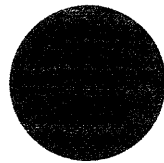
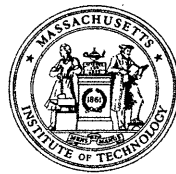


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JAPANESE SCIENTIFIC AND TECHNICAL
INFORMATION AT M.I.T

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MITJSTP 87-01

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Massachusetts Institute of Technology



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MIT-Japan Science and Technology Program
March 1987

EXECUTIVE SUMMARY

At the request of the Chairman and the Provost, the MIT-Japan Science and Technology Program conducted a survey in April 1986 to map professional interactions between MIT researchers and Japan, and to assess the nature and extent of Japanese scientific and technical information at MIT. Three hundred forty-two responses were received from Ph.D. level faculty and research staff in the Schools of Science and Engineering. Ten respondents were selected for follow-up interviews. (Questionnaire attached as Appendix).

It was clear that these interactions are extensive. MIT researchers are frequent visitors to Japan. Overall, 36% have been to Japan in the past five years; the percentage is significantly higher for Engineering School faculty, nearly half of whom recently have been to Japan. The most common reasons for travel to Japan (conferences, presentations) is to disseminate, rather than to create knowledge. Travel to Japan seems to be the single most important determinant of attitudes toward Japanese research and of access to Japanese scientific and technical information.

Although access to this information is a by-product, rather than a purpose of interactions between Japanese and MIT researchers, the MIT research community perceives significant mutual benefit from these interactions. Japanese research results are evaluated highly; MIT researchers report that they cite and distribute the information they receive from Japanese colleagues. They overwhelmingly believe that it is essential to keep abreast of Japanese scientific and technical developments.

JAPANESE SCIENTIFIC AND TECHNICAL INFORMATION AT MIT

Richard J. Samuels
D. Eleanor Westney

MIT-Japan Science and Technology Program
March 1987¹

INTRODUCTION

In the current debate over the apparent erosion of US industrial competitiveness, the ease and skill with which the Japanese have monitored and applied US science and technology have drawn increasing attention. Some of this attention has been couched in terms of outrage that the Japanese have enjoyed open access to America's research community without providing reciprocal access to Japanese research. Other observers have used the Japanese as a stick with which to beat US researchers for their parochialism and US industry for its sluggishness in utilizing its own nation's scientific and technological resources in commercially productive ways.

The arguments have not been informed by much systematic evidence about the flows of scientific and technical information in both directions between the United States and Japan. The few studies that do exist have been endlessly recycled, and are based on outdated counts of English language abstracts and translations of Japanese scientific and technical journals.² They do not address a primary medium of international scientific and technical information transfer, interaction between colleagues collaborating across national boundaries. We believe that systematic information about existing scientific and technical information flows is a necessary condition for the effective formulation and implementation of institutional or national policies concerning US-Japanese interactions in this area.

MIT provides an important setting for research into one part of that interaction-- how US scientists and engineers evaluate, acquire, use, and disseminate Japanese scientific and technical information, and how they perceive the level of reciprocity in information flows. Nearly two hundred

¹ The authors wish to thank Steven Schneider for his able research assistance.

² See Robert W. Gibson and Barbara K. Kunkel, Japanese Scientific and Technical Literature: A Subject Guide, (Westport, CT: Greenwood Press, 1981). Its estimate that no more than 20% of Japanese technical articles are available in English was based upon a 1970's survey and informed much of the discussion that led to the Japanese Technical Information Act of 1986.

Japanese researchers are in residence at MIT in any given year; more than fifty Japanese companies are members of the Institute's Industrial Liaison Program. MIT faculty and researchers are frequent travelers to Japan and MIT maintains an office in Tokyo that facilitates these visits. There are few institutions in North America that provide more opportunities for interaction between the research communities in Japan and the United States. This study is a preliminary effort to study how MIT researchers in science and engineering interact with their Japanese counterparts and how they evaluate that interaction; we hope to infer from these data whether the interaction is a resource or a liability (and for whom) and how the interactions can be improved. We also hope to use this information to facilitate wider dissemination of this information.

THE STUDY

As US researchers and policy makers have become aware of the importance of Japanese scientific and technical information (JSTI), they have engaged in numerous public and private discussions of how to identify, gather, and disseminate that information more effectively. In January 1983, the MIT-Japan Science and Technology Program for the first time brought together industry and government information specialists to discuss JSTI. This stimulated two rounds of Congressional hearings, government conferences, technology assessments, and several private sector initiatives. Ultimately, the Senate authored and Congress passed the Japanese Technical Information Act of 1986. Under the terms of this legislation, the US Department of Commerce now has responsibility for coordinating and expanding the gathering of Japanese scientific and technical information. In January 1987, the White House proposed that the National Science Foundation, the Department of Commerce and the Department of State jointly develop a new initiative in the area of foreign science and technology.

These initiatives have yet to address a key recommendation of the MIT conferees: a systematic review of end users and their demand for Japanese scientific and technical information in order that JSTI collection and dissemination be efficiently and effectively focused.³ In cooperation with the Provost's Office, the MIT-Japan Science and Technology Program has conducted an Institute-wide survey of researchers to identify the means by which its researchers learn about, get access to, and assess the value of Japanese scientific and technical information. Questionnaires were sent to each of the 1,090 Ph.D. level researchers affiliated with the teaching departments and research laboratories of the School of Science and the School of Engineering. Responses were received from 342 persons (31%). Of these respondents, 68% were faculty, and 32% were senior research staff members.

