の処理速度があります。

フィードバック型のモデルはレターなりをストアする情報のキャパシティが小さいという欠点があります。そこで第2のチップとして、バックプロパゲーションを用いたフィードフォワード型のモデルに合ったニューロ・チップを試作しました。入力層、中間層、出力層のニューロン数がそれぞれ25、29、26、で全部で90のチップです。インタコネクションの数は3648個で、チップの中にAからZの26文字を記憶として蓄積させています。

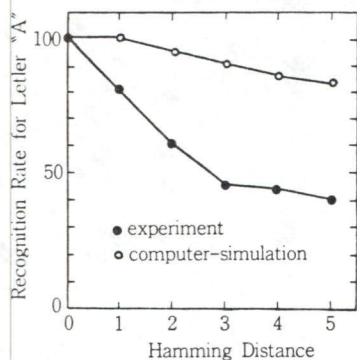
この場合固定型のニューロ・チップですので、シナプス荷重値は前もってワークステーション

表3 Summary of Fixed-Type Optical Neurochips

Models	No. Neurons	No. Synapses	Functions	Proc. Speed	No. Opt. Ele.	Chip Size
Feedback (Hopfield)	32	1024	3 Letters Recog. (A, J, E)	> 1 GCPS	32 LEDs & 32 PDs	7.2×7.8mm ²
Feedforward (Back-Prop.)	90 I = 35 H = 29 O = 26	3648 I/H = 2088 H/O = 1560	26 Letters Recog. (A to Z)	> 1 GCPS	66 LEDs & 118 PDs	10.4×10.9mm ²



(a) Experimental Configuration



(b) Typical Experimental Results

図10 Experimental Config. & Results for the BP Neurochip (Recog. of 26 Characters of Alphabet)

の上で計算しておいて、それを作成時にそのままコピーして作ったものです。

図10(a)はそのバックプロパゲーション用に試作したニューロ・チップの構成のレイアウトを示すものです。入力パターンが入ってくると、ここで入力層と中間層の演算がなされて、それ

でニューロンのしきい値作用をしたのち、中間層と出力層の演算をして、それで出力26個のうち最も大きな出力値を答えとするものです。ですからAの崩れたパターンが入ってきたりすると、いちばん上のニューロンの出力が大きくなって、これはAであると判断するものです。

図10(b)がその実験値で、コンピュータ・シミュレーションの結果と、実験値を示しています。多少実験値が悪いのは、いまフリップチップ・ボンディングの技術を使っているのです。その時に発生するメカニカルな位置ずれによるものです。ただ、こういった光チップの処理速度はGCPS以上で、チップのサイズも10mm角程度です。ですからシナプス荷重固定方式の光ニューロ・チップに関しては、光デバイスの集積化技術がまだ未成熟であるにもかかわらず、LSIニューロ・チップとほぼ同程度の集積度と特性が得られています。

さて、ニューラル・ネットワークの特徴は、やはり学習機能を有することで、したがって今まで述べてきたシナプス荷重が固定の方法ではなくて、シナプス荷重の書き換えができるようなデバイスの開発が必要になります。シナプス荷重可変方式のニューロ・チップを実現する最もてっとり早い方法は、図11(a)に描いてあるように、透過率が固定のマスクを可変の空間光変調素子に置き換える方法です。

しかしそこには2つの問題点があります。1つは集積化に適した空間変調素子がないことで

す。たとえば液晶と材料を組み合わせたいなデとです。

2つ目は空間変調素子があるので、発ギャップができてが発生するという

そこでわれわれは、受ける代わりに、受ける機能を兼ね備

Chip Size
$7.2 \times 7.8 \text{ mm}^2$
$10.4 \times 10.9 \text{ mm}^2$

用をしたのち、中間
それで出力26個のう
とするものです。で
が入ってきたりする
の出力が大きくな
するものです。
コンピュータ・シミ
値を示しています。
フリップチップ・
いるので、その時
ずれによるもので
ップの処理速度は
ズも10mm角程度で
定方式の光ニュー
バイスの集積化技
かわらず、LSIニ
の集積度と特性が

ワークの特徴は、
で、したがってい
重が固定の方法で
き換えができるよ
なります。シナプ
チップを実現する
1(a)に描いてある
を可変の空間光
す。
点があります。1
素子がないことで

