2 Improved Research Institute Productivity due to the Contribution of Foreign Researchers

p.26

If Japanese universities and research institutes do not supplement their excellent research capabilities with foreign researchers, then they will not be able to compete internationally. A very high international character is needed to create a world class research institute/center, and it is very meaningful to refer to research institutes that have demonstrated success in inviting and training foreign researchers to improve research productivity. This paper analyses various data concerning the International Center for Materials Nanoarchitectonics (MANA) program and its predecessor, the International Center for Young Scientists (ICYS) program, at the National Institute for Materials Science (NIMS) as part of the World Premier International Research Center Initiative (WPI). The results of the analysis show that a higher ratio of foreigners was accompanied by a much higher world ranking (number of citations) for the host institute. In the past few years, the number of paper citations in the field of materials science has jumped from a rank of 18 before the start of the ICYS program to 4th and 5th place. Both the ICYS and MANA programs have covered a wide range of scientific fields and have done much to increase the ratio of foreign researchers. This experiment to bring exceptional foreign researchers to Japan to work has clearly resulted in the production of high-quality research papers.

Contributing to this success have been career paths for the researchers that allow them to move up to better positions at research institutes in Japan and abroad or to be hired by the host institute as permanent employees; the provision of a comfortable lifestyle for foreigners; and efforts to remove linguistic barriers and teach foreigners about Japanese culture. While the number of visitors to Japan from abroad dropped steeply after the Great East Japan Earthquake, over 90% of foreign researchers in these projects returned to work.

There are misgivings concerning the weak global presence of Japanese research institutes and those in emerging countries that are catching up, and Japan needs to work on making its research institutes more competitive internationally.

(Original Japanese version: published in March/April 2012)

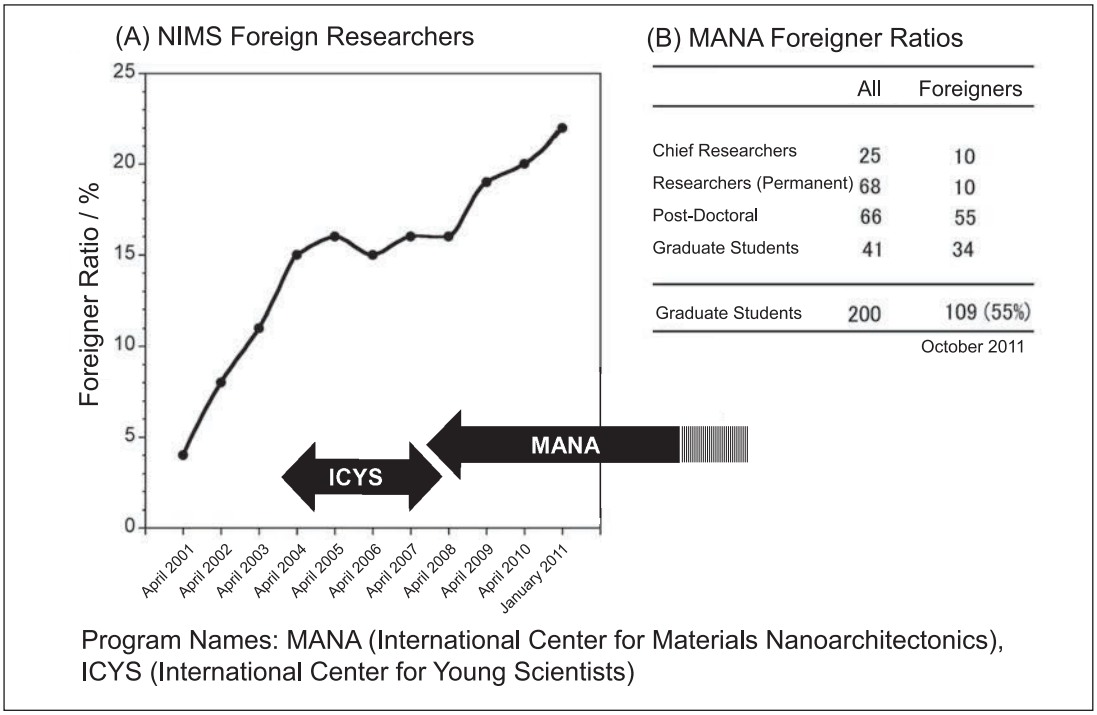

Figure : NIMS Foreign Researcher Ratios (A) and MANA Foreign Researcher Breakdown (B)
(Note: ICYS was downscaled in late-2007 and made part of MANA.)

