Diurnal Variation of Stratospheric Chlorine Monoxide: A Critical Test of Chlorine Chemistry in the Ozone Layer

P. M. Solomon, R. de Zafra, A. Parrish, J. W. Barrett

Abstract. *This article reports measurements of the column density of stratospheric chlorine monoxide and presents a complete diurnal record of its variation (with 2-hour resolution) obtained from ground-based observations of a millimeter-wave spectral line at 278 gigahertz. Observations were carried out during October and December 1982 from Mauna Kea, Hawaii. The results reported here indicate that the mixing ratio and column density of chlorine monoxide above 30 kilometers during the daytime are ~ 20 percent lower than model predictions based on 2.1 parts per billion of total stratospheric chlorine. The observed day-to-night variation of chlorine monoxide is, however, in good agreement with recent model predictions, confirms the existence of a nighttime reservoir for chlorine, and verifies the predicted general rate of its storage and retrieval. From this evidence, it appears that the chlorine chemistry above 30 kilometers is close to being understood in current stratospheric models. Models based on this chemistry and measured reaction rates predict a reduction in the total stratospheric ozone content in the range of 3 to 5 percent in the final steady state for an otherwise unperturbed atmosphere, although the percentage decrease in the upper stratosphere is much higher.*

Chlorine monoxide (ClO) has for some years been recognized as a key tracer of the stratospheric ozone depletion cycle arising from natural and anthropogenic injection of chlorine-containing compounds, principally halocarbons, into the atmosphere (*1*, *2*). The reactions

$$O_3 + Cl \rightarrow ClO + O_2 \quad (1)$$

and

$$ClO + O \rightarrow Cl + O_2 \quad (2)$$

constitute the catalytic cycle by which chlorine atoms convert ozone, O_3, to diatomic O_2.

There is a strong diurnal variation expected in the concentration of ClO. After the recombination of atomic oxygen at sunset, reaction 2 ceases. At night, ClO is believed to combine in a three-body reaction with NO_2 to form chlorine nitrate,

$$ClO + NO_2 \xrightarrow{M} ClONO_2 \quad (3)$$

which is thought to be the dominant reservoir of chlorine in the absence of sunlight. During daylight hours, free chlorine is again produced from this reservoir by the photolysis of chlorine nitrate:

$$ClONO_2 + h\nu \rightarrow Cl + NO_3 \quad (4)$$

The rate of nighttime removal of ClO via reaction 3 is dependent on the NO_2 concentration and the total density, both of which decrease with altitude above 30 km: thus high-altitude ClO is expected to last through the night, while ClO at lower levels (altitude $\lesssim$ 35 km) disappears. Earlier measurements by in situ resonance fluorescence (*3*), infrared heterodyne spectroscopy (*4*), balloon-borne (*5*) and ground-based (*6*) millimeter-wave spectroscopy have established the presence, approximate quantity, and vertical distribution of daytime stratospheric ClO. A more critical test of the full complex of reactions of stratospheric chlorine may be obtained from measurements of the diurnal variation of ClO. Such observations avoid the complications and uncertainties introduced by vertical and lateral transport and long-term seasonal trends. Earlier balloon-based millimeter measurements over a limited portion of the diurnal cycle have shown a decrease in ClO at sunset and an increase after sunrise (*5*). In this article we present a complete diurnal record of ClO variation, with a time resolution of 2 hours, acquired by ground-based remote sensing of millimeter-wave line emission.

P. M. Solomon is professor of astronomy and R. de Zafra is professor of physics at the State University of New York, Stony Brook 11794. H. Parrish and J. W. Barrett are research associates at the same institution.

Observations of Emission Lines

The ClO molecule has millimeter-wave rotational spectral lines spaced approximately every 37 GHz. We have reported measurement (*6*) of the line at 204.352 GHz from the $J = 11/2 \rightarrow 9/2$ levels. Our current measurements are based on the $J = 15/2 \rightarrow 13/2$ transition at 278.630 GHz. We use a cryogenically cooled millimeter-wave heterodyne mixer receiver with a noise temperature of 1100 K, approximately 2½ times more sensitive than our earlier detector (*6*). Use of this more sensitive detector, combined with an increase by a factor of 2.4 in the theoretical line intensity for the higher frequency 278-GHz line as compared with the 204-GHz line, has led to a sixfold increase in observational sensitivity. For a fixed signal-to-noise ratio, the required measurement duration is reduced by about a factor of 6^2 or 36, allowing a relatively high time resolution to be achieved. The "back-end" spectrometer consists of a filter bank with 256 channels, each with a bandwidth of 1 MHz. The measurement technique, calibration method, and instrumental configuration described earlier (*6*) remain unchanged.

Our observations were carried out at the summit of Mauna Kea, Hawaii (elevation, 4250 m; latitude, 19.5°N) during two periods, from 8 to 11 October and from 9 to 16 December 1982. The atmospheric water vapor content, which dominates the tropospheric absorption of stratospheric emission lines at millimeter-wave frequencies, was very low and generally stable around the clock during these observation periods (*7*).

In the following discussion, we present emission intensities as brightness temperatures in kelvins. This custom, commonly used in radio astronomy, is derived from the Rayleigh-Jeans approximation for blackbody radiation, in which emitted power per unit frequency is linearly proportional to temperature. All intensities represent the values that would be observed if one were looking through one stratospheric air mass toward the zenith after removing the effect of tropospheric attenuation.

In Fig. 1, we present a sample of midday (1230 to 1630) and nighttime for the development of new products. That picture represents a misunderstanding. Although MITI does indeed sponsor R & D programs, such as the highly publicized ones on integrated circuits and the fifth-generation computer, the R & D tends to be basic and engineering research. In the United States, such R & D efforts are centered in our universities.

The commercial R & D successes of Japan, as opposed to efforts to develop the underlying technologies, have been driven not by MITI but by Japanese industry, even in integrated circuits. The participants in the MITI-sponsored cooperative integrated circuits program went back to their own laboratories to develop the actual commercial 64K random access memory chips that have been so successful in the marketplace. Oki Electric, the fastest growing Japanese producer of 64K chips and the first Japanese company to test a 256K chip, did not even participate in the MITI program.

The Japanese government, which has played an important role in promoting its industries' fortunes through such means as protectionist trade policies, has not been a significant force in commercial technology selection and development. The successes of Japan in businesses based on advanced technology are mainly the result of smart, persistent industrial R & D management. Private corporations in Japan make long-term R & D commitments to relatively narrow areas. They pick a target, such as video recorders, assemble large teams to pursue that target, and stick with it for as long as is necessary to bring a winning product to market. They do not try to cover the R & D waterfront, and they do not back out if the payoff is not immediate. They also practice a technique that I call "innovation by experiment," whereby they put a product out on the market, even in imperfect and sometimes expensive form, and learn from the customers how to improve it. And finally, they are aggressive in acquiring, improving, and implementing technology that they did not develop.

These strategies do not explain all of Japan's success in commercial technology, but they do indicate that the real source of that success is Japanese industry. Also, they underscore the lesson that we should learn from Japan: that the selection of the product technology and its development is best left to the people intimately familiar with the technologies and the markets. Technology selection and development should not be managed from afar.

Creating Conditions for Innovation

What role should the U.S. government play with respect to R & D? That role is not to manage technology-based commercial innovation but to create the conditions for such innovation. The government should provide an encouraging and supportive environment and infrastructure within which industries select and develop commercial technology.

There are many features of such an environment that deserve attention: a favorable tax climate exemplified by R & D tax credits, by extension of those credits to software, and by fast depreciation of R & D equipment; modified antitrust laws that encourage cooperative R & D and limit damages for civil violations; export control laws and regulations that do not disrupt the interchange of scientific and technical information that is so vital to the progress of technology; and immigration laws that permit outstanding foreign scientists to remain in the United States to do R & D.

Support for University Research

The most important role for government in creating the conditions for commercial innovation is to support universities in their efforts to generate research and provide manpower. The most crucial issue we face is a lack of skilled manpower, a shortage of faculty in universities for training that manpower, and a deteriorating research capability in our great universities because of the shortages of both faculty and modern equipment for instruction and for research.

American industry today simply cannot get enough of the people it needs in such fields as microelectronics, artificial intelligence, communications, and computer science. The universities are not turning out enough R & D people in these areas, or enough research faculty. There is little that private companies can do about this. We contribute to the support of universities, but industry will never be able to meet more than a small fraction of university R & D funding needs. Even after a decade of steadily increasing industry support for universities, industry provides only about 5 percent of total university R & D funding. Congress is considering additional incentives for industry support of universities, but the fact remains that the primary responsibility for ensuring a strong, healthy academic research system and thereby for providing an adequate supply of research and skilled people must rest with the federal government.

There is wide agreement that the federal government should support the universities, and, in fact, federal basic research obligations to universities and colleges, measured in constant dollars, have grown by more than 25 percent over the past 3 years. But this is only a start in filling the needs. Department of Defense funding of basic research, for example, has only in the past 2 years returned to the level, measured in constant dollars, that it was in 1970. The Defense Department has traditionally played a vital role in supporting basic university research. A time of rapid expansion of the defense budget is no time to abandon that tradition.

Universities have had to compete with the national laboratories for the Department of Energy's research dollars. When research is funded at a university, not only does the research get done, but also students are trained, facilities are upgraded, faculty and students get more support, and thereby better faculty and students are attracted. Moreover, the students that go into industry help in the transition of advanced research into concepts for industrial innovation. When the same research is funded at a national laboratory, most of the educational dividends are lost.

Universities should not have to compete head on with national laboratories for mission agency funds. Unless the national laboratory will do a substantially better research job, the university should get the funds. The same holds for government funding of research in industry. Those funds that advocates of industrial policy propose to invest in government-directed industrial R & D would normally be much better spent in universities, unless there is a special reason why an industrial laboratory can do it much, much better.

I am not proposing that we simply throw money at universities. We need to be selective. To borrow a phrase from the industrial policy advocates, the government should stress the growth of "sunrise science and technology." Unlike the targeting of sunrise industries, the targeting of sunrise—that is, fast moving—areas of research can be done. We can identify these technologies, even if we cannot specify in advance precisely what products or industries they will generate. But we are not doing this as well as we can and should. In microelectronics, for example, a study by the Thomas Group, a Silicon Valley consulting firm, concludes that government support of university microelectronics programs totaled only about $100 million between 1980 and 1982. To put that into tive) from that of 17 with small-cell lung carcinoma (15 positive) is striking (see Table 1). Both cancers have common ancestry, but the former is of comparatively low malignancy and the latter is extraordinarily malignant.

5) While patients with carcinoma generally showed cellular and humoral immune responses to carcinoma-associated T antigen, the humoral response was stimulated preferentially by tubular and early lobular breast carcinomas, which had T activity comparable to other carcinomas. Significantly, these carcinoma types have a favorable prognosis among breast carcinomas (*8, 54*).

The Tn/anti-Tn system may complement the T/anti-T system in elucidating aspects of the pathogenesis of carcinoma and in early diagnosis. While the link between Tn and carcinoma has been known for a decade (*10*), this system has not been studied in the present context. Research is complicated by the usually low concentration of anti-Tn. Tn's immunodominant structure, GalNAc-α, is also the dominant part of the blood group A and Forssman haptens, which may prevent some anti-Tn immune responses. Furthermore, Tn antigen is not readily obtainable from healthy tissues (*7*). There are, however, some highly instructive experiments by nature herself that show not only how unmasked Tn arises in hematopoietic stem cells, usually persisting indefinitely without malignant change, but that Tn, the epigenetic sequela of a rare, benign, somatic mutation, occasionally precedes and then accompanies leukemia, disappears upon chemotherapy-induced remission, and reappears in relapse (*66*).

Conclusion and Prospects

The studies described here have revealed, in a large number of carcinoma patients, a close link between malignant transformation and early, persistent changes in common carcinomas: unmasked precursor antigens T and Tn, that allow the patient's immune system to qualitatively differentiate carcinoma from noncarcinoma.

On rare occasions, demonstrable T and Tn antigens occur in premalignant lesions, which may either remain that way permanently or progress to frank malignancy. Some tissues with such changes are accessible to longitudinal study and thus aid in determining the decisive point of malignant transformation. This approach may be facilitated by manipulation of immune responses, as well as by locating incipient carcinomas with labeled mono- and polyclonal anti-T and anti-Tn reagents (*25, 26, 67*) [but see the introduction and (*27*)]. Our monoclonal antibodies to T and Tn were generated by desialylized human O erythrocytes. We obtained three relevant specificities: anti-T, anti-Tn, as well as a specificity directed toward a moiety shared by T and Tn haptens (*67*). The three types of antibodies reacted strongly and specifically with carcinomas in immunohistochemical analyses of surgical specimens but less well in antibody absorption studies (*27*).

Our recent observation (*68*) in carcinoma patients, but not healthy persons, of a significant increase in lymphoid cell cytolytic activity against target cells with surface-exposed T and Tn antigens supports T and Tn's importance in the malignant process—especially since there was often a concomitant decrease in natural killer cell activity. The findings discussed here, although they are in an emerging phase, indicate that uncovered T and Tn antigens endow the carcinoma cells with a multitude of novel functions. These functions may be fundamental to the multistep processes of invasion and spread of carcinoma, and clearly have a profound, measurable effect on the tumor bearer's immune system. T antigen is likely to be a powerful probe in early carcinoma detection.

References and Notes

1. E. Silverberg, *CA—A Cancer J. Clinicians* **34**, 7 (1984).
2. P. Ehrlich, *Ned. Tijdschr. Geneesk.* **5**, 273 (1909).
3. M. Bertrand, in *Travaux de la 2e Conférence Internationale pour L'Étude du Cancer*, P. Delbert and R. Ledoux-Lebard, Eds. (Alcan, Paris, 1910), pp. 753–758.
4. L. Hirszfeld, W. Halber, J. Laskowski, *Z. Immunitaetsforsch. Exp. Ther.* **64**, 61 (1930); E. Witebsky, *Klin. Wochenschr.* **9**, 58 (1930).
5. E. J. Foley, *Cancer Res.* **13**, 835 (1953); R. T. Prehn, *Fed. Proc. Fed. Am. Soc. Exp. Biol.* **24**, 1018 (1965).
6. M. M. Black and F. D. Speer, *Int. Abstr. Surg.* **109**, 105 (1959); L. E. Hughes and B. Lytton, *Br. Med. J.* **i**, 209 (1964); R. B. Herberman *et al.*, *Natl. Cancer Inst. Monogr.* **37**, 189 (1973).
7. G. F. Springer, P. R. Desai, M. S. Murthy, H. Tegtmeyer, E. F. Scanlon, in *Progress in Allergy*, P. Kallós, B. H. Waksman, A. L. deWeck, K. Ishizaka, Eds. (Karger, Basel, 1979), vol. 29, pp. 42–96.
8. E. C. Rosenow III and D. J. Carr, *CA—A Cancer J. Clinicians* **29**, 233 (1979); D. E. Williams *et al.*, *J. Thorac. Cardiovasc. Surg.* **82**, 70 (1981); J. D. Minna, G. A. Higgins, E. J. Glatstein, in *Cancer Principles and Practice of Oncology*, V. De Vita, Jr., S. Hellman, S. A. Rosenberg, Eds. (Lippincott, Philadelphia, 1982), pp. 396–474; A. R. Moossa, *Cancer* **50**, 2689 (1982).
9. T. G. Frazier, E. M. Copeland, H. S. Gallager, D. D. Paulus, Jr., E. C. White, *Am. J. Surg.* **133**, 697 (1977); G. F. Robbins, in *The Breast*, H. S. Gallager, H. P. Leis, Jr., R. K. Snyderman, J. A. Urban, Eds. (Mosby, St. Louis, 1978), pp. 181–191.
10. G. F. Springer, P. R. Desai, I. Banatwala, *J. Natl. Cancer Inst.* **54**, 335 (1975); G. F. Springer and P. R. Desai, *Transplant. Proc.* **9**, 1105 (1977).
11. D. R. Howard and C. R. Taylor, *Oncology* **37**, 142 (1980); C. R. Boland, C. K. Montgomery, Y. S. Kim, *Proc. Natl. Acad. Sci. U.S.A.* **79**, 2051 (1982); T. F. Ørntoft, N. P. O. Mors, G. Ericksen, N. O. Jacobsen, H. S. Poulsen, *Cancer Res.*, in press.
12. J. H. Anglin, Jr., M. P. Lerner, R. E. Nordquist, *Nature (London)* **269**, 254 (1977).
13. J. C. Laurent, P. Noël, M. Faucon, *Biomedicine* **29**, 260 (1978).
14. C. Limas and P. Lange, *Cancer* **46**, 1366 (1980).
15. J. Coon, R. S. Weinstein, J. Summers, *Am. J. Clin. Pathol.* **77**, 692 (1982); J. L. Summers *et al.*, *Cancer Res.* **43**, 934 (1983).
16. T. P. Lehman, H. S. Cooper, S. G. Mulholland, *Cancer* **53**, 272 (1984).
17. M. Ghazizadeh, S. Kagawa, K. Izumi, K. Kurokawa, *J. Urol.*, in press.
18. G. F. Springer, M. S. Murthy, P. R. Desai, E. F. Scanlon, *Cancer* **45**, 2949 (1980).
19. V. Friedenreich, *The Thomsen Hemagglutination Phenomenon* (Levin & Munksgaard, Copenhagen, 1930); F. M. Burnet and S. G. Anderson, *Aust. J. Exp. Biol. Med.* **25**, 213 (1947); F. H. Caselitz and G. Stein, *Z. Immunitaetsforsch.* **110**, 165 (1953).
20. J. Dausset, J. Moullec, J. Bernard, *Blood* **14**, 1079 (1959).
21. G. F. Springer, H. Tegtmeyer, D. W. Cromer, *Fed. Proc. Fed. Am. Soc. Exp. Biol.* **43**, 6 (1984).
22. R. D. Owen, *Science* **102**, 400 (1945).
23. V. Boccardi, D. Attinà, G. Girelli, *Vox Sang.* **27**, 268 (1974).
24. G. F. Springer and H. Tegtmeyer, *Br. J. Haematol.* **47**, 453 (1981).
25. P. L. Zabel, A. A. Noujaim, A. Shysh, J. Bray, *Eur. J. Nucl. Med.* **8**, 250 (1983).
26. G. F. Springer, S. Metcalfe, H. Tegtmeyer, unpublished data.
27. G. F. Springer *et al.*, *Cancer*, in press.
28. N. Thatcher, K. Hashmi, J. Chang, R. Swindell, D. Crowther, *ibid.* **46**, 1378 (1980).
29. G. H. Vos, E. F. Rose, D. Vos, *S. Afr. Med. J.* **59**, 56 (1981).
30. J. Bray, G. D. Maclean, F. J. Dusel, T. A. McPherson, *Clin. Exp. Immunol.* **47**, 176 (1982).
31. G. F. Springer *et al.*, in *Cellular Oncology*, P. J. Moloy and G. L. Nicolson, Eds. (Praeger, New York, 1983), vol. 1, pp. 99–130; R. L. Goodale, G. F. Springer, J. G. Shearen, P. R. Desai, H. Tegtmeyer, *J. Surg. Res.* **35**, 293 (1983).
32. G. F. Springer and N. J. Ansell, *Proc. Natl. Acad. Sci. U.S.A.* **44**, 182 (1958).
33. K. O. Lloyd and E. A. Kabat, *ibid.* **61**, 1470 (1968).
34. G. Myllylä *et al.*, *Vox Sang.* **20**, 7 (1971); P. Sturgeon, S. J. Luner, D. T. McQuiston, *ibid.* **25**, 481 (1973).
35. G. F. Springer, P. R. Desai, H. Schachter, S. Narasimhan, *Naturwissenschaften* **63**, 488 (1976).
36. J.-P. Cartron *et al.*, *Eur. J. Biochem.* **92**, 111 (1978); P. R. Desai and G. F. Springer, *J. Immunogenet.* **6**, 403 (1979).
37. G. F. Springer and P. R. Desai, *Biochem. Biophys. Res. Commun.* **61**, 470 (1974).
38. R. Kaifu and T. Osawa, *Carbohydr. Res.* **58**, 235 (1977); R. M. Ratcliffe, D. A. Baker, R. U. Lemieux, *ibid.* **93**, 35 (1981); H. Paulsen, J. Jacquinet, W. Rust, *ibid.* **104**, 195 (1982); V. V. Bencomo and P. Sinaÿ, *ibid.* **116**, C9 (1983).
39. G. F. Springer, R. Cheingsong-Popov, V. Schirrmacher, P. R. Desai, H. Tegtmeyer, *J. Biol. Chem.* **258**, 5702 (1983).
40. G. F. Springer, J. L. Cantrell, P. R. Desai, H. Tegtmeyer, *Clin. Immunol. Immunopathol.* **22**, 9 (1982); P. R. Desai and G. F. Springer, in *Glycoconjugates, Proceedings of the Seventh International Symposium on Glycoconjugates*, M. A. Chester, D. Heinegård, A. Lundblad, S. Svensson, Eds. (Rahms, Lund, 1983), pp. 431–432.
41. H. Rauvala and J. Finne, *FEBS Lett.* **97**, 1 (1979).
42. B. Jirgensons and G. F. Springer, *Science* **162**, 365 (1968).
43. G. F. Springer and P. R. Desai, *J. Biol. Chem.* **257**, 2744 (1982).
44. A. Pierce-Cretel, M. Pamblanco, G. Strecker, J. Montreuil, G. Spik, *Eur. J. Biochem.* **114**, 169 (1981).
45. Z. Kim and G. Uhlenbruck, *Z. Immunitaetsforsch. Exp. Ther.* **130**, 88 (1966).
46. G. F. Springer and P. R. Desai, *Carbohydr. Res.* **40**, 183 (1975).
47. J. Bray, R. U. Lemieux, T. A. McPherson, *J. Immunol.* **126**, 1966 (1981).
48. G. F. Springer and P. R. Desai, *Naturwissenschaften* **69**, 346 (1982); P. Desai and G. Springer, in *Protides of the Biological Fluids*, H. Peeters, Ed. (Pergamon, Oxford, 1984), vol. 31, pp. 421–424.
49. G. C. Davey, G. A. Currie, P. Alexander, *Br. J. Cancer* **33**, 9 (1976).
50. V. Schirrmacher, R. Cheingsong-Popov, H. Arnheiter, *J. Exp. Med.* **151**, 984 (1980).
51. G. F. Springer, P. R. Desai, E. F. Scanlon, *Cancer* **37**, 169 (1976).
52. O. H. Beahrs and M. M. Myers, Eds., *Manual for Staging of Cancer* (Lippincott, Philadelphia, ed. 2, 1983).

computer scientists are more aware of the potential of the present systems and are willing to put more effort into using them, while pure scientists, for whom the computer is another tool, have a lower level of pain. If this is the case, it may be only a matter of time before everybody operates in the same mode. However, one can make the following observation: scientists, either in the laboratory or in computing, have shown that they will push their systems or tools to the limit in order to get to the results. In computing they are willing to learn to program in machine language if that gives the performance they need for a specific problem. We are now seeing physicists developing and building their own special-purpose calculating machines at a great cost in time and effort. In the laboratory it is common for scientists to take commercial instruments apart and rebuild them to improve performance, again at a great cost in time and effort.

In our laboratories, pure and applied scientists have access to the same facilities, but their patterns of collaboration are very different. It may well be that we are dealing here with subtle but strong cultural factors. It is easy to develop theories of why this is so, but it is difficult to decide one way or the other. This is a fascinating and important subject but more work, and perhaps more experience, is required to understand the reasons. Similar questions arise in connection with other fields that have proved intractable. For example, will education, that crude process in the classroom that has withstood every technical assault for the past 2000 or 3000 years, finally crumble before the impact of electronic progress? Some people think so and have projected that the interaction of computers with instruction will do it, but still we do not know. Will the availability of terminals in the home, the ability to program at home, and the ability to interact with others over wires, over glass, or possibly through satellites fundamentally change the working patterns of people? That is certainly possible, and again we do not know. Our inability to understand and predict the qualitative effects of computer technology is great. But even the straight-line projection, from what we have experienced to what we can reasonably expect to be the impact on science, is impressive.

References and Notes

1. I. de Sola Pool, Ed. *The Social Impact of the Telephone* (MIT Press, Cambridge, Mass., 1981).
2. K. Pandey, *Phys. Rev. Lett.* 47, 1913 (1981); *ibid.* 49, 223 (1982).
3. H. Gerola and P. E. Seiden, *Astrophys. J.* **223**, 129 (1978).
4. B. Mandelbrot, *The Fractal Geometry of Nature* (Freeman, San Francisco, 1982).

Protection of Plant Varieties and Parts as Intellectual Property

Sidney B. Williams, Jr.

The coming of age of the biological sciences has raised new questions about the protection of technology under the intellectual property laws. Intellectual property, as opposed to tangible property such as real estate or personal property, includes subject matter that is protected by patents, trademarks, copyrights, trade secrets, and more recently, patent-like plant variety protection for varieties reproduced by seed. The protection of intellectual property is not a new concept since its availability can be traced back to Greece as early as 200 B.C. (*1*). However, because the rewards for intellectual property have been high, the requirements for obtaining it have also been quite high. It is the question of what must be given in exchange for patent protection, together with the question of what scope should be given to such protection, that creates many problems in patent law. Nowhere is this more evident than in the protection of plant varieties and their parts.

The importance of protecting plant varieties is evidenced by the number of countries that have passed plant breeders' rights legislation and by the formation of the International Union for the Protection of Plant Varieties (UPOV) (*2*). UPOV administers the treaty that, among other things, requires member states to provide the same rights to plant breeders of other member states as it provides its own nationals.

Protecting Intellectual Property

Intellectual property is protected in two primary ways. The first is by statutory grants such as patents, trademarks, and copyrights. The second is by maintaining the subject matter a trade secret. Unlike patents, trademarks, and copyrights, which are mandated by federal statutory law, trade secret rights arise primarily from state court decisions or laws.

Trademarks are used to distinguish one's goods from those manufactured by others. They indicate the source of goods. The mark can be a word, symbol, name, device, or combination thereof. Examples include the Xerox, Coca-Cola, and Kodak brands.

Copyrights protect the manner of expression but not the ideas embodied in the expression. Examples are books, music, operas, maps. A copyright can only prevent others from copying the mode of expression. Independent creation is not an infringement of the copyright.

Utility (general) patents exclude others from making, using, or selling the invention and actually protect the embodied idea. They do not necessarily mean that the patentee can use his invention because it could be dominated by another patent. To be patentable the invention must be useful, novel, and unobvious (unobviousness requires a step that is not merely a technique within the scope of a person with ordinary skills in the art).

Plant patents provide protection for plant varieties that are reproduced asexually (by budding, grafting, tissue culture, and so on). Uncultivated and tuber-propagated plants (such as Irish potatoes and Jerusalem artichokes) are excluded from protection.

Plant variety protection provides patent-like protection for plant varieties re-

Sidney B. Williams, Jr., is associate patent counsel and manager, domestic patents, The Upjohn Company, Kalamazoo, Michigan 49001.

produced by seed. Fungi, bacteria, and first-generation hybrids are excluded from protection.

Trade secret law protects against unauthorized appropriation or disclosure of the proprietary information.

The systems for granting intellectual property rights vary. The two broad classes are registration and examination systems. Protection under a registration system is easier to obtain because usually the only requirement is that of either novelty or originality. Novelty requires that the subject matter be different from existing subject matter that is known. The extent of the difference is irrelevant. Originality means that the applicant created the subject matter. In other words, the subject matter was not copied. Examples of registration systems are the U.S. copyright, trademark, and plant variety protection schemes.

Protection under an examination system is more difficult to obtain because there is generally a requirement for unobviousness or an "inventive step" as it is referred to in some foreign patent laws. Unobviousness requires a step or result that is beyond that expected of a person with ordinary skills and knowledge in the field of the invention for which protection is being sought. Examples of examination systems are the patent systems of the United States, United Kingdom, Federal Republic of Germany, the Netherlands, and Japan. Patents obtained under examination systems generally provide a broader range of protection than those obtained under registration systems.

The claims of an invention define what is protected. The claims can be analogized to a real estate deed. Instead of using distances and landmarks the claims contain works that outline the boundaries of the invention claimed. For example, Fig. 1 shows the boundaries of a claim to a group of chemical compounds. The boundaries surround any use of the compounds and any method of making them. Therefore, if someone else either discovers a new use of the compounds or a new method of making them, he will have to cross the boundary to compound A to practice the new use or method. Crossing the boundary without the owner's permission is a trespass or, in intellectual property terms, an infringement.

Protecting Plant Varieties and Their Parts

Plant varieties. It is established that plant varieties that are reproduced asexually can be protected under the Plant Patent Law, the Townsend-Purnell Act of 1930 (*3*). It is also clear that plant varieties that are reproduced by seed are protectable under the Plant Variety Protection Act of 1970 (*4*). It is not so clear, however, whether asexually or sexually reproducible plant varieties can be protected under the general patent statute. Even though patents issued under the general patent law (*5*) have covered material containing living matter, the general patent law has most often been applied to inanimate subject matter. As a matter of fact, a great body of technology in which living material was utilized to produce chemicals provided the fertilizer for the production of steroids and antibiotics. However, a great deal of controversy arose when attempts were made to claim living organisms per se. Part of this controversy culminated in the case of *Chakrabarty* v. *Diamond, Commissioner of Patents and Trademarks* (*6*), in which the U.S. Supreme Court held that the fact that the claimed invention encompassed living matter did not preclude general patent protection. Specifically the Court held that the important fact in determining whether or not subject matter is patentable subject matter is whether or not there has been human intervention. *Chakrabarty* involved claims to certain human-modified microorganisms that were capable of "eating" oil. The case did not change the criteria of patentability (usefulness, novelty, and unobviousness). The Court specifically ruled on what was patentable subject matter. In other words, before the criteria of usefulness, novelty, and unobviousness can be applied to an invention it must first meet the criteria of being patentable subject matter.

Answering the question of whether the general patent statute can be used to protect plant varieties that are also protectable under the Plant Patent Law or the Plant Variety Protection Act requires a considerable amount of statutory construction. Statutory construction is a procedure used to interpret laws. One of its objectives is to determine which law among several laws dealing with the same subject matter is applicable when the laws conflict. Although such an analysis is beyond the scope of this article (*7*), it is clear that some thought will have to be given to whether or not there should be different treatment of food crop varieties as opposed to nonfood crop plant varieties. For example, the Plant Variety Protection Act contains express provisions for research (experimental use) and crop exemptions, whereas the general patent statute contains no such provision. Since the Plant Variety Protection Act was an attempt to correct the inequity of there being no patent-like protection for seed-reproduced plant varieties and since many of the varieties reproduced by seed are food crops, did Congress, by providing expressly for a research and crop exemption, articulate a different policy for food crop varieties than other plant varieties?

Plant parts. Plant patent and plant variety protection laws provide for the protection of plant varieties, that is, whole plants. But how do we protect their parts? This question has to be analyzed from two perspectives. First, if protection of the whole plant is obtained, are parts of the plant also protected? Second, is it possible to protect parts of plants without protecting the whole plant?

The question of whether protection of plant parts is obtained when a plant patent is granted has received some attention, especially in the area of cut flowers. The problem with cut flowers is that a plant can be purchased in the United States and taken to a country where there is no plant variety protection; the variety is then reproduced and the flowers are cut and imported back into the United States. The question here is whether it is an infringement of the plant patent to so sell the import under section 337a. One view is that a plant

Summary. In view of the Supreme Court decision in *Chakrabarty* v. *Diamond, Commissioner of Patents and Trademarks*, it is possible that plant varieties can be protected under three different U.S. statutes: the Plant Variety Protection Act, the Plant Patent Law, and the General Patent Law. The Plant Variety Protection Act protects varieties that are reproduced by seed, whereas the Plant Patent Law protects varieties reproduced asexually. Varieties, irrespective of how they are reproduced, could be patentable under the General Patent Statute. It is not clear whether parts of plants can be protected by grants under the Plant Patent Law or Plant Variety Protection Act and it is possible that they will be best protected under the General Patent Statute and by maintaining them as trade secrets. Only time will show whether the existing statutes are sufficient to provide both guidance and adequate protection or whether changes in the law will be required.

ute, it is probable that the disclosure requirements can be met by depositing seeds or other reproductive material for those varieties.

The Plant Variety Protection Act. It is already a requirement of the Plant Variety Protection Act that a sample consisting of 2500 seeds of the variety to be protected be deposited at the National Seed Laboratory at Fort Collins, Colorado. However, many questions linger with respect to depositing microorganisms or seeds. If the seed or microorganism mutates, are the requirements of reproducibility met? Is the mutant itself protected? Does the claimed process include use of the mutant?

To be protectable under the Plant Variety Protection Act a variety must be novel (*13*) and the right to the variety must not be precluded by the activities set forth in the section that defines the right to plant variety protection (*14*). A variety is novel under the Act if it is distinct, uniform, and stable. If a variety differs from all prior art varieties by one or more morphological, physiological, or other characteristic then it meets the criterion of distinctness (*15*). The degree to which a characteristic must differ to be distinct has not been addressed by either the Plant Variety Protection Office (PVPO) or the courts. This question has been raised by the International Union for the Protection of New Varieties of Plants (UPOV) under the categorization of minimum distance.

A variety is uniform if its characteristics can be described and predicted and if they are commercially acceptable (*16*). In the case of *In re Waller* (*17*), PVPO had to consider an application in which the question of uniformity was involved. In reversing a denial of protection on the grounds of lack of uniformity, the secretary of agriculture held that PVPO could not deny protection for a dahlia solely on the ground that it did not have a uniform flower color "if the variations in flower color are describable, predictable and commercially acceptable" (*17*, p. 7).

The requirements of stability (*18*) are met if the variety's main and distinctive characteristics remain unchanged when it is reproduced by seed. While the definition of stability has not been specifically addressed by either PVPO or the courts, it has been addressed implicitly by PVPO because the denial of the application by PVPO in the *Waller* cases was on the ground that it did not meet the requirement of uniformity and stability (*16*).

Difference between food and nonfood crops. Both the Plant Patent Law and the Plant Variety Protection Act provide protection for food and nonfood crops. However, except for fruits and nuts, most nonfood crops have been protected under the Plant Patent Law, whereas most food crops have been protected under the Plant Variety Protection Act. This is probably more historical than by design. The flower nursery industry, whose primary concern is with ornamental varieties, was a strong proponent of the Plant Patent Law, whereas passage of the Plant Variety Protection Act was strongly supported by the seed industry.

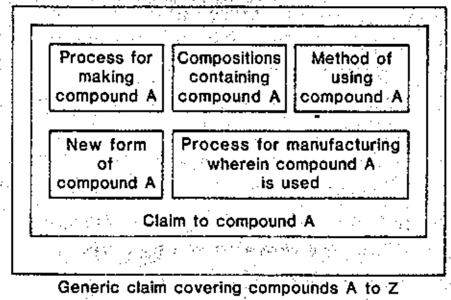


Fig. 1. Boundaries of a claim to a hypothetical group of chemical compounds. Compositions containing compound A include combination products having more than one ingredient.

As pointed out above, when the Plant Patent Law was enacted it was felt that the only way to reproduce varieties true to form was by asexual reproduction. Most ornamental plants (roses, chrysanthemums, and so forth) are reproduced asexually. They form the bulk of those plants covered by plant patents. Since most food crops are reproduced by seed, they cannot be protected by plant patents unless they are subsequently reproduced asexually. Because the technology has not yet developed to the point that most seed-produced crops can be produced more efficiently by asexual reproduction, food crops will probably continue to be protected under the Plant Variety Protection Act except when it is advantageous to attempt to do so under the general patent statute.

Protection of plant varieties under the general patent statute will raise some questions. One of the first is the question of experimental (research) use. Under the general patent statute there is no express provision for experimental use. However, a very narrow exception has evolved from case law. This exception excuses what would normally be considered infringing acts on the grounds that the acts were committed to satisfy scientific or philosophical curiosity. Acts have also been excused as being experimental on the grounds that they are considered to cause so little damage to the owner of the patent as to be meaningless. The Plant Variety Protection Act provides an express provision for a "research use" exception to infringement (*19*). Therefore, conflict could arise if a general patentee would attempt to prevent others from conducting research experiments with a protected variety. A question giving rise to the conflict is whether Congress expressed a public policy against suing researchers for infringement under the Plant Variety Protection Act that would override any rights under the general patent statute.

Another exemption that could create problems for the general patentee is the Farmers' Crop Exemption (*20*). This exemption gives a farmer who purchases a protected variety the right to use the variety to reproduce seed for production or use on his farm or to sell seed reproduced from the purchased seed. The right of a farmer to do this would appear to conflict with the provision under the General Patent Law under which the purchaser of a patented item can repair it but cannot reconstruct it. Also, at least one court has held that the Farmers' Crop Exemption does not entitle a farmer to promote or advertise the protected variety for sale (*21*).

Another difference between the General Patent Law and the Plant Variety Protection Act is that the former provides for compulsory licenses and the latter does not. Under the compulsory license provision the secretary of agriculture can permit others to produce a protected variety if he finds that to do so will be in the national interest. This difference, however, may be one of form rather than substance since the U.S. government (or a court when there has been an antitrust violation) can, under its powers of eminent domain, authorize others to use the patentee's invention. The patentee then has a remedy against the government in the U.S. Court of Claims (*22*).

Breadth of Protection

Two of the most interesting questions concerning the protection of plant varieties are (i) how different will the new variety have to be from the closest old variety in the prior art to obtain protection and (ii) how different will a variety have to be from a protected variety without infringing that variety?

The Plant Variety Protection Act. Many people in the seed industry contend that once a difference has been identified between a new variety and

sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made."
6. *Chakrabarty* v. *Diamond*, 206 *U.S. Pat. Q.* 193 (U.S. Supreme Court, 1980).
7. A. Diepenbrock, C. Neagley, D. Jeffrey, *Am. Pat. Law Assoc. Sel. Leg. Pap.* 1 (No. 2), 81 (1983).
8. *American Patent Law Association Plant Variety Protection Committee Annual Report* (1981).
9. 19 *U.S. Code*, sects. 1337 and 1337a.
10. 35 *U.S. Code*, sect. 271.
11. 7 *U.S. Code*, sect. 2541.
12. *In re Argoudelis*, 168 *U.S. Pat. Q.* 99 (Court of Customs and Patent Appeals).
13. 7 *U.S. Code*, sect. 2401(a).
14. 7 *U.S. Code*, sect. 2402.
15. 7 *U.S. Code*, sect. 2401(a)(1).
16. 7 *U.S. Code*, sect. 2401(a)(2).
17. *In re Waller* (U.S. Secretary of Agriculture decision, 14 July 1981).
18. 7 *U.S. Code*, sect. 2401(a)(3).
19. 7 *U.S. Code*, sect. 2544.
20. 7 *U.S. Code*, sect. 2543.
21. *Delta and Pine Land Co.* v. *Peoples Gin Co.*, 694 *Fed. Rep.* 2nd ser. (Fifth Circuit Court, 1983).
22. 28 *U.S. Code*, sect. 1498.
23. U.S. House of Representatives, *House Rep. No. 1129* (71st Congress, Second Session, 10 April 1930; U.S. Senate, *Senate Rep. No. 315* (71st Congress, Second Session, 3 April 1930).
24. *Graver Tank & Mfg. Co.* v. *Linde Air Products Co.*, 339 *U.S. Rep.* 605 (U.S. Supreme Court, 1950).
25. *Ex parte Jackson*, 217 *U.S. Pat. Q.* 204 (Patent and Trademark Office Board of Appeals, 1982).
26. *Regnum Veg.* 22, 30 (1961).

RESEARCH ARTICLE

A Deep 6-Centimeter Radio Source Survey

E. B. Fomalont, K. I. Kellermann
J. V. Wall, D. Weistrop

Abstract. *The Very Large Array has been used to survey a small region of sky at a wavelength of 6 centimeters down to a completeness level of 60 microjanskys—about 100 times weaker than the faintest radio sources that have been detected with other instruments. The observed source count at flux densities below 100 millijanskys converges in a manner similar to the lower frequency counts, although there is some evidence for an excess of sources weaker than 100 microjanskys. The sources in the survey are preferentially identified with faint galaxies.*

The shortest wavelength at which extensive radio source surveys have been made is 6 cm. At this wavelength surveys by the National Radio Astronomy Observatory (NRAO) and Max-Planck-Institut (MPI) have covered most of the northern sky down to a limiting flux density of 600 millijanskys (mJy), while the various Parkes surveys provide complete samples of sources down to 1 Jy (*1*). Over limited regions of the sky other single-dish surveys made at NRAO and MPI are complete to 35 mJy (*2*), 20 mJy (*3*), 15 mJy (*4*), and 14 mJy (*5*). Synthesis surveys covering even smaller regions have reached levels of 4.5 mJy at Westerbork (*6*) and 0.5 mJy at the Very Large Array (VLA) (*7*). We have used the VLA to extend the surveys to sources that are as faint as 60 μJy at 6 cm, or about 100 times weaker than levels reached with other instruments at any wavelength. Source catalogs constructed from these surveys provide the basis for further studies in the radio region and in other parts of the spectrum. Further investigation is in progress on the nature of these weak radio sources, their spatial distribution and luminosity function, and how these properties change with cosmological epoch.

Counts of radio sources made at centimeter wavelengths are of particular interest since, for the stronger sources selected at this wavelength, flat-spectrum compact sources and steep-spectrum extended sources (which dominate the long-wavelength counts) are present in roughly equal numbers (*5, 8–10*). Previous surveys made at 6 cm for relatively bright sources show that for $S > 100$ mJy (approximately the 20,000 brightest sources in the sky) the counts are closely represented by the "Euclidean" law

$$\eta_0(S) = 90\ S^{-2.5} \quad (1)$$

where $\eta_0(S)$ is the number of sources with flux density S per unit flux density interval.

Between 10 and 100 mJy the 6-cm counts begin to decrease in a manner qualitatively similar to the long-wavelength counts of the steep-spectrum sources (*5, 8, 9*). However, the extended Euclidean plateau at 6 cm differs dramatically from the long-wavelength count, which is characterized by a steep rise for strong sources (the brightest 1000 or so) followed by a rapid decrease in the density of the weaker sources.

In this article we report on observations of very weak radio sources at 6 cm, and we discuss the angular size, spectra, and optical identification of these weak sources.

Observations and Reductions

In order to investigate the number density of very faint radio sources, we have mapped a small area of sky, using the VLA to detect all sources with a flux density greater than 60 μJy. These new observations include the weakest radio sources yet cataloged and reach a source density of 6×10^5 sources per steradian. Supplemental information concerning this sample of sources was obtained through (i) VLA observations at 20 cm to determine the spectral index of the sources and (ii) optical observations with the 4-m telescope at Kitt Peak National Observatory (KPNO) to aid in the identification of the sources.