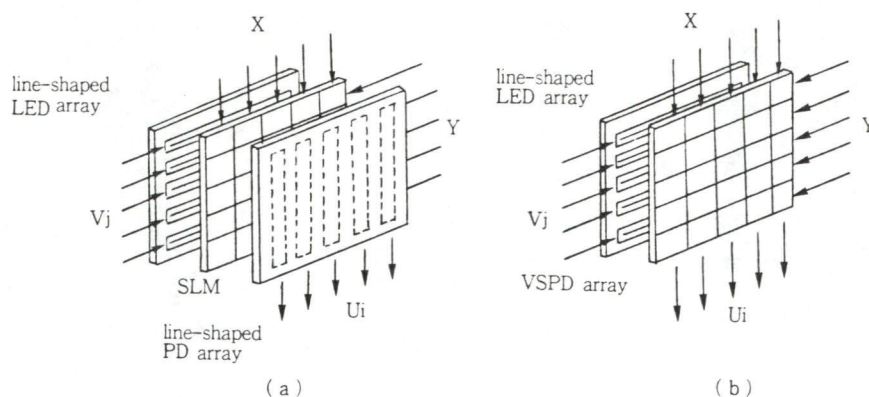


図11 Possible Structure of Optical Learning Chips

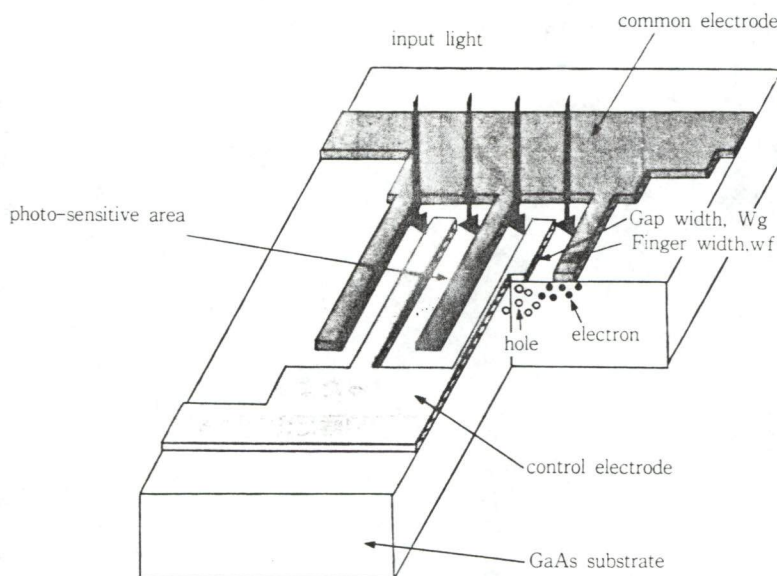


図12 Variable-Sensitivity Photodiode(VSPD)

す。たとえば液晶とかフォトコンダクティブな材料を組み合わせたものを真ん中に突っ込むと、お化けみたいなデバイスができあがるということです。

2つ目は空間変調素子を挿入すると、その厚みがあるので、発光素子と受光素子のあいだにギャップができてしまっ、光のクロストークが発生するという問題があります。

そこでわれわれは従来の空間変調素子を利用する代わりに、受光素子と空間光変調素子の2つの機能を兼ね備えた機能デバイス、すなわち

外部から受光素子の感度をコントロールできる感度可変受光素子の利用を考えました。これはバリアブル・センシティビティ・フォトダイオードで、以後 VSPD と呼びます。

図11(b)が VSPD を用いた光ニューロ・チップの構造ですが、VSPD を開発することにより、構造が3層構造から2層構造になって構造が簡素化されるとともに、ギャップがほとんどなくなるので、非常に高密度な集積化が可能になります。

図12は今回試作した感度受光素子の構成図で、

金属/半導体/金属構造，すなわち MSM 構造の VSPD です。このデバイスのキャリアの走行はドリフト電流が支配的ですから，その光電流の大きさは，この図に示されているインターデジタル電極に加えたバイアス電圧に依存します。したがって光を電気に変換する受光感度が等価的にバイアス電圧に比例することになります。

もう1つ非常に大きな特徴は，このデバイスは半導体を中心にして対称な構造ですから，加える電圧の極性を逆転させると電流の流れる向きが反対になります。このことは，1つのデバ

イスでニューラル・ネットワークに必要な興奮性シナプスと抑制性シナプスを同時に実現できる。しかもアナログデバイスだということになります。

図13は試作したデバイスの特性を示すもので，横軸が加えるバイアス電圧，縦軸が光電流です。この図を見ていただくと，光電流がバイアス電圧に対してアナログ的に変化している。しかも点対称になっている。ちょっと線が太くなっているのは，試作したデバイス10個程度の特性を示したもので，ほとんど特性に関するばらつきはありません。受光感度もだいたい5V, 6V 程度の電圧で，0.2から0.3A/W で普通の受光素子と同程度の感度が得られています。

シナプス荷重の階調がどれぐらい取れるかということですが，室温で動作している限りは6ビット以上取れています。いままで述べました VSPD の特徴をまとめると，まず1つ目にニューラル・ネットワークに本質的なアナログデバイスであるということが非常に大きな特徴です。2つ目の特徴は，1つのデバイスで，先ほど言ったように興奮性シナプスと抑制性シナプスを同時に実現できる。3つ目は構造が非常に簡単で寸法が小さいため，高密度な集積化に適しているということになります。4つ目は，基本的には高速デバイスで，GHz 程度に応答します。