Compiled by the Science and Technology Foresight Center

2

Improved Research Institute Productivity due to the Contribution of Foreign Researchers

Katsuhiko ARIGA
Affiliated Fellow
Hidenori GAMO
Green Innovation Unit

1 Introduction

If Japanese universities and research institutes do not supplement their excellent research capabilities with foreign researchers, then they will not be able to compete internationally. Although supplementation with foreign researchers is helped by individual researchers' efforts, in addition to arrangements such as systems that assist foreigners, passive efforts that wait for foreign researchers to come on their own initiative have not necessarily successful. Organizational and proactive efforts, plus the accumulation of detailed knowledge on how to deal with implementation-related problems, are in need. At present, research institutes have not built up this body of knowledge and, if they do not change, their efforts will only continue to grope in the dark. One way to make a breakthrough in solving these problems would be to show research institutes examples of how others have enjoyed success by inviting and training foreign researchers, and for these institutes to take note.

For example, the National Institute for Materials Science (NIMS) has an extremely high ratio of foreigners for a Japanese research institute. Two programs are a big reason for this: the International Center for Young Scientists (ICYS), and the International Center for Materials Nanoarchitectonics (MANA), which inherited the knowhow of the former. This report will compile numerical data on these programs—i.e. foreign researcher trends and career paths and how they have improved research at institutes—and formulates ways to treat foreign researchers. It will then extract conditions for research institutes to attract foreign researchers. Furthermore, this report will discuss how a high ratio of foreigners correlates to a research institute enjoying greater productivity by considering ways to improve research quality, such as the number of research paper citations. Moreover, it will inquire into frameworks needed in times of emergency, in addition to data on the state of foreign researchers' visits to Japan before and after the Great East Japan Earthquake, and on their flight from and subsequent return to Japan.

2 The Need for More Foreign Researchers and the Benefits Thereof

2-1 Requirements for a World Class Research Center

We know that it takes a very international nature to create a world class research institute/center. For example, the final conclusion of the Study on the World's Top Class Research Centers in the U.S.[1] finds that what is needed to become a world class research center is to "have the ability to attract top class, superior talent from around the world." According to this report, a point shared by a representative class of research centers with diverse characteristics participating in the study is that "world top class research centers make themselves attractive so that top talent from around the world (including engineers and graduate students, not only researchers), not just those from the same country, want to research and work there." Top class American research centers have scouted the best talent and recruited them. As a result, they have made their institutes more international. Paradoxically, the appropriate line of thought may be that a world class center cannot be made in a location that lacks an international setting. Thus, we need to push forward with programs in Japan such as the World Premier International Research Center Initiative (WPI) in order to foster highly productive research institutes that can compete globally.

2-2 Stimulating Local Internationalization ~ Expectations from Tsukuba City ~

Having more foreign researchers not only benefits a research institute/center: it also helps the surrounding community. According to the "Proposal to Make Tsukuba Science City an International Center"[2] from Tsukuba City, an approach of "recruiting talented minds from around the world, producing advanced research and using those results for business development" has reportedly produced major results. The Declaration also states: "It is common knowledge that in order to make a project successful, it is essential to have an environment in which foreign researchers and their families, etc. can live comfortably, in addition to a top caliber setting." Creating an international research center/institute does more than just deal with specific problems such as making research more productive: it also makes a great contribution throughout the surrounding community, rather than simply answering that community's needs and expectations.