When we analyzed the questionnaire data, we found that one of the most powerful predictors of the evaluation and access to Japanese research was

³ Reginald Gilmor and Richard J. Samuels (eds.). Japanese Scientific and Technical Information in the United States. Washington, DC: National Technical Information Service, 1983.

whether or not the respondent had visited Japan within the last five years. We were concerned that such individuals might have been considerably more likely to take the time to respond to our survey than researchers who had not had such direct exposure to Japanese research. To see how representative of the MIT research community the sample was, we conducted a telephone survey of a random sample of ten per cent of the researchers at MIT to test for the overrepresentation of those who had been to Japan. The telephone survey revealed that such a bias did exist, but that our sample differed from the total population on this variable by under ten percent. We now have an accurate representation of Institute researchers who have been to Japan and of those who have not, and in our analysis of the effects of other variables such as profession and age we controlled for what we have called "the Japan effect."

We followed up the questionnaire with personal interviews with ten respondents who indicated a willingness to take the time for further exploration of some of the key issues: two laboratory directors and two associate laboratory directors, one department head, three full professors, and two assistant professors. The fields they represented included aeronautics and astronautics, civil engineering, electrical engineering and computer science, materials science, mechanical engineering, and physics. Seven of the ten had visited Japan.

GENERAL FINDINGS

It is quite clear from the responses on the questionnaires and in the interviews that Japan is not a technological "black box." Japanese scientific and technical information is readily available, highly valued, and frequently used by the MIT research community. Eighty percent agreed that "it is essential for leading researchers in my field to keep abreast of Japanese scientific and technical information." This was no mere platitude: 80% also claim to have cited Japanese research in their own publications and 27% report that "Japanese research in my field has greatly contributed to my own work."

On the other hand, 66% agree with the statement that "Japanese research in my field involves incremental advances rather than major breakthroughs in knowledge." While this is a significantly smaller group of respondents than that which believed that important work was underway in Japan in their field, still we were puzzled by the way in which the two perceptions seem to contradict each other. One inference is that our respondents expect bigger things from the Japanese research community than they have yet seen. Another is that this is not the denigration of Japanese research one might think. Several interviewees suggested that they were favorably impressed by the incremental nature of research in Japan. One pointed out that in the United States researchers were always hoping to make the "big leap"-- that major discontinuous discovery that would immortalize the researcher-- whereas their Japanese counterparts were able to work cooperatively to advance by degrees. One interviewee likened the US approach to building an

island before considering how to link it to the mainland, while the Japanese approach was to reclaim the land foot by foot.

The sources from which the respondents obtain JSTI are many and varied. Professional journals are the most important (cited as an important source by 84% of respondents), followed by Japanese students and researchers at MIT (77%), conferences in the US (76%), other personal contacts (72%), working papers from Japanese researchers (67%), travel to Japan (59%), MIT libraries (56%), campus visitors (49%), abstracting and indexing services (45%), and industry and trade publications (36%).

Our telephone survey indicated that forty percent of the faculty and more than one-quarter of the research staff have been to Japan in the past five years. Overall, thirty-six percent have been to Japan in this period. The largest group within this sample to have been to Japan for professional purposes in the recent past were engineering school faculty, nearly half of whom responded positively to this question. As noted above, those who responded to our questionnaire were more likely than this to have been to Japan in the recent past: 45% as opposed to 36%.

For those respondents who have recently travelled there, the "pull" of Japan is greater than the "push" of research. Their most common reason for traveling to Japan is to disseminate research results rather than to participate in the creation of new knowledge through collaborative research. Academic conferences (69%) and research presentations (68%) are the most frequently cited reason for travel to Japan. Although many reported that they had been to Japan as visiting faculty (36%) or to do research at a Japanese university (25%), less than two percent of our sample had stayed in Japan more than twelve weeks, suggesting that they were more effective disseminators than creators of scientific and technical information while in Japan.

However, our interviews revealed (and inferences from our survey data suggest), that MIT researchers enjoy substantial benefit from their interactions with Japanese. One materials scientist claimed that he "gets more and better information when visiting (a leading Japanese firm) than when visiting (a leading American firm)" because he has helped train the senior Japanese researchers doing work in that area, and they feel an obligation to provide answers to his questions that Americans do not.⁴ Other interviewees also reported they had developed better information networks with some Japanese than with American firms.

The benefits of interactions with Japanese firms are particularly appreciated in fields such as power systems engineering where, as one interviewee pointed out, US research funding for commercial applications is being squeezed by competition from more lucrative defense-related areas. Japanese firms provide research funding that supports senior researchers and their graduate students. They also supply equipment and company-supported researchers. Most MIT researchers believe that these benefits extend to the

⁴ The names of these firms have been deleted here.

exchange of information, although this sentiment is not overwhelming: Fifty-eight percent of our survey respondents agreed with the statement that "Japanese researchers in my field share their findings as openly as do my other colleagues."

However, despite this perception of openness and reciprocal benefit, we have no evidence that the flow of scientific and technical information is balanced. The extent of the imbalance may vary by field. In some areas where the Japanese are only beginning to develop significant basic research capabilities, such as aerospace, the information flow is, according to one interviewee, "still about 90% from us to them". In areas where the Japanese capabilities are much stronger, our interviewees are a bit more ambivalent. One suggested that the Japanese are being pulled in two directions. On the one hand, "they have more to protect," while on the other hand, their growing sensitivity to "American irritation" makes them more eager than ever to provide information.