The 6-cm observations were made in the D configuration of the VLA to synthesize a 700-m-diameter antenna on a field centered at right ascension (α) = $00^h15^m24^s$ and declination (δ) = 15°33′00″ (epoch 1950.0). The resolution is about 18 arc sec and no emission will be missing for sources less than 120 arc sec in size. The general area of the field

E. B. Fomalont is a system scientist at the National Radio Astronomy Observatory, Socorro, New Mexico 87801. K. I. Kellermann is a senior scientist at the National Radio Astronomy Observatory, Green Bank, West Virginia 24944. J. V. Wall is head of Astrophysics and Astrometry Division at the Royal Greenwich Observatory, Herstmonceux Castle, Hailsham, East Sussex BN27 1RP, United Kingdom. D. Weistrop is a scientist at the Laboratory for Astronomy and Solar Physics, NASA-Goddard Space Flight Center, Greenbelt, Maryland 20771, and is a visiting astronomer at Kitt Peak National Observatory.

was not selected at random but was chosen for the following reasons. In order to observe during the night with the available scheduled time in the D configuration, the right ascension of the field had to lie near 1^h. Several deep optical plates were available for the chosen field (selected area 68.1). A high-resolution x-ray map from the Einstein satellite covered most of the area near the field. Finally, observations at Westerbork at 20 cm showed that there were no bright sources near the field which would interfere with the VLA high-sensitivity radio survey (*11*). The specific location of the Deep Field was random within the area constrained by these criteria. These selection biases should not affect the statistics of the present survey.

The observing program was also designed to measure the fluctuations of the cosmic background radiation as well as the number density of weak sources. The results on the background fluctuations are given by Fomalont *et al.* (*12*). The observations consisted of four 12-hour periods on 27, 28, and 29 September and 2 October 1981 to give a total integration time of about 40 hours on one field. All observations were made at elevations greater than 14° above the horizon. The diameter of the field was limited by the primary beam size of the 25-m antennas: 8.9 arc min full width at half-maximum and 17.1 arc min full width to the first nulls. Both the phase tracking (fringe-stopping) and antenna pointing were located at the field center position. In addition, we observed ten other fields surrounding the Deep Field for about 40 minutes integration each in order to provide better statistics for the source count level above 350 μJy. We refer to these as the Intermediate Fields; the locations of the fields are given in Table 1.

Table 1. Field centers.

Field	Position (epoch 1950.0)	
	α	δ
I1	$00^h14^m25^s.84$	15°19′00″
I2	00 15 24.00	15 19 00
I3	00 13 27.63	15 33 00
I4	00 14 25.84	15 33 00
I5	00 16 22.16	15 33 00
I6	00 13 27.63	15 47 00
I7	00 14 25.84	15 47 00
I8	00 15 24.00	15 47 00
I9	00 14 25.84	16 01 00
I10	00 15 24.00	16 01 00
Deep	00 15 24.00	15 33 00

The observations were made at night to avoid interference from the sun in the sidelobes of the antennas. The system noise temperature was 60 K in both left- and right-circular polarization channels, each with a bandwidth of 50 MHz. The antenna pointing was accurate to 0.3 arc min and the delay was tracked to better than 1.5 nsec. All data in which one antenna shadowed another were excluded from the analysis. The instrumental and atmospheric gain and phase fluctuations were monitored by observing the nearby calibrator source 0007 + 171 for 2 minutes at 30-minute intervals. The assumed position for the calibrator is $\alpha = 00^h07^m59^s.383$, $\delta = 17°07'37''.50$ (epoch 1950.0). An observation of 3C48, with an assumed flux density of 5.36 Jy at 4.9 GHz, was used to determine the flux density scale of the observations. It should not be in error by more than 3 percent.

Radio maps were made by following standard Fourier inversion techniques and the clean algorithm was used to remove the effects of the sidelobes in the synthesized beam pattern. The data were mapped so that each 20-second sample of the visibility data at each baseline was given equal weight (so-called natural weighting) to produce the optimum signal-to-noise ratio for a point source. The area of the cleaned synthesized region was 25.6 arc min square (256 by 256 map with a pixel separation of 6 arc sec), which extends beyond the null of the primary beam pattern of the 25-m antennas. The resolution of the map was 18 arc sec. For each of the 4 days of observations radio maps of the field were made separately in the right- and left-circular polarizations. These maps were compared to judge the reliability and sensitivity of the observations. The total intensity map was made by averaging the eight maps (4 days times two polarizations).

The sensitivity parameters of the observations are given in Table 2. The detection level was 60 μJy for a point source. Over most of the field of view the root-mean-square (rms) noise was 11 μJy; however, the noise level increased up to 18 μJy within the inner 5 percent of the field. The increased noise near the field center was caused by low-level correlated signals between the antennas; details are given by Fomalont *et al.* (*12*). Seven percent of the data were edited in order to decrease the effect of these signals. For the Intermediate Fields the detection level of 350 μJy was about 4.5 times the rms noise level.

The 20-cm VLA observations were obtained in February 1983 in the C configuration, which nearly matched the resolution of the 6-cm observations. Seven hours were integrated on the Deep Field, and four other surrounding fields were each observed for 25 minutes in order to overlap all of the intermediate 6-cm fields. Table 2 also contains the sensitivity parameters for these observations. The data were used to obtain estimates of the flux density at 20 cm for the sources found in the 6-cm observations; hence no detection limit is applicable. These data were reduced and processed in a manner similar to the 6-cm data.

Optical observations with the prime focus RCA/CCD camera on the 4-m Mayall telescope at KPNO were made on two nights in November 1982. Eight CCD frames, each 3 by 5 arc min in area, were needed to cover all the sources in the Deep Field. No observations were

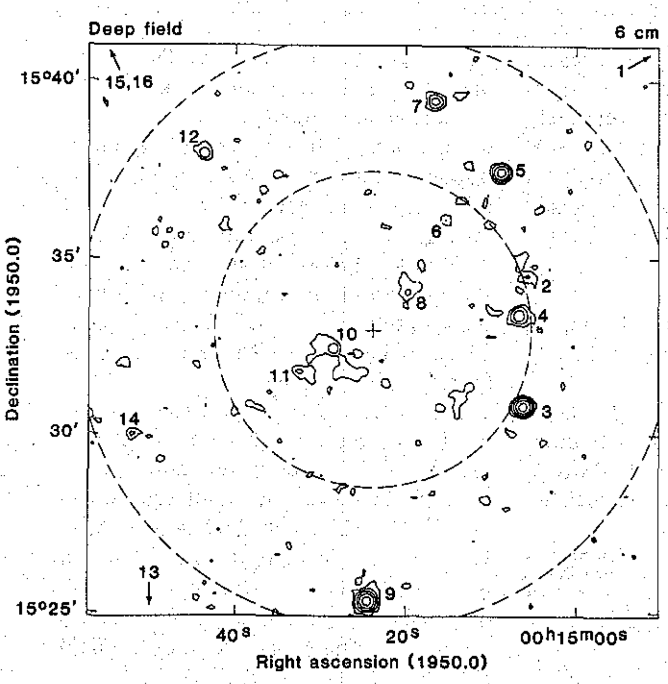


Fig. 1. Contour map of the Deep Field at 6 cm. Contour levels are at 25, 50, 100, 200, and 400 μJy per beam. Only sources with a second contour level have been included in Table 3 and are labeled with their catalog numbers. The cross shows the position of the field center and the two dashed circles show the 50 percent and 8 percent sensitivity loci of the primary beam. Sources 1, 13, 15, and 16 lie outside the 8 percent response. No correction for the primary beam response has been applied to the map.

prior art varieties, the question of how much difference or the type of difference cannot be looked into by PVPO. In other words, if there is any difference, plant variety protection must be granted. Although there is support in the seed industry for such a position, the time will come when PVPO and the courts will have to determine what constitutes a difference.

The Plant Patent Law. There are suggestions in the legislative history of the Plant Patent Law (*23*) that the importance of the distinction between the new variety and prior art varieties cannot be considered by the U.S. Patent and Trademark Office in its determination of whether a new plant is distinct. In other words, if there is any difference it is sufficient to meet the requirement of distinctiveness.

The General Patent Law. The general patent statute provides a situation different from that of the Plant Variety Protection Act since a variety, to be protectable under the general patent statute, will have to meet the additional requirement of unobviousness. The requirement of unobviousness inherently involves the question of how large a difference must exist for a variety to be unobvious in view of prior art varieties. It also differs from the Plant Patent Law in that it provides for multiple claims.

The requirement of difference between varieties for which protection is being applied and prior art varieties is being considered by UPOV under the concept of minimum distance between varieties. At a meeting sponsored by UPOV in Geneva, Switzerland, in November 1983, the question of minimum distance was discussed.

The breadth of protection provided by the patent or certificate is very important in an infringement suit. For example, the patent or certificate holder must show that the accused variety infringes the patent or certificate. One approach would be to have the breadth of protection tied to the ease of securing the protection. For example, if there is no requirement for minimum distance to obtain protection (which is the case under most registration systems) then there should be no doctrine of equivalents. The doctrine of equivalents is a principle of patent law that holds that a patent may be infringed even though the alleged infringing matter is not an exact duplicate of that claimed in the patent if it does the same thing in substantially the same way (*24*). This is a well-known principle in patent law, but it remains to be seen whether it will be applied in plant variety protection lawsuits or lawsuits under the general patent statute in which protection of plant varieties is sought.

In the case of *Ex parte Jackson* (*25*), it was held that even though three microorganism species of a genus were disclosed in the patent, 35 *U.S. Code*, section 112, was not met since the genus encompassed species other than those specifically exemplified. This raises the question of whether or not it would be possible to obtain generic coverage for similar plant varieties of a species under the general patent statute. Specifically, how many species will have to be disclosed to support the genus?

Plant Variety Denominations

No discussion of patent-like protection would be complete without mention of plant variety denominations (names). One requirement of protection under the plant breeders' rights laws of most countries and UPOV is that the variety for which protection is sought must be given a varietal name. The varietal name of a variety is similar to the generic name of a chemical compound. It is not a brand name or a trademark. The varietal name is important because it identifies the new variety by name and it establishes a name for the variety that is separate and distinct from any trademark that may be associated with the variety. In most countries it is not possible to register varietal names as trademarks because a variety could first be protected under plant variety protection laws and then protected perpetually under trademark laws.

Under the UPOV Convention the same varietal name cannot be given to varieties of the same species or a "closely related species." The latter phrase has elicited considerable debate between UPOV member states and has resulted in the drafting of guidelines on varietal denominations. It is probable that there will be continued discussion of the draft guidelines before a final version is adopted.

The Plant Variety Protection Act requires the assignment of a varietal name to the variety for which protection is being sought. However, there was no requirement in the Plant Patent Law until the United States joined UPOV. The Patent and Trademark Office established guidelines for varietal names for varieties claimed in plant patent applications. The guidelines are based on the International Code of Nomenclature (*26*).

Conclusion

Because more and more private research funds are being poured into the development of plant varieties, stable and definitive protection for these varieties and parts thereof is very important. It remains to be seen whether adequate protection is available within the framework of the existing patent statutes or whether new legislation will be required.

References and Notes

1. Frumkin, *J. Pat. Off. Soc.* **27**, 143 (1945).
2. International Convention for the Protection of New Varieties of Plants (2 December 1961; last amended 23 October 1978). There are 17 signatories to the treaty, including the United States, which became a member in 1980.
3. 35 *U.S. Code*, sect. 161 (patents for plants) (last amended 1952), states

   "Whoever invents or discovers and asexually reproduces any distinct and new variety of plant, including cultivated sports, mutants, hybrids, and newly found seedlings, other than a tuber propagated plant or a plant found in an uncultivated state, may obtain a patent therefor, subject to the conditions and requirements of title. (Amended September 3, 1954, 68 Stat. 1190.)

   The provisions of this title relating to patents for inventions shall apply to patents for plants, except as otherwise provided."
4. 7 *U.S. Code*, sect. 2321.
5. 35 *U.S. Code*, sect. 101 (inventions patentable), states

   "Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title."

   Section 102 (conditions for patentability; novelty and loss of right to patent) states

   "A person shall be entitled to a patent unless—

   (a) the invention was known or used by others in this country, or patented or described in a printed publication in this or a foreign country, before the invention thereof by the applicant for patent, or

   (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of the application for patent in the United States, or

   (c) he has abandoned the invention, or

   (d) the invention was first patented or caused to be patented, or was the subject of an inventor's certificate, by the applicant or his legal representatives or assignees in a foreign country prior to the date of the application for patent in this country on an application for patent or inventor's certificate filed more than twelve months before the filing of the application in the United States, or

   (e) the invention was described in a patent granted on an application for patent by another filed in the United States before the invention thereof by the applicant for patent, or on an international application by another who has fulfilled the requirements of paragraphs (1), (2), and (4) of section 371(c) of this title before the invention thereof by the applicant for patent, or

   (f) he did not himself invent the subject matter sought to be patented, or

   (g) before the applicant's invention thereof the invention was made in this country by another who had not abandoned, suppressed, or concealed it. In determining priority of invention there shall be considered not only the respective dates of conception and reduction to practice of the invention, but also the reasonable diligence of one who was first to conceive and last to reduce to practice, from a time prior to conception by the other."

   Section 103 (conditions for patentability; nonobvious subject matter) states

   "A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter

patent does provide such protection. This view is not held universally, however, and some feel that legislation should be introduced to make it clear that plant parts are protected by plant patents and that their importation into the country would constitute infringement of the plant patent (*8*).

Other commentators suggest that protection against the importation of cut flowers obtained from a protected variety is available in the International Trade Commission (ITC) under section 1337(a) of the Tariff Act (*9*). This act affords a remedy against an importer who commits an unfair trade practice that injures an industry in the United States. The Tariff Act specifically provides that infringement of a patent can constitute an unfair trade practice. Section 1337(b) of the Act is applicable because under the General Tariff Act the infringing acts must fall within the infringement provisions of the U.S. patent laws (*10*). However, section 1337(b) makes it an infringement to utilize a patented U.S. process in a foreign country for the purpose of producing an article or a good that is introduced into the United States. Since a plant patent covers asexual reproduction of a plant, it is in the nature of a process patent. Therefore, it can be argued that proceedings under the Tariff Act should be based on section 1337(b). While the situation of cut flowers has been cited as an example, there is no reason that the same argument cannot be equally applied to other plant parts.

Unlike the patent laws, which define infringement generally in terms of sale, manufacture, and use, the Plant Variety Protection Act spells out what constitutes an infringement of a plant variety certificate (*11*). It is clear from 7 *U.S. Code*, section 2541(6), that the sale of plant parts that can be used for reproduction of the variety constitutes infringement.

Protection of plant parts per se (protection that is sought for the parts themselves without any protection for the whole plant) is questionable under the Plant Patent Law and the Plant Variety Protection Act since both statutes provide protection for plants. How, then, may plant parts be protected? There are parts of plants that are readily identifiable—for example, the visible parts such as fruits, leaves, stems, and roots. Then there are the more esoteric parts such as cells, segments of DNA, plasmids, genes, and combinations thereof.

Since neither of the specific plant variety protection laws clearly provides protection for all parts of plants, it would seem that protection could appropriately be sought under the general patent statute.

If the plant part itself can be used to reproduce a hybrid plant or as part of a process to produce another useful item, an alternative means of protecting the part would be by trade secret. Trade secret law, while not governed by federal legislation, is well defined and is governed by state law in the United States. The practice of protecting hybrid plants by controlling the release of their parental lines was the primary reason that hybrids were excluded from plant variety protection.

Living Versus Inanimate Matter

The basic policy behind any type of protection system for intellectual property law is the granting of an exclusive right to the inventor for a clear description of the subject matter so that it can be useful to the public when it is disclosed. In other words, the individual is rewarded for disclosing new information that can be put into the general pool of knowledge and used to advance technology and benefit mankind. It is on the question of adequate disclosure that much controversy has arisen regarding patent-like protection for technical products in general and plant variety and their parts specifically. To help ensure that this general public policy of disclosure is carried out, the general patent statute has very stringent requirements for the content of the patent application. These requirements are set forth in 35 *U.S. Code*, section 112, which reads in part as follows:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same, and shall set forth the best mode contemplated by the inventor of carrying out his invention.

This section states in essence that the specification shall contain a written description that clearly defines the invention in terms that can be followed by one having ordinary skill in the art. It requires that the invention be reproducible, that is, when one skilled in the art follows the description contained in the application, the results obtained by the patentee can be duplicated. A person having ordinary skill in the art is a person who understands and is knowledgeable about prior inventions in the field to which the invention relates.

Because plant materials can change form without intervention by man, questions have been raised as to the ability of the inventor to describe an invention in such a manner that it can be duplicated by those skilled in the art. Specifically, the concern is that even though techniques are followed as set forth, changes or slight variations may cause changes in results.

Discussed below are ways in which these concerns for adequacy of description and reproducibility have been addressed.

The Plant Patent Law. In the legislative hearings preceding passage of the Plant Patent Law the questions of description and reproducibility were approached in two ways. Plant patent applications would not have to meet the stringent requirements of 35 *U.S. Code*, section 112. Specifically, 35 *U.S. Code*, section 162, expressly states that plant patent applications are exempt from the requirements of 35 *U.S. Code*, section 112, and that all the breeder has to do is describe the plants to the best of his ability. Another aspect that has more to do with reproducibility than description is the requirement for asexual reproduction. When the Townsend-Purnell Act was being considered, it was felt that plants could not be reproduced true to form by seed and that the only way to do this was by some form of asexual reproduction. Thus, the limitation.

The General Patent Law. Questions about reproducibility increased during the growth of the fermentation industry. The fermentation industry has been important in the development of antibiotic and steroid technology. The intensity of the questions heightened when attempts were made to claim specific organisms. These organisms were important in producing various antibiotics. One of the important requirements of 35 *U.S. Code*, section 112, is that the patent application contain a description that is complete at the time of filing. That is, one skilled in the art should be able to pick up the application as it is filed and reproduce the invention. In the case *In re Argoudelis* (*12*) it was established that this disclosure requirement could be satisfied by indicating that the microorganism claimed or used in a claimed process has been deposited at a depository and that it would be made available upon the issuance of the patent. This method of meeting the disclosure requirements has been accepted by most of the patent systems throughout the world.

With respect to the protection of plant varieties under the general patent stat-from our experience is in the area of the design of chips. Chips are made by creating masks for the lithographic process, which are essentially pictures of various layers in the silicon. They are tremendously complex, as there can be more than 100,000 transistors on a single chip. The data that go into each mask are stored in a computer, and this common database is accessed by the large number of engineers, who contribute individually to forming the mask. This kind of sharing is a commonplace of engineering today and is true of other aspects of chip design.

In software, collaboration of this sort is also routine. A compiler development involved the sharing of work between a California laboratory, the Yorktown laboratory, and an outside software company, with versions of the program transmitted back and forth continually between the three locations through the network. Various versions of a program under development are centrally stored, and the computer scientists working on it have access to it to update the individual versions and make changes. Software development today is often dependent on this kind of sharing.

Management

In the industrial research community there is a third class of people associated with scientific activity, and that is management. These are the people, mostly scientists and engineers themselves, who are responsible for the execution and coordination of the large variety of projects. For management in general, not only scientific management, the emphasis is not on MIPS or displays but on sharing.

In order to keep up with what is going on in a large research laboratory, mail systems, both text and audio, are extremely useful. One advantage is that they desynchronize communication. When you have an idea or want to know something, you can send your message off and it does not matter whether the people you send it to are there. When they come in or are available, they can find your message and reflect on it and reply. Another advantage is that of addressing a large number of recipients simultaneously. After registering your message only once, you can send it to any of those on a given list of people. These tools are very important to us already, and we expect that they will become widely used and will be major communication tools for management.

Discussion

To summarize, among the three populations that we have had experience with, for scientists MIPS come first; for engineers MIPS, displays, and sharing all play a role; and for management, communications is clearly more important. Are these patterns indicative of fundamental cultural differences, or simply transient reactions to a rapidly changing environment?

All aspects of computer technology will continue to evolve at a rapid pace. Figure 15 shows schematically our view of the computing system of the future. It is a complex of powerful engines connected in a network by good communications facilities. There is a central data-processing (DP) complex in which the 100-MIPS machines described earlier are located; hooked up to them are specialized processors, designed especially for engineering and scientific use. Scattered around are smaller processors, to which intelligent processors based on single microprocessor chips with a power of perhaps 10 MIPS are attached. Local area networks are hooked through a gateway and through communications to other systems, including the large one. Intelligent workstations (IWS) are connected to the network through a private branch exchange (PBX) and also to a number of intermediate machines that play a role as departmental processors or communicate directly with each other through a peer-coupled system. In addition, the network will transmit not only printed messages but also images and voices. Everything we know how to do today will still be done, but with a factor of 10 improvement in power. In addition, there are some things that are possible, though harder to predict, such as symbolic rather than numeric calculation and novel logic-based types of software such as expert systems. These requirements may lead to machines specialized for these needs.

More MIPS will mean, as in the solid-state example, that more problems become tractable. More displays, higher resolutions, and greater interactivity will mean that novel ways of using the displays, such as three-dimensional and other more complex techniques, will become more significant. Increased sharing should lead to better management and the use of project-sharing techniques worldwide.

These are the simple straight-line projections for the evolution of the technology. Its impact on various research activities is in the much more difficult realm of qualitative projections.

Will another factor of 10 cause scientists to cooperate and communicate through computer networks as engineers already do? It may be that engineers and

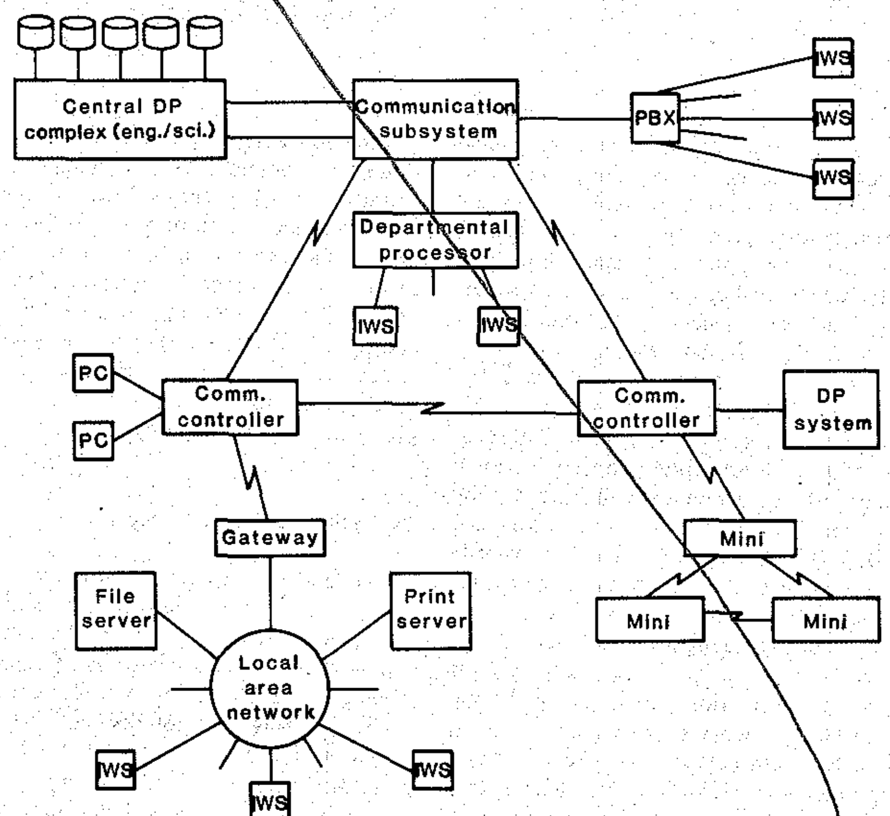


Fig. 15. View of a computing system of the future.

53. Lung disease patients with negative DTHR-T had: caseating granuloma (1), silicosis (3), tuberculosis with pleural effusion (1), intravascular angiogenic tumor (1), chronic bronchiectasis (5), chronic organizing interstitial pneumonitis (4), recurrent cyst (1), coccidioidomycosis (1), sarcoidosis (2), chronic obstructive pulmonary disease (8), chronic asthma emphysema, and pneumonitis (5), pneumonia (3).
54. E. R. Fisher *et al.*, *Cancer* **36**, 1 (1975).
55. D. L. Page *et al.*, *J. Natl. Cancer Inst.* **61**, 1055 (1978).
56. Patients with the following cancers reacted negatively (one of each): B-cell lymphoma; extrapulmonary carcinoid; astrocytoma; glioma; glioma-astrocytoma; liposarcoma; leiomyosarcoma; sarcomatous chordoma; localized, encapsulated papillary-, mixed papillary-, and medullary low-grade thyroid carcinoma. In addition, four patients with acute or chronic myelocytic leukemia and two with Hodgkin's disease in remission reacted negatively.
57. M. I. Bernhard, H. J. Wanebo, J. Helm, R. C. Pace, D. L. Kaiser, *Cancer Res.* **43**, 1932 (1983).
58. J. H. Kaplan, S. H. Lockwood, T. J. Cunningham, G. F. Springer, E. E. Uzgiris, in *Cell Electrophoresis in Cancer and Other Clinical Research*, A. W. Preece and P. A. Light, Eds. (Elsevier, New York, 1981), pp. 197–202.
59. B. D. Janković and B. H. Waksman, *J. Immunol.* **89**, 598 (1962); E. J. Holborow and G. Loewi, *Immunology* **5**, 278 (1962).
60. W. O. Weigle, J. M. Chiller, G. S. Habicht, *Transplant. Rev.* **8**, 3 (1972); P. A. Bretscher, *J. Immunol.* **131**, 1103 (1983).
61. The two-sample comparisons of the statistical results on carcinoma patients with those on patients with benign disease of the same organ are in most instances extremely significant statistically, with *P*-values of the order of several one-thousands. This also applies to both categories of squamous-cell carcinoma. In the case of pooled pancreas and pancreas benign, *P* is 0.0043; there are only five benign pancreas patients. However, if all pancreas carcinoma is compared with all pooled noncarcinoma, *P* is 0.0000. The same pertains if breast carcinoma Stage I infiltrating is compared with all noncarcinoma, while for breast carcinoma Stages II and III *P* is 0.0001 when compared with all noncarcinoma. A two-sample Student test of the hypothesis that the combined carcinoma and the combined noncarcinoma populations are the same has a *P* of 0.0000 and yields the very large, extremely significant *t*-statistic of > 9.5. Additional statistical information will be furnished on request to the author, as will be the individual Q_M ranges.
62. P. M. Brickell *et al.*, *Nature (London)* **306**, 756 (1984).
63. G. F. Springer *et al.*, unpublished data.
64. J. C. Mottram, *J. Pathol. Bacteriol.* **40**, 407 (1935); P. C. Nowell, *Science* **193**, 23 (1976); D. Douer *et al.*, *Br. J. Haematol.* **49**, 615 (1981); B. G. Neel, W. S. Hayward, H. L. Robinson, J. Fang, S. M. Astrin, *Cell* **23**, 323 (1981).
65. D. v. Fournier *et al.*, *Cancer* **45**, 2198 (1980); N. Hayabuchi, W. J. Russell, J. Murakami, *ibid.* **52**, 1098 (1983).
66. G. W. G. Bird, J. Wingham, M. J. Pippard, J. G. Hoult, V. Melikian, *Br. J. Haematol.* **33**, 289 (1976); P. M. Ness, G. Garratty, P. A. Morel, H. P. Perkins, *Blood* **54**, 30 (1978).
67. A. F. R. Rahman and B. M. Longenecker, *J. Immunol.* **129**, 2021 (1982); S. Metcalfe, R. J. Svvennsen, G. F. Springer, H. Tegtmeyer, *J. Immunol. Methods* **62**, pM8 (1983).
68. M. K. Robinson and G. F. Springer, *Proc. Am. Assoc. Cancer Res.*, in press.
69. I thank M. Dwass, Northwestern University, for the statistics. This work benefitted from the contributions of my colleagues; their names appear in the references. I owe special gratitude to E. F. Scanlon, P. R. Desai, W. A. Fry, and H. Tegtmeyer. I thank M. J. Cline, E. R. DeSombre, P. Heller, W. H. Kirsten, S. E. Krown, R. D. Owen, and J. Rosenblum for criticism. I thank Evanston Hospital's physicians for continued encouragement to study their patients. I dedicate this article to Heather Margaret Springer, née Blight, who lived from age 48 through 54 with metastases from bilateral breast carcinoma. Her courageous participation in investigation of unknown immunological territory and her painstaking clinical observations remain an enduring obligation. Support was provided by grants CA 19083 and CA 22540 from the National Institutes of Health and by the Julia S. Michels Investigatorship.

National R & D Policy: An Industrial Perspective

Roland W. Schmitt

Industrial policy has become one of the hot issues on our national agenda, with various advocates telling us how to beat the Japanese and solve the problems of unemployment, inflation, and industrial stagnation. The 1984 presidential candidates are picking up these ideas and testing them.

Industrial policy has many components—fiscal, monetary, and regulatory, for example. It touches on many areas, from international trade to retraining the work force. I can bring my expertise to only one corner of this many-sided subject: research and development policy. To me, industrial policy means what the government must do to shape our national industrial posture, and a clear understanding of what government should not do.

There has been no lack of proposals. Bills put before Congress in recent years have called for such changes as the establishment of a National Technology Foundation, or a Cabinet-level Department of Trade and Industry; the selection of a National Commission on Technological Innovation and Industrial Modernization to tell us "what the economic, educational, and industrial priorities of the United States ought to be"; a Presidential Program for the Advancement of Science and Technology; and a Commission on High Technology and Employment Potential. Another proposal would establish a government program to conduct research and development on improved manufacturing techniques; others would exempt joint research and development efforts from the antitrust laws.

All these proposals to aid U.S. R & D show a healthy and encouraging concern about the state of American industrial technology, but they may at the same time distract politicians and policy-makers from the most important need and the most important step that government can take to strengthen U.S. innovation. That task is to ensure and strengthen the health of our university system—in both the performance of basic research and the training of research manpower. The distraction is especially great if Washington pays too much attention to the growing number of calls for the government to take over the job of selecting and supporting R & D programs aimed at commercial results.

The author is senior vice president, Corporate Research and Development, General Electric Company, Schenectady, New York 12301. This article is adapted from his keynote speech at the National Conference on the Advancement of Research, San Antonio, Texas, 10 October 1983.

The Federal Role

In the commercial R & D area there are some things that government must and can do, and other things it cannot and should not do. Government has a crucial role to play in creating favorable conditions for commercial innovation, but not in actually producing those innovations. There are several reasons for this.

First, successful innovation requires a close and intimate coupling between the developers of a technology and the businesses that will bring products based on that technology to market and are themselves in touch with that market. This is essential in a diversified company, and even more essential in a complex and diversified economy. The R & D people must comprehend the strategies of the business as well as know what the market constraints are and what the competition is up to. The business people, in turn, must understand the capabilities and limitations of the technology. They must possess the technical strength to complete the development and believe strongly enough in the technology's potential to make the big investment needed to bring it to market.

Second, innovation works best if this close coupling is in place during the entire innovation process. It should exist when the R & D project is identified and should continue through planning and development. It must survive the inevitable adjustments during development, caused by shifting market constraints and technical surprises. It must withstand the decision points—when to go ahead or when to quit.

Finally, in a free-enterprise system, governments not only do not create the markets for products but are notoriously slow in reacting to shifts in the marketplace. They lack the crucial entrepreneurial spirit to perceive or acknowledge opportunities early in their development.

During the years of heavy government involvement in energy R & D, we used to hear over and over again the expressions "technology transfer," and "commercialization." Those terms embodied the notion that once a technology was developed by a government contractor or a national laboratory, the technology could then somehow be transferred to the marketplace and commercialized.

That did not happen for a simple reason. Technology transfer is not a separate process occurring downstream from R & D. The user and the performer of targeted R & D need to have established a close relation before there is anything to transfer.

In energy R & D, there were some who fell into the trap of thinking that if they got a concept defined, the technology to work, and someone to produce a favorable economic analysis, then commercialization would follow. They forgot to find out whether the customers would buy the product. The result was a misdirection of effort and money into technologies that never had a chance of commercial success.

Even in agriculture, where the United States has a great history of innovation, underlying research on corn genetics was performed at university research stations and largely supported by government. But private seed companies converted that research into hybrid corn products.

A close relation between the user and the performer of R & D cannot, in general, form when government selects commercial R & D targets. Instead, the government ends up being a third party—one that knows a great deal less about the technology than the developer and a great deal less about the market than the user.

As an example, there are proposals that the government fund R & D in manufacturing technology, in such application areas as programmable automation, robotics, advanced sensors, and computer-aided design and manufacturing. Part of this funding is to support R & D work to be done by industry.

These are key technologies for the future but, because they are so important, a large and growing number of companies are already addressing them. General Electric is investing millions of dollars in each of them. And, in each one, we are faced with a large number of tough competitors—foreign firms and U.S. firms, established firms and new ventures, joint ventures and industry-university cooperative programs. In just one corner of computer-aided design, for example, the field of solid modeling, we are competing against at least a dozen capable firms—established giants, smaller rivals, and newer ventures.

Summary. An analysis of how the government can and cannot use research and development policy to improve the nation's industrial posture suggests four guidelines for federal R & D policy: (i) concentrate direct support on academically based research, not on government-targeted industrial R & D; (ii) concentrate on sunrise science and technology, not on sunrise industries and products; (iii) concentrate on strengthening the climate for privately based innovation, not on government-selected innovation; (iv) concentrate on development for the government's own needs, not on development for market needs.

It is simply not plausible for an administrator in Washington—even with the help of a blue-ribbon advisory panel—to pick the winning solid-modeling product better than the dozen firms slugging it out in the marketplace. And even if government could pick the winner, that is only the first step. The suppliers of the funds, the performers of the R & D, and the businessmen who deal with the customers have to tie themselves together in a long-term relation. A government funding agency cannot create that kind of relationship.

There is, however, one important exception. It occurs when the government is the customer for innovation—as in defense R & D. Government should concentrate its development efforts on these needs of its own. If history is any guide, it will thereby also generate products and technology that can be tapped for commercial uses.

The government has clear needs in the area of supercomputers for weapons research, cryptanalysis, weather forecasting, economic modeling, the design of improved airfoils and projectiles, and many other uses. By meeting its needs in supercomputers, the government will also be sponsoring the development of a product that has many valuable civilian uses, such as improved oil exploration, better understanding of crack formation and propagation in alloys, new techniques in computer-aided engineering, and the design of new materials based on theoretical principles. The supercomputer is a prime example of a technology in which the government should take the lead.

In very large scale integrated circuits (VLSI) the government will also be a major customer and thus has a major role in sponsoring development work. One emerging opportunity is in the area of inference chips—VLSI implementations of intelligent electronic systems that work in real time, based on custom chips rather than computers. These inference chips could be used in military systems, for example, to help the pilot of an F-18 with an engine hit by shrapnel make the best use of the 3.6 seconds he has in which to decide whether he can limp home or should bail out.

Inference chips will also have great value in many commercial uses, such as in creating three-dimensional computer-aided design images in real time and in helping smart robots plan their paths. Again, by meeting its own development needs, the government may advance technology that can be used in commercial innovations. When the government is not the customer, government selection of developments is unlikely to promote such innovation and economic growth.

Competition from Japan

At this point, I would expect some people to be thinking about the Japanese. Did their government bureaucracy not pick the commercial technical winners and put money behind them? No, it did not. At the heart of that question is a misunderstanding about the Japanese government's Ministry of International Trade and Industry (MITI). The popular picture depicts MITI as selecting target industries, picking out the technological developments they need, establishing a consortium of Japanese firms, and supporting the commercial R & D needed perspective, the Department of Energy's program expense for just one unproved, highly speculative energy technique, magnetically contained fusion, was $295 million in 1982 alone. We face the same problem in several other crucial areas of university research. This is particularly true of engineering research—fundamental research in such areas as software engineering, automation, machining systems, materials engineering, and computer-aided engineering techniques.

The crucial distinction again is between support of the underlying research (the job that the government should be doing) and support of efforts aimed directly at generating products (the job the government should stay away from). Some of the bills before Congress do not clearly make this distinction. Consider, for example, the calls for government support of R & D in manufacturing technology. If a program for conducting the underlying research at universities is to be established, I will support it wholeheartedly. But when programs to produce more efficient manufacturing technologies are proposed, I worry that someone has ignored the difference between broadly relevant research and the job of selecting specific technology targets for new products and processes. And when anyone proposes conducting research utilization activities to encourage widespread adoption of these technologies, then I have serious reservations.

In the technology of controls, for example, fundamental theoretical advances are needed to catch up with the speed and power of microelectronics. Such work should be strongly supported at universities. But the job of putting research to work in, say, robots or machine tool controls for commercial markets should be addressed by private companies.

Some may be concerned that with so much emphasis on support of academic research in fast-moving areas, such as microelectronics and computer science, the needs of core industries, such as automobiles and steel, will be neglected. That is not so. The increases in efficiency needed by these industries will be provided much more by some of these fast-moving areas than by advances in the core technologies. These industries, too, are dependent on strong university research in the fast-moving areas. Moreover, these industries suffer from a lack of investment in already available technology. Giving them new technology without the corresponding investment to use that technology is hardly likely to improve their plight.

Immigration Policy

Another policy issue that strikes at the heart of our universities, yet is rarely discussed in the context of R & D policy, is immigration policy. In 1982 as many foreign students received engineering Ph.D.'s in our universities as did American students. Some regard these foreign students as a problem, and there even have been proposals to reduce their numbers. But the real problem is that not enough Americans are entering doctoral programs. The solution is to encourage more of our students, through adequately supported graduate fellowships, to go on to graduate studies. What is clearly not a solution is to force foreign students to leave. They are an important resource for our country. They account for a disproportionately large portion of our skilled manpower in the fast-moving areas of science and technology. They are not taking jobs away from Americans. They are filling a void and advancing U.S. science and technology. Historically the United States has benefited immeasurably from opening our doors to immigrant scientists and engineers. I need only mention such greats as Steinmetz, Alexanderson, and Giaever at General Electric; Tesla, Zworykin, and Ipatieff at other companies; and Fermi, Debye, Mark, and many others at American universities. Yet current laws create obstacles for foreign scientists who seek employment here. If we are truly concerned about enhancing U.S. industry's capability to do R & D, we should ease the regulatory barriers to hiring foreign-born students, especially those trained in this country. Proposed amendments to the Simpson-Mazzoli immigration bill now before Congress would do exactly that. Unfortunately, for reasons that have nothing at all to do with science and technology, that bill is now stalled in the House. The critical role that foreign scientists play in the United States must be addressed directly, rather than as an afterthought to a bill intended to deal with the problem of illegal, and largely unskilled, aliens.

Technology Leaks

A related national issue also directly affects the health of our universities: the problem of leakage of technology to the Soviet Union. In an attempt to stop that leakage, the Department of Defense and the Department of Commerce proposed regulations that would prevent foreign nationals from taking part in advanced microelectronics research in universities and industry. This is intended as just a first step. In the long run, the two departments are proposing to impose the same restrictions on virtually all fast-moving areas of advanced technology considered to be militarily critical.

There is no question that we must do a better job of preventing the Soviets from acquiring our technology, but such regulations are overkill. The Defense and Commerce Departments propose to change the export control regulations in ways that would seriously disrupt the nature of scientific discourse in U.S. universities and industrial R & D laboratories. No doubt some technology does leak to the Soviets in the course of our open scientific discourse. But by the Administration's own account, this is a very small part of the problem. It is counterproductive to impose such major restrictions on U.S. science and technology for such a small part of the problem. Again, foreign scientists play a critical role in most of our important areas of science and technology. Deny them access to these areas of research and we will do far more to damage our technological capabilities than any of the proposals being made in the name of industrial policy will do to help.

Conclusion

National R & D policy today poses both risks and opportunities. The excitement and attention that proposals for industrial R & D policy have generated threaten to distract us from the federal government's most important tasks. We need to go back to the basics. We need to remind ourselves of what it is that the government can and cannot do, and what it is that industry can and cannot do.

In summary, I want to suggest four specific guidelines for federal R & D policy: (i) concentrate direct support on academically based research, not on government-targeted industrial R & D; (ii) concentrate on sunrise science and technology, not on sunrise industries and products; (iii) concentrate on strengthening the climate for privately based innovation, not on government-selected innovation; (iv) concentrate on development for the government's own needs, not on development for market needs. I believe that these simple guidelines—many of which we have followed with success in the past, some of which we have violated with pain—will go a long way toward greatly strengthening and rejuvenating the dynamic innovative powers of our American system of research and development.

ENHANCED TECHNOLOGY TRANSFER

Many factors, including improving education, encouraging capital formation, developing new markets, and encouraging technological innovation will improve the U.S. competitive edge. One element stands out as the most cost-effective action we can take: improving the transfer of commercially useful technology that the government is already supporting. Historically, U.S. laws and agency policies have not offered efficient methods or incentives to promote commercial use of government-developed technologies. In recent years, however, several laws have enhanced technology transfer, but the provisions of those laws do not fully apply to some of our major labs, and changes would be useful.

In the free enterprise system, protection of intellectual property by granting exclusive patent rights offers important incentives to justify investment. Frequently, the research investment that results in intellectual property falls far short of the total investment needed to convert an idea into a commercial reality. Although not all government-supported technology needs to be protected by exclusive patent rights, granting exclusive rights to risk takers is important when commercialization requires extensive additional development. Granting non-exclusive rights to many often results in insufficient incentives to pursue new inventions. This is a case where "giving to everybody often means giving to nobody." And a worthwhile invention would remain uncommercialized or--worse yet--would be picked up by foreign entities to the detriment of U.S. domestic economy.

Incentives to promote technology transfer by granting exclusive patent rights also can improve our control of economically useful information to benefit domestic industry. The present lack of incentives in technology transfer actually encourages technical people to release unclassified information to the world through traditional channels in technical journals and professional conferences rather than through patents. With incentives in place, it would be productive for the laboratories to focus more of this technical data into protectable innovation that is more directly useful in the U.S. commercial world. And, the use of patents as a publication channel would increase, without slowing the more traditional forms of technical communication.

Patents are one important form of intellectual property protection. Copyrights, most notably for software protection and the protection of "mask works" for integrated circuits, are also increasingly important. These items are increasingly valuable products from many of the laboratories. Occasionally, the laboratories develop information that industry would label "proprietary"; examples are new processes or data that may be useful to industry. Frequently, proprietary information cannot be adequately protected by patents because such publication would teach anybody how to use such data in a way that would not be evident in a final product. There are presently either no provisions or limited provisions that allow government-funded laboratories to control all types of intellectual property for U.S. benefit. Of course, the government should retain rights to use the results of government-funded research for its own use.

Congress recognized these facts when it enacted legislation giving patent rights to universities and small businesses working under government contract. In particular, the Bayh-Dole Act and its amendments permit universities and small businesses that operate government laboratories to elect title to inventions made at those laboratories. For example, the University of California can take patent rights to inventions made at the Lawrence Berkeley Laboratory, which the university operates under contract to the Department of Energy (DOE). This encourages the university and the Lawrence Berkeley Laboratory to assist in the commercialization of inventions. Extending such policies to all government-funded laboratories is the cornerstone of an enhanced technology transfer program, and including patents copyrights, mask works, and proprietary and process data would further enhance the commercial value of laboratory technology.