図14はそういった2次元のデバイスアレイと

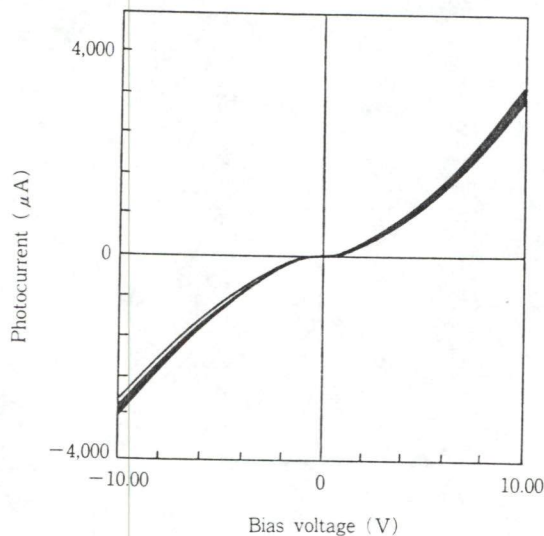


図13 Photocurrent vs. Bias Voltage

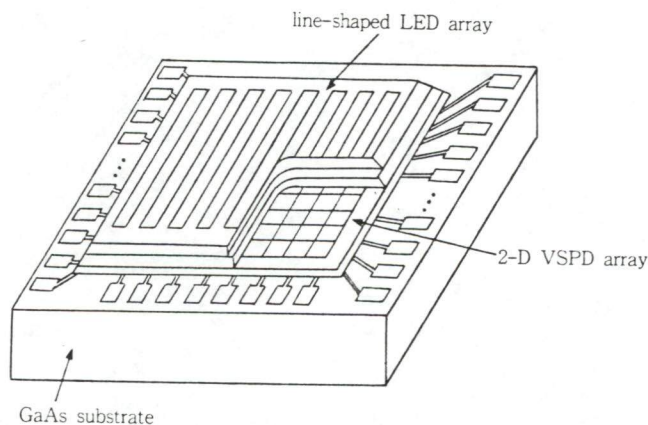


図14 Structure of Optical Learning Chip

発光素子を集積化した学習チップの構成図を示すもの。これはベクトルとマトリクスということを実現させる。このデバイスを使って学習させる。問題は，左側のパターンをどんどん入れ

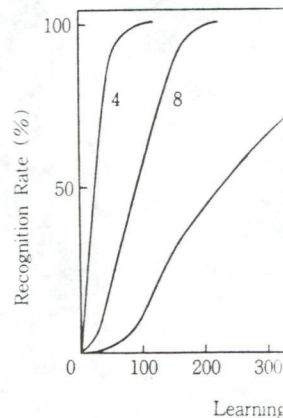
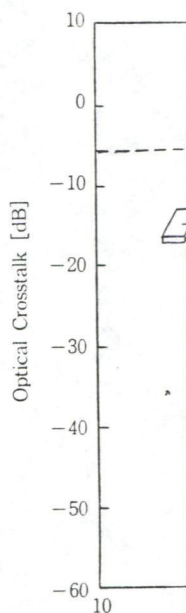


図15 Experimental Learning Rate (Recognition Rate)



ワークに必要な興奮
を同時に実現でき
スだということにな

の特性を示すもので、
縦軸が光電流です。
光電流がバイアス電
化している。しかも
と線が太くなって
ス10個程度の特性を
性に関するばらつき
たい5V, 6V 程度
で普通の受光素子
います。

しぐらい取れるかと
作している限りは6
いまで述べました
まず1つ目にニュー
質的なアナログデバ
常に大きな特徴です。
デバイスで、先ほど言
と抑制性シナプスを
は構造が非常に簡単
変な集積化に適して
4つ目は、基本的
程度に応答します。
のデバイスアレイと

発光素子を集積化した学習が可能なニューロチ
ップの構成図を示すものです。

これはベクトルとマトリックスの演算がうまく
いくということを実験した結果です。

このデバイスを使って学習実験を行ってみた
わけです。問題は、左側からバイナリな12個の
パターンをどんどん入れてやって、それを3つ

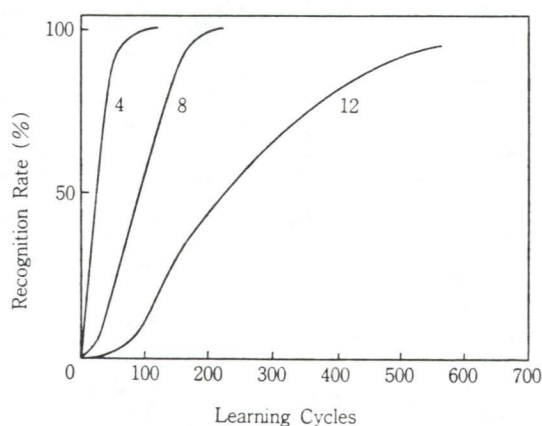


図15 Experimental Learning Curve
(Recognition Rate vs. Learning Curve)