There are several reasons why the flow of information may be unbalanced. For one thing, developing collegial relationships with Japanese counterparts is not effortless: 42% of the respondents believe that developing good relationships with Japanese colleagues takes longer than with American colleagues. Our interviewees suggested some of the factors that create difficulties: language (several informants suggested that Americans have a low tolerance for less than fluent English); the need to make efforts to maintain relationships over time; and the need for personal as well as professional reciprocity (e.g. seeing friends and family of Japanese colleagues when they visit Cambridge). A second factor is that Japanese researchers spend much more time studying the publications of US researchers than Americans do studying the work of their Japanese counterparts. One professor pointed out that Japanese researchers often benefit more from interactions because, unlike their American counterparts, they "do their homework." Of his interactions with Japanese academics one engineering professor said, "I have sometimes felt that I was not adequately prepared but I have never felt that they were not being straight with me."

A third set of factors can be subsumed under the rubric of "the culture of interaction." One interviewee recounted several instances where he had come across some interesting material from Japan either in publications or in working papers and had written to the author to ask for further materials, without getting any reply. In Japan such "cold" inquiries, coming without any mediation from a colleague who knows the person who wants the material, are far less likely to produce a response than in the United States. Furthermore, in face to face interactions (which are virtually always conducted in English) the Americans are more likely to feel comfortable talking than the Japanese -- and less comfortable listening. Several observers of informal US-Japanese exchanges among researchers have noted that the Americans are likely to consider a meeting enjoyable and successful if they have held the floor and if their views have been admired and approved. Even Japanese who very much want to reciprocate sometimes find it difficult to get the proverbial word in edgeways. Finally, particularly in interactions involving firms, US researchers are sometimes left feeling exploited in "one-shot" interactions such as ILP visits. One interviewee

recalled agreeing to meet with a researcher from a major Japanese firm, and having five people show up at his door expecting to spend the full day with him. Afterwards, with great ceremony, they presented him with a mechanical pencil, and he received none of the follow-up research reports and information he had expected. In such a situation US researchers are apt to feel either that the Japanese firms are being deliberately exploitive or that they do not understand the norms of interaction.

The Japanese scientific and technical information that does flow into the MIT research community is frequently passed along. The Japanese scientific and technical information MIT researchers receive is passed on to the American research community: 54% have circulated Japanese research reports to their colleagues at MIT, and 40% to colleagues outside the Institute. MIT researchers have used their contacts with Japanese to create forums for disseminating Japanese research more broadly: 51% reported that "researchers in my group/lab make sufficient efforts to learn from Japanese visitors."

In summary, our survey responses clearly indicate a high level of interaction between MIT and the Japanese research community. Moreover, 64% of our respondents indicate a desire to "have more opportunities to find out about Japanese research in my field." Yet, further analysis shows significant variations among groups of respondents that may be important in guiding the interpretation of the findings and drawing out their implications for policy. We assessed the importance of three factors that might affect how MIT researchers get access to, evaluate, and use JSTI: 1) travel to Japan, 2) profession, and 3) age.⁵ We shall explore each in turn.

THE JAPAN EFFECT

Our results reinforced conventional wisdom, viz., that flows of people enhance the flow of information. We have identified a "Japan effect" that influences researchers' perceptions of how to identify, use, and value Japanese scientific and technical information.

One of the most striking findings is that travel to Japan is associated with a broader range of sources of information, especially interpersonal and interactive sources (Table One).

⁵ We explored a fourth variable, discipline. We selected three subsamples, life sciences, materials science, and electrical engineering/computer science, but found no significant variation.

TABLE ONE
 IMPORTANCE OF SOURCES OF
 JAPANESE SCIENTIFIC AND TECHNICAL INFORMATION

SOURCE	TOTAL (n=342)	NOT BEEN TO JAPAN W/IN 5 YEARS (n=188)	BEEN TO JAPAN W/IN 5 YEARS (n=154)
PROFESSIONAL JOURNALS	84%	87%	82%
CONFERENCES IN USA	76	74	79
STUDENTS	77	72	84
OTHER PERSONAL CONTACTS	72	66	80
WORKING PAPERS FROM JAPANESE	67	62	73
TRAVEL	59	39	83
MIT LIBRARIES	56	65	44
CAMPUS VISITORS	49	42	58
ABSTRACTING/ INDEXING SERVICES	45	45	45
INDUSTRY/ TRADE PUBLICATIONS	36	35	37

While all respondents relied upon multiple sources of information about Japanese science and technology, seven out of ten of the respondents who had been to Japan regarded six sources as important; only three sources were important for the same proportion of the researchers who had not been to Japan. More of those who had been to Japan found personal contacts to be a valuable information source: 80% compared to 66% of those who had not travelled. That travel to Japan is an important way to build contacts is further confirmed by the fact that more than one-third of those who had not been to Japan believed that "travel to Japan is an important source of

information about Japanese developments in my field." Moreover, travel is associated with a greater tendency to value MIT-based interpersonal contacts: 58% of those who had been to Japan found campus visitors useful sources (compared to 42% of those who had not been to Japan), and 84% (vs. 72%) valued Japanese students as sources of information. These data, coupled with the interview data and with what we know about the culture of interaction, suggest that those who have been to Japan have both the contacts and the personal knowledge that enable the US researcher to draw effectively on the Japanese who come to MIT. Conversely, those who have not been to Japan are more likely to rely on "passive," published documents for their information on Japanese science and technologies. For them, professional journals were the most important single source of information, and they were much more likely to value the libraries as a valuable information source (65% vs 44%). Travel to Japan is clearly important not only in widening the researcher's range of contacts and in maintaining relationships already established, but also in sensitizing the researcher to the variety of possible ways to keep abreast of developments in Japan.