Several exceptions built into existing legislation make technology transfer from DOE Laboratories difficult. These exclusions refer to weapons laboratories of the DOE and laboratories managed by large for-profit contractors, whether or not the contractor works without profit or fee. Some of our country's largest laboratories are excluded from Bayh-Dole.

On April 10, 1987, however, the President issued an Executive Order pursuant to the Bayh-Dole Act and the Technology Transfer Act of 1986. The President directed DOE and other executive departments and agencies to encourage and facilitate technology transfer among Federal laboratories, universities, and the private sector. The Executive Order directs that patentable results of federal research be granted to all contractors who perform the research, regardless of size.

If the nation intends to fully utilize the potential of intellectual property to spur technology transfer from all of the national laboratories, the law needs to be changed or interpreted to allow more efficient management of all types of intellectual property. The exclusions that preclude application of Bayh-Dole and the Technology Transfer Act to nuclear weapons-related laboratories should be eliminated. The President's directive should be wholeheartedly adopted.

Under DOE program oversight, royalties generated by licensing technologies from large commercial contractors operating government-owned laboratories could be returned to the laboratories for further research and additional technology transfer efforts. Royalties also could be used for incentives to encourage staff to make more intellectual property disclosures. Presently,it is difficult for laboratories to accept royalties, even if all such royalties are used for additional research or technology transfer. This should be changed. Contractors that operate Federal laboratories should be able to enter into fair and reasonable arrangements with industry or third parties, such as universities or inventors, to encourage commercial development of laboratory-generated technology. Contracts would include plans for commercialization and, if expectations fail, there would be provisions to give another organization the chance to take over the invention.

Under certain circumstances, when the laboratories have unique capabilities, industry may wish to contribute funds for laboratory research programs. Current procedures for sponsoring programs at national laboratories require a lengthy negotiation. Such delays run counter to the spirit of maintaining competitiveness and waste valuable management resources. When there is no interference with laboratory programs, the laboratories should enjoy greater freedom in negotiating for such work.

In summary:

If the nation required a more uniform and progressive technology transfer policy for all government-owned laboratories, the result would include more inventions, more patent disclosures, more domestic commercial benefit, and more jobs for Americans. It would substantially enhance the technology transfer efforts of several major laboratories that undertake a significant share of our country's research.

Provisions that include the ability for all government-funded laboratories to directly and promptly negotiate agreements with risk-takers involving know-how and copyrights, in addition to patents, would be particularly useful. Business decisions involving new technology are inherently risky and uncertain, and delays, prohibitions, and uncertainties inherent in the present cumbersome processes inhibit commercial potential. The President's Executive Order of April 10, 1987, should be wholeheartedly adopted.

U.S. PATENT PRODUCTIVITY

Analysis shows a decline in inventive output for the U.S. chemical industry between 1965 and 1980 that may well be representative of industry as a whole.

Stephen F. Adler and Herbert H. P. Fang

On the basis of trends in patenting activity, one of us reported in an earlier study that there was compelling evidence of a decline in innovative activity in the U.S. for the period 1965–1975 (*1*). During the past decade or more, other observers have reached the same conclusion by other methods of measurement or reasoning (*2,3*). Since no one has yet proclaimed a renaissance of innovative activity, we may assume that things are still as they were or that they may have gotten worse.

The study reported in this article includes data from the mid-1960s through 1982–83 to get a longer view of this phenomenon. We have also examined several variables not studied in the first paper to see if we can better understand what accounts for the patterns of patenting activity both by U.S. industry and within various segments of the industry.

Recognizing that there are year-to-year variations in the patents issued by the U.S. Patent Office, most of the data used in this paper are running three-year averages reported for the second year of the period. The smoothed data for 1966–1982 (Figure 1) show that the total number of patents per year rose from ca. 60,000 in 1966 to ca. 75,000 in the early 1970s (*4,5*). Since about 1977, the level of activity has again declined to ca. 60,000. The data contain an important underlying message about the nationality of the inventors. Non-U.S. inventors have increased their absolute rate of generation from ca. 10,000 to ca. 25,000 patents per year. During the same period, U.S. inventors' production declined from ca. 50,000 to ca. 35,000 patents per year. In 1965, about 20 percent of U.S. patents were issued to non-U.S. inventors (Figure 2); by 1983, that figure had risen about 41 percent, and the Patent Office reports that for 1985 it was 43.9 percent.

The decline in U.S. inventive output is the most fundamental observation we have made. All of the other facts and observations that follow are merely elaborations of this.

In the earlier study we analyzed patent generation and R&D expenses over a decade for the 12 largest chemical companies. The R&D expenses were published figures corrected for inflation. The patent data were obtained from Information For Industry. A minor concern in the first study was that not all of the patents issued to any one company might have been counted because of assignments to subsidiaries with names that might not have been included. In the present paper, the patent data are those that were graciously supplied by each of the chemical companies (*6*).

The so-called "Big 12" companies can be used to monitor the activity of the chemical industry because they account for a large fraction of research expenditures and patent activity for that industry. For example, the "Big 12" spent ca. 40 percent of the industry's research dollars and got ca. 30 percent of the patents. Figure 3 shows how the "Big 12" share of the U.S. patents granted to U.S. inventors has changed between 1967 and 1980. Since 1974, that share has been down to a nearly constant 5.1 percent starting from ca. 6.5 percent at the beginning of the period. There is, thus, a double decline to be noted—(a) U.S.-invented patents have declined both in absolute terms and as a percent of the total patents, and (b) the chemical industry is getting a reduced share of that smaller pool.

Patent Productivity

"Patent productivity" is the ratio of patents issued in any year to the money expended on R&D in the same year. It has units of number of patents/$MM of R&D. Admittedly, this productivity quotient is simplistic because it ignores expenditures that do not have patents as an expected outcome. It also sidesteps the question of the time lag between the doing of the research and the issuance of the patent. Nevertheless, patent productivity is a concept that is useful for tracking an industry or a company to spot trends over a period of time. In this paper, the number of patents will always be the smoothed average and expenditures will always be reported as constant 1967 dollars by correcting actual figures with GNP price deflators (*7*).

Figures 4, 5 and 6 show the patent productivity for the "Big 12" as a function of time in groups of four companies arranged according to sales volume. The four largest companies (Du Pont, Union Carbide, D

Stephen Adler is director of Stauffer Chemical Company's Eastern Research Center in Dobbs Ferry, New York. He went to Stauffer in 1969. Adler got a Bachelors Degree in 1951 from Roosevelt University and M.S. and Ph.D. degrees in chemistry from Northwestern University in 1953 and 1954. He has published articles in the field of catalysis and holds more than 10 U.S. patents. In 1980 he received an award from the Philadelphia Patent Law Association for an article about the patent system by an author who is not a patent attorney. Herbert H. P. Fang is a program manager at the Eastern Research Center of Stauffer Chemical Company, where he has worked since 1975. A chemical engineer by training, he received his Ph.D. in 1972 from the University of Rochester and B.S. from National Taiwan University in 1965.

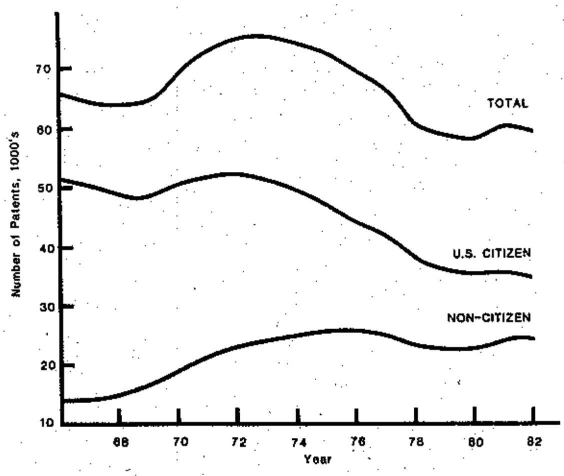


Figure 1.—U.S. Patents Issued.

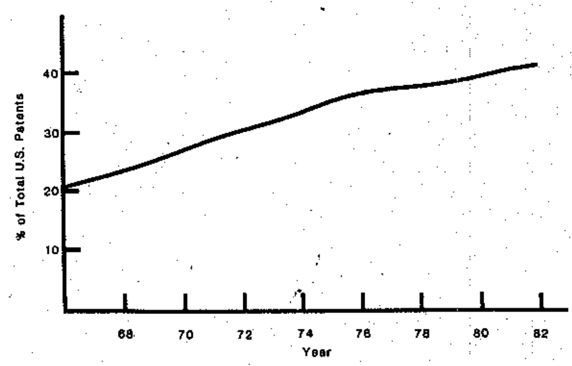


Figure 2.—Percent of U.S. Patents By Non-Citizens.

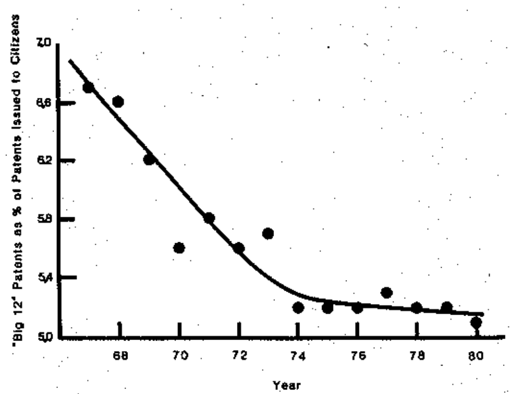


Figure 3.—Percent of U.S. Patents Issued To "Big 12" Chemical Companies.

and Monsanto) show a similar pattern. The data show an inverse relationship between patent productivity and company sales. This fact is examined in more detail in a following section. The middle group (Allied, Celanese, American Cyanamid and Hercules) follows a somewhat different pattern with time, with a more distinct maximum for each curve in the mid-1970s followed by a steep decline. There is once again the observation that patent productivity is apparently larger when sales volume is lower. In the third group, the curves for Ethyl and Stauffer have the maximum in the mid-1970s as noted in Figure 6, but Olin and Rohm and Haas have very different shapes. Also, one cannot say for Figure 6 that there is an obvious correlation between productivity and company size.

In the view of people who see research as a vital function of a corporation, sales might be expected to increase with more research (of the right kind). The same might be said of patents. That is, more research should lead to more patents. Figures 7 and 8 show how patents vary with R&D expenses for the "Big 12" (in constant 1967 dollars). The expected relationship of more patents with greater research expenditures is readily seen.

When the same analysis is made once more for patent productivity (number of patents/$mm of R&D), the picture is entirely different. We plot patent productivity against sales for two periods, 1971–75 and 1976–80 (*8*). Figures 9 and 10 show that productivity varies inversely with sales volume. What this says is that the efficiency of the R&D organization in producing patents goes down as the size of the parent corporation in constant 1967 dollars gets bigger. Is there no efficiency of scale in this process? We will return to this question again.

Figures 11 and 12 show the relationship of patent productivity to the percent of sales allocated to R&D. The two periods are once again 1971–75 and 1976–80, respectively. Although some scatter is seen in both plots, the predominant feature is an inverse relationship of patent productivity to R&D as a percent of sales. Both the abscissa and the ordinate refer to quantities that are the ratio of an output to an input:

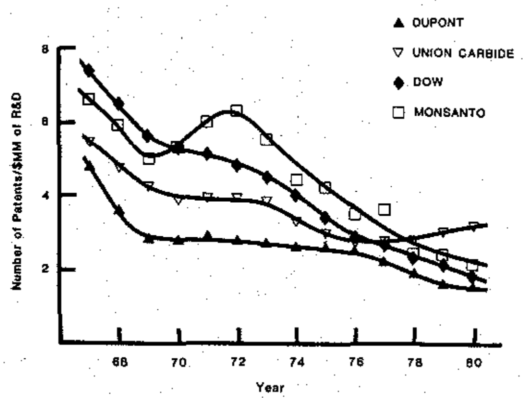


Figure 4.—Patent Productivity Vs. Time.

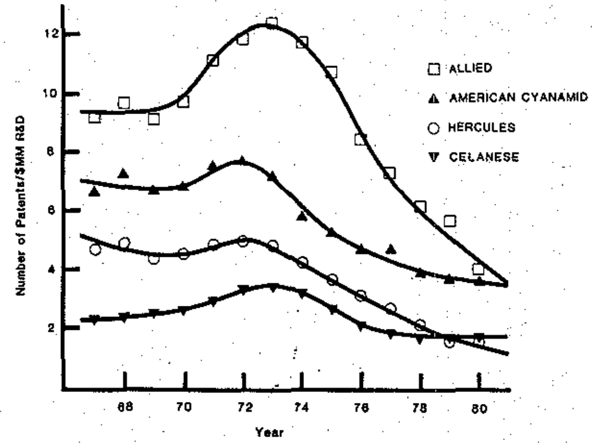


Figure 5.—Patent Productivity Vs. Time.

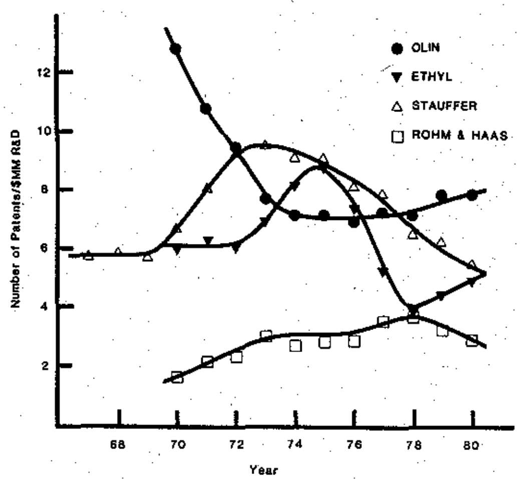


Figure 6.—Patent Productivity Vs. Time.

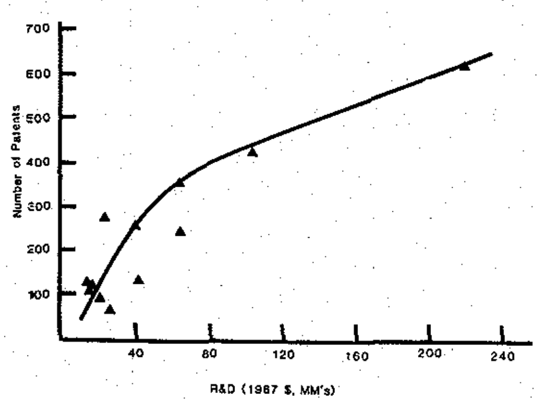


Figure 7.—Patents Vs. R&D (1971–75 Average).

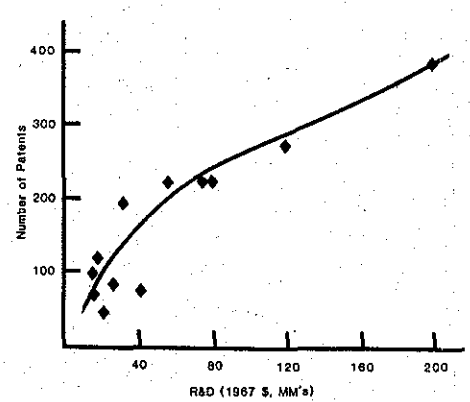


Figure 8.—Patents Vs. R&D (1976–80 Average).

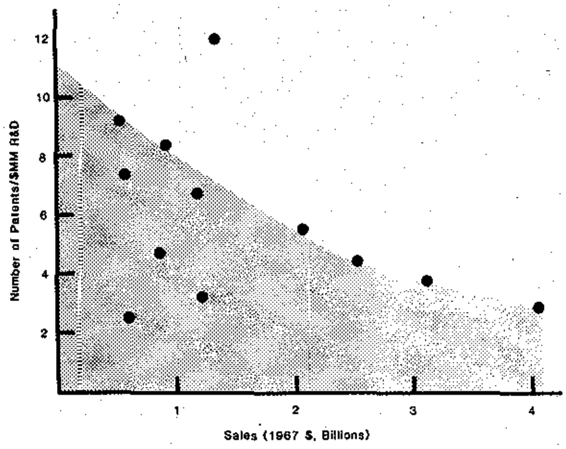


Figure 9.—Patent Productivity Vs. Sales (1971–75 Average).

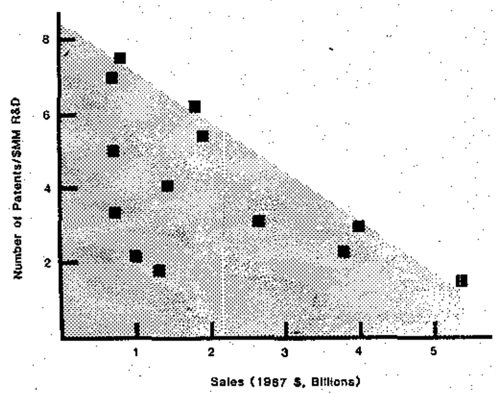


Figure 10.—Patent Productivity Vs. Sales (1976–80 Average).

$$\frac{\text{R\&D expenditure}}{\text{Sales volume}} \quad \text{and} \quad \frac{\text{Number of patents}}{\text{R\&D expenditure}}$$

It is also possible to see whether patent productivity increases with the absolute level of R&D expenditure. This is the most direct way to test the efficiency of the "process" of producing patents. In other words, if there is efficiency of patent productivity, we should see it reflected in the absolute size of the R&D organization and, therefore, in its annual expenditures. Figures 13 and 14 present these data. There is no doubt that, for both time periods, patent productivity decreases as the absolute level of R&D expenditure increases. It is not at all clear why patent productivity does not increase instead. The expected increase in efficiency is simply not there. In fact, larger R&D units become less efficient in the context of this paper.

One might wonder whether the findings about patent productivity for the chemical inudstry can be explained by the position of the "Big 12" relative to the U.S. as a whole. Table 1 shows the sales, R&D expenditures, sales volume, patents and patent productivity of the "Big 12" compared to total U.S. figures.

The table shows that sales, as a fraction of GNP, increased 17 percent but that R&D expenditures rose only about one-sixth as much from the early 1970s to the late 1970s. During that period the fraction of U.S. patents assigned to the "Big 12" declined 5 percent. (The patent statistics of the years 1982–84 show a modest upturn in the number of patents for the companies in the "Big 12." However, the ratio of patents to constant dollar R&D has continued to decline to ca. 1.2 for the group.) The large chemical companies invested more in research and got fewer patents out of the process. The data, when stated in terms of patent productivity, show that the "Big 12" had a decrease in the period studied that was half again as big as the 27 percent reduction experienced by the entire U.S. That is to say, the "Big 12" (and the chemical industry by extension) behaved like the whole country, just more so.

A comparison of the patent activity of the chemical industry with other industries is beyond the scope of this paper although it might lead to some important conclusions. However, one can choose representative companies from other business sectors and look for similarities in patent productivity. Table 2 presents such information for a group of companies compared to the "Big 12" and to Du Pont as a representative of the chemical group, and for the U.S. on average.

The data in Table 2 show that most of the companies have had reduced patent productivity and in three cases a larger reduction than is true for the "Big 12." Only one company in this group, General Electric, shows an increase of 14 percent. Further, the absolute level of productivity for the "Big 12" is higher in both periods than for any of the other companies reported. The picture that emerges is that most sectors of U.S. industry were declining in patent productivity over the decade of the 1970s and that the chemical industry is not atypical. Thus, if there is an innovation malaise, it is very widespread, and all sectors of U.S. industry need to be concerned.

Interpreting the Data

Before proceeding to a detailed examination of U.S. patent productivity, we should note that Gilman described another concept in 1981 which he called "patent inventivity" (9). This quantity is the ratio of patents issued to sales volume. He concluded from an analysis of patent inventivity that the largest companies were less inventive than smaller ones. This result was disputed by Jackson et al. who felt that Gilman had used a sample that led to an incorrect conclusion (*10*). Gilman and Siczek subsequently reported on a function that is the same as the one that we had

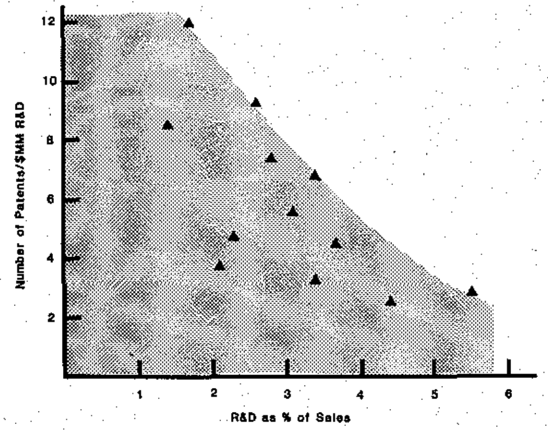


Figure 11.—Patent Productivity Vs. R&D As % of Sales (1971–75 Average).

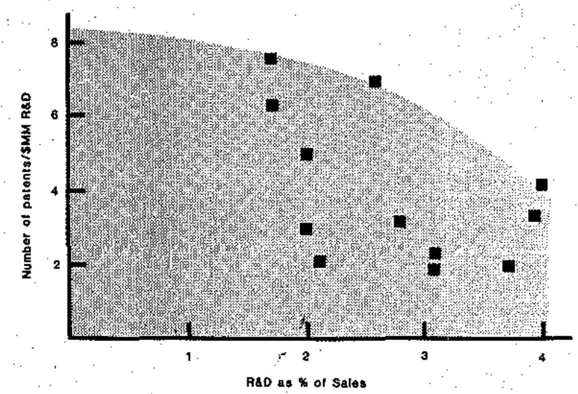


Figure 12.—Patent Productivity Vs. R&D As % of Sales (1976–80 Average).

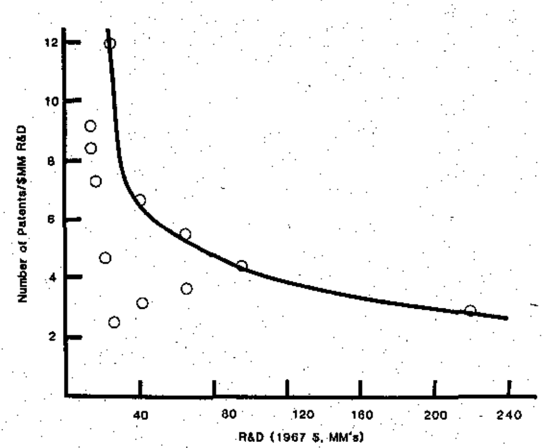


Figure 13.—Patent Productivity Vs. R&D (1971–75 Average).

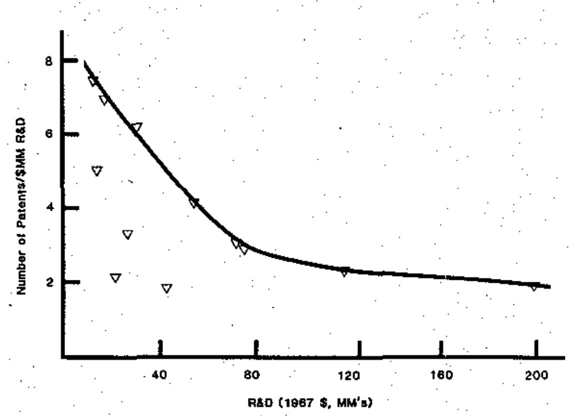


Figure 14.—Patent Productivity Vs. R&D (1976–80 Average).

previously called "patent productivity" (*11*). They looked at a broad range of companies whereas we looked in detail at the chemical industry. In this paper, we have examined only a handful of companies in other industries (Table 2).

In the earlier study, we speculated about the most likely cause or causes of the slowing in U.S. patent activity. Among the causes proposed and rejected in that study were the following:

- Companies are more careful or selective in choosing patents to file.
- Less R&D money is available because of funds diverted to meet regulatory requirements.
- There is more reliance on "trade secrets" vs. patents.
- The U.S. market is viewed as not worth the cost of getting patent protection.
- More stringent criteria are being applied by the U.S. Patent Office for allowing patents.

None of the above explanations makes any more sense today than it did in 1980. The one explanation that was thought to be most plausible then was that a shift in R&D orientation had taken place toward low-risk research such as product and process development. These activities are less likely to lead to large numbers of patents because they are designed to fine-tune formulations, discover new uses of a chemical or improve the process by which the chemical is made. We can test this hypothesis by looking at the record of three chemical companies with very different patent productivities. For each of three companies, Allied, Du Pont and Stauffer, the patents in each of three years were examined to find out what fraction were "composition of matter" as opposed to those with use or process claims only. It was assumed that larger numbers of composition of matter patents would correlate with higher patent productivity. Table 3 shows the results of this analysis. There is no obvious correlation between the type of claims and the number of patents per $MM of R&D for all three companies taken together. There is, however, an apparent

*Table 1—Sales, R&D Expenses and Patent Productivity**

	1971–75 avg.	1976–80 avg.	% Change
$(Sales)_{12}/(GNP)_{12}$	1.94%	2.27%	17
$(R\&D)_{12}/(R\&D)_{US}$	2.76%	2.84%	3
$(Patents)_{12}/(Patents)_{US}$	5.5%	5.2%	−5
$(Patent\ Productivity)_{US}$	2.2	1.6	−27
$(Patent\ Productivity)_{12}$	4.4	2.9	−33

*Number of patents per million of 1967 dollars spent on R&D.

Table 2—Patent Productivity in Various Industries

	Patent Productivity (# Pat/$MM R&D)		
	71–75 avg.	76–80 avg.	% Change
"Big 12" (Chemical companies)	4.4	2.9	−33
Du Pont (Chemical)	2.8	1.9	−30
AT&T (Communications)	3.0	1.0	−67
Hewlett-Packard (Electronics)	1.2	0.6	−49
General Electric (Electrical)	2.4	2.8	+14
Eastman Kodak (Photography)	2.7	1.2	−57
Merck (Pharmaceuticals)	1.9	1.8	−8
Motorola (Semiconductors)	3.0	2.6	−13
U.S. Average	2.22	1.61	−27

Table 3—Relationship of Patent Productivity To Type of Patent Claims

Company	No. of Patents Studied*	% of Patents with Comp. of Matter Claims	Patent Productivity No. of Patents/$MM R&D
Stauffer—1970	71	51	6.6
1975	127	60	9.0
1980	99	50	5.4
Allied—1970	39	26	9.7
1975	43	19	10.7
1980	38	11	4.0
Du Pont—1970	162	31	2.8
1975	112	39	2.6
1980	63	46	1.5

*All of Stauffer's patents were examined in the three years; one-third of Du Pont's and Allied's patents were examined.

correlation for each company by itself (Figure 15). Because of the few data plotted, it would be desirable to extend this analysis to other companies over more years to see if our observation is more than a coincidence.

It is undeniable that chemical and other companies have experienced a steady decline in both the number of patents granted and in patent productivity. The latter is a crude measure of the return on research investment. One can find a variety of explanations. Abernathy pointed the finger at management (*2*), whereas Kline indicated that we are about to enter a new age in chemistry (*3*). However, it is also possible that we are experiencing an effect in research that is analogous to the finding that "new oil is harder to find than old oil." Any resource that must be mined out becomes progressively more expensive because the most easily reached deposits are taken first. Is there such a phenomenon in industrial research? If there is, we should find that the money will increase that must be spent on R&D to achieve a fixed amount of progress. This should lead to the observations reported here.

Among the factors making research progressively more expensive is that the infrastructure required to do research in the 1970s and 1980s is increasingly sophisticated and expensive. For example, most research laboratories of any significance have analytical facilities that include NMR spectrometers, HPLCs, ESCA-Auger spectrometers, SEMs and the like. This equipment is typically run by highly skilled specialists. In an earlier time, analyses were thought to be adequate or acceptable with much simpler, less elegant and far less costly techniques. Also, the laboratory of

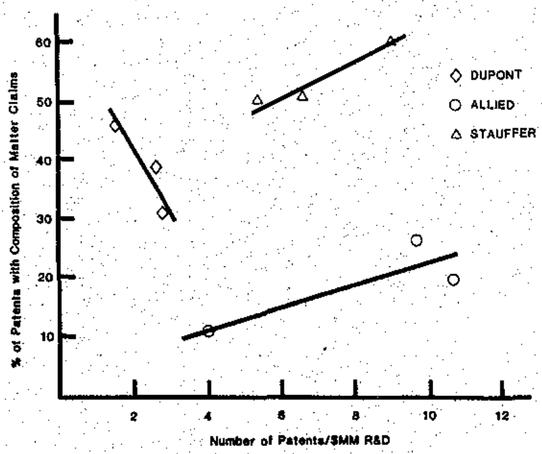


Figure 15.—Patent Productivity Vs. Type of Patent.

It is possible that we are experiencing an effect in research that is analogous to the finding that "new oil is harder to find than old oil."

today is equipped with a full range of sophisticated computers and database searching facilities. These are only two examples that can be cited. No wonder R&D costs are escalating. Furthermore, this is a factor that affects the larger companies more than the smaller ones. The large companies are the ones most likely to feel the need for highly sophisticated facilities to match the technological demands of their research areas.

If one now adds the economic criteria attendant to new research, the picture of high costs becomes even more pronounced. The chemical industry has seen a steady decline in profitability in the last two decades, and new research must face far more hard-nosed criteria of profitability and return on investment than ever before. New chemicals that might have been considered acceptable in an earlier time may now be thought to be too unprofitable to develop. This leads to R&D that has fewer commercial successes as a fraction of the numbers of areas explored.

Finally, we should address the question of the adequacy of R&D funding in the U.S. Between 1964 and 1978 the level of R&D funding as a fraction of GNP dropped 25 percent, from 2.96 percent of GNP to 2.22 percent. By 1985, however, it had moved back up to an estimated 2.7 percent. Increased spending on R&D cannot of itself guarantee greater innovation, and there is probably no "right" level to ensure a revitalized atmosphere of innovation. Nevertheless we are encouraged by this dramatic turnaround. Now it remains to be seen whether the U.S. patent output as a measure of innovation also turns around and heads back up. ⓐ

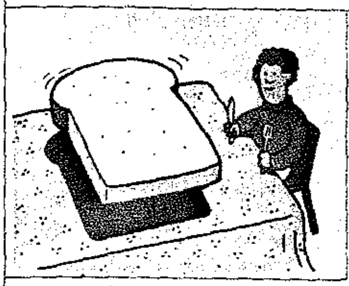
References

1. S. F. Adler, *Research Management*, XXIII, No. 4, p. 30 (July, 1980).
2. W. J. Abernathy, *Research Management*, XXV, No. 5, p. 34 (September, 1982).
3. C. H. Kline, *Chemtech*, March, p. 148 (1984).
4. National Science Foundation, *Science Indicators 1980*, U.S. Government Printing Office, Washington, D.D., 1981.
5. Chemical and Engineering News, July 23, 38 (1984).
6. Private communications from the offices of the patent counsels of each of the 12 companies.
7. Statistical Abstract of the United States—1984, U.S. Department of Commerce, Bureau of the Census.
8. Value Line.
9. Gilman, J. J., *Industrial Research & Development*, p. 124, June, 1981.
10. Jackson, K. A., et al., ibid., p. 210, February, 1982.
11. Gilman, J. J. and Siczek, A. A., *Research Management*, XXVIII, No. 4, p. 29 (July, 1985).

Developments to Watch

EDITED BY OTIS PORT

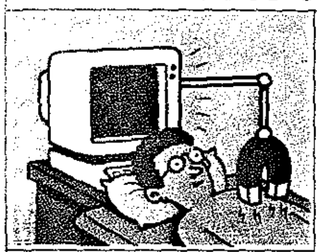
A NEW STAFF OF LIFE FOR DIETERS: FLUFFY CELLULOSE



Dedicated dieters know that the primary source of calories in such baked goods as bread and doughnuts is the flour, not added sugar or frostings. So the best way to cut the calories is to replace some of the flour with inert fillers. But current fillers are so unpalatable that if you substitute them for more than 15% of the flour, the result is too dense and gritty for even the most resolute dieter. That's because the fillers are cellulose derived from wood.

Now researchers at the U.S. Agriculture Dept. laboratory in Peoria, Ill., believe they have found just the filler for tasty diet goodies: a fluffy, fibrous cellulose made from non-woody plants. The new filler can be prepared from the husks or stems of bran, wheat, oats, and corn—and can replace up to 50% of the flour in baked goods. The result is so pleasing that "a taste panel couldn't tell the difference," says J. Michael Gould, a USDA chemist. The USDA estimates the product will quickly command a $500 million market. A half-dozen food-processing companies are lined up to license it.

PAINLESS ANGIOGRAPHY? GE IS WORKING ON IT



Virtually everyone who has undergone angiography wishes there were some other way to examine the body's blood vessels. To search for blockages that can cause strokes or arteriosclerosis, doctors inject dyes that show up in X-rays. The process is notoriously painful and lasts for hours. But it may soon be a thing of the past. Scientists at General Electric Co.'s R&D center in Schenectady, N. Y., have modified magnetic resonance imaging systems so they "paint" images of flowing blood on a computer screen.

MRI, which creates computerized images from the weak radio signals emitted by atoms in the body when they are exposed to a powerful magnetic field, is well known for its clear—but still—images of organs. To produce pictures of blood coursing through veins and arteries, GE developed a computer program that suppresses the signals from stationary tissues while highlighting the images of moving cells: the faster the flow, the brighter the image. The software will soon be available on GE's MRI scanners. Next, the researchers hope to adapt the technique to see the flow of blood inside the heart by canceling out the action of a beating heart.

CERAMICS COULD LEAVE COMBUSTION ENGINES IN THE DUST

Many automotive engineers are betting that ceramics will be the material of choice for tomorrow's super-efficient car engines. But ceramics may also be the key to a power source that could make some engines obsolete. Researchers at the Energy Dept.'s Argonne National Laboratory have built a prototype fuel cell that delivers twice the power and fuel economy of internal combustion engines—and double the output of other fuel cells. Fuel cells are essentially batteries with fuel tanks. They generate electricity directly from a chemical reaction between the fuel and a catalyst.

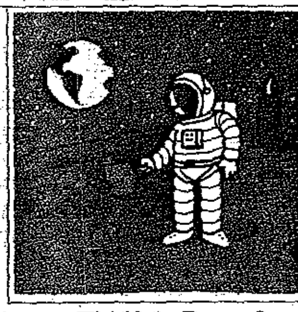
The secret of Argonne's fuel cell, says researcher Darrell C. Fee, is a new construction technique. The interior is made of thin ceramic sheets bent and bonded together like corrugated paperboard. The low-cost ceramic sheets function as the electrolyte part of the "battery," eliminating the need for the liquid electrolyte that weighs down most fuel cells. The Argonne unit can burn both liquid and gaseous fuels. Pound for pound, the ceramic design is so efficient that Fee says it might even be used in airplanes. And an electrical power plant using the new fuel cells could be 55%-to-60% efficient at converting fuel into electricity—vs. 30%-to-35% for coal-fired plants.

SUPERFAST CHIPS: A FRENCH STARTUP IS OFF AND RUNNING

Because they work at blinding speeds, so-called HEMT integrated circuits promise to form the basis for the next generation of computer chips. But the materials needed for high-electron-mobility transistors are so complicated that the technology is barely creeping out of the laboratory. To get HEMT speeds, the ICs must be "printed" on wafers that consist of a stack of exotic semiconductor materials—with each layer no more than a handful of atoms thick.

A European startup, however, believes it can give HEMT a push into the market by supplying such complex wafers. Nuyen T. Linh, former head of HEMT research at France's Thomson, last year left the electronics giant along with several members of his staff. They raised $4 million in venture capital and formed Picogiga, a startup in Les Ulis, near Paris. The company recently shipped its first wafers, which are produced by an esoteric technique known as molecular-beam epitaxy. ICs made with these wafers have switching times measured in picoseconds, or roughly 1,000 times faster than standard silicon-based circuits.

ONE SMALL STEP FOR GROWING FOOD ON THE MOON



Will men on the moon be able to grow food in the lunar soil? The answer is important to the dedicated band of scientists who believe that mankind will establish a permanent base on the moon. So in January they will launch experiments to find out whether wheat and perhaps soybeans will grow in lunar greenhouses. They won't fly there to plant the seeds, though—just to Florida's Epcot Center. The seeds will be planted in powdered rock quarried near Duluth, Minn., that closely matches the stuff on the moon.

Scientists at the University of Minnesota have already crushed and ground the first 200 lb. of ersatz lunar soil. Now they are working on imitating the glassy content of the real thing. Just mixing in regular glass won't do because the moon's glass—produced by the heat of meteor impacts—is light and porous. Kenneth J. Reid, director of the university's Mineral Resources Research Center, hopes that a plasma-arc furnace will do the job—and also drive off the moisture bound into the rock's minerals, making it even more like lunar soil.

MANSFIELD AMENDMENT

[COMMITTEE PRINT]

DOMESTIC TECHNOLOGY TRANSFER: ISSUES AND OPTIONS

PREPARED BY THE

SUBCOMMITTEE ON
SCIENCE, RESEARCH AND TECHNOLOGY

OF THE

COMMITTEE ON
SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES
NINETY-FIFTH CONGRESS

SECOND SESSION

Serial CCC

VOLUME I

NOVEMBER 1978

Printed for the use of the Committee on Science and Technology

U.S. GOVERNMENT PRINTING OFFICE
35-141 O WASHINGTON : 1978

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402

represent these officials. Concurrently, Federal department and agency liaison is being fostered. In this manner ISETAP is attempting to bring together the diverse components of the intergovernmental science and technology endeavor. However, questions have arisen as to the effectiveness of the Panel and as to whether its operation is meeting the policy objectives of the legislation which created it.

Lack of visibility and recognition have been complicating factors in the establishment of a base support for ISETAP's activities in the intergovernmental arena. The absence of a means to enforce participation in the Panel's programs and a lack of authority to implement recommendations directly have been obstacles to the development of an effective program in the Executive Office of the President. The uncertainties surrounding ISETAP's activities, Presidential support, and the reorganization have not helped in this respect. The situation is such that the Panel can be expected to work best when and if it is perceived as being an influential element of the decision-making process at the Presidential level. The reorganization and the subsequent relationship with the Office of Management and Budget are anticipated to increase the effectiveness of ISETAP. An assurance of support for the functions and operation of the Panel from OMB and the President's Science Advisor, coupled with increased interaction with Federal, State, local, and regional representatives, are understood to be essential to the recognition of ISETAP's function and further cooperation with the Panel's programs and objectives.

POLICY STATEMENT AND REPORTS

The previous section has reviewed the establishment and operation of intergovernmental science and technology activities at the Presidential level through the Intergovernmental Science, Engineering, and Technology Advisory Panel. ISETAP is only the most recent organizational response to a series of activities which extends back over more than the past decade. This section documents past attempts to develop a domestic technology transfer policy beginning with the New Technological Opportunities Program instituted in 1971 by the White House Domestic Council and including various other executive, congressional, State, and local endeavors. These activities resulted in numerous studies, statements, and recommendations concerning the issue of the intergovernmental utilization of Federal research and development results. Many of the recommendations are identical; all are related. They are discussed here to present a total picture of how our present activities are responsive to the needs and priorities indentified in the initial studies of the concept. Current technology transfer activities are discussed in subsequent sections and analyzed in terms of the policy issues and suggestions delineated here.

ACTIVITIES FOR INTERGOVERNMENTAL SCIENCE AND TECHNOLOGY DURING THE NIXON ADMINISTRATION

New Technological Opportunities Program (NTOP)

In July of 1971, the White House Domestic Council, at the direction of former President Nixon, initiated the New Technological Opportunities Program to examine Federal involvement in support of nondefense research and development. Under the leadership of William M. Magruder, the endeavor was to study ways to apply high technology to the solution of social and economic problems. This effort was the first such undertaking which recognized that the R&D capabilities of the Federal departments and agencies provided opportunities in the domestic and foreign technology transfer arenas.

Organized into three interagency task forces—problem identification, economic incentives, and international technology transfer—the NTOP study team requested agencies to identify technological activities related to potential domestic or foreign endeavors. Given a free hand, a list was drawn up which represented an enormous commitment of funds if it were to be implemented. Complicating the situation was the absence of accompanying analyses of economic, political, social, or environmental impacts. The Executive Office of the President subsequently decided that the time was not right for such a massive undertaking. Instead, an incremental approach was adopted. This attitude was reflected in the President's address to Congress in March 1972.

Intergovernmental Technology in President Nixon's Science and Technology Message

Former President Nixon's address to Congress on Science and Technology, delivered on March 20, 1972, was a major acknowledgment of the benefits to be derived from the Federal research and development endeavor. The statement was an announcement of a new effort to support and utilize science and technology for the improvement of the Nation's economy and its quality of life. The President called for new "partnerships" between Federal institutions, private industry, State and local government, universities, and research organizations to apply R&D results to civilian needs. Observing that "Federal research and development activities generate a great deal of new technology which could be applied in ways which go well beyond the immediate mission of the supporting agency," the President said States and localities need to play a central role in the decision-making process surrounding the application of these technologies.

In order to develop these Federal/State/local relationships, the Science Advisor, in cooperation with the Office of Intergovernmental Relations, was directed to serve as the focus for a discussion of the issues by the relevant Federal agencies and State and local representatives. Further, the needs of State and local jurisdictions were to be prioritized in a systematic way and the resultant data incorporated into the decision-making process at the Federal level. Alternative methods for improving access to Federal technical resources were to be discussed as well as mechanisms for the aggregation of State and local markets in such a way as to produce economies of scale.

FEDERAL COUNCIL FOR SCIENCE AND TECHNOLOGY (FCST)

The address to Congress by President Nixon paralleled work under way within the Federal Council for Science and Technology concerning State and local issues. The Federal Council had been created by Executive Order 10807 issued by President Eisenhower on March 13, 1959, and was designed to assist the various Federal departments and agencies in the coordination and management of problem-solving in science and technology. Located in the Executive Office of the President until 1973, the Council's membership was composed of Federal policy officials from thirteen departments and agencies and observers from other Federal units with the President's Science Advisor as Council Chairman.

In mid-1973, the Federal Council for Science and Technology (FCST) was transferred from the Executive Office of the President to the National Science Foundation whose director served as Science Advisor to the President. FCST was abolished when the National Science and Technology Policy, Organization, and Priorities Act (Public Law 94–282) was signed into law on May 11, 1976, and in its place a Federal Coordinating Council for Science, Engineering, and Technology (FCCSET) was established. Many FCST functions were absorbed by the newly created FCCSET. The intergovernmental responsibilities of the unit were taken over by the Intergovernmental Science, Engineering, and Technology Advisory Panel also created by the legislation.

The major portion of the work of the Federal Council for Science and Technology was conducted through interdepartmental committees which addressed specific issues. During the period of its operation, the Council established several units which dealt with State and local utilization of Federal research and development. A discussion of these committees and their work follows.