のクラスに分類しようという問題です。もし間
違っていけばバックプロパゲーション学習則に
従ってシナプス荷重を変えていくというもので
す。

図15は実験で得られた学習カーブで、横軸が
学習サイクル、縦軸が実際の正解率を示したも
ので、数百回学習させることによって、パター
ンがうまく分類できていることがわかります。
このデバイスはニューロン数にして8個、シナ
プス数にして64個で、まだ集積度が低いにもか
かわらず学習速度は600MCAPS、処理速度も
600MCUPS という非常に高度な特性が得られ
ています。この実験を介して、光素子技術の集
積度はまだ少ないですが、潜在的な有意性を実
証できつつあるのではないかと考えています。

さて、この光ニューロ・チップで将来集積度
がどのくらい上がるかを実際にシミュレーショ
ンで計算してみました。図16にあるように、こ
れは横軸が集積可能なニューロン数で、縦軸は
クロストークです。クロストークが、実は集積
度を制限する支配的なファクターになるんです

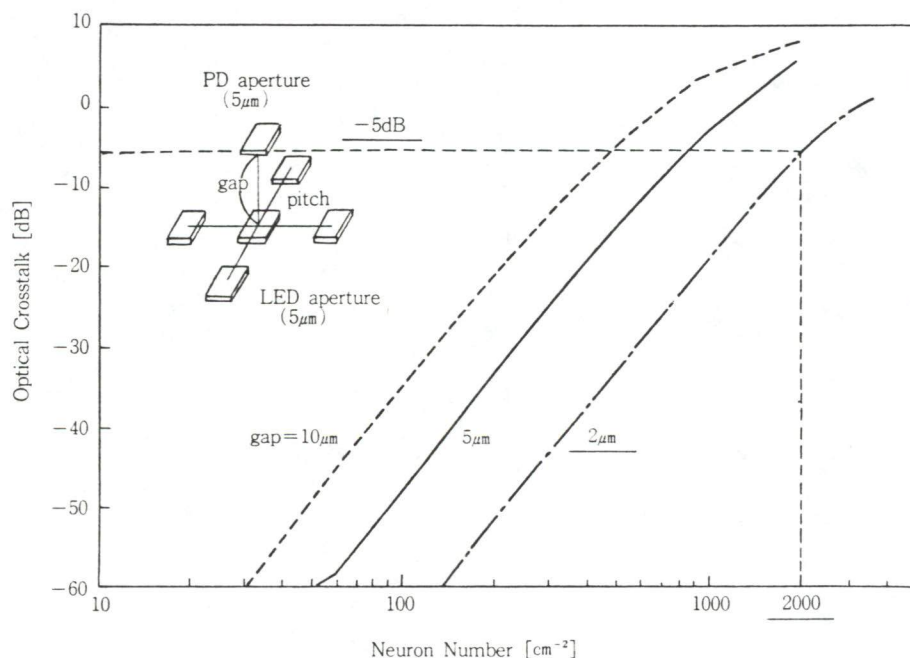


図16 Optical Crosstalk vs. Integration Density

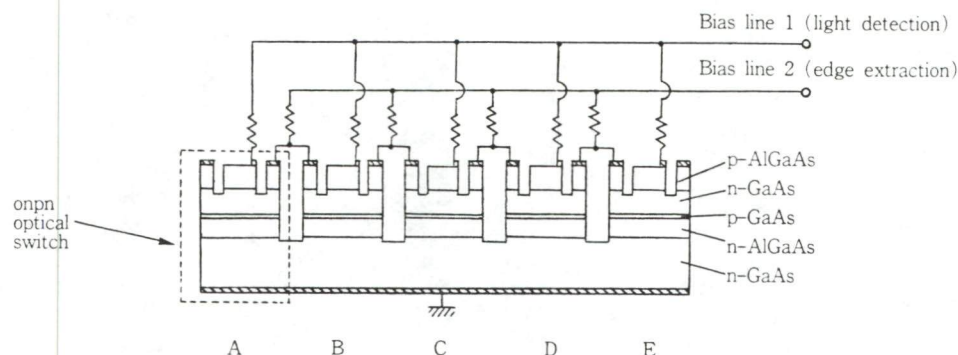


図17 Switch array for edge extraction

が、この図に書いてあるように、だいたい2000程度までは十分いきそうだという結果が得られています。

次に2つ目のデバイスを簡単にご紹介します。2つ目のデバイスは人工網膜に相当するデバイスです。人工網膜素子は2次元のアレイデバイスですが、これはアレイを構成する単体のデバイスを示したものです。ガリウムヒ素を基板にしたPNPN構造の光スイッチです。上から光を入力してやると、そのパワーがあるレベル以上になるとこのデバイスに電流が流れて、発光して光を出すというものです。