Not surprisingly, the "Japan effect" also influences the evaluation of Japanese research. The questionnaire contained five items designed to elicit the respondents' views of the strengths of the Japanese research community and the importance of Japanese research to their own work (Table Two):

TABLE TWO
EVALUATIONS OF JAPANESE SCIENTIFIC AND TECHNICAL INFORMATION

EVALUATION	TOTAL (n=342)	BEEN TO JAPAN (n=154)	NOT BEEN TO JAPAN (n=188)
LITTLE IMPORTANT RESEARCH IN JAPAN	10%	6%	14%
ESSENTIAL TO KEEP ABREAST OF JSTI	80	90	73
JAPANESE RESEARCH IS INCREMENTAL	66	58	72
JAPANESE FIRMS ADOPT RESEARCH RESULTS MORE QUICKLY	41	54	31
JAPANESE RESEARCH CONTRIBUTED TO MY OWN WORK	27	30	25

While there is little difference between the two groups on the rejection of the suggestion that there is little important research in their field taking place in Japan, the more positive items exhibited a noticeable "Japan effect." 90% of those who had been to Japan agreed with the statement that "it is essential for leading researchers in my field to keep abreast of Japanese scientific and technical information," while only 73% of those who had not been to Japan agreed. Likewise, 72% of those who had not been to Japan agreed that Japanese advances are "incremental" rather than "major breakthroughs in knowledge." Significantly fewer (58%) of those who had been to Japan share this view. And interestingly enough those who have travelled to Japan are more likely to be impressed by the ability of Japanese firms to apply research findings in commercial products than those who have not. There is, however, little difference in the two groups in the likelihood of believing that Japanese research has made a significant contribution to one's own work.

Travel to Japan also seems to affect the ways in which MIT researchers assimilate and use Japanese research results. In every case we examined, those who had been to Japan are more avid users and disseminators of Japanese scientific and technical information than are those who have not been to Japan. Those with Japan experience are more apt to cite (91% vs. 72%) Japanese research, to take note of others' citations (86% vs. 80%) to pass it along to colleagues within (62% vs. 46%) and outside (51% vs. 31%) MIT, and to encourage students to keep abreast of Japanese developments (69% vs. 44%), than are those without such experience.

It is possible, of course, that the "Japan effect" is precisely that-- an effect rather than a cause: those who already have been exposed to Japanese contacts and who evaluate Japanese research highly are probably more likely to seek out opportunities to travel to Japan than are those without such exposure. We therefore asked our interviewees about this point. They indicated that travel to Japan is an important independent variable. Two of the seven interview respondents who had been to Japan had relatively little exposure to Japanese research before their first trip. As a result of their observations there, the research contacts they made, and the research efforts they observed, they developed an interest in following up on what they had learned, and went out of their way to cultivate Japanese contacts and follow Japanese research papers. Those who were frequent travellers to Japan emphasized that every trip had been useful. One went to far as to say, "Every time I've gone, the experience has been well worth it and has had a major influence on my work here and my understanding of problems."

THE PROFESSIONAL EFFECT

We divided our respondents by profession to explore what effect, if any, scientific versus technical orientations might have on evaluations and use of Japanese scientific and technical information. We grouped our respondents as scientists or engineers based upon two factors. First, we sorted the respondents by their current research affiliation within MIT. Researchers working in laboratories, departments, and centers affiliated with the School of Engineering and in those affiliated with the School of Science were grouped accordingly. Respondents who did not provide a current research affiliation were classified by their field of doctorate.

The data suggest some ways in which professional norms affect attitudes and behavior vis-a-vis JSTI. This is evidenced first in patterns of travel to Japan. As noted above, engineers are more likely than scientists to travel to Japan. Of the 217 engineers who responded to the questionnaire, 110 (51%) had travelled to Japan within the last five years; of the 125 scientists, 44 (36%) had done so.

There were some interesting differences in the reasons for travel (Table Three):

TABLE THREE

REASONS FOR TRAVEL TO JAPAN
SCIENTISTS VERSUS ENGINEERS

REASON	SCIENTISTS (n=44)	ENGINEERS (n=110)
ACADEMIC CONFERENCE	77%	87%
PRESENTING RESEARCH	77	68
ILP/MIT ACTIVITIES	44	75
PERSONAL VISIT	48	43
RESEARCH WITH JAPANESE COLLEAGUES	34	46
VISITING FACULTY/ RESEARCHER AT JAPANESE UNIVERSITY	27	41
CONSULTING	16	13
STUDY GROUP	9	8
TO RECEIVE AWARD	7	5
FUND RAISING	2	9

Engineers were much more likely than scientists to travel to Japan through ILP; they were also more likely to go for research with Japanese colleagues and to function as visiting faculty. This suggests that engineers are more likely to travel to Japan than scientists because they are provided more opportunities to do so, rather than because they are more aggressive in seeking out such opportunities. This is indicative of Japanese patterns of borrowing and reliance upon foreign experts. The Japanese are now widely credited with leadership in many areas of applied science and engineering, yet this is precisely where their reliance upon foreign experts remains highest. One must tentatively conclude that Japanese remain willing to learn, even in areas of great strength; this suggests a comparison to American patterns in which borrowing gave way to a pervasive complacency--the so-called "Not-Invented-Here Syndrome"--by the middle part of this century.