FCST Committee on Intergovernmental Science Relations

The Federal Council established the Committee on Intergovernmental Science Relations in 1969 to study and suggest methods to improve the interaction of Federal, State, and local research and development programs and policies. Composed of twenty representatives from Federal agencies, the Committee was directed to:

- Inventory and evaluate the impact of Federal policies and programs on the scientific and technological activities of State and local governments.
- Inventory State and local science and technology activity and appraise its relation to Federal programs.
- Formulate, in consultation with representatives of State and local governments, recommendations for Federal initiatives to strengthen this activity and Federal cooperation with it.
- Identify the need for scientific resources, including manpower and institutional requirements, of State and local governments, and assess the adequacy and impact of Federal programs bearing on these needs.
- Recommend policies, procedures and programs to improve management, information exchange, planning, and coordination of Federal science and technology activities with related activities of State and local governments.[1]

A report, "Public Technology, a Tool for Solving National Problems," was issued by the Committee on Intergovernmental Science Relations in May of 1972. The document was the result of numerous meetings with State and local officials supplemented by a series of formal presentations to the group by representatives of State and local governments, congressional experts, and manpower specialists. A draft of the report was reviewed by a representative from each State, by local officials, by the twenty participating Federal agencies, and by independent experts in the field. Three days of hearings on

[1] Committee on Intergovernmental Science Relations. Federal Council for Science and Technology. Public Technology, a Tool for Solving National Problems [1972]. p. vii.

the study were held by the Science and Technology Committee of the National Legislative Conference.

The issues addressed by the Committee included cooperative programs between States and the Federal Government; State, local and regional science and technology organizations; manpower utilization by State and local jurisdictions; and Federal legislative initiatives to foster non-national S & T capabilities. The resultant report stressed the importance of improving State and local science and technology capabilities so as to meet the increasing demands of these jurisdictions in terms of the provision of goods and services. The committee addressed the issue on two levels—increasing the role of science and technology in the State and local decision-making process, and expanding the impact of State and local needs in decision-making within the Federal departments and agencies conducting research and development. The report discussed the interrelationships between the Federal government and State and local utilization of science and technology. It delineated several observations among which were the negative and unintended impacts of certain Federal policies and practices on State and local decisions and the lack of a sense of diversity between States or localities in terms of problems and possible solutions. What the committee suggested were new, more flexible arrangements which would improve the transfer of technology between jurisdictions and facilitate the flow of information between governmental units.

The recommendations which the committee made were designed to serve as guidelines for addressing the issues. Among the proposals delineated in the written report were: (1) development of mechanisms to strengthen the input of State and local needs and priorities in the Federal science and technology decision-making process; (2) identification of Federal programs and activities relevant to State and local decision-making; (3) improvement of the scientific and technological capabilities of States and localities; and (4) development and support of science and technology dissemination mechanisms.

FCST Committee on Domestic Technology Transfer

To facilitate the coordination of the technology and information transfer process in the relevant Federal departments and agencies, the Federal Council for Science and Technology created the Committee on Domestic Technology Transfer in April 1974. The Committee's expressed purpose was to

- Exchange information and experience on Federal agency efforts to disseminate technology
- Collect, compile, disseminate Federal agency data on technology transfer programs, contact points, support resources for use by State and local governments and private industry
- Exchange information on agency organization and experience for receiving user information of technology transfer needs and priorities.[2]

In pursuit of these objectives, the Committee published the "Directory of Federal Technology Transfer" in June of 1975. This book detailed Federal department and agency activities involving the domestic transfer of technology so as to publicize the resources available to State and local governments. Research capabilities, transfer policies and practices, contact persons, and user groups of over forty programs

[2] Linhares, Alfonso. An Overview of Federal Technology Transfer [1976]. p. 17.

were described. It was designed to serve as a guide for State, local, and industrial users in interacting with the Federal system.

An updated and expanded version of the Directory was published in June 1977 by the Federal Coordinating Council for Science, Engineering and Technology. In August 1978, it was decided that the Office of Science and Technology Policy and the National Science Foundation would jointly publish the Directory in the future and the Committee on Domestic Technology Transfer was abolished.

At the request of the Committee on Domestic Technology Transfer, the Office of National R&D Assessment of the National Science Foundation conducted a study on Federal technology transfer activities in twenty-five departments and agencies. The report, "Federal Technology Transfer, An Analysis of Current Program Characteristics and Practices" (published December 1975), addressed methods for assessing and improving technology transfer and utilization programs and practices. The analysis was directed towards Federal, policy level officials who input into the decision-making process. It outlined those factors influencing the transfer of technology which are amenable to policy decisions. Among the findings with legislative relevance are:

(1) The expression of support for technology transfer from top agency officials is an important influence in the extent of transfer activities.

(2) Agencies which have effective technology transfer programs tend to: (*a*) have specific allocations for tchnology utilization programs; (*b*) designate technology transfer responsibility to one unit with that mandate alone; and (*c*) use locally-based field offices staffed by Federal employees.

(3) Face-to-face transfer of information, expertise and technologies is most effective.

(4) The formalization of technology transfer programs with locally based staff and delineated budgets increase the success of the transfer and utilization activities.

FCST Committee on Federal Laboratories/Task Force on Intergovernmental Use of Federal R&D Laboratories

In 1967, the Committee on Federal Laboratories was established to inquire into the effective utilization of the Federal research and development system. In response to an increasing interest in expanding the use of Federal laboratories beyond their parent department or agency, a Task Force on Intergovernmental Use of Federal R&D laboratories was created by the committee on August 1973. Building on work published by the Council of State Governments, the General Accounting Office, and the National Action Conference on Intergovernmental Science and Technology Policy, the Task Force issued a report entitled, "Intergovernmental Use of Federal R&D Laboratories." [3] This study underscored the importance of tapping the technical resources of the Federal laboratory system to identify and meet the needs of State and local jurisdictions in the provision of goods and services. Given the increasing demands on these non-national units and the President's stated intention to institute a new policy of intergovernmental cooperation, a more flexible approach to the utilization of

[3] Federal Council for Science and Technology. Committee on Federal Laboratories. Intergovernmental Use of Federal R. & D. Laboratories. Washington, U.S. Government printing Office, 1974. 30 p.

the laboratories was acknowledged to be a significant component of the effective resolution of many State and local problems.

In its study of the issue, the Task Force determined that there were various institutional barriers to the effective utilization of the Federal laboratory system including budget and manpower limitations; lack of, or ambiguous, policy directives; and conflicting priorities. There appeared to be no legal obstacles to the use of these laboratories with the possible exception of the uncertainties surrounding the interpretation of the so-called Mansfield Amendment in the Military Procurement Act of 1970 (to be discussed in detail at a later point in this chapter). However, there was no clearly defined statement on behalf of the executive branch which would delineate the need for interagency coordination and thus provide the support for agency activities to this end. Because of the lack of integration between the participants in the intergovernmental transfer process and the stated benefits to be accrued by a coordinated effort, the Task Force report recommended that a systematic approach for technology transfer activities be institutionalized in, and between, agencies. The report also advocated greater use of the provisions of the Intergovernmental Personnel Act of 1970 and the Intergovernmental Cooperation Act of 1968, as well as a clarification of the Mansfield Amendment to promote the utilization of Federal research and development results from Department of Defense laboratories.

The published report suggested several guidelines for intergovernmental activities and the promulgation of a draft policy statement for expanded interagency cooperation in the utilization of Federal laboratories, but made it clear that each agency would have to develop its own specific procedures dependent on its mission and operation. Despite the support by the Federal Council which voted its approval of the report in plenary session on April 11, 1974, the President never accepted the recommendations contained within the document. It is believed that this was a result of a negative reaction by the Office of Management and Budget to the proposals contained in the report.[4]

GENERAL ACCOUNTING OFFICE STUDIES RELATING TO INTERGOVERNMENTAL TECHNOLOGY TRANSFER

The General Accounting Office (GAO) provides Congress with oversight on the operation of the executive departments and agencies. In conjunction with this mandate, GAO has produced several reports dealing with Federal activities in the intergovernmental transfer of technology.

"Means for Increasing the Use of Defense Technology for Urgent Public Problems" [5]

The study undertaken by the General Accounting Office addressed the relative roles and responsibilities of the Department of Defense and other Federal agencies in the technology transfer process; the legislative and organizational factors which influence the activity;

[4] U.S. Congress. House. Committee on Science and Technology. Subcommittee on Domestic and International Scientific Planning and Analysis. Interagency Coordination of Federal Scientific Research and Development: The Federal Council for Science and Technology. (Committee Print) Washington, U.S. Government Printing Office, 1976. p. 180.

[5] General Accounting Office. Means for Increasing the Use of Defense Technology for Urgent Public Problems. Washington, U.S. Government Printing Office, December 29, 1972. 58 p.

significant component of
al problems.
determined that there
ective utilization of the
and manpower limita-
and conflicting priorities.
use of these laboratories
es surrounding the inter-
ent in the Military Pro-
il at a later point in this
ned statement on behalf
the need for interagency
for agency activities to
between the participants
the stated benefits to be
rce report recommended
transfer activities be
he report also advocated
rnmental Personnel Act
ion Act of 1968, as well
nt to promote the utili-
esults from Department

idelines for intergovern-
raft policy statement for
lization of Federal lab-
would have to develop
mission and operation.
hich voted its approval
974, the President never
in the document. It is
eaction by the Office of
ontained in the report.[4]

S RELATING TO
TRANSFER

rovides Congress with
artments and agencies.
roduced several reports
vernmental transfer of

ology for Urgent Public

nting Office addressed
epartment of Defense
transfer process; the
nfluence the activity;

mmittee on Domestic and Inter-
Federal Scientific Research and
mmittee Print) Washington, U.S.

Technology for Urgent Public
1972. 58 p.

and the need for improved policies and procedures to promote the transfer endeavor. The resultant report, dated December 29, 1972, discusses the issues associated with utilization of defense-related technologies and technical expertise to meet and solve problems in the civilian sector.

The authors were concerned with increasing the returns from investments in research and development in the Department of Defense by applying the results of the science and technology efforts to delineated needs in both the civilian-oriented agencies and State and local jurisdictions. In analyzing the practices and prospects of using DOD as a technical resource, GAO raised various issues that it felt deserved further consideration. Among these was the absence of clear policy guidelines for the transfer of technology between governmental units. Compounding this was the uncertainty surrounding the legislation pertaining to DOD nondefense activities in the Defense Procurement Authorization Act (Public Law 91–121) and the 1971 Department of Defense Procurement and Research Authorization Act (Public Law 91–441). This legislation, discussed in detail in a subsequent section of this chapter, has served to induce hesitation on behalf of DOD officials to issue policies and develop programs to promote technology transfer, although it is believed that the legislation does not prohibit these activities as such.

The GAO study details the barriers to the intergovernmental utilization and transfer of technology created by personnel limits and accounting practices within the Department of Defense. In terms of DOD relationships with other Federal departments and agencies, the study indicated that each civilian agency differs in the methods by which, and the extent to which, it uses defense-related technology. Again, the absence of clear policy guidelines and a legislative mandate for such activities is noted. The findings underscored the increased benefits to be derived from the "active" transfer of technology by which face-to-face contact is achieved as opposed to the "passive" form of transfer which entails the passage of information through reports and documents. The authors stressed the importance of personal interaction in problem-solving and expressed doubt that technical documents transferred to another unit could match the problems encountered.

Following this review, the General Accounting Office made several recommendations designed to address the inadequacies of present transfer endeavors. Among the recommendations made, the report expressed the need for a clearly defined and stated governmental technology transfer policy emanating from the Office of Management and Budget or the Office of Science and Technology. It also called for the issuance of guidelines for formal transfer activities within, and between, governmental units and for the establishment of a technology transfer consulting team whose purpose would be to assist in the matching of Federal technical resources with national needs. In making these recommendations, GAO designed suggested guidelines for an OMB policy directive on interagency sharing of technology and for Department of Defense technology transfer with other Federal civil agencies and departments but stressed the importance of each agency developing its own program to meet its operational style. In response to these recommendations, OMB stated that it is the policy of the Federal Government to promote technology transfer but that written guidelines for Federal agency transfer endeavors would not be forthcoming. Commenting on this response, the GAO report reiterates:

> We recognize that there is and has been a general, although informal, policy encouraging the sharing of technical resources within the Government. However, civil agencies differ widely in their approaches to seeking and using these resources. We believe, therefore, that active and effective sharing requires a specific reiteration by OMB to elaborate on the policy, to provide guidelines for reasonably uniform and consistent implementation, and to establish a basis for monitoring compliance. In our opinion, civil agencies need the stimulus that could be provided by an OMB directive encouraging active interagency transfer methods. A statement such as we recommend should provide a framework against which each civil agency could promptly begin to establish its own policies, procedures, and transfer methods in consonance with the President's policy.
>
> The civil agencies whose activities are discussed in this chapter generally agreed to the need for policy guidance from OMB. Some of these agencies specifically supported an OMB policy that would require each agency to establish its own specific guidelines and implementing mechanisms for technology transfer.[6]

"Technology Transfer and Innovation Can Help Cities Identify Problems and Solutions" [7]

This General Accounting Office report is a study of the California Four Cities Program. The program, cosponsored by the National Science Foundation and the National Aeronautics and Space Administration, was designed to determine whether or not technology could be applied to State and local problems. The report concluded that, on the basis of its analysis of the operation and results of the endeavor, Federal technical assistance can provide solutions on the State and local level. It stated, however, that an understanding of the innovation processes as well as an understanding of the approaches toward acceptance of new technologies on behalf of non-national governments are necessary to the success of the transfer endeavor.

In the course of its study of the technology transfer activities of the Four Cities Program, GAO observed several barriers to the transfer process. Among these obstacles are: social, political, and economic constraints beyond technology; a lack of market aggregation mechanisms and practices to foster private sector involvement in public technology; and a tendency to avoid risks in government activities. In conjunction with these identified barriers, the report also delineated several conditions which influence the utilization process. The need for effective communications between city and Federal personnel, as well as between the Federal agency representatives themselves, and the importance of the strong support from local government officials are delineated as conditions necessary for successful intergovernmental technology transfer.

"Inventory of Current Federal Laboratory Studies" [8]

Brief mention is made here of an unpublished study conducted by the General Accounting Office which identified existing studies of R&D activities and utilization in the Federal laboratories. It was performed at the request of the Chairman of the House Committee on Science and Technology. The report identified 34 studies by Federal departments and agencies. Of these only approximately eight address cross sector utility of labs and technology transfer issues.

---

[6] GAO, op. cit., p. 37.

[7] General Accounting Office. Technology Transfer and Innovation Can Help Cities Identify Problems and Solutions. Washington, U.S. Government Printing Office, August 6, 1975. 55 p.

[8] U.S. General Accounting Office. Inventory of Current Federal Laboratory Studies. Unpublished report. May 1978. 65 p.

unnecessary duplication of special service functions; and to authorize all departments and agencies of the executive branch of the Federal Government which do not have such authority to provide reimbursable specialized or technical services to State and local governments.

The provision of technical expertise to State and local governments under this act rests on the assumption that these goods and services cannot be furnished through ordinary business channels. As stated in Title III, Sec. 302:

> . . . such services shall include only those which the Director of the Bureau of the Budget [now the Office of Management and Budget] through rules and regulations determines Federal departments and agencies have special competence to provide. Such rules and regulations shall be consistent with and in furtherance of the Government's policy of relying on the private enterprise system to provide those services which are reasonably and expeditiously available through ordinary business channels.

Legislative History

January 26, 1967—S. 698 introduced (Government Operations).

July 2, 1968—Senate report: 1456 to accompany S. 698.

July 23, 1968—Companion bill: H.R. 18826, introduced (Government Operations).

July 29, 1968—S. 698 passed Senate after adoption of committee amendments.

August 2, 1968—House report: 1845 to accompany H.R. 18826.

September 15, 1968—S. 698 passed House amended in lieu of H.R. 18826.

October 1, 1968—House agreed to conference report.

October 4, 1968—Senate agreed to conference report.

October 16, 1968—Measure signed into law by the President.

Military Procurement Authorization Act of 1969/Public Law 91-121 (S. 2546) November 19, 1969

Military Procurement Authorization Act of 1970/Public Law 91-441 (H.R. 17123) October 7, 1970

Description.—Title II, Section 203 of the Military Procurement Act of 1969 authorizing funding for the Department of Defense, provides:

> None of the funds authorized to be appropriated by the act may be used to carry out any research project or study unless such project or study has a direct and apparent relationship to a specific military function or operation.

Title II, Section 204 of the Military Procurement Authorization Act of 1970 contained similar but not identical language:

> None of the funds authorized to be appropriated to the Department of Defense by this or any other act may be used to finance any research project or study unless such project has, in the opinion of the Secretary of Defense, a potential relationship to a military function or operation.

Implications.—The Department of Defense, which is responsible for approximately half the Federal R&D budget, asserts that it is constrained in the application of DOD technology to meet State and local needs by the provisions of Public Law 91-121, later modified by Public Law 91-441. However, the history of the two bills indicates that the intention of Congress was not to entirely restrict non-defense oriented research and development activities in military laboratories.[12] After Public Law 91-121 was enacted, the Department of Defense

[12] GAO Report. Means for Increasing the Use of Defense Technology for Urgent Public Problems, p. 23-24.

;; and to authorize all depart-
:ederal Government which do
)ecialized or technical services

State and local govern-
ion that these goods and
inary business channels.

: the Director of the Bureau
dget] through rules and regula-
:s have special competence to
nt with and in furtherance of
enterprise system to provide
:y available through ordinary

Government Operations).
mpany S. 698.
:26, introduced (Govern-

:r adoption of committee

accompany H.R. 18826.
:use amended in lieu of

nce report.
ence report.
w by the President.
1969/Public Law 91-121

1970/Public Law 91-441

Military Procurement Act
ent of Defense, provides:

: by the act may be used to
project or study has a direct
:tion or operation.

curement Authorization
al language:

o the Department of Defense
:y research project or study
tary of Defense, a potential

., which is responsible for
dget, asserts that it is
ology to meet State and
91-121, later modified
of the two bills indicates
rely restrict non-defense
n military laboratories.[12]
Department of Defense

:gy for Urgent Public Problems." p.

terminated various projects which did not appear to have "a direct and apparent relationship" to a military operation. The latter bill modified the restriction, limiting the funding of projects to those determined by the Secretary of Defense to have a "potential relationship" to the defense endeavor.

The general interpretation of the legislation and the discussion concerning the modification of the original language of the restriction is that technology transfer efforts are valid provided they do not interfere with the primary mission activities of the Department of Defense and provided they are furnished on a cost-reimbursable basis. These endeavors are viewed as salient to the support of Government and thus strengthen our national defense. The practical guideline which has been followed in the past few years is that spending for nondefense-specific research and development by DOD be limited to 3 percent of the total funds.

Uncertainty has surrounded the issue of whether the so-called Mansfield Amendment to the Military Procurement Authorization Act continues to be valid. This question was addressed in a report written by David R. Siddall, Legislative Attorney, American Law Division, of the Congressional Research Service, dated March 16, 1978, which is included verbatim:

VALIDITY OF PUBLIC LAW 91-441 SECTION 204, THE MODIFIED "MANSFIELD AMENDMENT"

In 1969 Senator Mansfield proposed and the Congress passed an amendment to the military procurement authorization law for fiscal year 1970 which prohibited funds authorized *by that act* from being used to carry out research projects or studies not having "a direct and apparent relationship to a specific military function or operation." Public Law 91-121, § 204, 83 Stat. 206.

In 1970 the authorization bill for 1971 (H.R. 17123) was passed by the House without any similar amendment being included. The Senate Armed Services Committee recommended that the provision be included in the bill without change "in order to provide the same restrictions on research and development funds for fiscal year 1971." Senate Report 91-1016 at pp. 99-100. On the Senate floor, this Committee amendment to H.R. 17123 was considered as part of an amendment proposed by Senator McIntyre to add a section expressing the sense of Congress that funds for the National Science Foundation should be increased. 116 Congressional Record 30367. The Amendment unanimously passed the Senate. H.R. 17123 therefore went to conference containing a Senate-passed section 204 with language identical to the Mansfield Amendment, which was section 203 of the immediately preceding military procurement authorization act (Public Law 91-121).

In Conference the language of the Senate-passed section 204 was modified from the original provision requiring "a direct and apparent relationship to a specific military function or operation" to a requirement that the Secretary of Defense determine the existence of "a potential relationship to a military function or operation." A second change to the section altered the language so that instead of the provision applying "to funds authorized to be appropriated by this Act," the provision was made applicable to "funds authorized to be appropriated to the Department of Defense by this *or any other Act*" (emphasis added). The question presented is whether this second change, providing for the section to be applicable to "any other" act, is permanent law applicable to all subsequent Defense Department funds for research projects and studies.

The original version which the Senate placed in H.R. 17123 specifically applied only to funds authorized by the Act. The language was specifically changed in conference to include "any other act." There was no comment concerning this change in the Conference Report on the bill (House Report 91-1473), nor in debate on the House floor.

In the Senate, however, this change in language was discussed. 116 Congressional Record 34585-86. Senator Mansfield, questioning whether the addition of "any other act" would include the previous year's Act, queried Senator Stennis as to whether the "prohibition is prospective only, and in no way retroactive to up the standards required last year in the funding research." Senator Stennis' reply, made after consideration of the issue, was that the section "acts prospectively only and will not affect funds for fiscal year 1970, the fiscal year just closed, funds that have not been expended." Senator Mansfield later in the same discussion restated the agreed interpretation that "its application, if any, will be under the terms laid down by future appropriations acts."

The conferees specifically removed language from this section which would have limited its application to funds authorized by the Act itself. Language was added to make the section applicable to "any other Act." This language was agreed upon by the conferees after spending ". . . an awful lot of time determining the proper course of action. . . ." (Rep. Rivers, 116 Congressional Record 34152 col. 3) We therefore conclude that section 204 of Public Law 91-441 continues in force until repealed or amended and its provisions are applicable to all Defense Department funds used to finance research projects and studies.

Intergovernmental Personnel Act of 1970/Public Law 91-648 (S. 11) January 8, 1971

Description.—The Intergovernmental Personnel Act of 1970 was developed to strengthen the ability of State and local governments to deal with the problems under their jurisdiction. The various needs were expressed in House Report 91-1722 to accompany S. 11:

> Growth in population and increasing urbanization of the United States are greatly extending State and local government responsibilities. Citizens are demanding more effective government, better education for their children, more and better roads and public transit facilities, clean and plentiful water, unpolluted air, better police and fire protection, more and better recreation facilities, more and better hospitals, better facilities for the treatment of mental illness, programs for safeguarding economic security, and many other services. New and urgent urban problems have developed. . . .
>
> These mushrooming demands generally have been beyond the financial capabilities of the State and local governments to meet. Accordingly, there has been a continually increasing need for Federal aid. . . .
>
> The need of State and local governments for substantial financial assistance is only one of the main facets of the overall problem of meeting the demands of our citizens and of making our population centers fit places to live. Also critical is the fact that many of the States and local governments, now and in the foreseeable future, lack the highly qualified administrative, professional, and technical personnel in the numbers required to plan, innovate, organize, and execute the wide variety of necessary programs.

This legislation created a program of grants and training assistance designed to give State and local personnel the administrative, professional, and technical skills vital to governmental operation. Intergovernmental cooperation in grants administration is fostered through the establishment of an Advisory Council on Intergovernmental Personnel Policy appointed by the President. Not to exceed 15 members, the Council acts to advise the President on programs, problems, and policies concerning public administration, State and local capacity building, training, and intergovernmental assignment of personnel.

Grants are made available to State and local jurisdictions for programs to develop and institute improved personnel administration methods. State and local employees may be permitted to participate in Federal training programs under the provisions of this law and funds are designated for nonnational jurisdictions to ". . . train and educate . . . professional, administrative and technical employees and officials." Title IV provides for the temporary assignment of personnel from States and localities to the Federal Government and vice-versa.

cc: B. Merrifield, B. Ortiz

aa: ITA (for information)
cc: EA, GC, BJC, MFS

PROTECTIONISM IS DESTRUCTIONISM

614038

o Protectionism hurts Americans more than it hurts the foreigners it is aimed at. President Reagan says, "They ought to call it destructionism."

o During the past three years, the U.S. has experienced record trade deficits, yet our unemployment rate has fallen by about a third and 10 million more Americans have joined the workforce.

o Europe, on the other hand, is far more protectionist than the U.S., but has experienced economic stagnation for more than a decade. Total employment in Western Europe is virtually the same today as it was 10 years ago; since the labor force grew over the same period, unemployment has increased.

o Protectionism is occasionaly defended by some on national security grounds. Today, our national security depends on maintaining a technological edge over potential adversaries. Protectionism breeds stagnation and, even in such critical industries as semiconductors, is likely to be inimical to national security.

o Protection does not affect total employment. It simply shifts employment from more efficient industries to less efficient industries. Net affect lower productivity; lower national income.

The Costs of Protectionism

o Protectionism forces a massive transfer of wealth from ordinary Americans to the special interests. The cost of protectionism falls most heavily upon low-income Americans, because of higher prices on basic consumer goods.

o Import controls to protect 19 industries from foreign competition cost American consumers a staggering $56 billion in 1984 alone, according to a study published by the Institute for International Economics, a liberal Washington-based think tank. The study also found:

-- The per-industry cost ranges from $27 billion to protect the textile and apparel industries, down to about $100 million to insulate the canned-tuna industry.

-- It cost $1 million to save a single job in the steel industry in 1984; and $240,000 to save a single job in the orange juice industry.

o The International Trade Commission estimates that 1981-1984 Japanese auto import restraints saved 44,000 jobs in the U.S. automobile industry, but cost American consumers $16 billion. In other words, each job saved in the U.S. auto industry cost Americans about $90,000 per year.

o Economist Michael Munger estimates that the cost of protectionism today is between $1,500 and $2,000 annually for a family of four -- more than most families pay in federal income tax.

1:55 Rec'd. 5/19

o The cost of protectionism falls heavily on the poor. According to the Federal Reserve Board of New York, protection of sugar, clothing and automobiles was the equivalent of an income tax surcharge of 66 percent on a family earning between $7,000 and $9,350 in 1984.

Lessons of History Clear

o The 1930 Smoot-Hawley Act raised duties on nearly 900 items, from champagne and dolls to hand tools and farm products, pushing America's tariffs to their highest levels in the 20th century.

o A total of 59 countries protested to the U.S. Government about the danger Smoot-Hawley posed to the world economy, then reeling from the effects of the 1929 stock market crash. Over 1000 economists signed a petition urging Congress not to pass Smoot-Hawley, and asking President Herbert Hoover not to sign it.

o In the teeth of these protests, the measure passed both houses of Congress (with the Senate voting for the measure on Friday the 13th, June 1930) and was signed into law.

o Within months of enactment, our key trading partners began raising their tariffs and establishing exchange controls.

-- U.S. merchandise imports fell from $4.5 billion in 1929 to $1.3 billion in 1932, the lowest level since 1908.

-- U.S. merchandise exports fell nearly 60 percent from 1929 to 1932.

o Liberal and conservative historians agree that Smoot-Hawley deepened the Great Depression by encouraging other countries to erect trade barriers; isolating America's economy behind a high-tariff wall; and undermining European war debt repayment efforts.

Selected Quotations on Protectionism

Protectionist moves basically profit special interests at the expense of the consumer and at the risk of retaliation -- costing Americans their jobs.

--- Ronald Reagan
Remarks to the International
Forum, U.S. Chamber of Commerce
April 23, 1986

This philosophy of the free market -- the wider economic choice for men and nations -- is as old as freedom itself. It is not a partisan philosophy.

--- John F. Kennedy
Message to Congress on
Foreign Trade Policy
January 25, 1962

This is the first [shareholders] meeting where we can report things have never looked better... The Japanese have already added $1000 to their sticker prices and I expect they'll be adding $1000 in the next six months. That awful advantage we've been complaining about is gone and we think it's a great time to sell cars.

--- Lee Iacocca
New York Post, May 15, 1986

Protectionism is no solution to the economic problems we face. A highly industrialized country like the United States would suffer greatly if the doors to international commerce were closed.

--- Senator Walter Mondale
Congressional Record
December 13, 1974

What point is there in propagating sound economic principles if the electorate is set to have the country run on the principle that the objective in trade is to get rid of as much as possible and get as little as possible in return?

--- Economist Frank Knight

HOUSE OMNIBUS TRADE BILL - AN INVITATION FOR RETALIATION

o If enacted into law, H.R. 4800, the House Omnibus Trade bill, would be a serious step backward for U.S. international trade policy. Many provisions of the bill would undercut the President's recent success in Tokyo in engendering a new round of trade-liberalization talks.

o H.R. 4800 would severely damage the U.S. economy, destroy American jobs, reduce our international trade competitiveness, and embroil us in trade conflicts with virtually all our major trading partners.

o The big losers under the House bill:

-- Consumers who would pay higher prices on thousands of products;

-- Workers in many of the most dynamic U.S. industries, who would find overseas markets closed to them; and

-- Farmers would face additional financial hardships.

o As nine members of the President's Cabinet asked in a joint letter to the Congress, "Why should we jeopardize the livelihood of the five million Americans whose jobs depend on exports?"

Examples of Unsupportable Provisions of H.R. 4800

o H.R. 4800 would require mandatory quotas against exports from countries with large and persistent trade surpluses vis-a-vis the United States. Japan, Taiwan, and West Germany would be immediately subject to these quotas. This violates GATT and invites massive trade retaliation against U.S. exports, particularly agricultural commodities, aircraft, chemicals and data processing equipment.

o The bill would make denial of "internationally-recognized worker rights" an unfair practice actionable under Section 301. This standard would come back to haunt U.S. exporters -- in right-to-work states, for example. The concept of "internationally-recognized worker rights" is ambiguous at best. Congress has never recognized what that means.

o H.R. 4800 would unilaterally redefine what is an illegal subsidy, making some subsidies countervailable even if they are available generally (like irrigation and roads). This provision would invite retaliation against U.S. timber exporters, for example, who receive subsidized electricity.

o The bill would require mandatory Presidential retaliation in certain Section 301 cases by an inflexible deadline. Legalism in place of negotiation is no way to conduct U.S. foreign and trade policy.

o H.R. 4800 would prohibit the President from authorizing tariff cuts for certain import-sensitive articles. This would make it hard to get many nations to the bargaining table in a new GATT round; could make some mandated U.S. negotiating objectives impossible to achieve.

o H.R. 4800 would require a 40 percent reduction in items under national security export controls -- a meat-axe approach to export decontrol that ignores national security.

o The bill would also establish a Council on Industrial Competitiveness to carry out industrial planning -- a discredited scheme that would pit one industry against another. Americans don't want it and don't need it.

o H.R. 4800 could add to the budget deficit. Preliminary analysis indicates that H.R. 4800 would cost taxpayers an additional $6.5 billion over the next three years.

Building Blocks of a Bipartisan Trade Bill

o There are a number of important changes to U.S. trade law that would improve America's ability to compete. Supportable provisions of the H.R. 4800 include:

-- Expanding protection for U.S. intellectual property rights; and

- Providing the President with negotiating authority for a new round of multilateral trade negotiations.

o The Administration supports a number of changes in existing law, which are not presently included in H.R. 4800:

-- Amending U.S. antitrust laws to promote competitiveness of U.S. industries;

-- Establishing a "war chest" to support mixed credit loans to enable U.S. exports to compete effectively;

-- Amending the antidumping and countervailing duty law to provide a predictable pricing test covering non-market economies; and

-- Amending our trade laws to put a deadline on dispute settlement and to contain a fast-track procedure for perishable agricultural items.

o November 1, 1985: Retaliated against the EC's failure to negotiate a settlement to the long-standing GATT citrus dispute by imposing duties on EC pasta exports.

o October 16, 1985: Secured market-opening concessions from Taiwan on tobacco, wine and beer; and from Korea on motion pictures, in response to the threat of a 301 case.

o Throughout 1985: Successfully concluded MOSS talks with Japan in four areas: telecommunications; medical equipment and pharmaceuticals; electronics; and forest products.

-2-

Ongoing Trade Initiatives:

o The Reagan Administration has taken the unprecedented step of initiating four Section 301 unfair trade practice cases, concerning:

-- Brazilian informatics;
-- Korean insurance;
-- Japanese tobacco; and
-- Korean intellectual property rights.

o Unless the European Community rescinds its illegal quotas against U.S. agricultural products and provides compensation for increased tariffs, the United States will establish equally restrictive quotas and increase tariffs on their products entering our market.

o The President ordered a fact-finding inquiry to determine whether the European Community would unfairly penalize American exports of as much as $125 million work of meat if they implement their meat inspection programs.

o President Reagan has ordered an investigation of Taiwan's automotive export performance requirements. This is the first case ever initiated under Section 307 of the Trade and Tariff Act of 1984.

o For the first time, the United States has self-initiated an anti-dumping case against Japan on 265K RAMS computer memory chips.

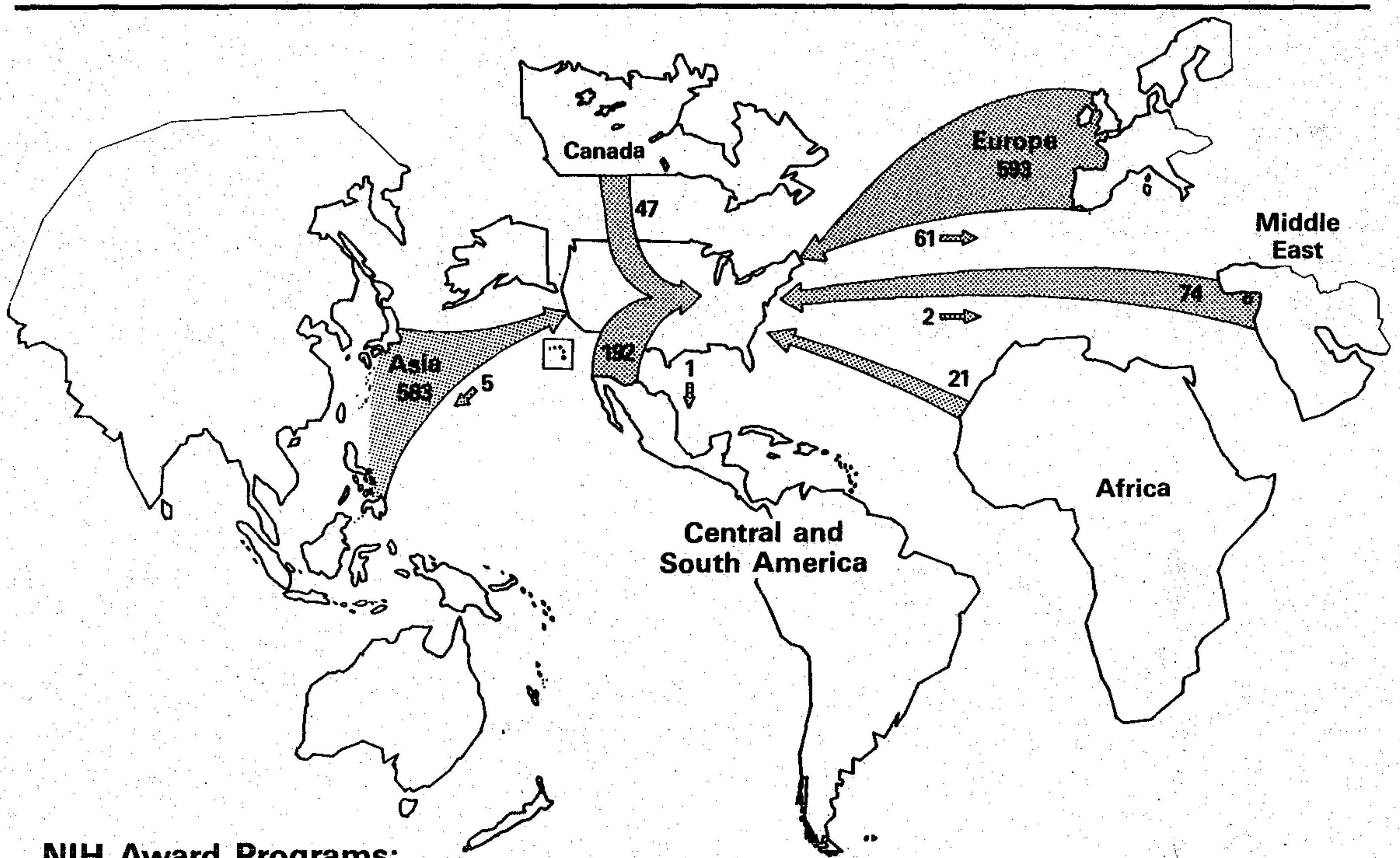
o The Administration is countering foreign subsidized agricultural exports by concluding over $400 million work of sales under the Export Enhancement Program. The Reagan Administration is also countering foreign subsidized export financing by aggressively using existing authorities. For the first time, the Export-Import Bank has extended concessionary financing to a U.S. firm for a sale in the U.S. market.

International Negotiations and Cooperation

o The Tokyo Economic Summit adopted new arrangements for closer economic policy coordination by the major industrial democracies. These arrangements should lead to improved growth, smaller trade imbalances and greater stability in international exchange rates.

o At the Tokyo Economic Summit, leaders of the seven major industrialized democracies and representatives of the European Community endorsed the early launch of a new round of multilateral trade negotiations, targeting the September GATT Ministerial meeting for decisive progress.

SCIENTISTS' MOBILITY, FY 1985



NIH Award Programs:

To the U.S.: International Research Fellows, Scholars-in-Residence, Exchanges, NIH Visiting Program Participants

From the U.S.: Senior International Fellows, Exchanges

TABLE 1

NATIONAL INSTITUTES OF HEALTH
INTERNATIONAL EXCHANGE PROGRAMS
PROGRAM DISTRIBUTION; FY 1985

	Participants	$ Costs
Visiting Program	1,403 Foreign	$24,077,100
Guest Researcher Program	558 Foreign	-0-
Intl. Research Fellowships	100 Foreign	3,374,000
Senior Intl. Fellowships	46 U.S.	1,165,000
Eastern Bloc Hlth. Sci. Exch.	20 U.S. 6 Foreign	47,980
French, Swedish, Swiss, German and Irish Fellowships	49 U.S.	1,042,000
French CNRS Exchanges	4 U.S. 6 Foreign	110,448
Scholars-in-Residence	8 Foreign	476,697
Total	2,081 Foreign 119 U.S.	$30,293,225

TABLE 2

NATIONAL INSTITUTES OF HEALTH
INTERNATIONAL EXCHANGE PROGRAMS
DISTRIBUTION BY GEOGRAPHICAL AREA; FY 1985

Geographical Area	Foreign Scientists to U.S.	U.S. Scientists to Foreign Country	Total
Europe	988	108	1096
East Asia & Pacific	636	8	644
N. Africa/Near East/S. Asia	321	2	323
Latin America & Caribbean	107	1	108
Sub-Saharan Africa	29		29
Total	2,081	119	2,200

TABLE 3

NATIONAL INSTITUTES OF HEALTH
INTERNATIONAL EXCHANGE PROGRAMS
DISTRIBUTION BY COUNTRY; FY 1985

Country	Foreign Scientists to U.S.	U.S. Scientists to Foreign Country	Total
Japan	397	3	400
Italy	196	2	198
United Kingdom	162	33	195
India	168		168
France	105	12	117
Israel	104	2	106
China, People's Rep.	92		92
Canada	81	11	92
Germany; Fed. Rep.	83	8	91
Australia	52	4	56
All others (65)	641	44	685
Total	2,081	119	2,200

INTERNATIONAL OPPORTUNITIES FOR UNITED STATES BIOMEDICAL SCIENTISTS

I. NIH Mechanisms

A. NIH Mechanisms to Conduct Research Abroad

1. National Research Service Awards - Postdoctoral and Senior Fellowships (48)*

2. Research Grants and Contracts

3. Special Foreign Currency Program**

a. India (58)

b. Israel (20)

c. Poland (9)

d. Yugoslavia (32)

B. Specific Fellowships for Conducting Research Abroad

1. FIC-Supported

a. Senior International Fellowships (45)

b. NIH-French CNRS Program for Scientific Collaboration (6)***

2. Foreign-Supported

a. Finland (1)

b. NIH-French CNRS Program for Scientific Collaboration (6)***

c. France-INSERM (2)

d. Federal Republic of Germany (open)

e. Ireland (1)

f. Israel (4)

g. Norway (1)

*( ) Approximate number of U.S. scientists supported annually
** Grants and travel support for U.S. collaborators and foreign scientist participants
*** Supported under a bilateral agreement

h. Sweden (4)

i. Switzerland (4)

j. Taiwan (open)

C. Health Scientist Exchanges***

1. Hungary (2)

2. Poland (1)

3. Romania (11)

4. Soviet Union (1)

5. Yugoslavia (5)

II. Sources

A. Publications

1. <u>Directory of International Opportunities in Biomedical and Behavioral Sciences</u>

International Research and Awards Branch
Bldg. 38A, Rm. 613
Fogarty International Center
National Institutes of Health
Bethesda, MD 20892

2. <u>A Selected List of Fellowship Opportunities and Aids to Advanced Education for U.S. Citizens and Foreign Nationals</u>

The Publications Office
National Science Foundation
1800 G Street
Washington, D.C. 20550

B. Organizations/Agencies (not included in publications above)

1. International Cancer Research Technology Transfer Programme (ICRETT)
rue du Conseil-General 3
1205 Geneva, Switzerland

2. Epilepsy Foundation of America
   4351 Garden City Drive
   Landover, MD 20785

3. Computerized Bulletin Board (being developed)
   Contact: Russell Morgan
   National Council for International Health, Inc.
   Suite 605
   1101 Connecticut Avenue, N.W.
   Washington, D.C. 20036

4. Japanese Government Research Awards for Foreign Specialists
   International Affairs Division
   Promotion Bureau
   Science and Technology Agency
   2-2-1, Kasumigaseki, Chiyoda-ku
   Tokyo, Japan

5. International Fellowship Program for Foreign Scientists,
   FORMEZ, Training and Studies Center for Southern Italy
   Via Salaria 229
   00199 Rome, Italy

C. Medical Students' Opportunities

1. "A Student's Guide to International Health"

   International Health Task Force
   American Medical Students Association
   1900 Association Drive
   Reston, VA 22091

2. MAP-Readers' Digest International Fellowships Program
   Box 50
   Brunswick, GA 31520

SCIENCE AND TECHNOLOGY POLICY

STATE-OWNED PATENTS SPREADING ABROAD

Tokyo KOGYO GIJUTSU in Japanese Mar 86 pp 44-48

[Article by Mitsuo Suzuki, director of the Japan Industrial Technology Association]

[Text] Why International Technology Cooperation Is Now Important

With a turnabout from the first oil crisis, the focus of world technology development trend has been shifting toward lightness, thinness, shortness, and smallness [micro] from heaviest, thickest, longest, and biggest [macro]. Countries in the world are fiercely competing for the development of high technologies, amid the great surge of new technologies from the 1970's toward a peak in the early 2000's.

Emerging as advanced technologies are the technology for utilizing limited sources of energy on earth, electronics technology for fostering an information society, new materials technology for bringing about metamorphic progress in industries, and biotechnology with diverse potential.

The collapsing condition of the Japanese economy after World War II has achieved a marvelous recovery through the support of technical assistance from abroad and the concerted efforts of the people. As a result, Japan has now established a high technology level worldwide.

While Japan has currently achieved economic growth through active industrial activities based on high technologies, other countries have increasingly been seeking Japan's technical cooperation. Public opinion is taking root in that Japan should further promote contributions intellectual to the international society through technologies.