3 Purposes of Research Programs Presented

This paper cites programs from the World Premier International Research Center Initiative (WPI)—in particular the International Center for Materials Nanoarchitectonics (MANA) and its predecessor, the International Center for Young Scientists (ICYS)—as examples of productive programs to build research organizations with a high ratio of foreigners. To start, let us first discuss the purpose of each of these programs.

3-1 Purpose of the World Premier International Research Center Initiative (WPI)

The WPI program was started up in 2007 to create world class research centers in Japan. Here the reader will find a brief introduction to the purpose behind the WPI's establishment. (A more detailed description can be found at the WPI website.) The "Message from Program Committee of the World Premier International Research Center (WPI) Initiative" gives the following intent and expectations for this research support program.[3]

"Over recent years, global competition in recruiting the best and brightest researchers has intensified. To maintain and improve Japan's scientific and technological standing, we will need to position ourselves within the global flow of outstanding human resources while creating research platforms that will naturally attract and amass such human resources in Japan. Given this imperative, it is the aim of the WPI Initiative to establish research centers of a caliber that will win high esteem throughout the world for the outstanding results they produce. Like Bio- at Stanford University, the Robotics Institute at Carnegie Mellon University, Janelia Farm at Howard Hughes Medical Institute (HHMI), or MRC Laboratory of Molecular Biology in the United Kingdom, these research centers should be capable of attracting frontline researchers from around the world and of advancing research that integrates cutting-edge fields while pioneering new domains of scientific pursuit. Doing so will require the realization of high level of research, done by physical assembly of outstanding researchers over a critical mass, and an excellent research environment. The WPI Initiative will provide financial support for measures aimed at realizing such a research environment free of conventional systemic constraints and achieving a critical mass of outstanding researchers in fields in which Japan's expertise excels. In this sense, it should be understood that this program is of a completely different nature from the usual funding programs operated mainly to provide support for research projects."

3-2 Purpose of the international Center for Material Nanoarchitectonics (MANA)

A part of the WPI program, the International Center for Materials Nanoarchitectonics (MANA) program has been adopted by Tohoku University, the University of Tokyo, Kyoto University, Osaka University (and later Kyushu University), in addition to one incorporated administrative agency: the National Institute for Materials Science. The purpose of MANA is to create international research centers that produce new paradigms in nanotechnology and materials science. This research center's vision is given in the proposal below.[4]

"However, doubt as to whether nanotechnology has made the expected progresses has recently been cast. This reflects the recent recognition of materials researchers that some breakthrough is necessary for nanotechnology to break out of the shell of nanoscience to become a truly practical technology. Nanoscience and nanotechnology have been developed

as a science or technology in limited nanospace. Demonstrations that have surprised material scientists have been presented one after another; however, these concerned only a small number of atoms or molecules in limited spaces at the nanoscale. However, for practical applications, the scaling up or improvement of the creation and fabrication methods and the organic integration and mutual linking of individual functional molecules and structures are required. We call this technological system "nanoarchitectonics*", and explore it at this research center. We will explore new paradigms for materials research on the basis of nanoarchitectonics, which is based on the above-described technological development, and create innovative materials that will enable the development of the new technologies required for sustainable growth in the 21st century."

3-3 Purpose and Significance of the International Center for Young Scientists (ICYS)

Since 2003, the National Institute for Materials Science has been implementing the International Center for Young Scientists (ICYS) program, the predecessor to the above-mentioned MANA program that built the foundation upon which MANA is run. The ICYS program provided instruction to competent young researchers regardless of their nationality. Its purpose was as below.

"This program has taken up the issues addressed by the FY2003 Strategic Research Centers Development (Super COE) program to accomplish the program's purpose, which is to bring together highly creative young researchers from around the world, transcend national and linguistic differences and create an appealing environment in which they can immerse themselves in independent research based on their own ideas, thus systematically producing research results by optimally demonstrating those young researchers' abilities and blending different fields of study and cultures."