As our total sample contained more engineers than scientists and as engineers are more likely to have travelled to Japan, what we have identified as a "Japan effect" might in fact be an outcome of different professional patterns rather than a direct effect of travel itself. For example, engineers may be more likely than scientists to rely on personal contacts, ILP visitors, and Japanese students to remain abreast of JSTI, in preference to libraries and publications. Therefore the "Japan effect" that found interpersonal sources more important for those who had travelled may simply be a result of the preponderance of engineers among the travellers. Table Four demonstrates that this is not the case:

TABLE FOUR

SOURCES OF JAPANESE SCIENTIFIC AND TECHNICAL INFORMATION
SCIENTISTS VERSUS ENGINEERS
(CONTROLLING FOR TRAVEL TO JAPAN)

SOURCE	BEEN TO JAPAN		NOT BEEN TO JAPAN	
	SCIENTISTS (n=44)	ENGINEERS (n=110)	SCIENTISTS (N=81)	ENGINEERS (n=107)
PROFESSIONAL JOURNALS	89%	77%	90%	84%
CONFERENCES IN US	89	78	78	71
STUDENTS	89	82	73	71
OTHER PERSONAL CONTACTS	80	80	68	65
WORKING PAPERS FROM JAPANESE	66	76	69	57
TRAVEL	86	81	44	36
MIT LIBRARIES	46	44	67	64
CAMPUS VISITORS	43	64	31	50
ABSTRACTING/ INDEXING SERVICES	41	46	46	43
INDUSTRY/ TRADE PUBLICATIONS	27	41	24	43

There is clearly a discipline effect on some sources: industry and trade publications are valued as sources by more engineers than scientists, as are campus visitors; more scientists value professional journals. However, for the most part the effect of discipline is much less important than the "Japan effect." Scientists and engineers who have been to Japan are equally likely to value highly personal contacts, whereas their counterparts who have not been to Japan assign them much less importance. The finding that those who have been to Japan are better able to tap MIT contacts for JSTI (students and campus visitors) holds across the professions. Scientists and engineers who have not been to Japan are equally likely to find the libraries a valued source of JSTI; those who have been to Japan are equally likely to downgrade their importance.

One of our interviewees said that in science (as opposed to technology-related fields) there was a fairly free flow of information across borders; it is relatively easy, he said, to keep track of what is happening in any subfield. One does not ask, "What is happening in Japanese science?" any more than one asks what is happening in German science. One asks what is happening in my field. The responses from scientists and engineers on the importance of working papers confirms this. Working papers from Japanese colleagues are as important for scientists who have not been to Japan as for those who have. For engineers, in contrast, the importance of working papers shows a strong "Japan effect," suggesting that personal contacts have far more importance in facilitating the flow of information across borders in engineering fields than in science. In general, the finding that travel to Japan significantly broadens the range of sources of JSTI and improves the researcher's ability to utilize personal contacts holds across the disciplines.

Responses to our questionnaire indicate some interesting differences between scientists and engineers in how they evaluate Japanese research. However, these differences like those in the previous table, add further weight to the importance of the "Japan effect."

TABLE FIVE

EVALUATIONS OF JAPANESE SCIENTIFIC AND TECHNICAL INFORMATION
 SCIENTISTS VERSUS ENGINEERS
 (CONTROLLING FOR TRAVEL TO JAPAN)

EVALUATION	BEEN TO JAPAN		NOT BEEN TO JAPAN	
	SCIENTISTS (n=44)	ENGINEERS (n=110)	SCIENTISTS (n=81)	ENGINEERS (n=107)
LITTLE IMPORTANT RESEARCH IN JAPAN	4%	6%	16%	12%
ESSENTIAL TO KEEP ABREAST OF JSTI	93	88	70	75
JAPANESE RESEARCH IS INCREMENTAL	48	63	74	70
JAPANESE FIRMS ADOPT RESEARCH RESULTS MORE QUICKLY	36	61	22	37
JAPANESE RESEARCH CONTRIBUTED TO MY OWN WORK	27	31	27	23

On the first three measures of evaluation the similarities in the responses of the scientists and engineers who have not been to Japan are marked. On each of these items, the difference across the disciplines was much less than the difference within each group between those who had been to Japan and those who had not. And interestingly enough the Japan effect seems more marked for scientists than for engineers: there is greater similarity in the responses between the two groups of engineers than between the two groups of scientists. Travel to Japan apparently does much to raise the respect that scientists have for Japanese research, both in terms of its general importance to the field and in terms of its capacity for innovative rather than simply incremental research. On the other hand, the Japan effect on the last two items is greater for the engineers. Engineers who have been to Japan are much more likely to be impressed by the ability of Japanese firms to commercialize research results and to use Japanese research in their own work. This last finding bears emphasis: engineers who have not been to Japan are less likely than scientists to build on Japanese research in their own work, but engineers who have travelled to Japan are more likely to do so. This reinforces the pattern that emerged in the previous table: the flow of scientific information from Japan to the United States is more

general and less linked to personal contacts than the flow of engineering research.