As regards technologies under such international circumstances, the recent activities concerning technology transfer and popularization of the Japan Industrial Technology Association (Inc.) (JITA) engaged in activities of spreading state-owned patents of the Agency of Industrial Science and Technology (AIST) at home and abroad will be outlined (see Figure 1)

Transfer of state-owned patents

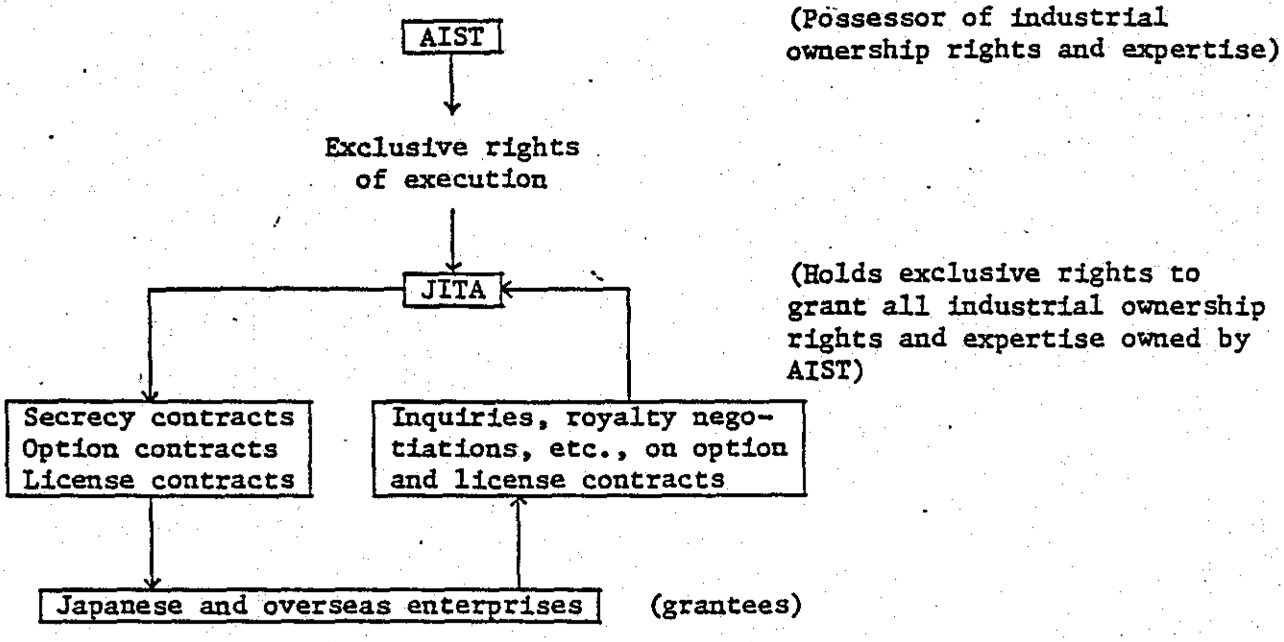


Figure 1. Technical Transfer System of AIST's State-Owned Patents

Activities of High Technology Interchange Missions

JITA has been sending missions to the various European and American countries annually since 1983 to introduce AIST's state-owned technologies in support of AIST and other quarters concerned. The dispatch of the missions is part of the technology interchange between Japan and the various European and American countries, and is also in response to criticism that Japan is not providing technology exports in comparision with the enthusiasm for exports of manufactured products. Among AIST's state-owned patents, 20 to 30 themes, which have been applied for industrial use by Japanese companies or those prospective technologies are selected annually for overseas supply upon approval for technical cooperation by the companies involved.

Missions comprising top technicians or leaders concerned in charge of technical development at such companies visited governmental organizations or research institutes of major enterprises in the various European and American countries to ascertain the needs of such countries (possibilities such as technology transfer and joint development). From this side, technical presentation was provided and at the same time relative discussions pursued.

Institutions visited by year follow:

1983	Sweden	(state) STU (Swedish Technology Development Agency) (private) ASEA Co., Volvo Co.
	West Germany	(private) Dynamite Nobel Co., Siemens Co.
	France	(state) CESTA (Advanced Technology System Development Center) (private) Toulouse City Chamber of Commerce and Industry
1984	United States	(state) Raleigh, North Carolina--Research Triangle Park (research consortium) (private) SWRI, IITRI, SRI (all nonprofit think tanks)
	Canada	(provincial) Montreal Urban Community (research consortium)
1985	Sweden	(private) IDEON (research consortium) (private) SKAPA (creative technology exhibit)
	Ireland	(state) IDA (Irish National Research and Development Agency)
	Britain	(state) BTG (British Technology Group, formerly NRDC) (private) Berkeley Tech Mart '85
	France	(state) CESTA (private) Rhone Poulenc Co.
	West Germany	(private) Bayer Co.

Fortunately, the dispatch of the missions over the past 3 years has resulted in steadily spreading state-owned technologies abroad due partly to the active cooperation of domestic licensee companies and various foreign governmental organizations and overseas companies. Among the themes presented, some concrete results are beginning to emerge, such as supplying information and samples, to include possibilities for future technology transfer and joint development, and the conclusion of secrecy contracts.

Table 1 shows typical technologies presented by the past three missions. A few examples among overseas responses to the missions were the request from Martin Marietta, a major U.S. enterprise, for a supply of several tens of kilograms of high-performance electromagnetic wave shield materials on a sample basis. Kuraray Co. and two other companies are now conducting experiments for practical application of the materials under the guidance of AIST's Industrial Products Research Institute. General Motors Corp. (GM), a major U.S. automaker, Alcan Canada Co. of Canada, Hinkley and ICI of Great Britain, and many other companies have shown interest in revolutionary fine ceramics processing technologies, and negotiations for a contract are now underway with a certain company. The ceramic technologies involved are the ceramics-metal

Table 1. Technologies Introduced Abroad Through State-Owned Patents

Category	Title of technology	Institute that made discovery	Year introduced		
New materials	High-performance electromagnetic shield material	Industrial Products Research Institute	1983	1984	
	Ceramics-metal bonding Ceramics-ceramics bonding	Osaka National Industrial Research Testing Institute (NIRTI)		1984	1985
	Zirconia sinter	Nagoya NIRTI	1983		1985
	Easy-to-sinter alumina	" "		1984	
	Lubricating agent for die-casting, forging	Osaka NIRTI	1983	1984	
	Lanthanum-chromate for heating	Daikoshi NIRTI	1983		
	Carbon-ceramics compound	Kyushu NIRTI		1984	
	High-performance pitch carbon fiber	" "	1983	1984	1985
	Ultrahigh-molecular polyethylene gel yarn	Research Institute for Polymers and Textiles		1984	
	Hydraulic injection plastic molding	"		1984	
	High-flux precision filtration membrane and its system	National Chemical Laboratory for Industry, Kyushu NIRTI, Osaka NIRTI	1983	1984	1985
	Photocrosslinkage polymer and screen printing	Research Institute of Polymers and Textiles	1983	1984	
	Gas separation using polyimide hollow fiber	National Chemical Laboratory for Industry			1985
	Ion exchange fiber and rare earth metal separation	Research Institute of Polymers and Textiles	1983	1984	1985
	High-performance deodorant	National Chemical Laboratory for Industry	1983		
Biotechnology	Production of oils and fats by mycosis	National Chemical Laboratory for Industry	1983		
	Production of gamma linolenic acid by mycosis	"		1984	1985
	Production of heat-resisting lipase and dissolution of oils and fats	Fermentation Research Institute		1984	1985
	High-performance cellulase	"		1984	
	Solidification of oxygen by ultrafine fiber carrier	Research Institute of Polymers and Textiles			1985
	Solidification of oxygen by photocrosslinkable polymer	"			1985
	Production of fry feed from alcohol fermentation wastes	Fermentation Research Institute			1985
	Artificial joints	Mechanical Engineering Laboratory			1985
Electronics	High-performance amorphous silicon solar battery	Electrotechnical Laboratory		1984	1985
	Semiconductor magnetic sensor and its applications	"		1984	1985
	Assessment of amorphous silicon manufacturing process under CARS system	"			1985
	ICTS system for detecting crystal defects	"			1985
	Nonvolatile semiconductor memory with floating gate	"			1985
	High-output GGG laser	"			1985
	Optical disk pickup (SCOOP)	"			1985
	Magnetic garnet film for optical IC	"	1983		

bonding and ceramics-ceramics bonding where research for practical applications is being conducted by Sumitomo Cement Co. and Daihen Corp., respectively, under the guidance of AIST's Osaka Industrial Research Institute. Negotiations are also underway with (Reuter) Gas Werke Co., a major West German pitch processing company, concerning technology to manufacture high-performance carbon fiber now being developed for practical application by more than 10 companies, including Nippon Carbon Co. Regarding lubricating agents for forging and die-casting, Hanano Shoji (Inc.) has completed development of manufacturing technology, and is now being made practical with a large amount of samples being supplied abroad for testing, while Great Britain's (Fuoseco) is seeking technology transfer.

In addition not only enterprises, but also Britain's BTG (R&D agency) and France's CESTA (advanced technology center) are requesting long-term, deliberative cooperative relationships with JITA missions, and are showing an active stance toward future technology interchange with Japan.

Progress in R&D of those technologies have been conducted by research institutions under AIST's umbrella with the cooperation of private-sector companies. Behind-the-scene movements concerning technology transfer through various channels have also been observed, and attention focuses on future developments.

Technological Transfer Based on Trusting Relationship

"The more information is assimilated, the more its essence is improved," is a wise statement about data bases by Tokyo University Professor Hiroshi Inose, last year's Cultural Merit awardee. In technology transfer, too, a certain preparatory period is initially required for the exchange of technologies and related information and establishment of a relationship of mutual trust between the provider and the receiver of technologies. The first problem in negotiating transfer of state-owned technologies abroad is that it takes considerable time to establish such relations of trust. Perseverance is required as in an extreme case where the party completely lacking information mutually about the other party begins from scratch. In addition, based on relations of trust, the supplier and receiver of technologies must seek terms on conditions which will mutually benefit both sides from a long-term point of view. Under such circumstances, recent trends for the future technologies or in exploring new areas such as cross-licensing and other forms are increasing.

Next is the establishment of relations of trust regarding protection of patents. The state-owned technologies to be definitely transferred abroad at present are basically on condition that the technologies involved are patented in the recipient countries. Accordingly, it is important that such technologies are fully protected under the recipient countries' patent system and in the operation thereof.

In the various countries visited by JITA's advanced technology exchange missions in the past 3 years, hardly a problem occurred due to the high reliability of the patent protection measures. However, of late, Japan has been strongly urged to expand technology transfer to the newly industrialized countries (NICS) and developing nations. The problem of patent protection in those countries will therefore be an issue to be resolved in the future.

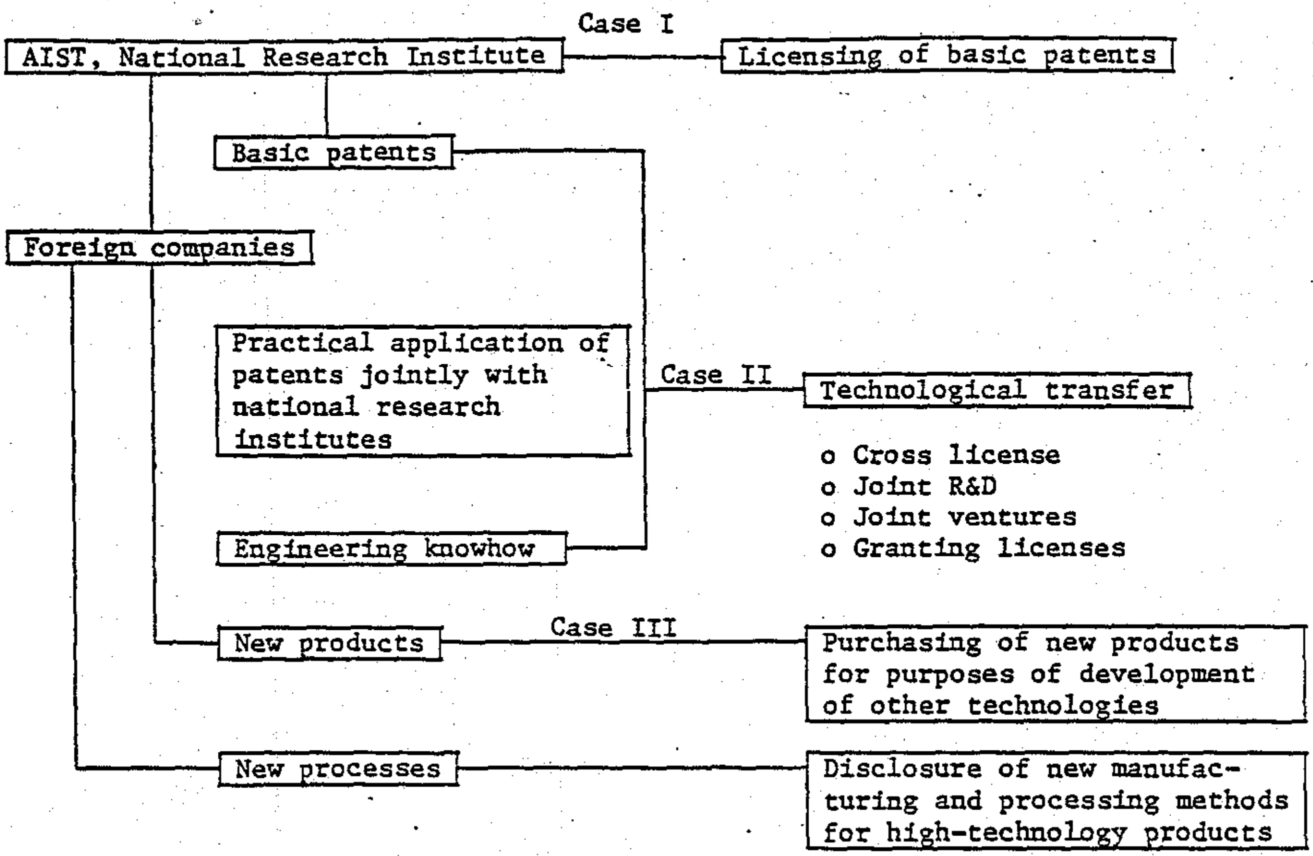


Figure 2. Technology Transfer of State-Owned Patents Abroad

Four Cases of Technological Transfer and Procedures for Transfer

Transfer of state-owned patents has various backgrounds depending on the technologies involved, which is not easy to generalize into one format. However, it can be classified roughly into four cases as shown in Figure 2.

Case I is the licensing of basic patents owned by the Agency of Industrial Science and Technology and of patents jointly owned by the national research institutes and private companies. Case II involves providing all the information necessary for commercialization ranging from basic patents owned by the AIST to related patents, manufacturing know-how and product specifications, etc., possessed by the implementing companies--in other words, the complete transfer of technologies. Depending on circumstances for the suppliers and the receivers of technologies, Case II can be subdivided into four types, i.e., cross-licensing mutually between companies, joint development by both companies for furtherance of technologies involved, establishment of joint ventures between companies based on mutual agreement and conditions for local production and sales, and the unilateral supply of all the technologies to the other country's enterprise in exchange for payment of certain remunerations.

In Case III foreign companies purchase products of technologies involved from the contract-implementing firms of Japan and use such items as a basis to develop new processes or new products. In Case IV foreign companies produce and process products on a contractual production basis, using high technologies developed from basic patents owned by the AIST. For example, one plan now under negotiation is the contractual production of special parts by a foreign enterprise using the "ceramics-metal bonding technology."

Table 2. Procedures for Technology Transfer

First stage Secrecy agreement	Providing secret information and samples necessary for assessment of technologies involved
Second stage Option agreement	Technical information including know-how, etc., data regarding economical phase, and samples or marketable products necessary for feasibility study
Third stage License agreement	All information necessary for practical application of technologies

Procedures for granting licensing of state-owned patents abroad are basically identical to those in Japan. The first stage, as shown in Table 2, is to cope with clients when they seek more detailed information and samples to be furnished so as to determine the industrial value concerning the nature of the technologies. In such case, if necessary, a secrecy agreement is concluded before providing them.

The second stage is for coping with cases where further concrete information beyond the first stage is sought by the clients such as information about economical feasibility, information concerning marketing and technical information to determine the industrial applicability of the technologies, as well as providing samples on a commercial basis, etc. Usually in this stage, information is furnished under an option agreement on the assumption that technologies involved will be applied for industrial purposes.

The third stage is the execution of technology transfer under a license agreement in which the contract discloses all technical information necessary for the application of technologies and the nature of the patents.

For the Future

Japan is a small country in terms of natural resources, energy, and food, but is substantially rich in intellectual resources. Using these resources, the country has accumulated industrial property and other technology assets since the end of the last war, making itself one of the leading technology-oriented countries in the world. Such intellectual assets will continue to serve as a bargaining power for Japan.

However, today's accumulation of technology assets has resulted from the introduction of technologies from advanced countries in Europe and America, and efforts for creative technology development. Moreover, in the background of facilitating Japan's introduction of technologies from European and American countries is the sense of trust when Japan was furnished technologies, being accustomed to assessing fair value of new, superior technologies which furthered the understanding of patent protection.

Meanwhile, Japan has been strongly criticized by various countries in Europe and America for its huge trade surplus stemming from expanding exports of manufactured products. Of course, free world prosperity lies in orderly exports and imports under the free trading system. However, Japan's export of its abundant intellectual resources, resulting in a surplus in the technology trade balance, would not create trade friction, but would rather contribute to the development and revitalization of the world economy. The conditions to smoothly transfer technologies overseas are as stated above. The three issues of relations of trust, mutual benefit, and patent protection have been proposed. However, these problems in the case of NIC's and developing nations are such that environments are yet to be sufficiently regulated. It is extremely important that Japan mutually cooperate in resolving these problems for future international cooperation.

20129/9365
CSO: 4306/3613

END

price which in case of [illegible] shall be calculated by deducting the variable costs of producing the product from the sales price of the product.

"(c) DEFINITIONS.—For purposes of this section—

"(1) The term 'interested party' means—

"(A) a manufacturer, producer, or wholesaler in the United States of a like or competing product, or

"(B) a trade or business association a majority of whose members manufacture, produce, or wholesale a like product or a competing product in the United States.

"(2) The term 'like product' means a product which is like, or in the absence of like, most similar in characteristics and uses with products imported into the United States in violation of section 592(a).

"(3) The term 'competing product' means a product which competes with or is a substitute for products being imported into the United States in violation of section 592(a).

"(d) INTERVENTION.—The court in which an action is brought under subsection (a) shall permit the United States to intervene in the action as a matter of right. The United States shall have all the rights of a party to the action if such an intervention is made."●

By Mr. MELCHER.

S. 929. A bill entitled the "Voluntary Protection Act of 1987"; to the Committee on the Judiciary.

VOLUNTEER PROTECTION ACT

● Mr. MELCHER. Mr. President, today I am introducing legislation to encourage States to grant volunteers of tax-exempt organizations immunity from personal civil authority for actions which they take in good faith and which are within the scope of their official functions.

Our country depends on volunteers to make things work: Town councils, libraries, school boards, fire departments, hospital boards, Scout troops and little league teams.

Yet, volunteers are getting harder to find. Why? Because volunteers are increasingly wary of being exposed to lawsuits—that is, being sued by someone who is injured, lost their job, or somehow damaged. If they are sued, the board members or other volunteers might lose their homes, farms or other assets.

Now this problem may be more one of perception as there have been successful suits against such volunteers. But we need people to keep on volunteering, and this bill is a simple way to help see that they are not scared off.

The second problem is that, when organizations do find volunteers, they find themselves forced to pay ever-higher insurance premiums—even if they've never been sued.

Let me give one example. As chairman of the Select Committee on Aging, I am concerned with the network of services being provided older Americans. Part of that network is the Volusia County Council on Aging in Florida. This nonprofit organization puchased liability insurance protection so, if it is sued, the insurance will cover any costs. In 1986, it paid $695 for a liability policy to protect them up to a half-million dollars [illegible]. In 1987, it paid $1,100—nearly four times that amount—for the same amount of coverage. Although there is little reason to think the council will ever have a liability lawsuit filed against them, there is not one of the council members that would afford to pay damages. So it is a "catch 22". They still have to buy the insurance [illegible] as a group, when none of them can afford it.

This isn't an isolated instance. A study by Peat, Marwick, Mitchell & Co. shows that 68 percent of insured nonprofit groups in this country said their most recent premiums had increased by one-half or more.

To Congress, the cost of an insurance premium might sound like a small sum. But for most nonprofit organizations, small sums make a vital difference in the services they can provide. If they have to pay more for insurance, they have less for actual services. And we need these services.

So let's encourage States to pass legislation to exempt unpaid volunteers from personal civil liability. Already 24 State legislatures have passed some legal immunity for volunteers. These States are Alaska, Colorado, Connecticut, Delaware, Georgia, Hawaii, Idaho, Illinois, Indiana, Louisiana, Maryland, Minnesota, Montana, North Dakota, New Hampshire, New York, Ohio, Oklahoma, Pennsylvania, Tennessee, Utah, Virginia, Washington, and Wyoming. The legislation I am introducing today would encourage the other States to do so by 1988. If they fail to do so, this legislation would reduce their social service block grants by 1 percent and redistribute these Federal funds to States which have acted.

This bill is identical to H.R. 911, introduced in the House of Representatives by Congressman JOHN EDWARD PORTER of Illinois with some 60 cosponsors.

This bill, the Volunteer Protection Act, simply protects individual volunteers who are acting in good faith and within the scope of their duties as a volunteer. It would not reduce the rights of those who have been harmed to obtain redress through civil suits. Individuals who have abused their positions of trust with volunteer organizations would still face criminal penalties and civil suits for willful and wanton misconduct. And the organizations could still be sued.

But our volunteers—those people who donate their time and talents without compensation to serve our communities—would not have to fear losing their homes and farms if they want to help make their communities a better place to live.●

X By Mr. BUMPERS:

S. 930. A bill to amend the Stevenson-Wydler Technology Innovation Act of 1980 to establish a Center on State and Local Initiatives on Productivity, Technology, and Innovation, and for other purposes; to the Committee on Commerce, Science, and Transportation.

LEARNING FROM THE STATES ON COMPETITIVENESS

● Mr. BUMPERS. Mr. President, in the current debate on how to assist our industries and businesses to regain their competitive edge in the international marketplace, there is very little consensus here in Washington on how to proceed and the massive Federal Government budget deficits severely constrict our options.

The debate on competitiveness is laced with ideological issues about the proper role of the Federal Government. Unfortunately, the debate often focuses on the extremes, with advocates on the one side arguing that the Federal Government should do nothing and advocates on the other arguing that the Federal Government should intervene actively in the marketplace. I believe firmly that there is a pragmatic middle ground in this debate which has not been fully explored.

We can, for example, take a positive and constructive step which does not involve establishing any new Federal policy or which drains the Treasury. We at the Federal level of Government can play a constructive role which does not impose a top-down national industrial policy. The Federal Government need not become a lender of last resort to every business which is adversely affected by international competition.

Specifically, the legislation I am introducing would establish a National Center in the Commerce Department to serve as a clearinghouse to monitor and assist State and Local governments with their initiatives to stimulate productivity, technology, and innovation.

The center on State and Local Initiatives on Productivity, Technology, and Innovation will help all of us to enhance the competitiveness of our country in international trade without erecting new trade barriers to imports or launching massive and untried Federal Government programs.

This modest proposal will help all of us to learn from the practical programs that State and local government agencies are undertaking to assist our industries and businesses to regain their competitive edge. The Center's service as a clearinghouse will help the State and local governments to learn from one another about which of their initiatives are the most effective and most cost effective and it will be valuable to those at the Federal level who are seeking to develop a concensus on how to proceed on this critical issue.

We have choices other than doing nothing and doing too much. We need not ignore the issue, as this administration has done. We can pursue a multifaceted, bottom-up competitiveness strategy. We can avoid centralizing the strategy-making process. We can be pragmatic, we can avoid ideolo-

Chuck Ludlam 224-3095 Bumpers —

gy, and we can come together as a nation to do what makes sense and what is necessary to advance our national self-interest.

We do not have to wait until there is a consensus at the Federal level about how we can be helpful in enhancing competitiveness. The State and local governments are not waiting for the Federal Government to address the challenge of competitiveness. They know not to expect action from this administration.

STATE AND LOCAL GOVERNMENT INITIATIVES

On the issue of competitiveness, State and local governments are demonstrating much more creativity than is the Federal Government. They are showing that they understand how serious the competitiveness challenge is for America and they are acting boldly and pragmatically to bring the public and private sector together in a constructive partnership to meet this challenge.

The range of these initiatives is too broad, the programs are changing too quickly, and the Federal Government has too little interest in monitoring these developments for us to have even a complete list, let alone an understanding, of what is happening now at the State and local government level.

We do know enough, however, about these initiatives to know that something exciting is happening at the State and local government level. We know they are experimenting with new approaches to the responsibilities of government, we know they are taking risks, and we know that they are challenging the traditional notions about the relationship between the public and private sector. Clearly, we need to know more and a national clearinghouse is the logical first step in educating ourselves about what already is happening.

RANGE OF STATE AND LOCAL INITIATIVES

The range of State and local initiatives to stimulate productivity, technology and innovation is broad and growing. With all 50 States interested in the issue, many novel programs have been launched and even more are being considered. The absence of Federal Government interest has challenged State and local governments to fill the void and they have done so with little hesitation.

There are programs where the State and local government itself is a partner in developing a new production process, a new technology or a new invention. Some State and local governments have establishing laboratories, experimental manufacturing facilities or education institutions which conduct basic or applied research. Some States have established incubators which provide low-cost physical space, equipment, and technical service to start up businesses. These initiatives are of great interest to the other States and to the Federal Government itself.

One of the best examples of State technology efforts can be found in Arkansas. The Arkansas science and technology authority plays a leading role in Arkansas in identification, development, and application of advanced technologies. It provides funding for basic research and applied research partnerships with industry, which industries in turn are eligible for State research and development tax credits. It stimulates a homegrown economy through the establishment of five business incubators which provide support to new technology-based businesses in Arkansas. It's seed capital investment fund provides the critical initial capitalization for these new ventures. Supplementing the work of ASTA is the center for technology transfer at the University of Arkansas, the quality-productivity task force of the Arkansas Industrial Development Commission, and the Industrial Services Association at Southern Arkansas University all of which are working with existing industries in Arkansas to find ways to increase productivity and promote the concept of quality management.

Many States are establishing programs which integrate universities in the search for more productive processes, new technology, and greater economic growth. Universities no longer are the ivory towers that some have thought they should be. "The Higher Education—Economic Development Connection: Emerging Roles for Public Colleges and Universities in a Changing Economy," American Association of Colleges and Universities and SRI International, 1986. Georgia Institute of Technology, the University of Alabama at Tuscaloosa, George Mason University, Michigan State University, and Oregon State University have been leaders in fashioning innovative university/private sector programs. Many other States are involved in similar efforts.

There are at least 10 States which are working on programs to assist small- and medium-sized companies in financing export sales. In California a government agency will guarantee 85 percent repayment on loans which banks give to businesses to finance working capital or receivables related to exports. "States Launch Efforts to Make Small Firms Better Exporters," the Wall Street Journal, February 2, 1987.

STATES ARE MORE PRAGMATIC

It should not be suprising that State and local governments are taking the lead on the competitiveness issue. State and local governments have intimate knowledge of what the decline in competitiveness means to the workers and managers in their region. They know what happens when a firm cannot compete in the international marketplace or when it determines it must relocate its firm overseas to take advantage of lower wage costs. They can see businesses struggling to adjust to changed markets and new technology. They see entrepreneurs with an idea who cannot obtain capital or who need assistance in commercializing an invention.

State and local governments know that under the current administration and with the huge Federal budget deficits, they cannot wait for Washington to formulate or implement a competitiveness strategy for the country. They know that their only alternative is to act on their own, using their own resources and relying on their own good judgment about what role government can play.

State and local governments are in much healthier fiscal shape than is the Federal Government. State and local governments taken as a whole are running a budget surplus, which contrasts starkly with the abysmal deficits we are running at the Federal level. Because of the irresponsible fiscal policies of this administration, at the Federal level we simply do not have the funds to appropriate for new initiatives, or even to provide adequate funding for existing programs in the areas of education, trade adjustment assistance, and export promotion. Our national economic well-being is threatened and we have been left with insufficient resources to make the investments which are necessary to meet this threat.

Most important, State and local governments are finding that they can play a constructive role in stimulating productivity, technology, and innovation. They do not have a rigid ideological suspicion of everything that comes from Government as does the administration in Washington. They're not concerned about ideological purity; they're just trying to solve problems. They don't throw around slogans about "Government Being the Problem." They see a problem and they go to work.

State and local governments know that it is simplistic and counterproductive to assert that Government "Is the Problem." Government certainly can create problems just as can a private business when it is poorly managed. We at the Federal level have made major mistakes in setting macroeconomic policy. But for good or bad, governments are here to stay and the issue is how well they are managed and how constructive the role is that they play. Government can be a partner or a meddler, but it is always a factor.

State and local governments are taking risks with these innovative programs. They are conducting experiments and we must understand that some of these experiments will fail. Some public money may not be invested wisely in searching for effective ways to stimulate productivity, technology, and innovation. Some of these programs already are subject to controversy and there is always controversy when taxpayers' funds are not invested with a maximum return. But, Government institutions need to take risks just as do corporations. New products introduced into the marketplace by corporations fail, indeed most new product introductions fail. This doesn't lead corporations to stop introducing new products. If Government refuses to take risks and refuses to try innovative approaches to pressing national problems, it may well become more of the problem than the solution.

With a national clearinghouse we all can learn more from experiments which others already are willing to undertake. The clearinghouse itself is itself a modest experiment given the willingness of State and local governments to fund and conduct—and take the heat for—experiments in enhancing competitiveness. In seeking to determine which experiments are succeeding and which are not, hopefully we all can avoid repeatedly making the same mistakes.

With a clearinghouse we are acknowledging that the Federal Government is not the only, and indeed it is not even the major, actor in enhancing the competitiveness of our business sector. There are 50 State governments, thousands of city and county governments, thousands of universities, thousands of foundations, thousands of nonprofit institutions, and thousands of private corporations which can take the lead. We need all of them to play a constructive role and we at the Federal level need to do all that we can to stimulate diverse approaches to the competitiveness challenge. It would be folly and unwise to pursue one single, national, and federally mandated strategy.

NEED FOR A CLEARINGHOUSE

What my legislation would do is create a center on State and local initiatives on productivity, technology, and innovation. The center would be located in the Commerce Department and its principle function is to serve as a clearinghouse on the competitiveness initiatives of State and local governments, regional organizations, university and private sector cooperation, and joint public-private sector partnerships.

The President's Commission on Industrial Competitiveness studied the efforts of State and local governments to boost competitiveness. In a report to the Commission prepared for the Task Force on State and Local Initiatives by SRI International and the Chemical Bank, it is recommended that "A national resource center should be established to identify State innovations, assess their effectiveness and promote action by States and industry." "Innovations in Industrial Competitiveness at the State level," report to the President's Commission, SRI International, December 1984, at 70.

This report found that "States, industry, and the Federal Government all need better information on which of the strategies attempting to promote industrial competitiveness at the State level are working." It found that only a "limited amount of systematic effort" had been made to "document and assess what has been happening." The recommended "National Resource Center" could "serve as a national clearinghouse, a neutral forum for discussions among sectors and a resource for technical assistance for States or industry interested in developing new strategies."

Similarly, the Congressional Office of Technology Assessment found that to provide direct or indirect assistance to State or regional high technology development, it would be helpful for the Federal Government to establish an information clearinghouse "containing a comprehensive and up-to-date list of State and local initiatives" that support high technology development. "Technology, Innovation, and Regional Economic Development," Office of Technology Assessment, July 1984. The report found that the most helpful type of information the clearinghouse could assemble would be a "project bank" such as that established by the White House Task Force on Private Sector Initiatives.

COMPETITION AMONG THE STATES

We all know that States and local communities compete among themselves to entice firms to locate or relocate their plants and headquarters. In this competition, one town may offer tax incentives, it may upgrade the local infrastructure or it may lease available land at a below-market rate.

Obviously, this type of competition has an impact on the economics of the firms which benefit from these incentives. Tax breaks, improved infrastructure and below-market rate leases will lower the firm's costs and that improves the firm's productivity.

But, this type of government assistance is more like a government grant than a bold experiment. It is not directed at changing the management approach of the firm, the manufacturing process, or the employee training at the firm. It is not directed at stimulating the development of new technology or the creativity of the firm's scientists. It does not encourage basic or applied research by the firm or investments in new equipment. And, as a result, it should be of much less interest to the center.

Let me be clear. The economic development efforts of State and local governments are valuable and important. They lead to economic growth and increased employment, but in many cases the result of these efforts is more to shift the growth and employment from one city or town to another, not to stimulate a net increase in the Nation's growth or employment. These efforts may amount to a zero sum game for the Nation's economy even though they provide valuable benefits to individual businesses.

It is not clear that the competition among the States always is healthy or fair. It is certainly difficult for a rural or economically disadvantaged community to compete with a relatively well-to-do town. Often the rich get richer and the poor get poorer in this competition. Poor States are forced to compete by offering more special tax breaks or other incentives, which they can ill afford to provide. One recent study by corporation for enterprise development found that "many Sun Belt States that cut taxes and services to attract industry are paying the price with lackluster economies * * *" ("Study Finds Sun Belt Suffers From Steps to Draw Industry," Washington Post, March 19, 1987).

This competition among State and local jurisdictions, however, is a fixture in our market economy. States are part of that market and the Federal Government should not attempt to arbitrate this competition. It certainly has no way to prevent it. At best, we can try to shift this competition to more constructive approaches, approaches which stimulate productivity of firms which already are located in the area or which stimulate the creation of new firms there and the center may help in this respect to reduce the type of competition among the States which has not proven to be constructive.

To ensure that the center does not become enbroiled in the intense competition among State and local governments, the clearinghouse I propose here is specifically prohibited from assisting one State or local government in encouraging a private business to relocate any facility from one State or local jurisdiction to another or to locate any new facility in one State or local jurisdiction rather than another. (Section 5A. (i)(1)(C).) The Federal Government has no legitimate role to play in favoring one State over another when a private firm is determining whether or not to relocate or where to relocate. The center could never establish a relationship of confidence with State and local governments if it became a partisan in disputes among the States.

Similarly, the bill would bar the center from providing any financial assistance to support a State and local government to stimulate economic development through the conduct of public works or the repair or replacement of infrastructure. (Section 5A. (i)(1)(B).) Again, these activities are important functions of Government and private businesses need the assistance of Government on these initiatives. But, these initiatives are routine functions of government, not bold experiments of interest to the Federal Government and other State and local governments.

Similarly, the center is barred from providing direct financial assistance to fund State and local development initiatives. (Section 5A. (i)(1)(A).) Funding for these initiatives might well be available from other Federal agencies and the center may perform a service by compiling inventories on Federal funds which might be available. But, the center must not become involved in providing the funding itself or intervening as partisan in the competition for scarce Federal resources.

Finally, the center is barred from considering any issued "included in a specific labor-management agreement without the consent and cooperation of all parties to the agreement." (Section 5A (i)(1)(D).) This prohibition has a similar intent to those just described. The center should not serve as an arbitrator of disputes. It should provide information and monitor developments. Once it becomes a player in these disputes, it will lose credibility with any parties with an adverse economic or political interest.

STATE INITIATIVES OF NATIONAL INTEREST

The purpose of the clearinghouse is to focus on State and local initiatives which provide a benefit to the Nation as a whole, which stimulate productivity for an entire industry, which develop a new technology which creates a new industry, and which lead to new discoveries about materials, products or processes. It is these initiatives which are of greatest interest to other State and local governments and to the Federal Government.

It is relatively easy for a State or local government to build a new road to service a new factory. However, State and local government initiatives which target productivity, technology, and innovation require much more sophistication. These initiatives are much more difficult to fashion and they are much more controversial. The success of these initiatives is much harder to measure. Initiatives of this type are experiments. When they succeed, however, these initiatives are the ones which are the most significant in our effort to enhance the competitiveness of the Nation as a whole.

The lessons about productivity which are learned by a firm in one State or city can be helpful to a firm in another State or city. One cannot pick up a new road and transfer it somewhere else, but we can easily transport an idea, a new process, or a new material from one State to another.

Under my legislation, the clearinghouse is directed to focus its efforts on those initiatives which are directed at enhancing productivity, technology and innovation. It is these initiatives which are most important to the Nation as a whole and it is these initiatives which are of greatest value to the efforts of the other States. There is great value in learning about how firms increase productivity, how they develop technology and how they enhance the inventiveness of a firm's employees.

COMPETITION FOR PRODUCTIVITY

What we want to encourage is competition among the States to increase the productivity of the firms in their area, not to compete with other States in offering economic incentives to firms to relocate. When States undertake experiments in government-private partnerships, they may do so partly to compete with other States which have launched similar programs. But, this type of competition is healthy; it's precisely the type of competition we want to encourage.

Indeed, if we find that State and local governments can help to stimulate productivity of the firms already located in their area, they may find it much less necessary to entice other firms to choose their town as the location for a new facility. The center can help the States find other basis for competition than forgoing the collection of taxes or providing special and costly services that are not normally available. If States have no ways to compete other than ways that may be shortsighted, they may nonetheless feel compelled to compete.

Some argue than the State and local governments need to be saved from themselves in this competition. Proposals have been circulated that the States agree among themselves to compete in a more positive, less self-destructive way. Such an agreement might take the form of a "disarmament" treaty in which States agree, for example, not to provide special reductions in property or other taxes to entice firms to locate or relocate their facilities in a State. But, until State and local governments voluntarily limit the competition among themselves, the best we can do may be to encourage competition on the basis of constructive partnerships in enhancing productivity, technology and innovation.

EVALUATING STATE AND LOCAL INITIATIVES

One area where State and local governments may need direct financial assistance is in evaluating the initiatives they have undertaken. Typically, evaluation is the hardest and most underfunded aspect of a program.

In some cases, there may be a reluctance to evaluate a program for fear that it will be found wanting. I say this knowing that this same reluctance is common in private businesses, especially for programs where success and failure is not measured simply by a reference to profit and loss.

To be fair, however, it is very hard to determine when an initiative of a Government agency has made the difference in increasing the productivity of a firm. Productivity itself is a concept that is hard to pin down. It is hard to know why some firms are more inventive than others. It is hard to say why one scientist discovers a new technology and another does not. There is controversy about how to evaluate a program just as there is in designing a program in the first place.

In addition to serving as a clearinghouse, therefore, the legislation I am here introducing authorizes the center to provide grants to help State and local governments evaluate their initiatives. (Section 5A.(C)(2).) These grants could be given to the local agency or to a third party, whichever is most appropriate. The legislation bars the center from providing financial assistance for the initiative itself, but it is quite appropriate for the center to provide such assistance for evaluation because only with proper evaluation can the center determine the effectiveness of the initiative.

The issue of evaluations is sure to be a sensitive one as well as an important one. State and local governments which are undertaking experimental programs have no interest whatever in the Federal Government—which has shown little willingness to undertake any initiatives on competitiveness—criticizing their efforts. If the Federal Governments chooses to be inactive on competitiveness issues, it has no right to make life more difficult for State and local governments which are taking up the slack. This is an issue of sovereignty as well as tact. But, the center will find that it cannot hope to establish a relationship of trust with State and local governments if it simply criticizes their efforts from "on high."

To ensure that the center does not trample on the prerogatives of State and local governments, the bill explicitly provides that the center may not evaluate a State or local initiative or disseminate information regarding such evaluations unless the State or local government carrying out the initiative "consents to and cooperates with such evaluation." (Section 5A (C)(2).) This limitation will ensure that when the center does conduct an evaluation, it will be fully informed of the nature and terms of the local initiative. It cannot hope to have all the information it needs if the State and local government is unwilling to provide it. But, it needs more than access to data. It needs to discuss the initiative with the State and local government officials involved to learn from their views and their experience.

There is a need for the center to fund generic research in how any governmental agency can measure the effectiveness of its competitiveness initiatives. The bill I am introducing permits the center to award some grants for this purpose. (Section 5A.(F).) While the center may fund this research, it must be very careful in commissioning such research.

The interest of the center in assisting State and local governments to evaluate their initiatives is, in part, a selfish interest. The center is just as interested in the results of these evaluations as are those involved in the initiative. The center is interested in disseminating information on the most successful initiatives and in disseminating information on how each initiative compares to others and it needs as much data as it can assemble on the impact of these programs.

COMMERCE DEPARTMENT AND OPTI

In my bill, the new center is to be located in the Office of Productivity, Technology and Innovation (OPTI) in the Department of Commerce. OPTI is an agency that I have long supported and on several occasions I have made sure that the administration's efforts to slash its budget have not been successful. Indeed, at one point the administration argued that OPTI should be abolished because its mission had been "completed." In fact, OPTI is a bright light in this administration as an agency which is trying to make government work, not simply to avoid dealing with real problems.

To a very limited extent, the functions of the center are performed already by the OPTI. Because OPTI does monitor developments at the State and local level and serve to a limited extent as a clearinghouse, the bill places the center within OPTI. By establishing the center by statute, however, we can give it visibility, ensure it has enough resources, and lend it the credibility of the Congress.

The center belongs in OPTI and its existence will enhance everything that OPTI already does to stimulate the competitiveness of the country. OPTI is one of the only current Federal agencies which can understand and appreciate the initiatives of State and local governments.

THE CHALLENGE WE FACE

It may be said that this proposal is not dramatic enough or massive enough. Some would argue that we need to spend huge new sums on some programs on competitiveness. Others would argue that we need to erect barriers to the imports which are flooding our markets. But I think the competitiveness problem is more complex than that and that we need to undertake many different initiatives to have an impact.

We cannot pursue any single strategy. Our economy and the world economy are too complex for any level of government—Federal, State, or local—to have a major impact on the competitiveness of the private sector. The resources of government can help but the private sector has many times the resources available to it.

Indeed, in many ways government cannot affect the competitiveness of private business. The competitiveness of a firm depends in large part to the foresight of its management and the creativity of its technical people. These are qualities that cannot be legislated.

But, the Government may be able to serve as a partner. The State or local government may be a more sensitive and more constructive partner than can be the Federal Government. The Government can provide some leadership. It can encourage risk taking and it can provide information.

What this proposal says is that we need a decentralized strategy which draws on the creativity and innovation of many sectors, public and private, nonprofit and commercial, education and training.

By pursuing a broad-based and multifaceted strategy, we are more likely to enjoy success. Vast new Federal programs have a potential for doing harm as well as good, especially if they impede our efforts to control the budget deficit.

Given the constraints on funding any new Federal Government programs, the Federal Government can start by working constructively with State and local agencies which are taking the lead in stimulating productivity, technology, and innovation. It can at least help us all to learn about the complex challenge we face from international competition.

We can all benefit from the initiatives of State and local governments if we share information about their successes and failures. The clearinghouse can bring us together with information, which can help to bring us together for action.