In other words, one could say that the purpose of the ICYS program—in contrast to MANA's goal of creating a global nanotechnology and materials science center in a very international environment—was to recruit the international talent that make up the heart of such a center and to foster educational knowhow.

4 Data Showing Research Program Results

4-1 Higher Ratio of Foreigners ~ Tsukuba City Research Institute Foreigner Ratios ~

First, Table 1, showing the ratio of foreigners at public research institutes in Tsukuba City, offers an objective look at the situation. Although the figures are affected by the size of the institute in question, we can see from Table 1 that the National Institute of Materials Science (NIMS), the National Institute of Advanced Industrial Science and Technology (AIST) and the High Energy Accelerator Research Organization (KEK) have a notably higher number of foreign researchers. The authors believe that compared to institutes that are relatively limited to narrow subjects or matters relating to Japan's land and meteorology, the AIST (which deals with science and technology in a more general sense), the KEK (which is founded on facilities and original technologies with widespread potential applications) and the NIMS (which deals with materials science and nanotechnology, subjects that countries around the world are engaged in) are comparatively more receptive to accepting foreigners. However, the AIST has around three times as many total researchers as the NIMS, giving the latter an overwhelmingly higher ratio of foreign researchers. Meanwhile, the NIMS is engaged in science in a wide range of fields, and its high ratio of foreign researchers demonstrates, as shown in Figure 1, the effect of the ICYS and MANA programs. Within the MANA program by itself, over half the researchers are foreigners. One could perhaps speculate that there is no other setting like this at any other research institute in Japan. We can see that a combination of both the ICYS and MANA programs has played a major role in raising the ratio of foreign researchers to a level unseen elsewhere in Japan.

4-2 Improving Research Activity

This is how the authors would like to prove, from a number of concrete numerical data sets concerning the present state of affairs, that an environment with a high ratio of foreign researchers leads to improved research productivity. Table 2 shows a world ranking of citations from Thomson Reuters' Essential Science Indicators in the materials science field, in which

Table 1 : Foreigners at Tsukuba City Public Research Institutes (as of March 2011)

Research Institute	Foreign Researchers
Nat'l Institute of Materials Science	585
Nat'l Inst. of Advanced Industrial Science & Tech.	493
High Energy Accelerator Research Org.	305
Nat'l Institute for Environmental Studies	130
Nat'l Agriculture & Food Research Org.	64
Japan Int'l Research Center for Agr. Sci.	51
Nat'l Institute of Agrobiological Sciences	28
Nat'l Institute for Agro-Environmental Sciences	18
Public Works Research Institute	12
Meteorological Research Institute	10
Forestry and Forest Products Research Institute	6
Building Research Institute	3
Nat'l Institute for Land & Infrastructure Mgt.	1
Geospatial Information Authority of Japan	1

(excluding trainees)

Source: Tsukuba Science City "Foreign Researcher Study Report"[5]