大きな特徴は、入ってくる光のパワーが非常に小さくても動作します。

この光スイッチデバイスを図17のようにアレイ状に並べて、バイアスライン1、バイアスライン2の2つの電圧をうまく切り替えると、画像のエッジだけを抽出するような人工網膜素子ができあがります。実はバイアスライン1というのは、上から光が入ってきた時に、明るい領域のスイッチだけがオンして光を出させるもの、バイアスライン2というのは、明るい部分と暗い部分のエッジだけを抽出して光を出すためのものです。

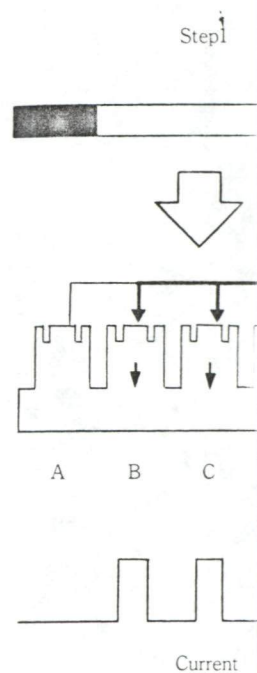
ですから上からなんらかの画像パターンが入ってきた時に、まずバイアスライン1に電圧を加えると、そのパターンに対応した光が発光し

ます。その次にバイアスライン2の電圧を加えると、はじめは全体のパターンが光っているわけですが、次はエッジに相当する部分だけが光るというものです。

いまは1次元のデバイスですが、その応答速度が100ns程度です。完全に並列入力で、並列処理で、並列出力ですから、素子数を多くして集積度を上げててもスピードは変わりません。ですから100ns程度の処理速度でこのような視覚情報処理が、たぶん数年後にはできるのではないかと。左側に書かれているように、チェスの駒の2次元画像をインプットすると、右側に描いてあるようなエッジに相当する光が放たれるといったデバイスです(図18)。

人工網膜素子とニューロ・チップを組み合わせると、非常に高速で、非常に柔軟な画像情報処理システムができるのではないかと思います。

ニューラル・ネットワークをより大規模、たとえば数万個以上のニューロンのネットワークを実現するための方法として、2つの方法をご紹介します。1つの方法は、シリコンのマザーボードの上に、光の配線を主な役目とするニューラル・ネットワーク、マルチプレクシングとかニューロンの非線形処理などを担当するLSIのチップをハイドリッドに実装したものです。こうすることによって、光の特徴を生かした光電子共存型の大規模なニューラル・ネットワー



クができるのではないかと
もう1つの方法は、光ニ
くさん透明絶縁基板上に並
っ間コミュニケーション
クシオン技術を使って実現
方法はどちらかというと理
が、なかなか難しい技術で
今後必要な研究テーマは
1つはモデルの研究、2つ
です。とくに大規模に光テ
技術が必要です。そのため
しては結晶成長技術はもち
プロセス、実装技術、光デ
いった技術が必要になるの
す。

最後に、システム的に
使っていくということで、
能なアーキテクチャ、2次
るようなプロセッサ、ニュ
クとか、人工網膜とか、テ

light detection)
edge extraction)