The center speaks of risk taking, partnerships, and long-term efforts. It is not a panacea. It does not overpromise. It does not underestimate the complexities of the challenge. It's a modest proposal but therein lies its virtue. It will help, it is constructive, it is pragmatic, and it is something we can come together to do now while we debate grander and more controversial proposals.

This bill is not printed here but will be forwarded to members and any interested parties upon request.●

By Mr. BUMPERS:

S. 931. A bill to amend the Internal Revenue Code of 1986 to provide preferential treatment for capital gains on small business stock held for more than 4 years, and for other purposes; to the Committee on Finance.

INCENTIVES FOR LONG-TERM INVESTMENTS IN AMERICA

● Mr. BUMPERS. Mr. President, I am introducing a bill to encourage investors to make long-term investments in growth-oriented small business ventures. By encouraging these investments, we encourage investments in the future prosperity and competitiveness of America. Indeed, without these investments, our Nation's economic strength is sure to decline.

The bill I am introducing would provide a modest tax incentive to encourage investors to provide long-term capital to growth-oriented, small businesses. This incentive is available to entrepreneurs who risk their own capital in establishing these business ventures, to outside investors who buy stock issued by the entrepreneur, and to employees who purchase stock in the company under incentive stock options or similar plans.

It is crucial to the prosperity of our capitalist economic system that entrepreneurs, investors, and employees take risks by founding, investing in, and working for startup small businesses. These startup ventures are the hope for both economic growth and competitiveness for our country. However, these ventures desperately need capital to grow and often are unable to attract capital because there are safer investment options available.

ECONOMIC IMPACT OF SMALL BUSINESS

The tax incentive I propose is targeted at startup ventures and other small businesses because we know that they have the greatest potential for creating jobs, for innovation in products and services, and for enabling the United States to remain competitive in international markets. Despite this fact, these businesses have the greatest difficulty in obtaining the capital needed to become larger businesses because so many of these ventures fail.

Employment growth in small business-dominated industries, at 5.1 percent, far outpaced that of large business-dominated industries, at 0.7 percent. "The State of Small Business," report of the President, 1986, at XIII. Small firms generated most of the net new jobs during the economic downturns from 1979 to 1983 and they continue to be the major employer of younger and older workers, women and veterans.

It is quite clear that the small firms which thrive on venture capital investments make a major contribution to the economic growth of the country. In one study of 72 firms in which venture capitalists had invested only $209 million during the 1970's, the firms had combined annual sales in 1979 of $6 billion and had created 130,000 jobs. "Government-Industry Cooperation Can Enhance the Venture Capital Process," General Accounting Office, August 1982, appendix II, page 9.

CAPITAL NEEDS OF SMALL BUSINESS

What these startup ventures and other small businesses need most is patient capital, capital which is invested for a substantial period of time while the firm grows, innovates, and penetrates or creates new markets. Unfortunately, small businesses have difficulty in obtaining sufficient capital because it is much less risky for investors to make short-term investments, to seek returns based on next quarter's profit-and-loss statement, or to rely on a steady stream of dividend income.

The reason why small businesses have difficulty in obtaining capital is that they may never generate any profits and dividends for the investor. A study of 10 venture capital funds through 1983 found that roughly 26 percent of the investments lost money and consumed 34 percent of the capital invested. Another 25 percent of the investments produced only a return of the original capital after many years of waiting for a return. Almost another 40 percent returned less than 5 times the original investment and only 5 percent returned more than 10 times the original investment. Unpublished study of Horsley, Keogh & Associates, cited in "Tax Policy Influence on Venture Capital," Burton J. McMurtrey, Technology Venture Investors, 1985.

EIJI MIYAZAWA / BLACK STAR

Workers from the United States (left and center) are trained at a compact disc factory in Kawasaki, Japan.

A National Interest in Global Markets

SUMMARY: This much has not changed: The Pentagon keeps a short leash on those who wish to export technology, and measures are being directed at keeping U.S. companies competitive with foreign firms. Yet advances in high technology are increasingly being made through cooperative international efforts. The United States is finding a major challenge in balancing two essential, oft-conflicting interests: selling U.S. products abroad while maintaining national security.

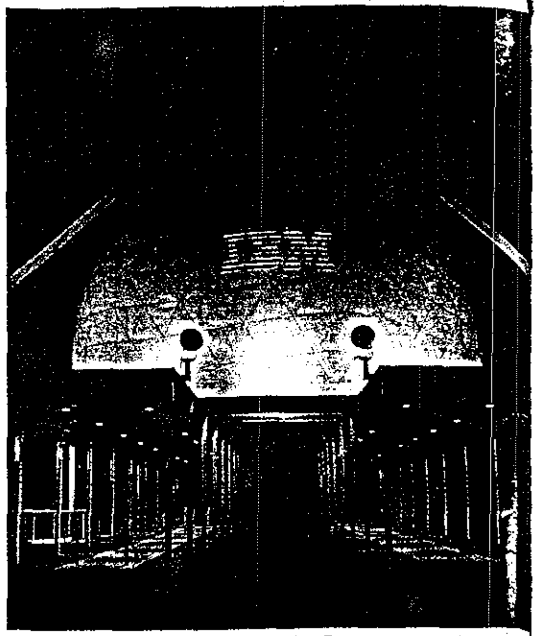
The first shot in the superconductor revolution was fired by two European scientists working for a U.S.-owned multinational firm in Switzerland. Sometime, somewhere, someone might sort out the tangled genealogy of that first discovery — and the dozens of breakthroughs all over the world that have followed it in the past few months. But right now it seems pointless. Americans, at the present moment — at Paul Chu's laboratories at the University of Houston, at Wayne State University in Detroit, at IBM's research facility near New York — hold sway in the superconductivity race.

But in a few months' time the pendulum might well swing toward Japan, where two special superconductor committees have already been set up by the government's Science and Technology Agency. Or perhaps it will swing to Western Europe, where scientists and engineers have been as consumed by the promise of superconductivity as their counterparts elsewhere.

There is little geographic logic to the pace of scientific discovery. New breakthroughs flow quickly and easily through national and political barriers, with endless and confusing permutations. The next frontier in superconductivity could be explored by a Japanese graduate student working for a U.S.-funded lab at a European university. This is a world only science can conjure, a world without borders.

When the new realities of superconductivity pass from research laboratories to private industry in the next few years, there is little doubt that the United States and Japan will lead the rest of the world in commercial exploitation. But separating the efforts of the two, and defining precisely what their leadership actually entails, may prove as difficult then as it is now. The U.S. chemical giant Du Pont Co. employs 180 scientists at a lab in Yokohama, Japan. International Business Machines Corp. has thousands of researchers at facilities in Tokyo and Yamato City. On the flip side, Japan has thousands of graduate students in U.S. universities, sponsors millions of dollars' worth of research at them and puts up still more millions in


SHAHN KERMANI / GAMMA - LIAISON



CHARLIE COLE / PICTURE GROUP

Products of borderless venture capital: First U.S.-made Toyota, under deal with General Motors; IBM Pavilion in Japan

venture capital for American high-tech companies.

New cross-licensing and joint venture agreements between Japanese and U.S. firms are reached at a dizzying pace. General Motors Corp. and Toyota Motor Corp. make cars together in California. Texas Instruments Inc. makes advanced microchips in Japan. U.S. electronics giant Motorola Inc. swapped secrets with Toshiba Corp. late last year.

"As more and more high-tech firms implement such strategic alliances," Lenny Siegel, editor of Global Electronics newsletter, says, "competition . . . will be less between the U.S. and Japan and more between transpacific corporate alliances, each containing one or more American and Japanese firms." What's the likeliest scenario for superconducting microchips? Try a mixture of Silicon Valley technology, Japanese manufacturing know-how and international venture capital.

Twenty and 30 years ago it was true that if a government made an investment in research and development, or in the country's scientific base, it could be reasonably sure of reaping the benefits itself. That is no longer true. But this does not mean that in today's global environment individual governments have given up on high-tech policies. In fact — and this is the paradox of the internationalization of science and technology — the demands of the new world economy have made the countries of the developed world pursue their national strategies more aggressively than ever before. Not all of these nationalist strategies will work. Some will simply be the product of reflexive protectionism or of nativistic fears. But there remain, even in a globalized economic environment, legitimate areas of individual government action. Finding those, and striking a balance between national interest and international competitiveness, may well be the principal political challenge of the 1990s.

Why has Tokyo stepped in to coordinate research and commercial activity surrounding the superconductor race? "We are working to assure that all this will not be just a fad," explained Mitsuig Chiba of Japan's Science and Technology Agency. "We want it to be a solid, feet-on-the-ground campaign." Officials in Washington publicly shy away from advocating so bold an exercise in government management. "We have a secret weapon that will overwhelm [the Japanese] process," said William Graham, head of the White House Office of Science and Technology Policy. "We call it the free market. It's far better to let industry make the investment decisions for profits and to let government devote its resources to the basic research and underpinnings."

But Graham's words belie a federal effort as pragmatic and interventionist, in many ways, as Japan's. The U.S. government has $29 million earmarked for superconductor research this year, with much of that going to federal labs and Defense Department offshoots — such as the Defense Advanced Research Projects Agency — which have always worked closely with private industry. In the air in Congress is talk of a special superagency to coordinate industry activity in certain high-tech areas and dole out research money. Frank Press, president of the National Academy of Sciences, expresses a common nationalistic sentiment: "Superconductivity has become the test case of whether the United States has a technological future. That future depends on our ability to commercialize our scientific discoveries. If we lose this battle, it will wound our national morale."

This idea of an affirmative national policy — what Harvard economist Robert Reich calls "technonationalism" — does not always sit easily with the realities of the modern world economy. Reich says that many of the measures suggested and implemented in the past year in behalf of U.S. "competitiveness" actually are unworkable or even absurd in the light of the worldwide diffusion of science and technology.

Suggestions have been made in Congress, for example, to increase federal research and development funding for various scientific and industrial endeavors on the condition that those resources be limited to U.S. engineers, scientists and companies. But what, in the age of the strategic alliance, is an American company? What if a U.S. citizen is working for a Japanese company? In 1984, roughly 2,000 scientists and engineers immigrated to the United States from the developed world. Some of them are in the States only on temporary visas; most are not yet U.S. citizens. Would they qualify?

It makes little sense to base public policy on technonationalism, Reich argues, when our institutions are organized on a global model. Nor is it in America's long-term interest to bar foreigners from the fruits of its research and development. Technology is not a "scarce commodity," Reich says. "Rather than guard our technological breakthroughs, we should learn how better to make use of breakthroughs wherever they occur around the globe."

He has a point, but the fact is that in many cases the United States has little choice but to follow technonationalistic policies. As William Schneider Jr., under secretary of state for security assistance, science and technology, has put it, trade policies "cannot be divorced from our broad political security objectives. . . . Our economic policies must support our key objectives of deterring Soviet adventurism, redressing the military balance between the

West and the Warsaw Pact and strengthening the Western Alliance."

The cost of the U.S. position as the military leader of the West has always been a need to sacrifice economic goals to strategic or national security considerations. Not surprisingly it is the Pentagon, not protectionist businessmen, that has been behind much of Reich's technonationalism. In January the Defense Science Board, a Pentagon task force, released a report titled "Defense Semiconductor Dependency," a worried look at the U.S. semiconductor industry. The task force saw the globalization of the electronics industry as a serious military problem, in that dependence on outside suppliers could threaten Pentagon access to leading-edge technology.

This was not so much of an issue in the early 1960s, for example, when the United States imported only about 5 percent of its gross national product and exported only about 9 percent. But in 1984 those figures were 30 percent and 25 percent respectively, and the Pentagon finds itself dealing with a world technology market increasingly beyond its control. Forty percent of the electronics in U.S. weapons systems comes from Japan, and by the early 1990s, according to some analysts, that figure will top 50 percent. "Ten years from now Japan will have a separate industrial base, one perfectly capable of carrying on without the United States," says Michael Borrus of the Roundtable on the International Economy, a research group at the University of California at Berkeley. "At that point reliance on Japanese technology may not be the best idea for the United States."

CHARLIE COLE / PICTURE GROUP

RICHARD HOWARD / BLACK STAR

Reich says United States should use breakthroughs "wherever they occur."

KEVIN T. GILBERT / INSIGHT

Graham: Benefits of a free market

The Pentagon does not want a global economy that puts U.S. interests at the mercy of its allies' trading policies. The Defense Science Board recommended that the Reagan administration put up $2 billion over five years to prop up certain key areas of the U.S. semiconductor industry. The Strategic Defense Initiative, in addition to its stated goals, also represents a multibillion-dollar attempt by the Defense Department to develop cutting-edge technologies in aerospace and electronics.

But building up a healthy domestic high-tech base is not the only concern of the Defense Department. The task force worried not just about promoting U.S. technology but also making sure such expertise stayed in the country. Why? Because the globalization of high technology makes it easier for the Soviets to obtain products and know-how. And when that happens, the report warned, "The U.S. could lose the considerable margin of advantage it holds over the U.S.S.R. in this critical area of technology — and upon which it relies to offset quantitative military advantages."

Restricting the flow of American expertise overseas, however, is not easy, and after 6½ difficult years the Reagan administration still has not struck a clear balance between national security and technology trade. Take the touchy issue of scientific freedom. Not long ago, the Defense Department seemed to know what it wanted. If scientists engaged in strategically important research or took Defense Department money, they would have to submit to department controls. In April 1985 the Society of Photo-Optical Instrumentation Engineers received word from the Pentagon that 43 of the 219 papers scheduled to be presented at a conference could not be given in open sessions. Three years before that the Defense Department ordered restrictions prompting the withdrawal of 100 papers from a similar conference in San Diego and intimated that more restrictions might be forthcoming. The actions caused a surge of outrage among scientists.

Today the issue has died down somewhat, with the Pentagon apparently respecting the desire of the scientific community that no controls be attached to either basic research or research conducted on a university campus. But the matter is far from settled. "DOD is pretty two-headed on this issue," says Stephen Gould, a project director of the Committee on Scientific Freedom and Responsibility at the American Association for the Advancement of Science in Washington. He points up the distinction in the Pentagon between those whose jobs are concerned with national security policy and those who are charged with advancing scientific and technological programs.

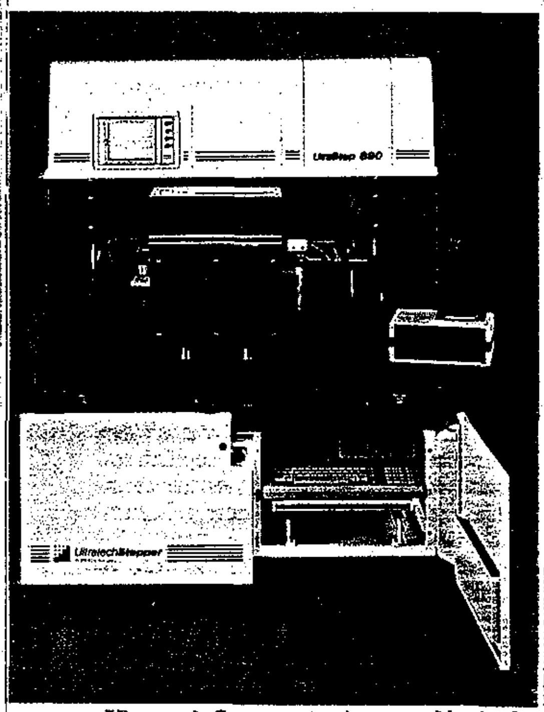
Insiders paint a picture of a Pentagon that talks tough on research controls but shies away from implementing regulations as aggressively as the language would allow. That may represent a victory for the scientists, but its impermanence leaves some of them nervous. And in the meantime the gap between rhetoric and reality has made it difficult for the Pentagon to articulate a position on what many scientists see as the next critical issue: whether, in the name of national security, it is even worth placing restrictions on applied research. One of the inventors of the atom bomb, Edward Teller, for example, has argued that all that is needed to keep U.S. science ahead of the Eastern bloc is to control the opportunity of Soviet scientists and engineers to work side by side with U.S. scientists. Any other method of technology transfer — scientific conferences, academic papers — Teller has said, is of little value to countries playing catch-up.

CHUCK NACKE / PICTURE GROUP / FOR INSIGHT

Perrone's company was stymied in sale of semiconductor technology to China.

More serious is the Reagan administration's attempt to control the export of what it deems militarily and strategically significant products and technology. Here the administrative framework is more convoluted. It revolves around two acts of Congress and has been disfigured by a turf war between the departments of Commerce and Defense. Also involved is a clumsy and largely ignored agreement among the major nations of the Western alliance to limit exports to the Eastern bloc.

The economic costs of restrictions are high. In 1985, according to the National Academy of Sciences, in the name of national security, these controls cost the most dynamic high-tech sectors of the U.S. economy some $9 billion in lost sales and 200,000 jobs. The administration wants to inhibit Soviet access to high technology, but there is a growing body of criticism that says the existing export control system in the United States just doesn't work.



ULTRATECH STEPPER

Ultratech Stepper equipment: No deal

"The whole theory of export control is based on a notion that's completely outdated," says Bill Maxwell, director of international issues for the Washington-based Computer and Business Equipment Manufacturers Association. Ten or 15 years ago, forbidding the export of American high tech meant that foreign countries did not get high tech. Today it means they buy it from someone else.

Export controls are supposed to be lifted if it can be proved that the technology in question is readily available elsewhere in the world. But that rarely happens. A blue-ribbon commission appointed by the National Academy of Sciences to study export controls concluded, in a report published earlier this year, that "foreign availability has had virtually no impact on the objective of achieving decontrol." In the past four years, 20 technology areas have been thought to be sufficiently global to be worthy of decontrol. Only three have been dropped from government lists.

This has had a substantial effect on a number of U.S. manufacturers. The Andover, Mass.-based GCA Corp., for example, used to be one of the world leaders in making the sophisticated equipment used in manufacturing semiconductors. But, says economist George Gilder, who is writing a book on the semiconductor industry, "Right at the moment that Nikon and Canon entered the market and Asia became the fastest-growing semiconductor area, GCA was prohibited from selling overseas for national security reasons." The result? The Japanese got a free pass to the world chip equipment market, while GCA was handcuffed. "It was a really unfortunate policy that had no defense justification whatsoever," says Gilder. "The whole thing has been incredibly badly conceived."

The critics of export control do not doubt the national security justification for the program; they just think that the controls are administered unwisely. "Technology moves very rapidly," says Lou Perrone, vice president of the California electronics firm Branson-IPC, "and it's difficult for a government the size and complexity of ours to keep up with it." Perrone's company made a deal to sell a few million dollars' worth of what it felt was obsolete equipment to the People's Republic of China in late 1984. The sale was blocked by the Reagan administration, and Perrone still does not know why.

"If China, or any Eastern bloc country for that matter, came to us for state-of-the-art equipment, I would say forget it. I wouldn't even bother to ask for an export license; I'm not stupid. But here was a logical case of some technology and some capability that had little fundamental use elsewhere in the world, except in parts of the Third World and developing countries." This spring, after more than two years of time-consuming and costly pleading in Washington, parts of the deal were approved.

Ultratech Stepper, another California firm, also made a deal to sell what it thought was obsolete equipment to China two years ago. In its eyes there was no reason to believe that an export license would be denied: U.S. firms had already sold comparable equipment to China; the Chinese could easily get more sophisticated equipment from Hong Kong; and when the Pentagon sent an expert to examine the proposed equipment for export, he agreed that it was obsolete. So why is Ultratech Stepper still waiting for a license? "It's not a technological issue anymore; it's a political issue," says Kay Mascoli, a company spokesman. She charges that the Defense Department did not understand the technological issues and let its national security concerns determine the result.

The experience of Ultratech and Branson-IPC is not typical. The average processing time of an export license in the United States is, according to the Pentagon, one to two months. What does seem to be typical, however, is the role played by the Pentagon in the decision making process. The Export Administration Act of 1979, which governs the export of com-

> "Why should we buy controlled American chips that come with all kinds of strings attached when we can buy uncontrolled Japanese chips?"

mercial and military technologies, is supposed to be administered by the Commerce Department. Defense is to act in an advisory capacity.

Richard N. Perle, who was the assistant secretary of defense responsible for the Pentagon's export control policy until he resigned this spring, denies that the Defense Department has encroached on Commerce's authority in this area. He points to a presidential directive, implemented by Defense Secretary Caspar W. Weinberger in 1984, that calls for defense-related technology to be treated as a "valuable limited national security resource, to be husbanded and invested in pursuit of national security objectives."

Jurisdictional issues aside, however, there is little doubt that the effect of Pentagon involvement is to make controls much stricter and the licensing process more complicated than would otherwise be the case. Commerce Secretary Malcolm Baldrige has consistently called for a 30 percent to 40 percent reduction in the number of items on the Pentagon's export control blacklist, which is currently about the size of the Los Angeles phone book. "The whole list needs an overhaul," Baldrige said in March. "It's very easy to add things to that list, but it's very hard to take them off."

The Pentagon's response at the time was firm. "Any loosening at this point would be extremely harmful to national security," explained Stephen D. Bryen, then Perle's deputy. Perle himself has said that the list's comprehensiveness is its strength, not its weakness. As he told Congress in 1984: "We have sought, and believe it makes sense to seek, the greatest possible precision. And precision is attained by having a list that is sometimes excruciating in its detail, because it enables people who have to make judgments on licenses to reference the precise commodity or technology in question. . . . The size of the list, which has frequently been the subject of criticism, is not the relevant measure of effectiveness."

Does the Pentagon really understand the rapidly changing face of American high technology? Boyd McKelvain, who is chairman of the export control blacklist advisory committee, likens the process of defining military criticality to the problem faced by "a Supreme Court justice in defining pornography: 'I can't define it, but I know it when I see it.' "

Commerce and Defense are agreed on basic principles. When former White House science adviser George A. Keyworth III complained that "the Soviets are robbing us blind" on high tech, he spoke for the entire administration. The argument is simply over procedure, and in many ways those problems are being addressed. President Reagan recently directed the National Security Council to study the entire export control system with an eye toward reform. Reform came up again in January's State of the Union address, and the current House omnibus trade bill contains a number of provisions that would liberalize the Export Administration Act. The Pentagon has tried to streamline the licensing process as well. During his tenure at Defense, Perle eliminated the backlog of applications that had piled up in 1981 and beefed up equipment and support staff.

There is no way around the fact that the heightened awareness of national security needs leaves U.S. high technology at a significant disadvantage, however, with respect to Europe and Japan.

Almost all Western nations are supposed to abide by the rules of the Coordinating Committee on Multilateral Export Controls, which governs exports to the Soviet bloc; but, perhaps unsurprisingly, levels of compliance vary widely. The United States takes longer to process licenses, requires more red tape and checks up far more closely than any other major industrialized country.

Says Daryl Hatano, an official at the Semiconductor Industry Association, "Companies are saying, 'Why should we buy controlled American chips that come with all kinds of strings attached, about how they can be used or where the end product can be sold, when we can buy uncontrolled Japanese chips?' ". Of the U.S. firms surveyed by the National Academy of Sciences panel, 52 percent reported lost sales because of export controls, 26 percent said they had had deals turned down because of them and 38 percent said existing customers had actually expressed a preference for shifting to non-U.S. sources to avoid controls.

Controls have not been the only sticky wicket in government-industry relations. The government directly funds some 775 research laboratories across the country, employing some 80,000 people (about one-sixth of the nation's scientists and engineers) and gobbling up about half of the annual $123 billion that goes to pure and applied research nationwide. These are the labs that do research on the Strategic Defense Initiative, missile systems, nuclear energy, synthetic fuels or the space program. They lay the scientific groundwork for much of the U.S. public sector's use of advanced technology. But the work they do — publicly funded, much of it unclassified and easily accessible — does almost nothing for the country's broader economic competitiveness. Since the 1950s, only 5

GLEN STUBBE / INSIGHT

Pentagon's Perle kept firm grip on exports, despite objections from Commerce.

Says one observer, "The notion that what government labs do is just all-out wonderful stuff for industry to commercialize on is a pipe dream."

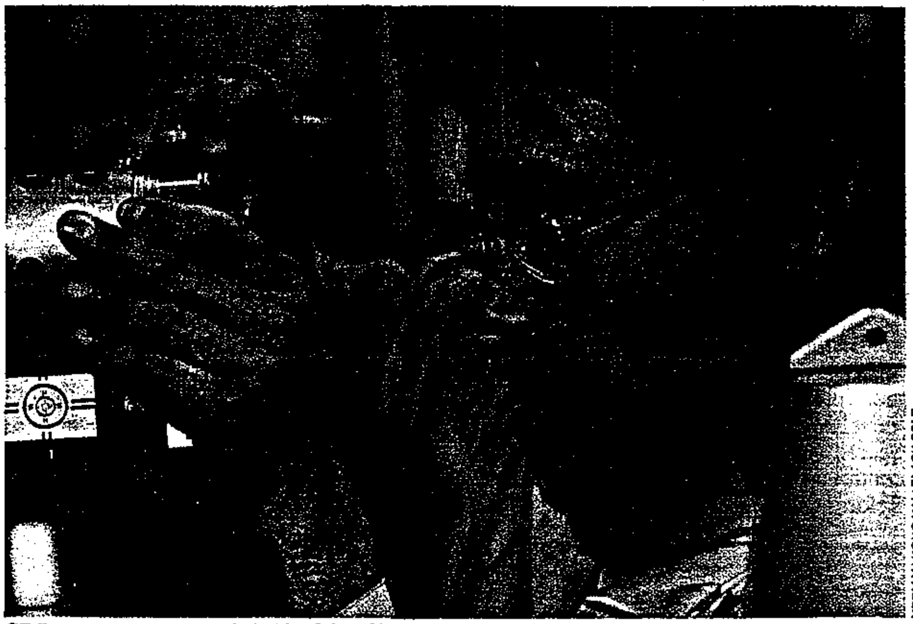
percent of the government's 28,000 patented inventions have been licensed for commercial use.

In recent years, in Congress and the executive branch, this underutilization of federal technology has been ascribed to a lack of coordination between private industry and public labs. In 1980, Congress passed the Stevenson-Wydler Technology Act, which requires the government's larger labs to set up special offices to promote technology transfer. Last year, Congress beefed up the act, making special allowances for cooperative research and development efforts between government and private industry, strengthening individual labs' technology transfer offices, formalizing the creation of a federal laboratory transfer consortium and, most critical, providing government inventors with incentives — including royalties and patent rights, which are unheard-of in most corporate laboratories — to make commercial use of their research.

The key word in the new technology transfer vocabulary is communication. Officials at federal labs around the country speak of the importance of networking. Argonne National Laboratory in Illinois uses an electronic mail system to relay information and assistance around the country. Critics of practices from the old days have cited the fact that only the United States among the world's leading industrial nations has no centralized government office to coordinate public sector research with private sector needs. Their views struck a nerve: The past six years have seen the creation and refurbishment of, among other organizations, the Commerce Department's Center for the Utilization of Federal Technology; the National Industrial Technology Board; the private Technology Transfer Society; and two directories, the Guide to Federal Technology Resources and the Directory of Federal Technology Transfer Personnel; not to mention technology transfer operations sponsored by the National Bureau of Standards.

At congressional hearings on technology transfer, the air was thick with definitions, explanations, caveats and analogies, all in the new language of competitiveness. A.T. Brix, president of Battelle Technology International Exchange, warned Congress: "Technology isn't like Campbell's soup. It doesn't come in a nice container, properly bar-coded for easy pricing. It cannot be rendered delicious by merely adding two cans of water and simmering it on the stove." What is it then? "Technology transfer can be more realistically likened to going into a supermarket and finding ingredients for soup interspersed with detergents, bakery goods and pots and pans. In short, here are some herbs, potatoes and onions; now make your own soup."

That culinary challenge is intended primarily for U.S. companies. Indeed, the 1986 law makes it clear that, whenever possible, domestic industry should be given preference in licensing agreements. But, one Senate staffer concedes, there is no way to guarantee that Yankee know-how will go to Yankee companies, and the fact is that the Japanese and West Germans have historically been far more interested in the fruits of U.S. government research than have U.S. companies. "There's nothing illegal in what they're doing," the staffer says. "They're just more aggressive. They appreciate the values of tapping into these resources. What we're doing as a Congress is taking a gamble that by trying to speed up the transfer of technology we'll benefit this country. Whether this will work remains to be seen."



HERMAN KOKOJAN / BLACK STAR

SDI research: A good deal of funding but few commercially exploited patents

A more serious question, however, is whether improved networking and communications is actually the answer to the technology transfer at all. "The notion that what government labs do is just all-out wonderful stuff for industry to commercialize on is a pipe dream," says Richard Nelson, a professor of international political economy at Columbia University. "A lot of folks in Congress have misconceptions about the way technical change proceeds." Commercial labs and federal labs, the argument goes, do different kinds of research for very good reasons: because commercial labs have tested similar waters and found them wanting, or because government research priorities — especially those having to do with defense — are so specialized as to have little commercial use at all. One of the pioneers of Silicon Valley, Robert Noyce, founder and now vice chairman of Intel Corp., has put it bluntly: "There is no work of interest to commercial industry going on in government laboratories."

If he is right, then the enormous resources devoted to federal research — important as that research is, and however much it contributes to the welfare and security of the country — nevertheless represent a net drain on the economy's productive capacity. The efforts of the recent technology transfer brigade to bring considerations of the national interest into step with the demands of the world economy may, ultimately, prove fruitless. The same is true for export controls. It may be possible to ease the economic burden that restricting Soviet access to Western technology places on American high technology, but as long as U.S. foreign policy objectives coexist with economic considerations, there must be some sacrifice. What is good for General Motors is not always what is good for America. That is truer now than it has ever been. The challenge of the modern world economy is to strike the proper balance.

— *Malcolm Gladwell*

The British Elite in Exodus: 'We're Losing Our Captains'

SUMMARY: Brain drain, the loss of a nation's elite, is usually a problem for developing countries. But in Britain, it is epidemic. Scientists there face relative salary declines, harsh budget cuts and a government that has been ill-disposed to university research. Public funding is rising finally, and scientific special interest and support groups are springing up. But Britain's brain drain is not likely to end.

Some of the best minds in the world come from Britain, and the better they are the faster they come. Over the past few years, the cream of the nation's academia, thousands of its top scientists and engineers, have left to take high-paying jobs in the United States. Twenty-five percent of the fellows of the Royal Society, the United Kingdom's most prestigious scientific organization, work abroad. All of the Royal Society of Chemistry medals for research last year went to British scientists working in America. "We're losing the top four or five in every field," says one professor at Oxford University. "We're losing our captains."

This is far from the first time brain drain has become an international issue. From the time of the biblical exodus to the group of Jewish scientists and intellectuals (including Albert Einstein, Sigmund Freud and a young Henry A. Kissinger) who fled Nazi Germany in the 1930s, the talented have always been the first to migrate in search of better opportunities. But since the end of World War II, brain drain has primarily been an issue between the developed and the developing worlds, wherever the differences of economic climate and personal opportunity have been greatest. In the industrialized world, the pressure to compete internationally and the push toward high technology have made countries more aware than ever of the importance of keeping the best and the brightest at home. Brain drain, in the West, is a nonissue.

Except in Britain.

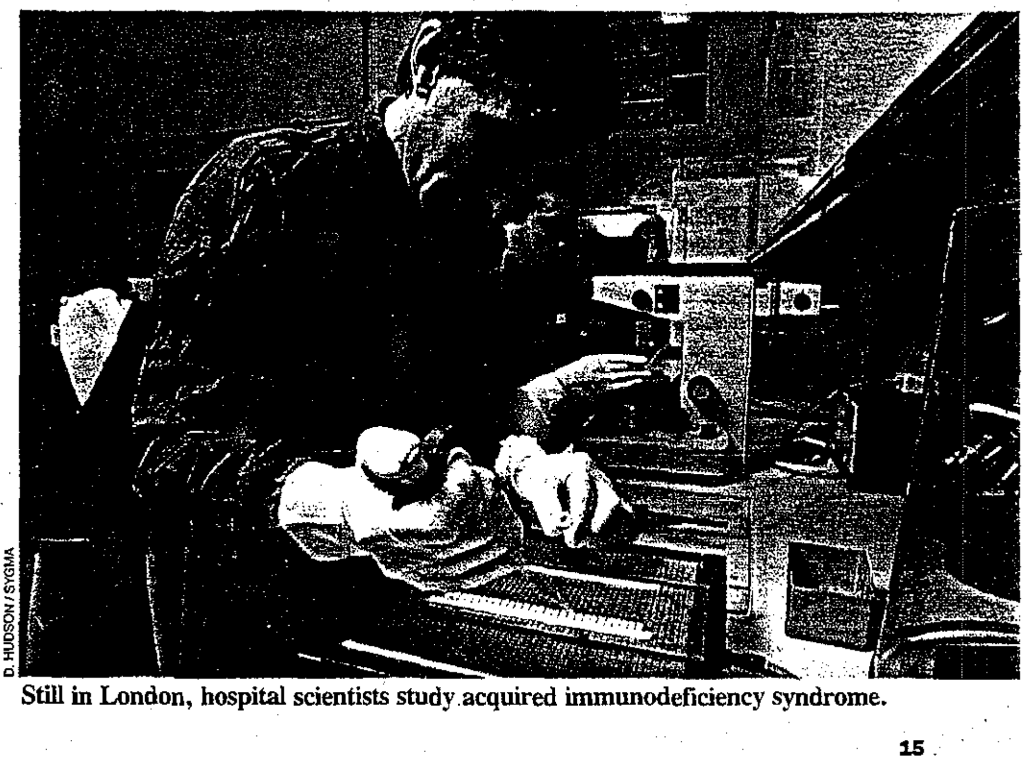
More scientists leave the United Kingdom every year than leave the rest of Europe combined, and the brain drain has never been worse. The golden age of British science, between 1950 and 1975, when the Nobel Prizes won for England were legion, is but a memory. In comparison to the rest of the world — from the United States, where fostering high-tech research and promoting competitiveness is all the rage; to West Germany, which spends nearly twice as much per capita on civil research and development as Britain; to France, which coddles its scientific community — Great Britain has been markedly less concerned about the fate of its intellectual resources. In the long term, that may mean trouble for the country in an increasingly competitive and technologically dependent world economy.

In 1981, the Conservative government of Prime Minister Margaret Thatcher cut back government funding for university research. "I think that that first round actually did us some good," says Dick Bishop, president of Brunel University in London. "It made us think more seriously about the research that we were doing. But we thought things would level off by 1984, and they didn't. It's been a slow squeeze. The cuts have begun to hurt."

The percentage of gross national income that Britain spends on research and development has remained virtually unchanged over the past 25 years, even as technological needs have intensified and the cost of research has skyrocketed. Last year the government's Science and Engineering Council, which doles out research money, closed up shop for six months because it ran out of funds. The horror stories of what budget cuts have done to British universities are legion: libraries that cannot afford scientific journals, laboratories that cannot afford to hire technicians. The University of Southampton is so strapped for cash it cannot afford to buy a Macintosh computer for the dean of its mathematics department. Right now he is ninth on the school's waiting list.

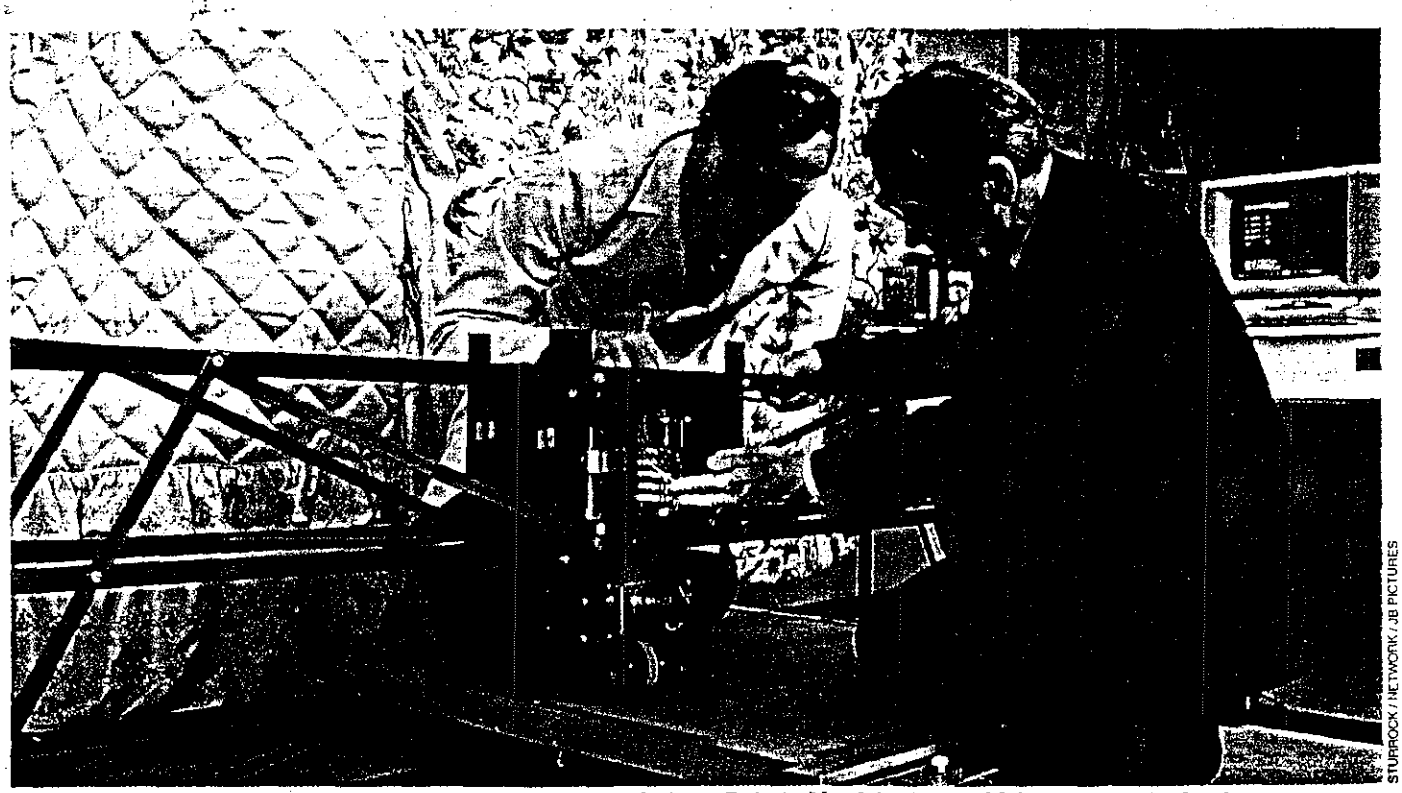
Faced with these frustrations, and salaries that have fallen 12 percent relative to average income since 1980, some of Britain's best are simply going elsewhere. "I don't think I've ever seen the morale of British science so low," says Professor John Ziman, chairman of the recently created Science Policy Support Group.

Those scientists who do not leave face a research climate of increasing uncertainty. Oxford Professor Denis Noble, who heads Save British Science, a recently formed lobby of distinguished scientists and Royal Society fellows, says that what



D. HUDSON / SYGMA

Still in London, hospital scientists study acquired immunodeficiency syndrome.



Cambridge University researchers and their robot may help keep Britain No. 2 in the world for patentable developments.

he calls internal brain drain is as bad as the external kind. He compared U.S. and British grant requests and found that, as a rule, researchers in the United States receive three times as much money from their science council as their British counterparts. "Those that stay have their own intellectual resources drained by a continual process of keeping their research going. In the U.S. the top people are far better-off. It's inconceivable that the equivalent of a Royal Society fellow would find himself in the position of scrambling for money. Yet that's the case in England."

Much first-class work is still being done. The Royal Society recently compared Britain's performance in basic scientific research with that of the rest of the world and found that while the country had slipped from second to fourth in theoretical and experimental physics over the past 10 years, it still led everyone outside the United States in biomedical research and genetics. And the Thatcher government has not been been deaf to the pleas of the scientific community. In February the government agreed to raise academic salaries 24 percent over the next few years. Also, as part of the Tories' preelection promise to raise public spending 1.5 percent this year, the Department of Education and Science is slated to get a 7 percent budget increase and universities an additional $80 million.

But some wonder if these measures will actually solve Britain's problems. The salary increases still leave the nation's universities at a substantial disadvantage when it comes to competing with the $70,000 to $100,000 positions often offered by U.S. schools, and Save British Science estimates that nothing short of a flat-out $180 million research increase will ensure that all worthy projects are adequately funded. Indeed, even if the government has loosened the purse strings somewhat, it continues to defend the original premise behind the spending freeze of the last six years.

Thatcher still says that much of university research is wasteful, supporting what one of her ministers calls scientific "white elephants." The government has long argued that scientific prowess is not necessarily related to economic success. In recent hearings in the House of Lords, Treasury officials cited the fact that Britain's postwar scientific brilliance coincided with the period of the country's greatest economic decline.

By the same token, with science in apparent decline, the economic outlook now is rosier than it has been in years. Economic growth is expected to reach 3 percent this year, higher than most industrialized nations. London's financial markets are the most important in Europe, drawing banks and investors from around the world. After the lean early years of Thatcher's economic program — which saw unemployment triple to 3 million and whole sectors of manufacturing, particularly traditional smokestack industries of northern England and Scotland, collapse — Britain has made impressive strides in developing new, internationally competitive high-tech industries. California has Silicon Valley; England has a silicon crown around London.

Does Britain really need a strong, publicly funded research base? And even if it does, does it matter that that base is moving overseas? "People who migrate from a country don't necessarily disappear from view," points out Jagdish Bhagwati, a trade economist and brain drain expert at the World Bank. "That was the tendency in early brain drain literature. Today we tend to look at a diaspora model. People keep their ethnicity. Communication and return to the home country is much easier now. Smart developing countries also have been facilitating increased participation in their own scientific work of people who have settled abroad." Losing scientists does not necessarily mean losing the fruits of their work.

Even so, commercial high tech in the developed world, and particularly in the United States, historically has tended to grow in clusters around such prominent universities as Stanford in California and the Massachusetts Institute of Technology and Harvard in Cambridge. The proximity of scientists and businesspeople seems to count for something in the chemistry of entrepreneurship. Nor does it follow from the apparent lack of correlation between British scientific achievement and economic success that science should be cut back. "It's a non sequitur," says Ziman. According to the National Science Foundation in Washington, British science trails only the United States in developing patentable technologies. British science isn't wasteful; it's wasted by a commercial industry that, as George Walden, minister responsible for science, readily admits, "is at the top of the league in pay raises and bottom in research."

So why use science as a scapegoat? "I think that our Treasury doesn't have any great sympathy for or understanding of science," says Ziman. "It's part of the two cultures in this country. There are no scientists in the Treasury."

"A top-ranking researcher might enthuse another 30. If you lose people like that you lose the stimulus that others get from interacting with him."

His theme is echoed by other academics, who insist that science has never been properly respected or represented in the United Kingdom. Noble recruited 2,000 prominent British academics for Save British Science because, he says, "there came a point when people began to wonder that what was wrong was that we didn't have what people in America have: a political lobby capable of putting political pressure on the government." The House of Commons has nothing like the U.S. Office of Technology Assessment to keep it abreast of developments in science nor even a standing committee dealing with science and technology. Scientists are conspicuous only by their absence on corporate boards and in positions of political responsibility.