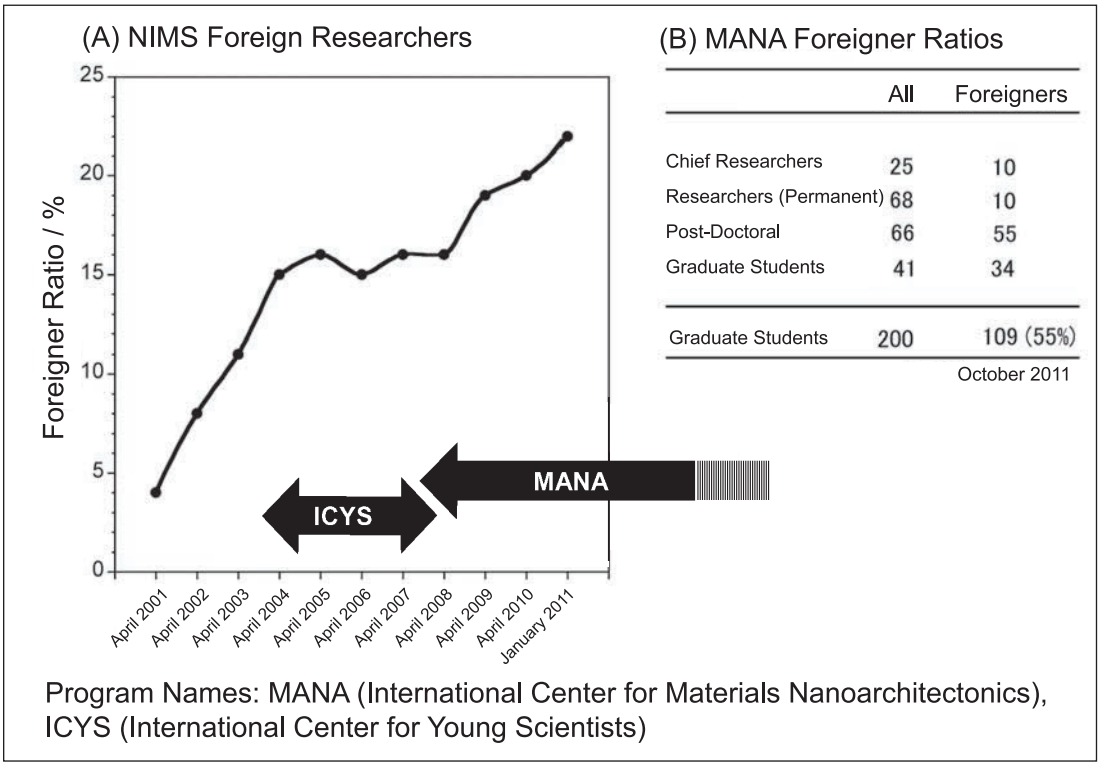

Figure 1 : Figure 1: NIMS Foreign Researcher Ratios (A) and MANA Foreign Researcher Breakdown (B)
(Note: ICYS was downscaled in late-2007 and made part of MANA.)

Compiled by the Science and Technology Foresight Center

NIMS, the host institute, appears. Before the ICYS program to raise the ratio of foreign researchers got started, NIMS' world ranking never rose above 18th. But in the past five years, after the ICYS and MANA programs, NIMS' ranking has risen to 4th. Note that two other research institutes in Table 2, the Chinese Academy of Sciences and the Max Planck Society, are groups of research institutes, not single entities like NIMS. Thus, in a real sense NIMS is second among the world's research institutes, trailing only the Massachusetts Institute of Technology (MIT).

Table 3 shows a breakdown of citations that demonstrates the MANA program's level of contribution to NIMS overall. NIMS published 38% of its papers in 2007 when the MANA program began, and 52% of those cited were contributed by MANA

Table 2 : World Ranking of Citations in Materials Science (Institute names are abbreviated.)

	11 Years Prior to ICYS/MANA Start (Jan. 1994 to Dec. 2004)		5 Years After (Jan. 2007 to Jan. 2011)	
	Institute	Citation	Institute	Citation
1	Max Planck Society	25739	Chin. Acad. Sci.	45576
2	Tohoku Univ.	23891	Max Planck Soc.	16318
3	MIT	18568	MIT	11514
4	UC Santa Barbara	17338	**NIMS**	**11266**
5	Penn. State Univ.	15503	Natl. Univ. Singapore	11209
6	Chin. Acad. Sci.	15101	Tsing Hua Univ.	10436
7	Univ. Cambridge	14977	Tohoku Univ.	10291
8	Kyoto Univ.	13301	Georgia Tech.	9463
9	Osaka Univ.	12575	Ind. Inst. Tech.	9459
10	Russ. Acad. Sci.	12556	Univ. Manchester	9197
.....				
.....				
.....				
18	**NIMS**	**10474**		

Compiled by the Science and Technology Foresight Center

Table 3 : MANA's Contribution to Published NIMS Papers

(A) MANA's Share of NIMS Papers and Citations (2007-2010)

分野	Papers					Citations				
	2007	2008	2009	2010	2007-2010	2007	2008	2009	2010	2007-2010
Chemistry	49%	47%	58%	63%	55%	68%	69%	63%	66%	65%
Materials Science	32%	32%	40%	44%	37%	33%	45%	49%	55%	51%
Physics	29%	28%	34%	29%	30%	63%	54%	60%	58%	58%
total	33%	33%	41%	43%	38%	48%	49%	51%	53%	52%

(B) Citation Rankings of Papers Published Since 2007 (22 of top 31 from MANA. Bold font indicates foreigners among authors.)