We see further evidence of this in Table Six:

TABLE SIX

ACCESS TO JAPANESE RESEARCH - SCIENTISTS VERSUS ENGINEERS
(CONTROLLING FOR TRAVEL TO JAPAN)

	BEEN TO JAPAN		NOT BEEN TO JAPAN	
	SCIENTISTS (n=44)	ENGINEERS (n=110)	SCIENTISTS (n=81)	ENGINEERS (n=107)
BEST JAPANESE RESEARCH SOON PUBLISHED IN ENGLISH	91%	58%	74%	57%
JAPANESE OPENLY SHARE	66	63	61	51
OUR LAB LEARNS FROM JAPANESE VISITORS	50	53	61	43
RELATIONSHIPS WITH JAPANESE TAKE LONGER	48	44	33	43
I KNOW HOW TO GET JSTI	86	65	69	51
WANT MORE OPPORTUNITY TO GET JSTI	57	74	51	66
JSTI EASIER TO ACQUIRE FOR MIT RESEARCHERS	25	32	17	12
EXTRA EFFORTS NEED TO OBTAIN JSTI	34	51	32	47

Scientists are much more inclined than engineers to agree with the statements that "The best research in my field is published very quickly in English," and "If I need Japanese research results I know where to get them." Moreover, scientists who have been to Japan are significantly more confident than those who have not been to Japan that the best research is available in English and that they know how to get access. This suggests that in scientific fields personal observation of Japanese research lessens the suspicion that important work in Japan is not reported in English. For engineers, however, there is no difference between those who have been to Japan and those who have not in the perception that the best Japanese

research is soon published in English; only slightly over half of the respondents in each category agree that it is. On the other hand, engineers who have travelled to Japan are more likely than those who have not to perceive their Japanese counterparts as openly sharing their information. It is therefore hardly surprising that engineers are more likely than scientists to believe that extra efforts are necessary to obtain Japanese scientific and technical information and to desire more opportunities to gain access.

There is a clear Japan effect in the responses to the item, "I believe MIT researchers find it easier to get timely access to Japanese research results than researchers elsewhere." While only a minority of the total sample agree with this statement (22%), those who have been to Japan, both engineers and scientists, are significantly more likely to perceive "the MIT advantage."

Finally, we note that engineers, particularly those who have been to Japan, are more likely than scientists to circulate Japanese research reports within MIT and to colleagues elsewhere. The "Japan effect" is particularly striking on the third measure in Table Seven below: engineers who have not been to Japan are less likely than scientists to encourage their students to "keep abreast" of Japanese research, but those who have been to Japan are much more likely to do so.

TABLE SEVEN

DISSEMINATING JSTI: SCIENTISTS VS. ENGINEERS
(CONTROLLING FOR TRAVEL TO JAPAN)

	BEEN TO JAPAN		NOT BEEN TO JAPAN	
	SCIENTISTS (n=44)	ENGINEERS (n=110)	SCIENTISTS (n=81)	ENGINEERS (n=107)
HAVE PASSED JSTI TO MIT COLLEAGUES	61%	63%	43%	49%
HAVE PASSED JSTI OUTSIDE MIT	46	53	28	34
ENCOURAGE MY STUDENTS TO KEEP ABREAST OF JSTI	57	74	46	42

In summary, we have found clear indications that the "Japan effect" holds across both disciplines in terms of the evaluation, access to, and dissemination of Japanese scientific and technical information. It does not, however, always affect both disciplines to the same degree and in the same direction.

THE GENERATIONAL EFFECT

We further divided our sample into three generational cohorts to examine the effect of age on perceptions and utilization of Japanese science and technology. Members of the most senior cohort (48 in all) were awarded their doctorates before 1955. They are all full professors and senior research staff at MIT. The second group was the largest of the three (178 persons) and was comprised of those who received their doctorate between 1956-1975. This group included many full professors and most tenured associate professors, as well as principal research staff. Those in the youngest cohort (116) received their doctorates after 1976, and included all the assistant professors and most untenured associate professors.

Younger scholars are significantly more apt to study Japanese than are their senior colleagues. More of our respondents who received their PhD after 1975 have studied Japanese (16) than in the other two cohorts combined (14). This seems easily attributable to the suddenness with which Japanese technical literature and Japanese colleagues have become prominent across

disciplines. Yet any eager overinterpretation of the relationship between age and study of Japanese must be tempered by several points. First, the relative number of both younger and older MIT researchers who have studied Japanese is extremely small. Ninety-one percent overall and 86% of even this youngest generation have never studied Japanese at all. Second, our absolute number of respondents who have studied Japanese at some minimal level offers little correspondence to the 100% of Japanese researchers who have completed at least 15 years of English language study. This notwithstanding, the willingness of MIT scientists and engineers to study Japanese and the receptivity of younger researchers to active sources of Japanese scientific and technical information should combine to produce a significantly better informed and even more active MIT research community in the area of Japanese scientific and technical information.

While more younger scholars have studied Japanese language, travel to Japan is strongly and significantly correlated with seniority. Nearly 60% of the most senior cohort has been to Japan in the past five years, compared to 31% of junior researchers. That the number from the younger cohorts was as high as one-third indicates that seniority alone does not determine travel to Japan, but seniority (which presumably indicates professional visibility and status) is clearly important. The differences in the patterns of travel are important, because the Japan effect varied by cohort, often in unexpected ways.