To some extent this is the fault of scientists themselves.

"Bound up in their own self-congratulatory elitism and academic self-importance," says Ros Herman, a prominent British science writer, "scientists have largely lost touch with the rest of society." A recent Royal Society report worrying about the image of science in Britain prompted the formation of an ad hoc Committee on the Public Understanding of Science, drawing from all of Britain's major scientific organizations. Planned are a $750,000 investigation into the way science and technology are perceived by the public and a massive "scientific literacy" campaign in the media next year. Will it work? Nature, Britain's most influential scientific magazine, does not think so. The journal described the report's analysis as "overflattering to the scientific community everywhere" because it refused to address "the convention of self-certitude that has been taken up by academics."

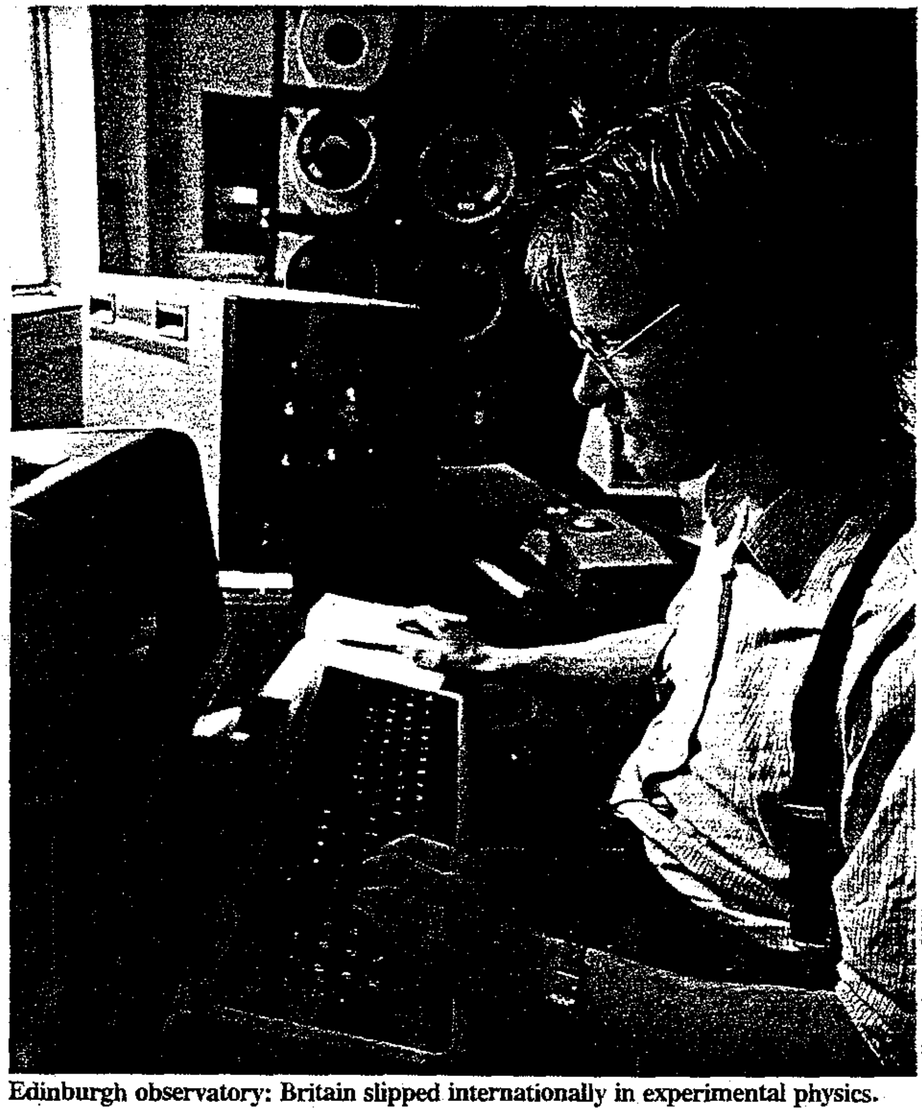
Ultimately, though, the ball is in the government's court, and more support is now its stated goal. For example, Thatcher has said that she would like to see the portion of university research supported by industry rise from its present 2 percent to somewhere in the vicinity of 30 percent. But policies may be lagging behind proclamations. Corporate donations to universities are not tax deductible. Nor has the prime minister changed the tax code to encourage increased commercial research: There are no tax credits for industrial research and development, which most of the country's competitors allow. Even on the critical question of encouraging companies to exploit new technologies, Thatcher's policy has been indifferent. Technology transfer may be a big issue in the United States, but in the United Kingdom the Technology Exchange Center just went bankrupt.

Brain drain is the price that Britain is paying for this. One thousand of its finest leave every year, and although that figure is small compared with the 50,000-odd new scientists and engineers who join the work force in that time, it is the quality of those leaving that counts. "A top-ranking researcher might enthuse another 30," says one professor. "And they in turn might enthuse a few hundred of their students. If you lose people like that you lose the stimulus that others get from interacting with him."

"We are moving from economies that basically deal with materials — iron, steel, coal — to economies driven by information," says Carver A. Mead, one of the prime movers behind the modern microchip. For the U.S. scientist, the intellectual component in any product is increasingly becoming more important than the actual manufacturing process or materials involved. Brains count for more in the high-tech age. Last year Texas Instruments Inc. renegotiated all its patent agreements with Japanese electronics manufacturers, raising the cost of licenses by millions of dollars. "More important than the immediate financial impact of these settlements," company President Jerry R. Junkins said at the time, "may be the general recognition by our industry that intellectual property has considerably greater value than has been recognized in the past."

If he is right, that may mean trouble for Great Britain. "Somehow," says Brunel's Bishop, "the excitement seems to be gone from British science."

— Malcolm Gladwell in London



RICHARD KOZAK / INSIGHT

Edinburgh observatory: Britain slipped internationally in experimental physics.

Williams
– Allen

Japanese Launch Bid to Lead the World in Pure Science

But Skeptics Say They Are Too Wedded to Product-Oriented Research

By Stephen Kreider Yoder
Staff Reporter of The Wall Street Journal

KYOTO, Japan – Yoko Naya has it good running a laboratory for Japan's biggest whiskey distiller. Her 20 young researchers, several of them foreigners, enjoy a fat budget and the latest lab equipment in a spotless building nestled in a bamboo grove.

They never have to touch a drop of liquor. "Application isn't our work," Ms. Naya says.

Instead, they do research on such topics as why certain fish are attracted to each other, on how barley roots extract iron from soil and on insects' sex lives. At the Suntory Institute for Bioorganic Research, Ms. Naya says the projects "aren't something that will pay off commercially."

A CHANGING JAPAN

PART OF A SERIES

The Suntory Ltd. lab represents the new gospel of creativity in corporate Japan. Japan feels it has caught up in applied research – where researchers have a commercial product or process in mind – and desperately wants to take a lead in pure science. Dozens of companies, from electronics giants to steelmakers to food companies, are staking millions of dollars to set up basic-research labs. The government, too, has pitched in with showy programs to encourage basic research.

'Seeding' Future Industries

The call to science stems not from curiosity about nature but from a deep and growing fear that Japanese industry will run out of steam without its own scientific "seeds" to feed future industries. Genya Chiba, a manager at the government's Research Development Corp. of Japan, says Japanese companies have mastered research aimed at creating commercial products and now "discover they are at the end of the road."

Government and industry leaders voice growing anxiety over where the ideas for Japan's next bonanza industries will come from. Not only is the West refusing to give away its best technologies as freely as before, they say, there are fewer of those technologies to draw from.

"America has been our pacemaker," says Hisatoshi Goshima, an executive manager at Nippon Telegraph & Telephone Corp., or NTT, Japan's largest company. "That pacemaker is harder and harder to see."

The solution: "If we train more researchers and inject more money, we will decisively leapfrog into a top world position," says Prime Minister Yasuhiro Nakasone in his party newspaper. At the Venice summit next week, Mr. Nakasone will plug a multibillion-dollar Japanese biotechnology-research program.

Grave Doubts Remain

But while prophets trumpet a new age of creativity in which Japan becomes the world's supplier of basic science, grave doubts remain that Japan can make the leap. The boom is a passing fad, skeptics say, doomed by risk-shy managers and economic factors such as the strong yen. And much basic research in Japan is stifled by a calcified bureaucracy, poorly equipped universities and a conservative education system that hampers free-thinkers.

"There is still a major gap in the mentality between our researchers" and those in the West, says Hisashi Shinto, president of NTT. The Japanese "move on others' findings so that they won't make mistakes. They've fallen into a trap."

Research managers like Eiichi Maruyama want to change that. Mr. Maruyama oversees Hitachi Ltd.'s Advanced Research Laboratory, opened in 1985 in a wooded oasis outside Tokyo.

In a room full of tubes and beakers, a geneticist pores over thousands of tiny plants in glass vials. Down the hall, a researcher is developing a computer model of human thinking, a task he expects will take decades. Soon they and 80 others will move to a new seven billion-yen ($50 million) lab in a quiet suburb far from Hitachi headquarters. The lab doesn't take orders from product planners; researchers choose their own themes. "We want to value the individual researcher's personality to let him be creative," says Mr. Maruyama.

Until now, Japan dismissed basic research as too risky and too expensive. For every promising scientific discovery, thousands more don't make it out of the lab. But Western industrialists say Japan has come too far on borrowed science. "Japan isn't performing its fair share of the basic, scientific research which adds to the world's store of knowledge," says William C. Norris, chairman-emeritus of Control Data Corp.

Research Risks

Hitachi's Mr. Maruyama agrees. "Now we're rich, and we have to take the responsibility of being rich," he says. "That means not simply making products but contributing to science. We have to take on the risks of investing in research that has uncertain results."

That mood has been growing since the early 1980s, when creativity became a catchword among Japanese opinion leaders. NEC Corp. has set up a basic-research lab where newly hired scientists study, among other things, the nervous system of microscopic worms. Toshiba Corp. plans to boost basic-research spending to 20% of its research budget within five years, up from 10% now and nearly zero in 1983.

Kobe Steel Ltd. has a new biotechnology lab. Toyota Motor Corp. does biomedical studies at its research subsidiary. Ajinomoto Co., a food-products company, opened a basic research lab in February. By one estimate, more than 30 major companies have set up basic-research labs in the past five years.

A recent survey indicates that corporate research expenditures in the life sciences jumped 16% to 429 billion yen ($3.05 billion) in 1985, the largest rise in the survey's history. And manufacturers are starting to woo more theorists. One-fourth of the doctoral-degree graduates in theoretical physics at the University of Tokyo between 1981 and 1985 took posts in corporate labs. "In 1970, no one would touch them," says Steve Yamamoto, a physics professor at the university.

Government bureaucrats have eagerly joined the fray. The Ministry of International Trade and Industry, or MITI, started promoting basic research in 1984. The education ministry boasts a new high-energy particle accelerator. The science agency gives $10 million grants to senior researchers.

Nakasone's Pet Project

Then there is Mr. Nakasone's pet project, the Human Frontiers Science Program. The plan is to bring together the world's scientists to unlock the secrets of biology – to determine how organisms convert energy into motion, for example, or the mechanisms behind such mental functions as creativity, memory and recognition. MITI officials have spent the past year garnering international support for the program, which, by an early MITI estimate, will cost one trillion yen over 20 years.

Japan is indebted to the West, says Mr. Nakasone. "We now need to repay the favor."

But Japanese companies still must tap the West for research talent. Some, like Ohtsuka Pharmaceutical Co., have opened research institutes in the U.S. Others give huge grants to U.S. universities to tap into their research.

Still others import Western-educated scientists. A law passed last year lets government labs hire foreigners. Hitachi plans to hire foreign scientists for 20% of the 250 posts its lab will have by 1990.

When Suntory's managing director, Teruhisa Noguchi, shifted the Suntory bioorganic lab from liquor-related research in 1979, he hired as the lab's manager Koji Nakanishi, a professor at New York's Columbia University. Eight foreign researchers now work there. To staff a new biomedical lab next door, Mr. Noguchi pulled 10 researchers from overseas labs.

Japan Moves to Hasten Public-Works Spending

A Wall Street Journal News Roundup

The Japanese government, as part of its effort to spur economic growth, decided at a cabinet meeting yesterday to initiate in the fiscal first half 80.1% of the public-works budget for the year that began April 1.

Yesterday's decision, which had been expected, followed last Friday's approval by the government of a package of spending, largely for public works, and tax cuts totaling six trillion yen ($42 billion).

The yen's strength has made Japanese products more expensive on overseas markets, hurting the country's export-driven economy. Japan also has been under pressure from its trading partners, particularly the U.S., to stimulate its economy in order to encourage the purchase of imports and narrow its trade surplus.

Japan's trading partners also have been pushing for greater access to the country's markets. Yesterday, British Chancellor of the Exchequer Nigel Lawson said "satisfactory progress has been made" in talks with Japan on trade in financial services.

Mr. Lawson said a review of the talks in Japan shortly "is likely to lead to the outcome we wish," namely, that three British investment banks will gain membership on the Tokyo Stock Exchange. Formal notice of the decision to admit those firms is expected by the end of the year, and the firms should become members when the exchange expands in 1988.

Officials of the major industrialized nations will meet at an economic summit that begins Monday.

WSJ
6/3/87

APR 8 1987

The Status of the Space Station Under the Technology Transfer Act of 1986

Concern has been expressed about the ownership and transfer of technology that may be created during the use of the Space Station. In particular, there is a need to find ways to encourage businesses in the United States to commercialize the technology created during the operation of the Space Station. This commercialization would benefit not only individual firms but the global competitiveness of the U.S. economy.

Treatment of the Space Station as a government-operated federal laboratory would make available a mechanism to resolve issues of ownership of technology created during research aboard that vehicle. This mechanism would be available if the Space Station were construed as a federal laboratory within the meaning of section 11 of the Technology Transfer Act of 1986, (P.L. 99-502), (the "Act"). This Act provides rules under which government-operated federal laboratories, as distinguished from contractor-operated laboratories, may enter into cooperative arrangements with other parties, including state and local governments, foundations, universities and other nonprofit organizations and private firms. Under these agreements employees of the laboratory and employees of the other party may work together, with ownership in any resulting inventions being distributed according to a pre-existing agreement between the parties.

This paper consists of two parts. The first part examines whether the Space Station might be treated as a federal laboratory for purposes of section 11 of the Act. The second part discusses in detail the advantages that recognition as a federal laboratory might offer to the operation of the Space Station.

Would the Space Station be a Federal Laboratory Under the Act?

Section 11(d)(2) of the Act defines a government-operated federal laboratory as "a facility or group of facilities owned, leased, or otherwise used by a federal agency, a substantial purpose of which is the performance of research, development, or engineering by employees of the federal government". The legislative history of the Act notes that "this is a broad definition which is intended to include the widest possible range of research institutions operated by the federal government". (Senate Report No. 99-283.) The Space Station under current plans will almost certainly meet this definition and qualify under section 11 of the Act as a federal laboratory.

The first criteria is that the Space Station must be "owned, leased, or otherwise used by a federal agency"; that is, as described in the Act's legislative history, the facility must be "operated" by the federal government. In the case of the Space Station, the National Aeronautics and Space Administration (NASA), under current plans, will have borne a major share of the costs of the development and construction of the facility, and will have the primary responsibility for operating the facility once it is successfully placed in earth orbit. Further, NASA will have the responsibility for providing transportation to and from the Space Station. NASA and other federal agencies will not only be operating Space Station, however, they will be making use of it both directly and through agreements with private firms and other governments. Thus, the first criteria under the present concept of the Space Station will be met.

The second criteria, that the Space Station must have the substantial purpose of "the performance of research, development, or engineering by employees of the Federal Government", is also met. The exact nature of the activities that will occur aboard the Space Station cannot be predicted at this time, but "research, development, or engineering" by federal employees will almost certainly be a major part of those activities. Other activities may occur on the vehicle, such as the conduct of research by employees of private businesses or foreign governments, or limited manufacture of products. As long as research, development, or engineering by government employees remains a substantial purpose of the Space Station, however, the authorities found in section 11 of the Act would remain available to the Space Station, as a government-operated federal laboratory.

However, if the Space Station is placed under international control, it will not be a federal laboratory. In such an instance, we would have to assure that any patent rights clauses in any international agreement would provide maximum rights of commercialization to U.S. industry.

Authorities Available to the Space Station Under the Act

Assuming that the Space Station were deemed a federal laboratory under the Act, the path would be opened for the transfer of technology created aboard the vehicle to U.S. firms. These firms would have the opportunity to commercialize these inventions, thus benefitting the individual U.S. companies, and indeed the competitiveness of the entire U.S. economy in the global market place.

Inventions by Government Employees Absent a Cooperative Agreement

Inventions created aboard the Space Station might be either the product of federal employees working alone, or the product of federal employees working together with scientists employed by a collaborating organization, such as employees of businesses, universities, state and local governments, or even of foreign businesses. If the invention were the product solely of federal employees who are not working under a cooperative agreement with a non-federal organization, the U.S. government would own any resulting patents, and would be free to license those patents on an exclusive basis to U.S. firms. In such a situation, section 13 of the Act provides that royalties earned by the invention would be retained by the federal agency whose laboratory made the invention. After payment of 15 percent of those royalties to the inventors, NASA could give the balance of the royalties to the Space Station, but must under any circumstances give it more than half with the remainder divided among other NASA laboratories. That is, the Space Station would receive at least the majority share of any royalties earned from inventions made solely by federal employees while aboard the Space Station. At the same time, the technology would have been transferred through the licensing process to a U.S. firm that would enjoy the benefits of its commercialization of the product.

Inventions Made by a Government Employee Under a Cooperative Agreement

Inventions made aboard the Space Station might also be the product of a collaborative effort between federal employees and employees of other organizations, entered into under cooperative research and development agreements under the Act. The official designated as "laboratory director" for the Space Station will be authorized under section 11(a)(1) of the Act to enter into agreements for the conduct of cooperative research and development aboard the Space Station with state and local governments, foreign and domestic businesses, public and private foundations, nonprofit organizations including universities, and other persons. As part of these agreements, under section 11(b)(1) of the Act, the Space Station would be permitted to accept funds, personnel, services, and property from collaborating parties, and in turn, to provide personnel, services, facilities, equipment or property, but not funds, to the collaborating parties. Further, under section 11(b)(2) and (3) of the Act, the director would be permitted to grant in advance to a collaborating party patent licenses or ownership to any resulting inventions made in whole or part by a federal employee under the agreement. Under these licenses, royalties would be paid to NASA by the collaborator in accord with section 13 of the Act. As explained above, the majority share or more of the royalties would thus return to the Space Station, where the funds could be used to pay for further research. The U.S. government, however, would retain a non-exclusive license to any inventions for its own use. This would provide the collaborating U.S. organizations the exclusivity needed to commercialize the invention.

In sum, in the context of the Space Station, a wide range of possible cooperative research activities might occur involving federal employees and employees of other organizations. For example, cooperative agreements might cover research aboard the Space Station between federal employees and employees of a U.S. corporation, university or other domestic organization, or research conducted only by employees of a domestic organization, where the facilities and/or equipment were provided by the U.S. government. By entering into a cooperative agreement under the Act, the U.S. government could assure that any resulting technology would be licensed or owned by a U.S. corporation. The U. S. government could agree to grant a royalty-bearing license, or ownership, for any inventions made by a federal employee under section 11(b)(2) or (3). This would permit the U.S. organization to take commercial advantage of any patents resulting from inventions made in the course of the research aboard the Space Station. In this way, the benefits of the research would go to the U.S. economy. At the same time, the Space Station would be the recipient of royalties earned by the licenses pursuant to section 13 of the Act.

The Act provides special rules for those circumstances in which a federal laboratory might agree to a cooperative research and and development venture with a foreign firm or firms, where employees of those firms would conduct joint research with federal employees aboard the Space Station. The Act, in section 11(c)(4)(B), permits cooperative agreements with foreign firms, but requires that the laboratories "give preference to business units located in the United States which agree that products embodying inventions made under the cooperative research and development agreement... will be manufactured in the United States". Further, the Act requires that the laboratory director, before entering into an agreement "in the case of any industrial organization or other person subject to the control of a foreign company or government, as appropriate, take into consideration whether or not such foreign government permits United States agencies, organizations, or other persons to enter into cooperative research and development agreements and licensing agreements". Should the Space Station decide to enter into cooperative research agreements with a foreign corporation it should assure that any patent rights clause in the agreement provide maximum rights of commercialization to U.S. firms.

Technical Data

For your information the latest draft of the proposed Executive Order on technology transfer requires agencies to delegate to its Federal laboratories the right to negotiate in cooperative agreements the disposition of intellectual property. As intellectual property includes technical data, the Space Station as a Federal laboratory could enter into a cooperative agreement leaving ownership or an exclusive license to technical data with a non-Federal entity.

Conclusions

(a) As Currently envisioned, the Space Station could be a Federal Laboratory for purposes of the Technology Transfer Act of 1986, as it falls within the "laboratory" cirteria of the Act.

(b) As a Federal laboratory, the Space Station could retain a significant portion of royalties generated by inventions made by federal employees either under a cooperative agreement with a non-Federal entity or made in the laboratory independent of such an agreement.

(c) As a Federal laboratory Space Station, Federal employees could receive up to 15% of royalties generated by inventions they made.

(d) The Space Station as a Federal laboratory could enter into cooperative agreements with non-Federal entities and provide the non-Federal entity with either ownership or an exclusive license of any inventions or technical data resulting from the agreement.

(e) The Space Station as a Federal laboratory permits cooperative agreements with foreign firms but requires preference be given to U.S. firms. Further, before entering into a cooperative agreement with a foreign firm the Space Station must determine that the country of the foreign firm accords equal treatment to U.S. firms vis-a-vis cooperative R&D agreements, licensing requirements, and access to the laboratories of the foreign country.

(f) However, if the Space Station is placed under international control it would not be a Federal laboratory under the Act. In such an instance the U.S. should assure that any international agreement contains intellectual property clauses (patents and technical data) which provide maximum rights of commercialization to U.S. industry.

Why Developing Nations Should Protect Intellectual Property

A strong case can be made that protection of intellectual property is in the long term interest of developing countries. Although a number of developing countries currently have policies designed to acquire their technology from developed countries in the belief that inadequate protection is in fact a positive step that will eventually produce their own technological self sufficiency and increase their international competitiveness. It is important that such countries be made to understand that they are in fact limiting their own development by restricting technological development to their ability to exapproprpriate foreign technologies. Policies of inadequate protection of intellectual property create a domestic environment that does not provide either incentives for development of indigenous R&D capability nor does it provide incentive for the necessary investment of technical skills and capital by large multinational research intensive corporations. The absence of proper protection of intellectual property often coupled with price controls that do not permit R&D cost to be recovered and requirements for technology sharing as a basis for doing business create an environment in which neither foreign nor domestic industries can afford to innovate and undertake research and development. Such situations actually lead to the irony of increased technological dependency on developed countries which are becoming increasingly unwilling to remain passive in the face of massive increases in counterfeiting and the production of inferior quality goods. Specific benefits of a system of adequate protection for intellectual property follow:

. Access to Technology

New products and technology flow into countries which have adequate protection because the developers of the technology can proceed without concern for loss of their innovation. This produces a more rapidly expanding economic base and enables the country as a whole to take advantage of and utilize such technologies with resulting benefits to the economy, including agricultural, industrial, and health and environmental benefits. For example, countries which do not allow adequate protection or agricultural chemicals create a system in which manufacturers simply cannot afford to produce the most modern and effective pesticides since without patent protection they cannot hope to recover their investments.

Providing a General Climate of Trust

With adequate protection for intellectual property the opportunities for potential capital investment and development are enlarged along all development lines. Growth of "state of the art manufacturing" facilities and expansion of the manufacturing base occurs when companies feel that it is safe for them to manufacture their newest lines of equipment without fear of loss of prioritary technology.

. Such a climate also provides the potential for a growth in partnership and joint ventures activities with developing countries. This kind of infusion of technology and expertise and capital simply will not occur at an optimal level without adequate protection.

Adequate protection for new technologies will increase and encourage innovation. Absent such protection it is not possible to recover R&D and other technology development costs which are essential to long term growth. Protection of intellectual property is based on the premise that progress of science depends on protection of intellectual property rights which promote technological advance, international competitiveness, and the ability to keep pace in the world of rapid technological change. As we continue to experience constantly evolving technology, the ability to attract and develop new technologies leads to new products and new manufacturing processes that improve quality, increase innovation, and reduce protection costs.

. The ultimate aim of protection of intellectual property is to promote technical, industrial and economic progress. The secrecy which must surround activities absent property patent protection interferes with the free flow of knowledge and technologies essential for the innovative process.

INTELLECTUAL PROPERTY AS A TRADE ISSUE

Protecting patents, trademarks, and copyrights abroad has become a vital trade policy issue as evidence of product piracy and commercial counterfeiting mounts. More and more innovators and creators are discovering their products and technology being copied and sold in the international marketplace in competition with the legitimate product. The laws of many countries do not provide means for innovators and creators to acquire rights in their intellectual creations or to protect the rights they have obtained. The copied products, therefore, interfere with legitimate trade flows. Industry calls such copying "piracy" when it involves copyrighted works like books, films, records and software, and "counterfeiting" when a product bearing a trademark is involved. "Counterfeiting" also can mean copying labels, graphics, and trade dress (i.e. the appearance of the nonfunctional features of a product). Using another's invention, whether by producing a product or using a process, is called infringement.

Intellectual property protection is particularly important for the growth and development of industries producing new products that change rapidly because of intensive research and development. Patents, trademarks, and copyrights provide the economic incentive that spurs the research and development. They also spur the competition among firms within a field. The ability of inventors, authors, and producers to acquire rights in intellectual property worldwide and the extent to which they can enforce those rights have a profound effect on international trade and on investment. Lack of rights or ineffective enforcement causes problems not only in a country where the protection is lacking, but in the home market of the innovator or creator and in third country markets. Improved intellectual property protection worldwide, therefore, should be a major trade objective of every country interested in improving its industrial base.

The actual revenue losses to innovators and creators caused by patent infringement, counterfeiting and piracy are impossible to estimate. Technology itself has made copying of most products in large quantities simple. Shipping goods throughout the world is easy. Those who copy have no incentive to keep permanent records of their activities. What records there are deal with incidents that are detected and estimates of the total problem are based on those. For example, using answers to questions on trademark counterfeiting submitted to U.S. companies, the U.S. International Trade Commission, in a recent report, estimated that $8 billion in income was lost in 1982 due to counterfeiting. The U.S. Customs Service estimates the annual loss to U.S. businesses as closer to $20 billion from trademark counterfeiting. No government estimates have been done of patent infringement or piracy.

The cost to developing economies also is impossible to evaluate in strict economic terms. Much of the cost involves that which never happened, i.e., the investment that was not made, the research and development that did not take place, the university graduate who did not remain at home to use his knowledge. That which never happened, however, does mean that a country has fewer businesses employing fewer people producing fewer goods. The country remains dependent on foreign technology rather than developing its own. The country's businesses are the followers, not the leaders in the international marketplace. Its exports are less competitive in the world market than those of other countries unless they are low priced copies of foreign goods. If the latter is the case, the exports become the subject of trade restrictions in the markets where intellectual property protection is strong. Export earnings are less than they might be. Scarce capital is used in unproductive ways. As the reputation of the country suffers and the flow of investment capital and technology decreases further. Educated nationals go to other countries to use their hard won knowledge.

It is important both to developed and developing countries to solve the problems created by the lack of an adequate framework for the acquisition and protection of rights in intellectual property. Solving the problem will require the combined efforts of national governments and of industry. Governments must enact effective laws protecting intellectual property rights. The creators and innovators must use those laws. The laws themselves should be harmonized in order to ensure that, in providing for enforcement of exclusive rights in intellectual property, governments don't establish barriers to trade in legitimate goods.

Technology Commercialization

ISSN 1059-292X

North America Edition

APRIL 2003 Vol.13 No. 4

Nanotech: Next Tech-transfer Task?

NNI research needs to translate into products

Beneath the enthusiasm of this month's National Nanotechnology Initiative (NNI) meeting was concern that the US may not be paying sufficient attention to translating NNI research results into new products or processes.

"It's not enough for [the United States] to be spending more than the Europeans or the Japanese," one industry delegate said. "We've got to ensure the technology gets patented and rights transferred promptly to a US company that can make and sell it."

Some attendees also worried that nanotech research at federal or national labs might not get patent protection because of labs' money worries.

"If the [US] fees go up, labs will likely seek fewer patents," a civilian agency official agreed.

"Deciding which [ideas] get patented will become a gamble because few labs have money to assess the market potential of their inventions," he said.

About 500 people from federal agencies, industry, and academia took part the April 3-4 conference in Washington DC.

PRE-TAX LOSS OF $61-MILLION EXPECTED BY BTG

Licensing firm's results in line with earlier expectations

BTG plc anticipates its results for the financial year ended March 31 2003 will be "broadly in line" with expectations—total and net revenues of $48.67-million and $26.69-million, respectively—while pre-tax losses may exceed $61.25-million.

"The reorganization of our business announced in December has been implemented successfully," CEO Ian Harvey said on April 3. "We expect, as previously stated, to see resumption in revenue growth from this financial year as our business progresses."

Preliminary BTG results for the financial year will be released on May 29.

BTG still expects to achieve its goal of being profitable by March 2006, excluding any impact from Provensis Ltd, a subsidiary that's developing a varicose vein treatment.

The bigger pre-tax loss is blamed on a "higher than normal" patent amortization charge, and write-down of equity investments.

UK CLARIFIES PATENTING OF STEM CELLS

Practice Notice issued by the UK Patent Office

"On balance," the UK Patent Office says, "the commercial exploitation of inventions concerning certain types of human embryonic stem cells (pluripotent cells) would not be contrary to public policy or morality in the United Kingdom." as a result, it says, they should not be excluded from patentability.

The April 11 practice notice by the UK Patent Office, which clarifies the UK position on inventions relating to human embryonic stem cells, was widely welcomed.

Instances where the UK Patent Office would not grant or consider inventions that involved human stem cells are also explained in the notice.
[Continued, page 8]

COMMERCIAL LICENSING & AGREEMENTS

- **Flamel Technologies S.A.** and GlaxoSmithKline plc (GSK) announced that Flamel has licensed its *"Micropump"* controlled-release technology to GSK, which is to develop a new formulation for an undisclosed existing product. Flamel will get an upfront payment of $2-million, and milestone and royalty payments from GSK based on sales of the product. The companies estimate, based on continued successful development and commercialization of the formulation, that payments to Flamel could be up to $45-million by the end of the first year, following launch. Of this figure, $25-million would be due to reaching certain milestones. Flamel might also participate in manufacturing the product. "We're confident of the potential of *Micropump* technology for these large and still growing markets," Flamel president & CEO Gerard Soula said. "This additional agreement further demonstrates the interest of major worldwide pharmaceutical companies in our versatile technology platforms." Soula noted that this was Flamel's second license agreement with GSK on the *Micropump* in the past 9 months. GSK officials said the collaboration with Flamel will enable the company to maintain its leadership in product r&d, especially within the therapeutics area.
- **UTEK Corporation** and GloTech Industries Inc. signed a strategic alliance agreement that tasks UTEK with identifying unique technology acquisition opportunities for GloTech and, where appropriate use its *USB* model to enable GloTech to acquire licenses to these technologies. "GloTech has built an innovative, electro-luminescent safety product business based on technology developed at the University of Florida, and UTEK helped us identify and license our core technology," GloTech Industries' president & CEO Heinz Fraunhoffer said. "Potential expansion of our product line through UTEK's established relationships with research organizations and universities offers [us] exciting growth potential." The agreement was signed on April 15.
- **Dow Chemical Co.** is transferring its *"Intacta"* Performance Polymers polyurethane gloves business to YTY Industry Sdn Bh of Malaysia. Dow developed the *"Intacta"* latex-free gloves in response to growing concerns about natural rubber latex (NRL) allergies. The gloves, which are used typically for medical and dental examinations, have become a success because of a proprietary aqueous-based polyurethane dispersion chemistry that's used in the manufacturing process. "We're very pleased with this agreement and see it as a logical evolution of Dow's gloves business," Dow Polyurethane's new business development director Greg McDaniel said on April 10. "Dow will now focus on its core strengths and continue to supply YTY with the polyurethane polymers and technology required to make the gloves," he said, "while YTY leverages its expertise in manufacturing and marketing to further grow the business globally." YTY was formed in Malaysia in 1988 and has become of the leading makers of a range of disposable examination gloves, exporting to North America, Europe, and Japan. YTY had contract manufactured the gloves for Dow since 2000. Terms of the arrangement were not disclosed by the companies.
- **Monsanto Company** has licensed its *"YieldGard"* Rootworm corn technology to DuPont's subsidiary, Pioneer Hi-Bred International Inc. "This furthers our commitment to broadly license our biotechnology traits so that growers have access to traits they want in the seed brands of their choice for use on their farms," Monsanto's chief operating officer Hugh Grant said April 15. Although few details of the agreement were disclosed, the license is a worldwide one and Pioneer will pay royalties to Monsanto, while DuPont is to make other unspecified payments in connection with the license. "This licensing agreement allows us to provide our customers with additional new corn technology in Pioneer brand hybrids," Pioneer president Rick McConnell said. The technology, which received EPA registration recently, allows commercialization this planting season of the first biotech corn to control the corn rootworm pest. [More items, page 7]

The iNSIDe tRACk

Flat revenues for the year are forecast by Scipher plc, the UK technology development and licensing company.

In a statement released on April 1, Scipher officials said revenues for the company's financial year ended March 31 2003 will be "flat compared to last year," and below market expectations. "Order books have strengthened during the 2nd half, [but] sales from several high-value contracts that were expected [in this period] have slipped into the next financial year."

In prior years, it was explained, over 25% of the annual sales came in the last month of the financial year. That's not been the case in the current year.

"The effect of lower [sales] in the year, combined with a lower gross margin compared to last year, will result in a loss... that's greater than market expectations," the statement said.

Scipher acquired the Internet-based business yet2.com in December, and this has extended Scipher's expertise into all phases of intellectual property management and licensing. The purchase also offered opportunities to expand services in the US, Japan, and Europe.

Excellent market prospects are forecast for licensing, but completion of a number of new high-value licensing deals have been delayed and will not now occur until later in this year, Scipher admits.

Secure Identification has seen growth in sales of fingerprint readers and other systems, while the Communications business made a profit.

Scipher's 3-D sound systems business has strengthened, but delays in two licensing deals have resulted in lower sales. Sales of displays are up 40%.

Sensors exhibited substantial revenue growth with first commercial sales of the CO2 sensor and detector products;

Directors of Scipher warn that results for the financial just ended will be disappointing, but they see "good prospects" for renewed growth with particular benefits being derived from the patent licensing and secure ID operations.

Four scientists were named as recipients of the prestigious Lavoisier Medals of Achievement this month.

The highest honor for science excellence awarded by DuPont, the four 2003 medalists are:

—***L. John Hoffbeck***, considered one of the most successful corn breeders at Pioneer Hi-Bred International, the world's largest seed company;

—***Richard W. Rees,*** who discovered a unique family of tough, clear plastics now sold as DuPont's *Surlyn* ionomer resins that are used to protect food in packages with air-tight seals to tough coverings for golf balls and bowling pins;

—***Rolando Pagilagan***, who used fundamental chemical principles to develop and guide DuPont's engineering polymers business; and

—***Rudolph Pariser***, who contributed to polymer chemistry and enhanced understanding of colors and dyes, and was involved in the development of several key DuPont elastomers.

The awards will be made on June 16 in Wilmington.

With the exception of Pagilagan, who continues with research at the Washington Works site in Parkersburg, W.Va., all the medalists have retired.

Named after Antoine Lavoisier, who served as a mentor to the founder of DuPont, the medal of achievement has only been awarded to 65 scientists.

Preclinical studies of using chimeric natriuretic peptides to treat congestive heart failure show promising results, according to Research Corporation Technologies Inc.

The studies, which were supported by RCT, found the lead candidates were non-immunogenic and extremely potent during repeated dosings in studies with primates.

Tucson, Ariz.-based RCT has an exclusive worldwide license on the technology, and now seeks a licensee to continue developing the technology for CHF and other conditions.

Developed by Drs. John Burnett and Ondrej Lisy of the Mayo Clinic, the chimeric natriuretic peptide technology is protected by US patent No. 6,407,211.

A progressive disease in which the heart gradually fails to deliver adequate blood, about 4.7 million Americans suffer from CHF and over 275,000 people die each year from the disease.

Further details of the technology from Bennett Cohen of RCT at (520) 748-4400.

A strategic alliance agreement to evaluate new university and federal laboratory technologies that complement G-TEC's business strategy was signed recently by UTEK Corp. and Graphco Technologies Inc.

A wholly-owned unit of RCM Interests Inc., G-TEC is a technology, software, and systems development and licensing company specializing in law enforcement information sharing, and biometric ID and security systems.

"We look forward to working with G-TEC again to identify new technology acquisition opportunities that are synergistic with their business development strategy," UTEK CEO Clifford Gross said.

G-TEC chairman Christian Ivanescu was equally enthusiastic. "We believe [they] can help us accelerate the discovery and acquisition process for new technology opportunities," he said.

On April 16, Pfizer Inc. became the world's largest research-based pharmaceutical company when it combined operations with Pharmacia Corp.

"Today, we go forward as a single company, providing more products to help more patients than any other pharmaceutical company has ever done before," Pfizer chairman & CEO Hank McKinnell said.

"On any given day, we estimate that nearly 40 million people around the world are treated with a Pfizer medicine," he said.

Pfizer's Global R&D (PGRD) is the largest privately-funded biomedical organization in the world, and has over 200 projects in the development pipeline, including 100 distinct new molecular entities and 100 projects to evaluate new indications or delivery systems for currently marketed medicines. There are over 400 projects in PGRD's discovery pipeline.

During the five-year period through 2006, PGRD expects to submit 20 new major medicines for regulatory approval.

"Our industry is entering a period of momentous change and opportunity," Pfizer senior vice president for s&t Peter Corr said. "An era when sequencing of the human genome combined with new technologies holds great promise for developing new medicines."

Corr explained that the integration of Pharmacia into PGRD will "enhance our ability to turn scientific advances into products that both extend lives and also improve the quality of life for patients worldwide."

Only a small percentage of compounds ever become a new medicine, but Corr said PGRD's goal is to boost that rate through "targeted applications of new technologies, both in discovery and early clinical development, as well as utilizing disciplined resource allocation."

Financial results for UTEK Corp. for the year ended Dec.31 2002, show decreased revenues and net income from its operations.

"2002 was a challenging

year," UTEK CEO Clifford Gross admitted. "Never-the-less, we completed six technology transfers, consummated eight strategic alliances which have provided cash or unregistered common stock compensation."

In addition, he noted, UTEK had expanded its university supplier network, acquired the Intellectual Property Technology Exchange Inc., and its TechEx.com website.

Founded by Yale University, TechEx is used now by many tech-transfer and research professionals to exchange licensing opportunities and seek innovation partners, Gross explained.

Income from operations in 2002 was $3,385,335 (2001:$4,075,248) of which sales of technology rights were $2,088,254 ($3,419,653), consulting fees were $1,264,249 (534,782), and net income from investments was $32,832 ($120,813).

Expenses in 2002 were $3,140,151 (2,611,970).

Pretax income was $245,184 ($1,463,278) and net income operations was $153,643 ($907,980).

UTEK's investments of dropped 38% in value between 2001 and 2002, from $9.99 million to $6.21million, and its total assets fell 37% in the same period.

The net asset value of a UTEK share dropped 26% from $2.53 to $1.87 during the same period.

WIPO, the World Intellectual Property Organization, made two awards to inventors at this month's Geneva International Exhibition of Inventions.

Liz Williams of the UK received the "best invention by a woman" award for an alarm that deters muggers can assist in identifying them.

Jose Sangiovanni of Uruguay received the "best invention by a national from a developing country" award for a safety device to collect blood.

The awards are part of WIPO's outreach mission to promote innovation and recognize inventors.

Awards consist of a gold-plated medal, a certificate signed by the WIPO Director General, and $2,000 in cash.

Massachusetts Institute of Technology (MIT) granted 125 licenses in fiscal year 2002, according to its Technology Licensing Office (TLO).

The statistics show that of these 112 were invention licenses and 13 were for trademarks. Forty-one software end-user licenses were signed in the period.

Some 31 license options (not including ones that are part of research agreements) were granted by MIT.

Gross revenues from licensing were $33.52-million with TLO royalties of $28.05-million.

Twenty-four companies were started (venture capitalized and/or with a minimum of $500,000 of other funding) by MIT during the fiscal year, according to TLO.

Total invention disclosures in FY-2002 were 484. Of these 434 were from on campus sources, and the remainder from Lincoln Labs.

MIT filed 245 US patent applications and was issued 126 US patents in the year.

TLO spent $9.1-million on patents in FY-2002m, but it received $4.54-million in patent cost reimbursement.

Other revenues included $240,000 interest, and $66,000 of equity cash-ins.

Fred Hassan didn't move to Pfizer Inc. when it merged with Pharmacia Corp. earlier this month.

The former chairman & CEO of Pharmacia, Hassan has been a widely respected figure in the global pharma industry, and he will now "pursue other career opportunities," according to a statement released on April 14.

"I'm proud to have been associated with Pharmacia, its predecessors and its people," he said.

Recent Federal Licensing

• **Department of the Navy's Naval Research Laboratory** is considering grant of a revocable, non-assignable, exclusive license in the US & certain foreign countries to Second Sight LLC for 5 inventions: Nanochannel glass matrix used in making mesoscopic structures; Nano-post arrays and process for making them; Micro-electronic stimulator array; Permanent retinal implant device; and Fabrication of microelectronic array having high aspect ratio microwires. The field-of-use may be limited to retinal implants

• **National Institutes of Health** is considering:
— grant of an exclusive worldwide license to Vaccinex Inc. (Rochester, N.Y.) for several immunologically active fusion protein inventions covered by US and PCT patent applications. The field-of-use may be limited to development of human therapeutics for cancer & other infectious diseases.
—grant of an exclusive, royalty-bearing license to Research Institute for Genetic & Human Therapy (Washington DC) for 8 inventions: Procedure to block the replication of reverse transcriptase dependent viruses using inhibitors of deoxynucleotides synthesis; Mixtures of dideoxynucleosides and hydroxycarbamide for inhibiting retroviral spread; Mixtures of DDI & D4T with hydroxycarbamide for inhibiting retroviral replication; Method of treating HIV in humans by administration of ddI and hydroxycarbamide; Procedure to block replication of reverse transcriptase dependent viruses by use of inhibitors of deoxynucleotides synthesis; Method of treating HIV in humans by administration of ddi and hydroxycarbamide. NIH may limit the license's field-of-use to development of drugs of hydroxyurea alone and in combination with dNTP competitors for blocking reverse transcriptase dependent viruses, including HIV.