	Authors	MANA	Source Title	Category	Year	サイテーション
1	**Waser, R; Aono, M**	○	NATURE MATERIALS	Materials Science	2007	513
2	**Ariga, K; Hill, JP; Lee, MV; et al.**	○	SCIENCE AND TECHNOLOGY OF ADVANCED MATERIALS	Materials Science	2008	281
3	**Ariga, K; Hill, JP; Ji, QM**	○	PHYSICAL CHEMISTRY CHEMICAL PHYSICS	Chemistry	2007	272
4	Mizuguchi, Y; Tomioka, F; Tsuda, S; et al.	○	APPLIED PHYSICS LETTERS	Physics	2008	200
5	**Yoo, E; Kim, J; Hosono, E; et al.**		NANO LETTERS	Chemistry	2008	199
6	**Fang, XS; Bando, Y; Gautam, UK; et al.**	○	JOURNAL OF MATERIALS CHEMISTRY	Materials Science	2008	179
7	**Golberg, D; Bando, Y; Tang, CC; et al.**	○	ADVANCED MATERIALS	Materials Science	2007	171
8	**Pumera, M; Sanchez, S; Ichinose, I; et al.**	○	SENSORS AND ACTUATORS B-CHEMICAL	Engineering	2007	141
9	Kuroda, S; Nishizawa, N; Takita, K; et al.	○	NATURE MATERIALS	Materials Science	2007	123
10	**Xie, RJ; Hirosaki, N**		SCIENCE AND TECHNOLOGY OF ADVANCED MATERIALS	Materials Science	2007	99
11	**Margadonna, S; Takabayashi, Y; Ohishi, Y; et al.**		PHYSICAL REVIEW B	Physics	2009	97
12	**Ariga, K; Vinu, A; Hill, JP; et al.**	○	COORDINATION CHEMISTRY REVIEWS	Chemistry	2007	92
13	**Margadonna, S; Takabayashi, Y; McDonald, MT; et a**		CHEMICAL COMMUNICATIONS	Chemistry	2008	84
13	Kimoto, K; Asaka, T; Nagai, T; et al.		NATURE	Multidisciplinary	2007	84
15	**Yuan, JK; Liu, XG; Akbulut, O; et al.**		NATURE NANOTECHNOLOGY	Materials Science	2008	83
16	**Fang, XS; Bando, Y; Shen, GZ; et al.**	○	ADVANCED MATERIALS	Materials Science	2007	81
17	**Fang, XS; Bando, Y; Liao, MY; et al.**	○	ADVANCED MATERIALS	Materials Science	2009	80
18	**Pumera, M**	○	LANGMUIR	Chemistry	2007	76
19	Mizuguchi, Y; Tomioka, F; Tsuda, S; et al.	○	APPLIED PHYSICS LETTERS	Physics	2009	68
19	Honma, T; Ohkubo, T; Kamado, S; et al.	○	ACTA MATERIALIA	Materials Science	2007	68
19	**Xie, RJ; Hirosaki, N; Kimura, N; et al.**		APPLIED PHYSICS LETTERS	Physics	2007	68
22	Maeda, H; Haketa, Y; Nakanishi, T		JOURNAL OF THE AMERICAN CHEMICAL SOCIETY	Chemistry	2007	65
22	**Li, L; Ma, RZ; Ebina, Y; et al.**	○	JOURNAL OF THE AMERICAN CHEMICAL SOCIETY	Chemistry	2007	65
24	**Belik, AA; Iikubo, S; Yokosawa, T; et al.**	○	JOURNAL OF THE AMERICAN CHEMICAL SOCIETY	Chemistry	2007	63
25	**Ma, RZ; Liu, ZP; Takada, K; et al.**	○	JOURNAL OF THE AMERICAN CHEMICAL SOCIETY	Chemistry	2007	62
26	Yamauchi, Y; Kuroda, K	○	CHEMISTRY-AN ASIAN JOURNAL	Chemistry	2008	61
27	**Takakura, H; Gomez, CP; Yamamoto, A; et al.**	○	NATURE MATERIALS	Materials Science	2007	60
28	**Pumera, M**	○	CHEMISTRY-A EUROPEAN JOURNAL	Chemistry	2009	59
28	**Ji, Q; Miyahara, M; Hill, JP; et al.**	○	JOURNAL OF THE AMERICAN CHEMICAL SOCIETY	Chemistry	2008	59
28	**Wang, DF; Kako, T; Ye, JH**	○	JOURNAL OF THE AMERICAN CHEMICAL SOCIETY	Chemistry	2008	59
28	**Okubo, M; Hosono, E; Kim, J; et al.**		JOURNAL OF THE AMERICAN CHEMICAL SOCIETY	Chemistry	2007	59