There is no significant overall generational difference in the extent to which MIT researchers respect the quality of Japanese research (for example, 73% of the most senior, 84% of the middle group, and 78% of the most junior cohort agreed with the statement that "it is essential for leading researchers to keep abreast of Japanese scientific and technical information"). However, there were some interesting differences across the three cohorts in the strength and direction of the "Japan effect" on these measures.

TABLE EIGHT

EVALUATIONS OF JAPANESE SCIENTIFIC AND TECHNICAL INFORMATION
BY GENERATIONS
(CONTROLLING FOR TRAVEL TO JAPAN)

EVALUATION	BEEN TO JAPAN			NOT BEEN TO JAPAN		
	SENIOR (n=29)	MIDDLE (n=89)	JUNIOR (n=36)	SENIOR (n=19)	MIDDLE (n=89)	JUNIOR (n=80)
LITTLE IMPORTANT RESEARCH IN JAPAN	7%	5%	8%	32%	9%	15%
ESSENTIAL TO KEEP ABREAST OF JSTI	90	90	89	47	79	73
JAPANESE RESEARCH IS INCREMENTAL	48	63	56	58	66	81
JAPANESE FIRMS ADOPT RESEARCH RESULTS MORE QUICKLY	52	60	42	21	33	31
JAPANESE RESEARCH CONTRIBUTED TO MY OWN WORK	45	29	19	21	26	25

The most striking feature of Table Eight is the homogenizing influence of the Japan effect on the respect accorded Japanese research. On the first two items, among those who have not been to Japan the senior cohort is clearly much more likely to be skeptical of the value of Japanese research. However, there was very little disagreement among the cohorts of those who have travelled to Japan: all evaluated Japanese research very highly. The power of the Japan effect on the senior cohort is demonstrated even more clearly by the last item: senior researchers who have travelled to Japan are more than twice as likely to consider that Japanese research has contributed to their own work than senior researchers who have not had that experience. Indeed, this group contains more individuals who have built on Japanese research than does any other.

There were, however, two items on which the Japan effect increased variation among cohorts. One is the assessment of the commercialization capacities of Japanese firms. In keeping with the previous analyses of the Japan effect, those who have travelled to Japan are more likely to be impressed by the ability of Japanese firms to adopt research results quickly. However, the "junior" cohort which has travelled to Japan is less likely to be impressed than their more senior colleagues. More striking is

the response pattern on the last item: junior researchers who have been to Japan are the group least likely to credit Japanese research with a contribution to their own work. They are even less likely to do so than researchers in their own cohort who have not been to Japan. We believe that this pattern is related to the findings on access:

TABLE NINE

ACCESS TO JAPANESE RESEARCH - GENERATIONAL COHORTS
(CONTROLLING FOR TRAVEL TO JAPAN)

	BEEN TO JAPAN			NOT BEEN TO JAPAN		
	SENIOR (n=29)	MIDDLE (n=89)	JUNIOR (n=36)	SENIOR (n=19)	MIDDLE (n=89)	JUNIOR (n=80)
BEST JAPANESE RESEARCH SOON PUBLISHED IN ENGLISH	66%	71%	61%	84%	64%	60%
JAPANESE OPENLY SHARE	66	66	50	58	57	51
OUR LAB LEARNS FROM JAPANESE VISITORS	48	53	53	47	52	50
RELATIONSHIPS WITH JAPANESE TAKE LONGER	38	46	47	42	43	34
I KNOW HOW TO GET JSTI	76	72	64	53	65	54
WANT MORE OPPORTUNITY TO GET JSTI	66	71	67	47	58	64
JSTI EASIER TO ACQUIRE FOR MIT RESEARCHERS	14	38	22	16	12	18
EXTRA EFFORTS ARE NEEDED TO OBTAIN JSTI	28	49	53	26	42	43

While the senior researchers who have travelled to Japan are more likely to be pleased with the access they receive than their colleagues who have not travelled there, the junior researchers who have been to Japan are less likely to be pleased than their counterparts who have not visited Japan. Senior researchers who have visited Japan are less likely than their counterparts at home to believe that it takes longer to develop

relationships with Japanese colleagues than with Americans, but junior researchers who have visited are more likely to believe it. Even more striking, senior researchers who have travelled are more likely than their non-travelling counterparts to believe that the Japanese researchers share information as freely as Americans, but junior researchers are no more likely to agree with this than their counterparts who have not been to Japan. Indeed of all six groups, the group which has the lowest level of agreement with the "openness" question are the junior researchers who have been to Japan.

None of our interviewees reflected this perspective, although several suggested partial explanations for it. One had found that senior Japanese researchers tended to be more open than younger researchers, although he was not sure of the reason. And several felt that in their experience researchers in Japanese firms were more likely to be open in a situation where they too wanted information: a reciprocal bargaining situation was likely to produce more open interactions than simply a request for information. Japanese researchers may therefore indeed be more open with senior researchers, whom they perceive to be more likely to have something important to offer. Another factor may be that within the Japanese research community much more respect is paid to seniority than in the United States, with some reason: senior researchers (particularly at elite institutions) are more likely to have extensive networks and to be useful sources of information than their more junior colleagues.

That senior researchers do indeed have better access to Japanese information is suggested by the response pattern on the item "If I need Japanese research results, I know where to get it." The group that was most confident on this measure was the senior researchers who have been to Japan. Of those who had travelled to Japan, it was the junior group that had the lowest level of agreement. And it was this group that was most likely to agree with the statement, "It requires extra effort to obtain JSTI."