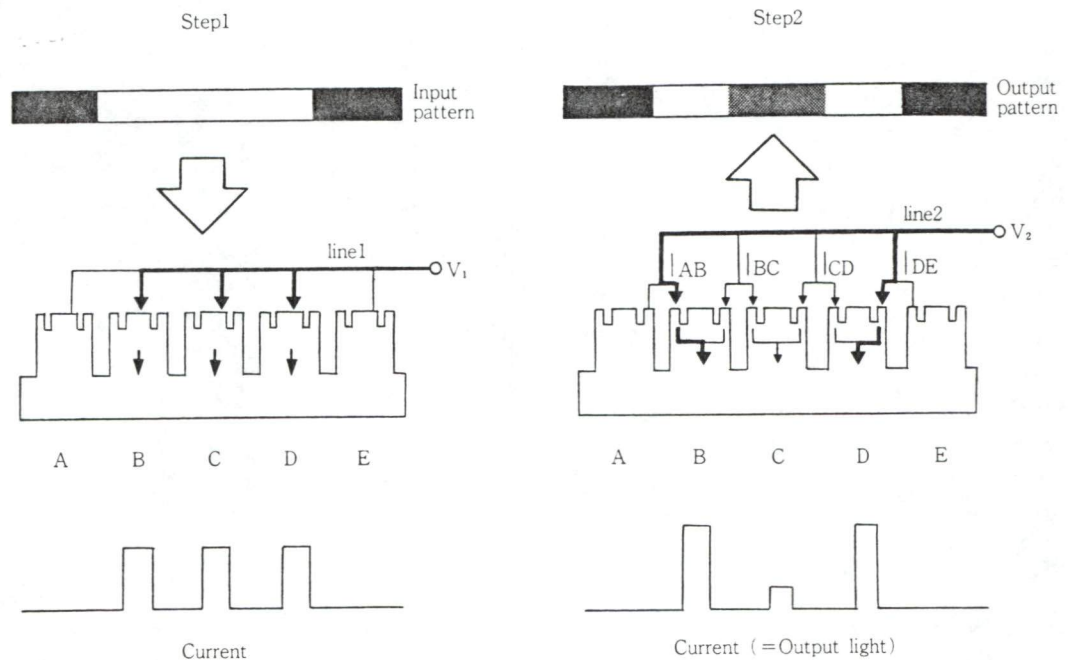


図18 Operating principle of edge extraction

クができるのではないかと考えています。

もう1つの方法は、光ニューロ・チップをたくさん透明絶縁基板上に並べて、それぞれのチップ間のコミュニケーションを光インターコネクション技術を使って実現する方法です。この方法はどちらかというと理想的な方法なんですが、なかなか難しい技術です。

今後必要な研究テーマは山積みされています。1つはモデルの研究、2つ目がデバイスの研究です。とくに大規模に光デバイスを集積化する技術が必要です。そのために必要な要素技術としては結晶成長技術はもちろんですが、ドライプロセス、実装技術、光デバイスのCAD技術といった技術が必要になるのではないかと思います。

最後に、システム的には光チップをたくさん使っていくということで、モジュラーで拡張可能なアーキテクチャ、2次元の画像を直接できるようなプロセッサ、ニューラル・ネットワークとか、人工網膜とか、デジタル・コンピュー

タなどと統合化された新しいコンピュータなどが研究のターゲットではないかと考えています。以上です。どうもご清聴ありがとうございました。

質疑応答

座長 どうもありがとうございました。いまのご講演、光ニューロ・チップの現状、展望といったことに関して何かご質問、コメントがございますでしょうか。

質問 お話の中で挙げられた光をニューロ・コンピューティングの中に導入する時のメリット、たとえば3次元アーキテクチャとかハイデンシティ・コネクティビティなどの期待される利点、たとえば積和演算のモデルなどと組み合わせると、光の空間電波を利用して、そこにおける1対NとかN対1のインタコネクションをフレキシブルに使うということあたりがいちばん光に対して期待される場所ではないかと

いう印象を受けたのですが、ご紹介くださった光ニューロ・チップでは、基本的には1対1の光インタコネクションを電気でもっと横につないでいるかたちになっているようにみえますが、これは要するに1対Nを利用する1つの過渡的なステップとお考えでしょうか。

久間 ある意味では、おっしゃるとおりだと思います。電気でシナプス荷重制御すると、そこでネックが生じるわけで、将来的にはやはり光がかえていきたいと思います。ただし、LSIニューロ・チップと比較して、このままの方式で競争したらどうなるかを考えてみると、光チッ

プが負けるわけではありません。たとえば、いまの $0.8\mu\text{m}$ のプロセス技術を使って、シリコンのアナログデバイスを作っても、シナプス1個に必要な面積は $70\mu\text{m}$ から $100\mu\text{m}$ 角なんです。これに對して、今日ご紹介したMSM構造の光シナプス素子を使うと、たぶん $10\mu\text{m}$ 以下です。ですからこのままの方式でも、実際に実用されるかどうかは別として、性能上はLSIと勝負できるのではないかと思います。

ただしファイナルなかたちとしては、光でシナプスを書き換えた方が、光のメリットをより生かせるのではないかと思います。

海外情報

IS

はじめに

ISO/IEC JTC1/SC2 (tems)の第8回会議が、13日までの4日間、フ開催された。これに日でその概要を報告する

SC26については、わ興協会が引き受け団体委員会を設置してこれ務局は、協会基盤技術している。また、日本事国としての任務をも運営に関するすべてのを負担する責任を負っ来はIEC時代のSC各用していたが、今回よ

本SCのChairman (米国)であり、Secre本、日本電気)である。1に示す。前回のフラ国は6か国であったかた。

Logged

"CORRESPONDENCE TRACKING"

TYPE: ACTION DOCUMENT NUMBER: 9124241
ORIGINATOR: 02 STATUS I DIRECTORATE STATUS

FROM: SINGER, Maxine: CARNEGIE INSTITUTE OF WASHINGTON

TO: DR. D.A. BROMLEY

DATE OF
CORRESPONDENCE: 09/27/91

SUBJECT: REQUEST TO HAVE PRESIDENT BUSH SEND CONGRATULATORY
LETTERS TO THE TWO AMERICANS, MICHAEL SWARC AND
EDWARD LORENZ WHO WILL BE RECEPIENTS OF THE KYOTO
PRIZE.