Compiled by the Science and Technology Foresight Center

(see Table 3 (A)). Furthermore, 22 of the 31 papers with the most citations were from MANA (see Table 3 (B)). The contribution of citations from MANA is extremely high because only 18% of researchers are affiliated with the program.

This data shows that programs which actively recruit foreign researchers contribute greatly to improving an organization's achievements. Their effect is not merely cosmetic, simply raising the ratio of foreign researchers: they also have an undisputable effect on research quality. MANA and ICYS recruit exceptional researchers who are capable of high productivity by setting standards such as whether applicants can, as lead authors, produce papers with high impact factors. What is more, they dramatically increase a research institute's chance of recruiting highly capable researchers from at home and abroad by not limiting their screening process to Japanese applicants, but rather by making their recruitment efforts international. In other words, increasing the number of foreign researchers (i.e. internationalizing) raises the overall (i.e. average) level of an institute's researchers.

Another point worth noting is that foreign researchers are proactive about engaging in joint research. The fact that many of the top papers by the researchers in Table 4 (B) were jointly written by authors of different nationalities clearly shows this to be the case, as 20 of the top 31 papers were written by multinational teams of authors, while 2 were written by a single foreign author. This also shows that in terms of raising research mobility both within and without an organization, improving competitiveness by bringing in research from multiple countries has a major impact. We can certainly expect from these points that adopting such a policy would also raise the level of Japanese researchers.

4-3 Improved Career Paths for Foreign Researchers

Foreign researchers who work in other countries are more mobile compared to those who work in their own countries. In many cases, they transfer to other positions within institutes from their homelands after completing the research in their research programs. On the other hand, Japanese research institutes can

Table 4 : ICYS and MANA Researchers Advancing Careers (All researchers, including foreigners)

(A) Positions after ICYS

	All Researchers Advancing Careers				
	Abroad	Japan			
Fiscal year	Research Institute	University / Company	NIMS (Permanent)	MANA Researcher	NIMS (Post-Doc)
2004	3	0	0		
2005	9	0	3	5	
2006	4	3	1		
2007	16	1	3	2	
2008	2				
2009	2		1	1	
2010	8		2		2
Total	44	4	10	8	2

(B) MANA Researchers Advancing Careers

	All Researchers Advancing Careers				
	Abroad	Japan			
Fiscal year	Research Institute	University / Company	NIMS (Permanent)	MANA Researcher	NIMS (Post-Doc)
2008	4				
2009	7	2	1		
2010	22	2	2	1	4
2011	13	4	1	2	1
Total	46	8	4	3	5

Compiled by the Science and Technology Foresight Center

rarely take on the responsibility of hiring foreign researchers so long as they do not offer such promising career paths. Table 4 shows the career paths of ICYS and MANA program researchers. They move up to outside institutes, as well as find jobs as personnel at NIMS, the host institute. Former ICYS and MANA researchers in particular get onto the tenure track better in NIMS.