These findings have important implications for the Japanese research community. As the interactions between Japanese and Western researchers become increasingly oriented to collaboration, the Japanese research community will have to develop ways of integrating junior researchers into the exchange networks more effectively if precious opportunities for scientific exchange and progress are not to be lost. Indeed the junior researchers who currently express skepticism about Japanese openness and about the ease of access, in spite of first-hand experience in Japan, may not revise their opinions as they gain seniority. The difficulties they experience at the junior level may color their perceptions for years, at great long-term cost to productive research interactions between the two countries. It is clear that while increasing interaction among researchers is essential to build the foundation for productive exchange, it may require some mutual adjustments in communication patterns and expectations.

The analysis to date has somewhat neglected the middle cohort -- the largest -- because they tend to fall between the senior and junior groups in most responses. However, on dissemination measures, they are the most

active, especially in passing JSTI on to colleagues both within and beyond MIT:

TABLE TEN

DISSEMINATING JSTI: GENERATIONAL COHORTS
(CONTROLLING FOR TRAVEL TO JAPAN)

	BEEN TO JAPAN			NOT BEEN TO JAPAN		
	SENIOR (n=29)	MIDDLE (n=89)	JUNIOR (n=36)	SENIOR (n=19)	MIDDLE (n=89)	JUNIOR (n=80)
HAVE PASSED JSTI TO MIT COLLEAGUES	55%	67%	56%	32%	54%	41%
HAVE PASSED JSTI OUTSIDE MIT	41	53	53	32	34	29
ENCOURAGE MY STUDENTS TO KEEP ABREAST OF JSTI	72	72	58	32	45	45

Again, we see the disquieting pattern of the junior cohort of those who have been to Japan ranking considerably below their more senior colleagues, this time in terms of encouraging their students to keep abreast of Japanese research.

CONCLUSIONS

Scientists and engineers at MIT overwhelmingly agree it is essential for them to keep abreast of developments in Japan in order to stay on top of research in their fields. Evaluations of Japanese scientific and technical developments are uniformly high across each subgroup we examined: scientists and engineers, those who have and who have not been to Japan, and across age cohorts. These evaluations are underlined by the consistently high level of personal interaction with Japanese colleagues that is enjoyed by MIT researchers.

Although the high level of interaction between MIT researchers and Japanese colleagues is mutually beneficial, the distribution of these benefits is hard to determine. The interaction that MIT's scientists and engineers have (and highly value) with Japanese researchers provides useful information about Japanese scientific and technical information. Yet, we

see these interactions seem more often designed to collect than to create knowledge. This means that the collection of JSTI by MIT researchers, while considerable in scope and breadth, is an incidental (if not unintended) consequence of their interactions with Japan.

Other benefits are related to the quality and breadth of the information networks that include MIT and Japanese researchers. These networks provide more than just information and research results, they provide alternative access to funding as well as equipment and researchers themselves. These networks are therefore valuable even where the Japanese have yet to make major research contributions. One interviewee in Aerospace Science pointed out that "the Japanese have phenomenal learning curves" and that now that aerospace has been identified by Japanese government and industry as a research target, their contributions are likely to grow rapidly. Contacts developed now will probably pay off handsomely in the coming years, and unless US researchers begin to keep tabs now on what the Japanese are doing, "they are going to be very surprised in about ten years."

Travel to Japan was clearly the glue that bound MIT researchers to this network and that ensured considerably higher and more reciprocal levels of information flows. In fact, we learned from the sub-sample of engineers that their travels to Japan considerably enhanced their ability to use MIT resources for JSTI, including students and ILP visitors. Our finding that the youngest cohort was the most difficult to convince of the value of JSTI was unexpected, but enlightening.

It follows from this that the benefits of interactions, palpable though they are, are less than they might otherwise be. It is therefore especially unfortunate that MIT researchers do not recognize how important a resource their potential and actual access to JSTI really is, and may not exploit the potential as well as they could and should.

10. Have you been to Japan in the past five years for:
(Please feel free to indicate multiple reasons for any visit)

	YES	NO
a. Academic Conference	[]	[]
b. ILP/MIT Activities	[]	[]
c. Joint Research with Japanese Colleagues	[]	[]
d. Visiting Faculty/Researcher at Japanese university/laboratory	[]	[]
e. Presenting Research	[]	[]
f. Personal visit to Japanese Colleagues	[]	[]
g. Study group/tour	[]	[]
h. Consulting	[]	[]
i. Fund raising	[]	[]
j. Receiving Award	[]	[]

11. Which of the following applies to you:

- [] I have never studied Japanese.
 [] I have studied conversational Japanese.
 [] I use Japanese professionally.

- I. HOW IMPORTANT ARE THE FOLLOWING SOURCES OF INFORMATION ABOUT JAPANESE DEVELOPMENT IN YOUR FIELD?

	<u>Very Important</u>	<u>Somewhat Important</u>	<u>Unimportant</u>
a. Travel to Japan	[]	[]	[]
b. Japanese graduate students and visiting researchers	[]	[]	[]
c. ILP and other campus visitors from Japanese firms	[]	[]	[]
d. Professional conferences in the United States	[]	[]	[]
e. Abstracting and Indexing Services	[]	[]	[]
f. MIT Libraries	[]	[]	[]
g. Professional Journals	[]	[]	[]
h. Industry/Trade Publications	[]	[]	[]
i. Working papers sent by Japanese researchers	[]	[]	[]
j. Other personal contacts	[]	[]	[]