DIRECTORATE STAFF
ASSIGNED: INTERNATIONAL/POLICY ASSIGNED: S/B

ACTION STAFF
REQUIRED: FOR DAB'S SIGNATURE ACTION:

SENDER'S DUE DATE:
OSTP DUE DATE: 10/11/91 STAFF DUE DATE 10/09/91
DATE COMPLETED: DATE COMPLETED/DEPT:

COPIES TO: D. Allan Bromley

WHITE HOUSE TRACKING #: CONTACT PERSON:
REMARKS: PHONE: EXT:

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OSTP RECEIVED: 09/30/91 DEPT RECEIVED:
FILE: P-INTERNATIONAL-JAPAN

4241

CARNEGIE INSTITUTION OF WASHINGTON
1530 P STREET, NORTHWEST
WASHINGTON, D. C. 20005

RECEIVED

OFFICE OF THE PRESIDENT

91 SEP 30 AM : 26

27 September 1991.
OFFICE OF THE DIRECTOR

Dr. Allan Bromley

Dear Allan,

Kasuo Inamori, a Carnegie Institution trustee, is the founder and benefactor of the Kyoto Prizes. He is a fascinating and generous person, deeply interested in science.

This year, two Americans, Michael Szwarc¹ and Edward Lorenz² will receive this increasingly prestigious international prize. It would be a good thing if President Bush could send congratulatory letters to these two distinguished scientists. Other heads of state customarily do likewise. Whatever could be done to facilitate this would be welcome. The benefit would be to science, to U.S.-Japan relations, and of course would be exciting for the recipients.

Thanks for considering this.

Best regards,
Maxine

¹ University of Southern Calif.

² MIT.

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¹ University of Southern Calif.

² MIT.

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF SCIENCE AND TECHNOLOGY POLICY
WASHINGTON, D.C. 20506

Ken Gale -

Is the reference
to the OVP correct?

JR
10/21/21

yes, absolutely.

~~Ken~~

For Jernal
JR
10/22

THE WHITE HOUSE

WASHINGTON

October 25, 1991

Dear Maxine:

Thank you for your letter of September 27, 1991. I understand the Office of the Vice President will be requesting Presidential letters of commendation for the American Kyoto Prize recipients.

Thank you for your interest in this matter.

Sincerely,



D. Allan Bromley
The Assistant to the President
for
Science and Technology

Ms. Maxine Singer
Office of the President
Carnegie Institution of Washington
1530 P Street, N.W.
Washington, D.C. 20005

Logged

"Document Control"

TYPE: ACTION DOCUMENT NUMBER: 9124333
ORIGINATOR: 02 STATUS I DIRECTORATE STATUS

FROM: MUSSMAN, Harry C.

TO: DR. D.A. BROMLEY

Sara

DATE OF
CORRESPONDENCE: 09/27/91

SUBJECT: SEQUEL TO DR. HESS' LETTER OF 09/23/91 RE: THE USDA
MEMBER OF THE U.S. DELEGATION TO THE JOINT HIGH
LEVEL COMMITTEE MEETING IN TOKYO AND A REQUEST TO
HAVE JAMES PARKER AS THE USDA PRINCIPAL AND DR.
WILLIAM TALLENT ALSO ATTEND AS A TECHNICAL ADVISOR.

DIRECTORATE STAFF
ASSIGNED: INTERNATIONAL/POLICY ASSIGNED:

ACTION STAFF
REQUIRED: FOR DAB'S SIGNATURE ACTION:

SENDER'S DUE DATE:
OSTP DUE DATE: 10/11/91 STAFF DUE DATE
DATE COMPLETED: DATE COMPLETED/DEPT:

COPIES TO: D. Allan Bromley

WHITE HOUSE TRACKING #: CONTACT PERSON:
REMARKS: PHONE: EXT:

No response necessary
SIB

CLOSED

OSTP RECEIVED: 10/08/91 DEPT RECEIVED:
FILE: P-INTERNATIONAL-JAPAN



DEPARTMENT OF AGRICULTURE
OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20250

4333
91 OCT 8 P 2: 59

RECEIVED
OFFICE OF THE
DIRECTOR

SEP 27 1991

Dr. D. Allan Bromley
The Assistant to the President for
Science and Technology
The White House
Washington, DC 20500

Dear Dr. Bromley:

This letter is a sequel to Dr. Hess' letter of September 23, 1991, concerning the USDA member of the U.S. Delegation to the upcoming Joint High Level Committee meeting in Tokyo.

In order to have a USDA representative at a comparable high level to other delegation members, we nominate James V. Parker, Agricultural Minister-Counselor, American Embassy, Tokyo, as the USDA principal. We wish to have Dr. William H. Tallent also attend as a technical advisor to assist Mr. Parker.