• **NASA Marshall Space Flight Center, Huntsville, Ala.,** is considering grant of an exclusive license to Bombardier Motor Corporation of America (Delaware) for three inventions: Aluminum alloy and articles cast therefrom; Process for producing a cast article from hypereutectic aluminum-silicon alloy; and High strength aluminum alloy for high temperature applications. US patent applications have been filed for some of these inventions.

• **NASA Langley Research Center, Hampton, Va.,** is contemplating grant of a partially-exclusive license to Automated Control Technologies Inc. (Fairmont, W.Va.) for several of its inventions. These include: Reactivation of a tin oxide-containing catalyst; Process for making a noble metal on tin oxide catalyst; Catalyst for carbon monoxide; Catalyst for carbon monoxide oxidation; Catalytic process for formaldehyde oxidation; Catalyst for oxidation of volatile organic compounds; and Process for coating substrates with catalyst materials Several of the inventions are subjects of patent applications.

• **Centers for Disease Control and Prevention, Atlanta, Ga.,** is contemplating grant of a worldwide, limited field–of-use, royalty-bearing, exclusive license to Transgenomic Inc. (Omaha, Neb.) for 12 CDC inventions. They are: Rapid and sensitive method for detecting Histoplasma capsulatum; Nucleic acids for detecting Aspergillus species and other filamentous fungi;Molecular identification of Aspergillus species; Nucleic acids for the identification of fungi and methods of using same; Nucleic acids of the M Antigen of Histoplasma capsulatum, antigens, vaccines, and antibodies; Nucleic acids for detecting Fusarium species and other filamentous fungi; Nucleic acid probes for detecting Candida species; Nucleic acid probes for Candida Parapsilosis methods for detecting Candidiasis in blood; Nucleic acid probes for detecting Candida tropicalis in blood; Nucleic acid probes for detecting Candida krusei cells in blood; and Nucleic acid probes for detecting Candida glabrata DNA in blood; Nucleic acid probes and methods for detecting Candida DNA cells in blood. CDC's field-of-use restrictions on Transgenomic's possible license, means the probes can only be used for rapid identification of fungal pathogens and diagnosis of mycotic diseases.

COMMERCIAL LICENSING & AGREEMENTS (Continued from page 2)

- **Competitive Technologies Inc.** (CTT) is adding a vehicle rollover warning technology that uses micro-electromechanical systems (MEMS) to its portfolio for licensing. National Highway Traffic Safety statistics indicate that about 10,000 roll over deaths occurred in 2001, accounting for about one-third of passenger vehicle occupant fatalities. "We believe our technology—designed by Craig Carlson—will help reduce this staggering number of deaths each year," CTT vice president Scott Bechtel said. The Carlson system, which is claimed to be low-cost and would fit inside a rear-view mirror, senses dangerous driving conditions and warns the driver. In off-road settings, the system will warn of dangerous tilts and inclines that risk rollover. CTT also plans to commercialize another Carlson technology, an emergency-stop warning system that can be built into a vehicle's rear center high mounted stop lamp. "We selected Carlson's rollover warning technology because it was the most reliable, safest, and most cost-effective solution available, CTT president & CEO John Nano said on April 7.
- **Brookhaven National Laboratory** (BNL) has licensed exclusively to UTEK Corp., a patent-pending technology for chemical detection developed at the US Department of Energy laboratory. Known as *"Mini-Kaman Lidar,"* the technology is described as a short-range tool to screen for unknown chemical, narcotic, and hazardous substances without needing to come into contact with them. UTEK has assigned the patent to Circle Group Holdings Inc., in exchange for a stock transaction. "When fully developed, this tool will give first responders the ability to detect substances on surfaces as well as in bulk quantities from a distance of three to fifteen feet," BNL chemist and co-inventor Arthur Sedlacek III said. "Working in partnership with Circle Group, we look forward to completing the development of this new, non-contact detection system." Located at Upton, N.Y., BNL is managed for DOE by Brookhaven Science Associates, a limited liability company formed by Stony Brook University and Battelle. "The technology is a terrific opportunity," Circle Group CEO Gregory Halpern said. "It's one of the most timely security detection technologies that we've seen to date and I'm very excited about its potential and the need in the marketplace."
- **GlaxoSmithKline plc** (GSK) and Germany's Merck KGaA agreed to end their joint development of *"Vilazodone"* because results from a Phase IIB program do not justify proceeding to Phase III trials. Under the terms of their agreement, GSK will return all rights to *"Vilazodone"* to Merck KGaA. Also known as EMD 68843 and SB 659746-A, the compound was discovered and transferred into early development by Merck, which is now considering various future options. The compound, which combines properties of a selective serotonin-reuptake inhibitor with that of a partial agonist, was being tested as a treatment for depression. Founded in 1668, Merck KGaA is based in Darmstadt, Germany, and is 74% owned by the Merck family. Its former US subsidiary, Merck & Co., has been an independent company since 1917.
- **Daiichi Pharmaceutical Co. Ltd** (DK) licensed exclusively a potential new anti-infective agent, known as DK-507k, to Pfizer Inc. The agent—a novel extended-spectrum quinolone—has been shown in pre-clinical tests to be active against several drug-resistant strains of bacteria, and is in development for both oral and intravenous treatments for respiratory tract and other infections. Pfizer will, under terms of the agreement, gets an exclusive license to DK-507k to fund, develop, and conduct ongoing development, and market it in all major markets except for Japan, China, and other Asian countries. Daiichi can jointly market the treatment with Pfizer in the US. No financial terms of the arrangement were given.

HEADLINES

Stem cells *(from page 1)*

Human embryonic pluripotent stem cells don't have potential to develop into entire human bodies, the notice says, and numerous reports by different scientific, medical, and political entities have indicated that stem cells have "enormous potential" to deliver new treatments for a wide range of serious diseases.

Patents should provide an incentive to innovate, the Patent Office says.

Without the protection of offered by patents, it says, industry and other inventors might not "undertake the risk, investment and necessary research to make the advances that we hope for in this area, such as improved health care products."

But the Patent Office will not grant patents for:

—Processes for obtaining stem cells from human embryos because under the amended 1977 UK Patents Act, uses of human embryos for industrial or commercial purposes are not patentable inventions;

—Human totipotent cells, which have the potential to develop into an entire human body, because the human body at various stages of formation and development is excluded from patentability under the 1977 law.

However, it will grant patents for inventions involving human embryonic pluripotent stem cells if they satisfy the normal requirements for patentability.

An EU Directive on patenting "bioinventions" offers a useful framework, and is incorporated into the UK law.

The UK Patent Office notice can be found at http://www.patent.gov.uk/patent/notices/practice/stemcells.htm

The EU Directive is at: http://europa.eu.int/smartapi/cgi/sga_doc?smartapi!celexapi!prod!CELEXnumdoc&lg=guichett

---

Editor: Neil MacDonald

Editorial address:
"Technology Commercialization"
P.O. Box 10060,
Arlington, Va. 22210, U.S.A.

E-mail contact:
Editortekcomm@aol.com

Annual North American subscriptions are US $200, payable in US dollars with a check drawn on a US bank. Purchase orders are only accepted by prior arrangement.

"Technology Commercialization" Newsletter
P.O. Box 10060,
Arlington, Va. 22210

FEDERAL TECHNOLOGY WATCH

VOL. 1 ISSUE 16, APRIL 28 2003

WEEKLY REPORT ON FEDERAL TECHNOLOGY NEWS AND POLICIES

SBIR funds hit $1.6 billion

Thousands of the nation's small businesses and entrepreneurs each year discover the Small Business Innovation Research (SBIR) program and the opportunities it offers to launch new products.

"I can't believe this program existed and we didn't know about it,"a first-time attendee from Michigan at last week's *National SBIR Spring Conference* in Arlington, Va., told *FTW*. "If the project doesn't work we don't have to pay the money back, and the government doesn't own the patent rights. It seems too good to be true," he said.

Launched in the early 1980s, SBIR is a highly-competitive program for small businesses to engage in federal r&d with commercialization potential. The program's funding is based on 2.5% set-aside of the extramural research spend of federal agencies with r&d budgets of $100-million or more.

Having three distinct phases, SBIR offers funding of up to $100,000 for a six-month feasibility study (Phase I), and up to $750,000 over two-years for research to demonstrate proof-of-concept (Phase II) of the project. No federal funding is given for Phase III because that's when most SBIR projects are expected to be commercialized by leveraging private funding.

"Commercialization is the new imperative," Department of Education SBIR coordinator Lee Eiden reminded delegates.

The size of awards varies from agency to agency, but typically about 3,500 Phase I and 1,500 Phase II awards are made each year.

Funding by the 10 federal departments and agencies that participate in SBIR will exceed $1.6-billion this year, with $832-million from Department of Defense programs and $566-million from Health & Human Services.

Inside:

In 2000, Congress reauthorized the program until 2008, and required the Small Business Administration to set up new award databases, standardize agency procedures and nomenclature, and commission a new National Research Council study of SBIR.

Last week's conference was organized by BRTRC Inc. under contract from DOD, and included presentations by officials of SBA and all the SBIR agencies, speakers from 3M and Boeing, and past award recipients who have become SBIR "success" stories.

The Department of Homeland Security may become a participant in SBIR in FY-04, but a decision is not expected until summer.

Last week's conference was organized by BRTRC Inc. under contract from DOD, and included presentations by officials of SBA and all the SBIR agencies, speakers from 3M and Boeing, and past award recipients who have become SBIR "success" stories.

Getting nano's measure

When he undertook a research project for IBM on toner used in photocopy machines in the early 1980s, Professor Mihail Roco had no idea it would lead to nanotechnology or give him a front seat in the development of this important field.

"I discovered that the properties of a particle—as it gets smaller—behave very differently," he recalled in an interview with *FTW* on April 17 at the National Science Foundation. "It wasn't extrapolation."

Roco's interest was further piqued by a separate experiment that involved reverse coating between two cylinders, also related to photocopiers. "I found that if you changed the size of the gap by one molecule—or one or two nanometers—the particles could behave like a superfluid," he said

Although Roco found this behavior very intriguing, few others were interested in his results. Some people even thought he had made some errors during the research.

Today, as senior advisor on nanotechnology at NSF, Roco rarely has the luxury to look backward because almost everyone wants to know where nano developments are headed!

Also a key figure in the National Nanotechnology Initiative (NNI), where he is chair of the Nanoscale Engineering, Science, and Technology (NSET) subcommittee of the National S&T Council, Roco has exchanged his workbench for the meeting room and podium to become a well-respected advocate for nano in the United States and overseas.

While many of his counterparts in the US research community like to focus on exciting future applications of nano, Roco is much more interested in discussing the potential that nano offers for the environment.

He enjoys describing its likely impact on industrial processes, energy production, and the remediation of toxic waste sites, and is a strong believer in public examination of the societal issues that get raised about nanotech.

One group has proposed that all nano research should be regulated—in an FDA-type fashion—by the United Nations to ensure it poses no threat to humans. While sympathetic to concerns about potential adverse impacts, Roco feels they need to be examined by the different types of societal implications projects already underway.
[*Continued page 6*]

LANL is dilemma for UC

The University of California's management of the Los Alamos National Laboratory continues to exercise many on Capitol Hill, and the latest hearing to examine UC's contract for the lab is scheduled this week.

Congressman James Greenwood, R-Pa., chairman of the House Energy & Commerce Oversight and Investigations Subcommittee, has set a hearing for May 1 to review UC's management contract for Los Alamos.

No witness list was available as this issue went to press, but the hearing is expected to provide an opportunity for panel members to explore whether UC's contract for LANL should be terminated and reassigned. Energy officials admit privately that few other organizations are likely to be interested or qualified to take over the LANL contract, but they believe a change has become inevitable. Energy Secretary Abraham is thought to share this view.

A Hill staffer told *FTW* on Friday that the continuing management problems at Los Alamos had "exhausted" lawmakers' faith in UC being capable of resolving the situation. "A final decision, albeit it a painful one, will have to be made very soon," he said.

Among those considered potential candidates for the LANL contract are the University of Texas, and the University of Chicago, which already operates Argonne National Laboratory.

Several lawmakers have in recent months urged that UC's role at Los Alamos should end, but few have been as well-positioned to comment as Senator Pete Domenici, R-N.M., who spoke last week at the lab.

"I've been proud of the University of California under whose management the laboratory has largely flourished for 60 years," he said on April 22. "But, we all know that the present manner in which the laboratory is managed must change in ways that are inevitable..."

Serious mistakes and poor management in key areas of LANL had gone uncorrected for too long, he said.

"While critics have carped, I've worked to ensure that none of the attacks harmed the laboratory," Sen. Domenici said. "But I worry that the attacks on Los Alamos will only intensify if we don't take dramatic action to improve the lab's management and reputation."

The senator revealed he has told Secretary Abraham that "at the end of the current [UC] contract, I will support an effort by [him] to conduct a competition to solicit the very best proposals on how the laboratory could be managed."

However, Sen. Domenici's support for a competitive process was contingent on the current LANL contract [which expires in Sept. 2005] not being canceled, but continuing unabated through its full term.

"I'll meet with Secretary Abraham later this week to discuss the impending review of the Los Alamos contract," Sen. Domenici said, adding that he hoped the DOE Secretary would join in "guaranteeing that whatever management regime we develop, UC will be able to compete and compete well."

Later that day, UC president Richard Atkinson took the unusual step of issuing a statement on Sen. Domenici's remarks.

"We agree with his criticisms of the management problems at Los Alamos, and we are gratified to receive his strong support for the corrective actions we have taken," the statement said.

"On the issue of competition, if Secretary Abraham's decision is to compete the LANL contract, then our instinct is to compete, and to compete hard. However, any final decision regarding UC's participation in such a process rests with the UC Board of Regents. Until the Secretary announces his decision and terms of any competition, further comment ... would be inappropriate."

UC may revamp its labs

But a review of LANL given to the regents by UC's interim vice president for laboratory management Bruce Darling earlier this month offered a bleak picture.

"To date, 18 laboratory senior managers and employees have been terminated, removed from management positions and/or reassigned to new positions," he told them.

A team of 30 Ernst & Young consultants has been at Los Alamos for several weeks to review the lab's financial processes and other functions, and is due to report back to top UC officials in May, Darling revealed.

But his most interesting disclosure was that UC is working on a "larger revamping" of its governance structure for the three national labs—Los Alamos, Lawrence Livermore, and Lawrence Berkeley—it runs for DOE/NNSA.

"We're examining various national [and federal] laboratory management models for elements that we can draw upon to improve our own oversight," Darling said on April 3.

Those examined are: Sandia National Laboratories, Argonne National Laboratory, Oak Ridge National Laboratory, Brookhaven National Laboratory, DOD's Draper Laboratory, and NASA's Jet Propulsion Laboratory.

"Our goal is stronger oversight by people with expertise in science and weapons, technology businesses, and corporate governance, who will hold the labs and the university accountable," he told the regents.

Costs deter foreign patents

Small US firms are not protecting their inventions through the filing of foreign patents as often as large companies, a study released last week by the Small Business Administration's Advocacy Office finds.

This lower rate of patenting likely results in fewer commercial opportunities being realized by small firms and lost revenues, officials said.

"Small firms are incredibly inventive, but many times they are unable to protect their inventions in the global marketplace due to their inability to secure foreign patents,"said Chief Advocacy Counsel Thomas Sullivan.

"If small firms are unable to protect the results of their hard work, our country could lose its most valuable source of new ideas and innovations," he claimed.

Smaller firms are seeking to protect their inventions more than before, the study finds, but they still patent abroad less frequently than large companies and also allow their patents to lapse.

The high cost of filing foreign patents and the resource limitations of small firms seem the most likely reasons for this situation.

Performed under contract by Mary Ellen Mogee, PhD, the study updates a 1995 examination of foreign patenting practices, and was released on April 23.

"Foreign Patenting Behavior of Small and Large Firms: An Update," can be found at: http://www.sba.gov/advo/research or ordered in hard copy from NTIS on (800) 553-6847, quoting ref: PB2-003-101302..

FLC signs MOU with NIJ

A memorandum of understanding (MOU) has been signed by the Federal Laboratory Consortium (FLC) for Technology Transfer and the National Institute of Justice (NIJ), *FTW* has learned.

FLC serves as a national network for over 700 federal laboratories and research centers that work on tech-transfer activities with the private sector, while NIJ is the Justice Department's principal research agency.

Officials hope the MOU will help transition to the private and public sector technologies developed by federal labs that can improve the effectiveness and safety of law enforcement, corrections, and related activities. Also, in the event of a crisis or major incident, FLC will coordinate with NIJ to help identify and deploy appropriate technologies, resources, and expertise.

Recognizing needs of the "first responder" community, FLC and NIJ also will employ the MOU to coordinate with other federal agencies and professional organizations on topics such as communications equipment interoperability, less-than-lethal and critical incident technologies, and investigative and forensic sciences.

The MOU was signed on March 23 by FLC chair Ann Rydalch and NIJ Office of S&T Director David Boyd.

[Boyd has since moved to a new position in the S&T Directorate's Office of R&D at the Department of Homeland Security.]

The initial term of the MOU is two years, but it can be extended by mutual agreement of the parties. A review will be made after a year to ensure the MOU is meeting the intended purpose and to make any revisions.

FLC expects to sign an extension to an existing Metro Fire Chiefs MOU soon, and an MOU with the US Fire Administration may be signed by FLC in May.

DOE's new King Coal?

The Department of Energy wants comments on its plans to implement a $1-billion, 10-year demonstration project for the world's first coal-based, zero-emission pilot plant to produce electricity and hydrogen.

DOE announced last week that it is seeking public comment on the "FutureGen" project, which is expected to establish the technical and economic feasibility of producing electricity and hydrogen from coal while capturing and sequestering the carbon dioxide created during the process. Coal is the nation's lowest cost and most abundant domestic energy resource..

But the ultimate success of FutureGen will, DOE officials concede, depend on acceptance of the sequestration process by the industries likely to be most impacted by future limits on carbon emissions.

To help advance this activity, DOE plans to "non-competitively enter into a cooperative agreement" with a consortium led by the coal-fired electric power industry, and the coal production industry.

This consortium, operating under the guidance of a federal steering committee, will be responsible for the design, construction, and operation of the FutureGen plant, and for monitoring, measuring, and verifying the carbon dioxide sequestration.

DOE says members of the consortium shall collectively own and produce at least one-third of the nation's coal, and at least one-fifth of its coal-fueled electricity.

Consortium members are expected to: (a) Be geographically diverse and represent both eastern and western domestic coal producers and generators of coal-fueled electricity; and (b) Be resource diverse by representing the full range of producers and users of coal types.

DOE believes the public interest will be served by having this broad cross-section of coal producers and electricity generators involved in FutureGen. The project was first revealed by President Bush on Feb.27 2003.

Companies interested in establishing the consortium, and individuals with comments, need to contact DOE by June 16.

More details from Keith Miles, National Energy Technology Laboratory, P.O. Box 10940, MS 921-107, Pittsburgh, Pa. miles@netl.doe.gov

Last week, it was revealed that Battelle is coordinating formation of an alliance to support FutureGen. The nine companies in the working group are: American Electric Power; CONSOL Energy; Kennecott Energy; North American Coal Corp; PacifiCorp; Peabody Energy; RAG American Coal Holding Inc.; Southern Company; and TXU.

Urban S&R panel to meet

Officials from the Federal Emergency Management Agency's (FEMA) Emergency Preparedness & Response Directorate will give updates on the National Urban Search & Rescue Response System (NUSRRS) to an advisory panel this week.

EPR directorate staff are expected to provide the advisory committee with details of ongoing program activities, including recent exercises and training.

The panel plans to review the current and future program requirements and will make recommendations on budget allocations for FY-2004 and FY-2005.

Operational status of NUSSRS and transportation issues will also be discussed by the committee.

The two-day meeting is scheduled to be held April 30-May 1 in Washington DC.

Formerly an independent agency, FEMA is in the Department of Homeland Security.

Further details from Michael Tamillow on (202) 646-3498.

MEP gets renewed support

There has been renewed bipartisan support by lawmakers in recent weeks for continued funding of the Manufacturing Extension Partnership (MEP) program.

Funding for MEP was slated to be cut to \$13-million in FY-03 from about \$110-million in the previous year. That request by the president was overturned by Congress which restored the funding to \$106.6-million. The renewed congressional support for MEP is intended to allocate \$110-million in FY-04 for the program, and prevent a rerun of the earlier scenario.

Manufacturing task forces in the Senate and House as well as those representing California and the Hispanic Caucus, have submitted letters supportive of continued MEP funding to budget appropriators.

Senate activity drew support from 58 senators, while combined efforts in the House drew support from 246 Representatives.

"We're very grateful to Congress for its support," Modernization Forum president Michael Wojcicki said last week.

"Quite simply, MEP is a smart investment for the federal government," he said. "It builds the economy, puts more into the [US] treasury than it takes out, and creates a lot of well-paying jobs."

The Modernization Forum is the national association for MEP centers, most run by state, local government or nonprofit entities.

Sens. Olympia Snowe, R-Maine, and Joe Lieberman, D-Conn., co-chair the Senate Task Force while Reps. Jack Quinn, R-N.Y., and Marty Meehan, D-Mass., co-chair its House counterpart.

Wireless technology event

A two-day wireless technology conference and showcase to highlight new and emerging innovations will be held next month.

Organized by Commerce's National Telecommunications & Information Administration (NTIA) and the Department of State's Office of International Communications & Information Policy, the *"Wireless Innovations Conference"* will be held May 12 & 13 in Washington DC.

The technology showcase, featuring exhibits and demonstrations of the latest wireless technologies and devices, will be held on the first day. A roundtable with panel discussions on unlicensed wireless technologies, will occur on the second day.

Both activities will be held at Commerce's offices at 14th and Pennsylvania Ave. NW.

More details from Joe Gattuso on (202) 4823-18801; jgattuso@ntia.doc.gov

Joint DOD office for CBD

The first ever Joint Program Executive Office for Chemical and Biological Defense (JPEO-CD) has been formed by the Department of Defense, it was revealed Friday.

Formed from the Army's existing Program Executive Office for Chemical and Biological Defense, as well as current Navy, Air Force, and Marine CBD program offices, Pentagon officials hope the JPEO will "streamline" chemical and biological defense acquisition and leverage the unique capabilities of each of the services.

Also responsible for r&d, acquisition, fielding, and life-cycle support of CBD equipment and medical countermeasures, the JPEO's programs include CBD detection devices, medical vaccines, pre-treatments, therapeutics and diagnostic equipment, individual protective masks and suits, collective protection shelters, and decontamination systems.

The threat of CB weapons being used against the US by terrorists or rogue nations, has heightened the need to better coordinate the nation's CBD efforts.

In accordance with existing legislation, Army remains the executive agent for the Chemical and Biological Defense Program, and JPEO-CBD reports to Army's acquisition executive and defense acquisition executive.

Assistive technology devices

The Interagency Working Group on Assistive Technology Mobility Devices will hold a public forum next month.

Chaired by Secretary of Education Rod Paige, the group was created earlier this year by a presidential executive memorandum, and is charged with two tasks: Identifying existing federal programs and resources designed to help people with disabilities get assistive technology (AT) mobility devices needed for their education and employment; and Working with state, local, and tribal governments to identify their programs for AT mobility devices for disabled individuals.

As a result of these efforts, the working group will prepare a report for the president detailing how each of the agencies that are represented in the working group will: 1. Improve coordination among its existing programs; 2. Train vocational rehabilitation counselors, other service providers, and individuals with disabilities; and, 3. Share these findings with individuals with disabilities.

The group's report also will describe how such individuals can "pool" funding from existing sources to obtain mobility devices, such as various manual and powered wheelchairs, and scooters.

According to the Feb.12 executive memorandum signed by President Bush, the working group shall be terminated 30-days after submitting its report.

Apart from the Education Secretary, members of the working group include the Health & Human Services Secretary, the Labor Secretary, and the Commissioner of Social Security, together with other officials designated by the assistant to the president for domestic policy.

The report is due no later than Aug.12.

The working group's May 21 forum will be held from 9-a.m. to 5-p.m. in the Barnhard Auditorium of the Department of Education, 400 Maryland Ave. NW, Washington DC.

Persons planning to attend or speak at the forum must register by May 16 with Loretta Petty Chittum, Office of Special Education and Rehabilitative Services, on (202) 205-5465; osers.at@ed.gov

Representatives from all the agencies mentioned above are expected to attend as well as the Department of Veterans Affairs. Participants from the AT mobility device community, AT research and policy officials, and service organizations are also expected.

S&E infrastructure needs

An urgent need exists to increase federal investment in the nation's science and engineering (s&e) research infrastructure to ensure it is the "latest and best," a recent National Science Board report says.

A modern, effective research infrastructure is critical to maintaining US leadership in s&e, according to the 50-page document. Evidence of its central role is suggested by the number Nobel Prizes awarded for development of new instrument technologies—8 in the past 20 years including for electron and scanning tunneling microscopes, laser and neutron spectroscopy, and particle detectors—the report notes.

NSF is a leader among federal agencies in providing the US academic community with access to "forefront" instrumentation and facilitie necessary to "address currently intractable research questions, the answers to which may transform current scientific thinking," the NSB study says.

Five recommendations to tackle these concerns are proposed in the report. They include: Hike the share of NSF's budget for s&e infrastructure from the current 22% to nearer 27%; Give special emphasis to four categories—instrumentation research, midsize infrastructure projects, large facility projects, and advanced cyber infrastructure; Expand education & training opportunities at new and existing facilities; Strengthen the planning and budgeting for new infrastructure; and Develop interagency plans and strategies.

NSB's task force on s&e infrastructure was chaired by John A. White, Jr.

"Science and Engineering Infrastructure for the 21st Century: The Role of the National Science Foundation," was issued as NSB 02-190 on April 9, and can be found at: http://www.nsf.gov/nsb/documents/2003/strat.htm

Getting nano (continued from page 1)

One issue Roco encountered during his early research has made him keenly aware of the different agendas people have for nano.

"Many colleagues in the university community looked [at nano] as speculation or something that was too technology-related," he recalled. "They didn't feel it was an academic research topic."

Industry's response was possibly worse.

"They perceived [nano] as science fiction," Rocco said, "and thought that making things smaller was just an extension of micro-electromechanical systems (MEMS)."

Despite this environment, in 1991 he initiated the first US government program to focus on nanoscale science and engineering.

By 1999, Roco's nano background began to find an outlet at NSF and on March 11 of that year he proposed the NNI to the National Science & Technology Council.

His memory of the event is vivid.

"I was in competition with about 30 other topics that were being considered that day," he said. "Up to that meeting, interest in nano had been quite low, and so I had prepared only a 10-minute presentation. But after my talk there a discussion lasting about two hours! There were concerns about the speculative nature of the subject and some thought [the topic] was too exploratory, while others were afraid of the hype and not being able to deliver on the promises."

Today, NNI is a highly-regarded activity with a budget of $744-million in FY-03 that receives close attention from America's major technological rivals, and Roco is seen as its principal architect and conscience.

A survey by *Forbes Nanotech Report"* recently named Roco the No.1 Nanotech Power Broker, and consistent with this perception he continues to be sought out by top industry officials who value his vision of nanotechnology's future. The same survey assigned former Speaker Newt Gingrich an "honorable mention."

Is there a risk US nano r&d efforts will be eclipsed by those of Japan and the EU or that intellectual property rights will be ignored?

Roco is confident that US leadership in nanotech can be maintained, and he sees no evidence of US researchers neglecting to protect their inventions with patents.

To illustrate this point, he pulls out two charts, one showing nanotech spending and the other listing annual nanotech patents by country. As US spending on nanotech rises in the late 1990s through to 2002, patents issued to US inventors leap to levels of 4,000, 5,000, and 6,000 a year, far exceeding those for Japanese and European Union inventors.

" I can see, not too far in the future, where we will create a critical mass of nano knowledge so we can choose a systematic method to design a product," Roco said. "Nano is cross-cutting and you need this systematic approach to get knowledge and create products."

Technology Transfer

• ***National Institutes of Health's Office of Technology Transfer in Rockville, Md.,*** is considering grant of an exclusive, worldwide, royalty-bearing license to OmniViral Therapeutics LLC (Germantown, Md.) for a novel protein that can be used to remove or inactivate HIV in fluid samples. The invention is described in US Patent application 60/359,360, "An obligate domain-swapped dimer of cyanovirin with enhanced anti-viral activity." The license would be limited by field-of-use.

Biosyn Inc. (Philadelphia, Pa.) seeks what seem to be identical rights to this same NIH invention with similar field-of-use limitations.

• • • • • • • People • • • • • • •

President Bush announced on April 24 his intent to nominate eight individuals to serve as members of the President's National Security Telecommunications Advisory Committee. They are:

—***James Albaugh*** (Boeing Co.);
—***Frank Ianna*** (AT&T);
—***Richard Notebaert*** (Quest Communications);
—***Hector de Jesus Ruiz*** (Advanced Micro Devices Inc.);
—***Patricia Russo*** (Lucent Technologies Inc.);
—***Stratton Sclavos*** (VeriSign Inc.);
—***Susan Spradley*** (Nortel Networks); and
—***John Stanton*** (Western Wireless, T-Mobile).

• •

Secretary of the Army ***Thomas E. White*** submitted his resignation on April 25, but its effective date remains to be determined. In a statement, Defense Secretary Donald Rumsfeld expressed appreciation of White's "long and able service" to the country, first as a career USA officer, and for the past two years as Secretary of the Army.

• •

The National Academy of Sciences' Public Welfare Medal will be presented to ***Shirley Malcom,*** head of AAAS's Directorate for Education and Human Resources, tonight (April 28) at a ceremony in Washington DC.

• •

Federal Technology Watch is published weekly and is available by subscription only
Editor: Neil MacDonald
Contact: Editortekcomm@aol.com
Annual subscription is $450 for 50 issues, delivered electronically. Rates for site licenses are available upon request.

CC → NIL.

TECHNOLOGY TRANSFER IN JAPAN

An Introduction to the Current State of Japanese Industry

Koji Kobayashi Presented by Uenohara
Chairman of the Board and
Chief Executive Officer
Nippon Electric Co., Ltd.

Foreword

I wish to thank you, Dr. Sherman Gee, Chairman of the Organizing Committee of this conference, as well as the representatives of various countries, for having accorded me this opportunity to present to you the situation currently prevailing in my country, Japan.

A variety of obervations and evaluations are today being made both at home and abroad concerning recent developments in the Japanese economy. Some of them give high marks to our nation for having appropriately dealt with the grave confusion created by the petroleum crisis that arose in the Fall of 1973. Also noticeable are the complaints that we are upsetting the economic order of various countries by increasing our exports, riding the crest of a wave, as our efforts to develop the competitiveness of our products have met with success.

Even for us who are directly involved, it is difficult to gain a correct perception of the actual state of the Japanese economy. I believe it is because this economy is caught in a whirlpool of violent change. The result is that either or both of the two observations I have cited may be true; it is difficult to grasp the whole picture of the numerous complicated phenomena existing today.

I therefore intend to introduce to you the current situation in Japan, while keeping in mind my assigned theme of "Technology Transfer."

I. The Postwar Contributions to the Japanese Economy of Technology Transfer from America and Europe

Following the enactment of the "Law on Foreign Capital" in 1950, various Japanese enterprises made very energetic efforts to import advanced technology from the United States and Europe, seeking to catch up with the level prevailing in the industrially-advanced Western nations. One of the reasons for this was the need to manufacture domestically various required products at a time when the balance of payments followed a deficit trend because of structural reasons. This became our basic policy as a nation.

Another reason was the conculsion reached that it was more advantageous both from the financial and time-saving aspects to import advanced technology by paying for it in order to make up for the then existing dearth of advanced technology, taking into consideration the prevailing financial difficulties of individual Japanese enterprises.

A further point that must be mentioned is the special circumstances in which Japanese industry found itself before and after the Second World War. There was a tendency to deny industrial property rights to technology developed by private industry and pressure towards donating it to further the nation's industrial power. This trend developed from 1934 onward as the country moved onto a virtual war footing. As a result, even such technology as was publicly known in our country was found, after the war, to infringe upon patents of foreign enterprises. There were numerous cases where Japanese enterprises in spite of possession of their own technologies had to obtain licenses from foreign companies under their patents. Furthermore, the then existed patent rights of the Allied Nations were extended for a further period of ten years by order of the Occupied Forces. This put Japan in a very inferior position concerning technologies.

Under such circumstances, patents and know-how concerning various chemical products, electrical and electronic devices, varied transportation equipment, metallurgy and machinery were imported in rapid succession. This introduction of new technology reached its peak between 1955 and 1960 and it was absorbed and put to use in a comparatively short period of time. Products produced with this imported technology initially served to develop the domestic market consisting of 100 million inhabitants, bringing about the GNP growth exceeding 10% throughout the 1960s.

In the meantime, the government provided guidance and support to convert the existing labor-intensive industrial structure, centered on light industry, to a capital- and technology-intensive structure centered on the heavy and chemical industries. While restricting random new entries into industry on the one hand, it paid due attention to the maintenance of the market principle of free competition. The nickname for the Japanese economy, "Japan Inc.," that was bandied about some years ago, may be said to be the proper evaluation of this system of governmental and private cooperation that prevailed in the stage when Japan sought to catch up with the industrially advanced countries. The term "Japan Inc." is used still now, but in most cases, this word seems to be used through misunderstanding of a real state of Japan or for lack of sufficient information on it.

Is this leap forward of the postwar Japanese economy simply an imitation of what industrially advanced countries has already accomplished? Before answering this question, I should like to present you with a very brief description of Japanese history.

It is true that from the historic occasion of the visit of the American fleet led by Commodore Matthew C. Perry in 1853, Japan established relations with America and Europe and developed a modern civilization within a century, exactly half of the 200 years since the Industrial Revolution that were required by the Western world to reach the same goal. But this was not the first international technology transfer into Japan. It was actually the third wave.

The first instance was the technology transfer from the Chinese continent in the 7th and 8th centuries at a time when this marked its climax in Japan. This was the first wave. As you are probably aware, the original form of our written language came from the Chinese continent at this time. Later on, Japan closed its doors to the outside world, but the second wave developed in the 15th-16th centuries. At this time, technology was transferred not only from China but also from various European countries. Firearms came in during this period. In the 16th century, Portugal, where this conference is being held, established contacts with Japan. Its envoy, Saint Francis Xavier, attracted many disciples here. Many words that had their origin in Portuguese are still frequently used by the Japanese.

What should be noted is that despite this transfer, this was a period of isolation for our country. During this time, a fusion took place in Japan of things native and foreign, and unique new things thus came into being. This can serve to explain the reason why Japan, while having a certain homogeneity with the industrially advanced countries of the West, is still a country with a nature of its own. The framework of modern Japan, therefore, consists of a multi-layered structure formed by elements imported through technology transfer and elements developed on its own.

The effects of the postwar technology transfer from America and Europe were enormous, but today's products are no longer blind copies of what was imported. What must not be ignored are the alterations and improvements made to them by Japan.

II. Input and Output Factors that Are the Key to Success in Technology Transfer in the Light of Japanese Experience

We consider that Japan represents the best example of successful technology transfer in the world and throughout history. It cannot be determined immediately whether a type of technology will spred just because it is good. Judging from our experience, the following elements are essential to make a successful transfer of technology.

First, there must be an appropriate difference in levels between countries. Technology, like water, flows from high ground to low ground, but when the difference in levels is too great, it tends to flow past without stopping. There must be an educational level that is sufficiently high to absorb the technology.

I have previously referred to Japanese history. I now wish to add to my remarks, particularly with regard to education. In about the 10th Century, the ability to write was common in the higher levels of Japanese society. This included women, as shown, for example, by "The Tale of Genji" written by Lady Murasaki. This tale is one of the masterpieces in Japanese classical literature and has been introduced to abroad, too. Moreover, in the three centuries between the introduction of firearms and Perry's arrival, farmers, at the bottom of the social ladder, became able to read, write and make simple calculations.

In more recent times, the school attendance rate rose rapidly under the primary education system to reach 95% at the end of the 19th century, a proportion above that existing in European and American countries at that time. This spread of education was a major motive force in the development of Japanese industry. Consequently, attention must be paid to this point in transferring technology to developing countries, a subject I shall discuss later.

Second, the same effect of levels can be said to occur within the confines of a country. There is a need to distribute human resources. In a specific field, when human resources and funds are concentrated in one place creating a shortage in other places, technology transfer to the needy areas does not progress. That is a condition on the input side.

Third, it is important to keep in mind the potential for diffusion of technology. In concrete terms, this means that technology must be marketable and be suited to immediate use. If it is highly sophisticated, its cost becomes high, thereby reducing the inducement to use it. Such unsuitability for transfer can be seen in technology related to space exploration.

Fourth, the technology must be without restrictions. It is natural that classified technology cannot be transferred. For instance, patents, secret know-how and military technology that cannot be made public cannot be considered objects for transfer. Moreover, sophisticated military technology, for example, is often difficult to adapt to civilian or industrial use because of the numerous problems arising from its cost and safety aspects.

The success of technology transfer is inseparable from the characteristics of technology as cited above.

Now in comparing the United States with Japan, we find that 70% of the research and development costs in the U.S. are funded by the government, with more than half devoted to military R & D. In Japan, 70% of the total amount spent on R & D is funded by private enterprise, with the major proportion of the new technology thus obtained being intended for direct civilian and industrial use. Moreover, secret military technology is almost nonexistent in Japan and our sophisticated technology pertains to the field of general private technology.

In addition, Japan's postwar military burden is light compared with that of other countries. This situation is due, in one sense, to heteronomous factors but also to Japanese desire to seek permanent world peace. Today our military budget represents less than 1% of the GNP. The comment that Japan's startling economic development could not have been achieved without taking into account this light defense burden seems appropriate, and we are well aware that we face several grave national security problems. However, to state that Japan is getting a "free ride" in defense burdens seems to me one-sided, and I do not believe, for instance, that other countries expect Japan to acquire nuclear weapons as soon as possible. This is a complex problem that cannot be solved by ordinary means. Consequently, it must be said that there is little military technology in Japan that can be transferred to peaceful use.

What about mammoth scientific technology projects by government agencies and the transfer of their results to industry? First, in the field of space exploration, a meteorological satellite was developed this June. However, because Japan lacked the ability to launch this satellite, the operation was entrusted to the United States and it was lofted from Cape Canaveral. After being adjusted and tested by the National Space Development Agency (NASDA), the satellite is expected to be placed under the control of the Meteorological Agency. In addition, however, space exploration from a purely academic viewpoint has been carried out since 1950 with Tokyo University at its core and with the assistance of industry.

The development of nuclear power has become and urgent task. A nuclear fuel reprocessing plant has been completed and is ready to begin test operations. As is generally known, this matter has now become the subject of diplomatic negotiations between Japan and the United States. In the field of energy, the "Sunshine Project" is now being pushed for the purpose of developing alternate energy sources to replace petroleum. A "Moonlight Project" is also being prepared to devise means to save energy. Joint reasearch between governmental research organizations and private electronics companies has also started on a projcet for the very-large-scale integration of semiconductors (VLSI) with the government providing assistance with part of research funds. But, this is limited only to researches. Industries are pursuing the necessary development under their own funds on a competitive principle with each other.

The predominant interest now is how existing technology, even from other fields, can assist in achieving the objectives of these various development projects. It is still too early to look for its ripple effects upon the other areas. Every possible effort is now being directed rather to the development of technologies required for these projects.

A characteristic feature of the mammoth projects in Japan is that they are principally aimed at being directly utilized for civilian use. What the Apollo Project was for the U.S., and the Concorde was for France and the United Kingdom, the Shinkansen (bullet train) was for Japan. It is also common knowledge that the outstanding shipbuilding technology which produced the huge battleships Yamato and Musashi formed the foundation of the technology needed to build today's economically superior 300,000 and 500,000-ton tankers. It is significant in looking at the situation in Japan today, to note that immediately following the end of the war the wartime engineers and technicians endeavored to transfer the technologies they possessed to civilian use.

III. Technology Transfer from Japan to Developing Countries and the Emergence of Semi-Developed Asian Nations

Today, in quantitative terms, the volume of output of Japanese industrial products such as steel, ships, passenger cars and television sets is among the largest in the world, and these products have attained a top-level worldwide reputation for quality, performance and value. They have gained the utmost confidence among consumers because of their fine finishing, low defect rate, and dependable servicing. The reason for their having achieved this high quality can be found in the unceasing efforts of the Japanese to achieve perfection. Take for example quality control. Japan did not simply import from America the principles of quality control, but contrived various improvements and launched a wide-scale movement for the application of these methods. This has contributed greatly to the excellence of Japanese products.

For instance, the ZE (Zero Defects) movement was launched in Japan 12 years ago. Today 8 million people working in 7,000 plants and factories participate in this movement. Every year, 3,000 worker delegates representing their respective workshops gather for a general meeting. This makes an impressive sight. Such ingenious measures together with the transfer of Western technology are integral factors in raising the quality of Japanese products.

From the standpoint of Japan's geographical position, it is quite natural that Japanese industrial technology is being gradually transferred to neighboring Asian countries. The greatest results achieved so far have been in the Republic of Korea, Taiwan, Thailand and Singapore, followed by Malaysia, Indonesia, the Philippines, Hong Kong and other countries. Among the types of technology transferred are those in the fields of textiles, electrical and electronic products, chemical products and foodstuffs. There are some cases where technology for heavy industiral products of a medium scale such as steel, ships and transportation equipment has been included, but labor-intensive light industry technology is in the lead.

Most of the countries that have been provided with such technology transfers are no longer underveloped nations but have reached the stage of semi-development. The Republic of Korea takes the lead among them. Economic activity in these countries is extremely brisk, their rallying cry being "Catch up with Japan."

Basically, I believe that Japan should freely provide the technology it possesses when requested and herself develop more sophisticated techniques in new fields for her own activities. Our country today still imports more technology than it exports, but the day should not be far off when a balance will be struck in this respect.

Japanese technology is naturally also being exported to Europe and America as well as to those Latin-American countries now at the stage of semi-development and to Arab and African nations.

In the field of technological cooperation with developing countries, the need is increasing for personnel exchange and for individual training. We are learning that the results of technological transfer depend on the adaptability level of the recipient country and how well it is prepared to fulfill the required conditions.

It can thus be said that Japan, which 10 or 15 years ago was in the position of pursuer of the world economic society, is now becoming the country being pursued by these nations.

IV. Building an All-Around Security System and the International Transfer of Technology

A diversification phenomenon has been taking place in world politics in the last few years with a relaxation of international tension through detente and the return of China to international society. On the other hand, the economic environment is also undergoing major change as the result of the stagflation that developed around the time of the oil crisis, the uncertainty prevailing among international currencies and other factors. As a consequence, it appears as if the high postwar tide of technological innovation and economic growth were now ebbing. At the same time, the world and especially the industrially developed countries are facing common tasks as they are confronted with challenges of new dimensions.

The first of these is the question of how to deal with the shortages in resources and energy; second is ensuring and improving public safety through pollution-control and disaster-prevention measures; third is how to deal with the excessive population density of urban areas, and fourth is searching for measures to eliminate the gap between the northern and the southern portions of the globe.