I hope these recommended participants will meet with your approval.

Sincerely,

HARRY C. MUSSMAN
Acting Assistant Secretary
Science and Education

"CORRESPONDENCE TRACKING"

TYPE: INFORMATION DOCUMENT NUMBER: 9124232
ORIGINATOR: 02 STATUS C DIRECTORATE STATUS

FROM: MOORE, W. Henson: DEPUTY SECRETARY OF ENERGY

TO: DR. D.A. BROMLEY

DATE OF
CORRESPONDENCE: 09/25/91

SUBJECT: ACCEPTANCE OF THE INVITATION TO PARTICIPATE IN THE
JHLC MEETING.

DIRECTORATE STAFF
ASSIGNED: ASSIGNED:

ACTION STAFF
REQUIRED: ACTION:

SENDER'S DUE DATE:
OSTP DUE DATE: STAFF DUE DATE
DATE COMPLETED: DATE COMPLETED/DEPT:

COPIES TO: D. Allan Bromley
INTERNATIONAL/POLICY

WHITE HOUSE TRACKING #: CONTACT PERSON:
REMARKS: PHONE: EXT:

OSTP RECEIVED: 09/30/91 DEPT RECEIVED:
FILE: P-INTERNATIONAL-JAPAN



4232

The Deputy Secretary of Energy
Washington, DC 20585

September 25, 1991

RECEIVED
91 SEP 30 P 2:57

OFFICE OF THE
DIRECTOR

The Honorable D. Allan Bromley
Assistant to the President for
Science and Technology
The Old Executive Office Building
Room 360
Washington, D.C. 20506

Dear Dr. Bromley:

I appreciate the invitation to join you as a member of the U.S. Delegation to Tokyo for the Joint High Level Committee meeting on the U.S.-Japan Agreement on Cooperation in Research and Development in Science and Technology. The Agreement is an important element of our overall relationship with the Japanese and, as you know, encompasses a number of programs of key interest to the Department of Energy.

I am pleased to accept your invitation to participate as a member of the U.S. Delegation and look forward to working with you on these issues.

With kindest personal regards, I remain

Sincerely yours,

A handwritten signature in dark ink, appearing to read "W. Henson Moore", is written over the typed name.

W. Henson Moore

"CORRESPONDENCE TRACKING"

TYPE: INFORMATION DOCUMENT NUMBER: 9124250
ORIGINATOR: 02 STATUS C DIRECTORATE STATUS

FROM: PAAL, Douglas H.: NATIONAL SECURITY COUNCIL

TO: DR. D.A. BROMLEY

DATE OF
CORRESPONDENCE: 09/18/91

SUBJECT: HE IS UNABLE TO ATTEND THE U.S. DELEGATION FOR THE
THIRD JOINT HIGH LEVEL COMMITTEE MEETING HELD IN
TOKYO OCTOBER 17 AND 18.

DIRECTORATE STAFF
ASSIGNED: ASSIGNED:

ACTION STAFF
REQUIRED: ACTION:

SENDER'S DUE DATE: STAFF DUE DATE
OSTP DUE DATE: STAFF DUE DATE
DATE COMPLETED: DATE COMPLETED/DEPT:

COPIES TO: INTERNATIONAL/POLICY
D. Allan Bromley

WHITE HOUSE TRACKING #: CONTACT PERSON:
PHONE: EXT:
REMARKS:

OSTP RECEIVED: 10/01/91 DEPT RECEIVED:
FILE: P-INTERNATIONAL-JAPAN

4250

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NATIONAL SECURITY COUNCIL
WASHINGTON, D.C. 20506

91 OCT 1 P 3: 38

September 18, 1991

OFFICE OF THE
DIRECTOR

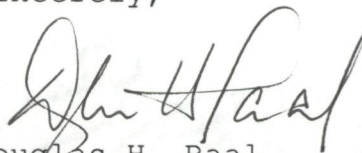
Dear Dr. Bromley:

Thank you for your letter of invitation to be a member of the U.S. Delegation for the Third Joint High Level Committee (JHLC) meeting to be held in Tokyo on October 17 and 18, 1991.

I would very much like to participate in the discussions, but regret that my schedule will not permit me to travel to Tokyo at that time. John Boright and the Joint Working Level Committee have done outstanding work and I am confident that your trip in October will bear the fruit of this effort. Your work, in turn, will set the scene for the President in his meetings in Tokyo on U.S.-Japan science and technology cooperation.

Best wishes for a productive meeting in Tokyo.

Sincerely,



Douglas H. Paal
Special Assistant
to the President
and Senior Director for
Asian Affairs

The Honorable D. Allan Bromley
Assistant to the President
for Science and Technology
Office of Science and Technology Policy
Washington, D.C. 20506