The reasons that program members enjoy better career prospects are believed to be: (i) during hiring, research institutes screen and recruit with high standards for accomplishments and ability, and they hire highly talented individuals who will also be competitive in future job-hunting; (ii) many program researchers who are hired leave behind exceptional results from their research in the program; (iii) many of the senior researchers and program advisors with whom they conducted joint research are prominent researchers in their field who can help the program members find work through their personal networks.

5 Presentation of Unquantifiable Knowledge

Here the authors would like to refer to enacted policies as well as real yet abstract factors regarding the questions of what is actually happening in the programs' projects, and in particular, what factors keep foreign researchers within an organization and whether they lead to improved productivity.

ICYS and MANA employ the three policies below to provide a welcome environment in which foreigners can work. First we cite examples of more conventional attempts. (Please see References 6 and 7 for more on assisting foreigners living in Japan.)

5-1 Conventional Attempts at Internationalization

5-1-1 Creating International Environments Conducive to Research and Daily Living

- The international character of MANA's general affairs department (many staff in Tsukuba with international experience; knowledgeable about how to treat foreigners since the time of the ICYS program)
- Practice of regularly conducting orientation sessions and lab tours in English
- Contract with the Japan International Science and Technology Exchange Center (JISTEC) to assist foreign researchers living in Japan (alien registration procedures, opening bank accounts, finding housing, attending contract signings, accompanying on hospital visits, emergency assistance, etc.)
- Thorough arrangements for foreign researcher housing (Ninomiya House, Takezono House)

5-1-2 Removing Linguistic Barriers in International Settings

- English as a common language (seminars, meetings, accommodations, English emails, bulletin boards, notices)
- English intranet (information for foreign researchers, external grants, etc.)
- Bilingual (Japanese and English) forms (NIMS guidebook, document formats)
- Internationalized administration at NIMS (TOEIC test-taking, scaled communications training, foreign language training [6 weeks of language training at Montana State University], internships [6 months at UCLA])

5-1-3 Learning about Japan in an International Setting

- Setting up Japanese language classes (introductory and beginner classes)
- Setting up Japanese culture classes (karate, origami, yukata, acupuncture and moxibustion, Japanese drums, tea ceremony, haiku, seal cutting, furoshiki, indigo dyeing, Girls' Festival)

5-2 Keeping and Securing More Exceptional Foreigners

Next, measures to keep and secure more exceptional foreign researchers are divided into three categories: reasons why ICYS and MANA attract foreign research officers, reasons why foreign research officers stay, and research organization efforts regarding researchers in general.

● Reasons why ICYS and MANA attract foreign research officers

- NIMS is the premier organization in Japan for materials science and nanotechnology, and it has many applicants, including foreigners.
- Prominent researchers are assigned as chief researchers in relevant fields, thus leading to lots of exchanges and applications from overseas.
- The programs are enthusiastic about lobbying and advertising in Nature and other famous academic

journals.
- Advisers are leaders in their fields, making the organization known internationally as a prestigious one.
- Many introductions from foreign researchers who were in the programs (good reviews, long-lasting personal connections).
- The Open Research Institute and the Internship Program invite foreign faculty and graduate students for short stays, creating exchanges that lead to applications. Former program members also revisit Japan.
- The WPI program has set a goal for each research center to have a foreign researcher ratio of at least 30%.

● Reasons why foreign research officers stay
- The overall research level is high, so it is easier to produce research results while there.
- Office personnel are completely bilingual and provide sufficient attention to solve problems foreign researchers have living in Japan.
- This attention makes host researchers unnecessary and prevents them from being bothered by the foreigners. The result is that good host-guest relations are maintained.
- Foreign researchers can devote themselves to their research.
- The presence of a large, existing foreign population makes it easier for them to help each other. A small foreign population can be troublesome to care for, but when it rises to a certain point, that burden disappears because they can help each other.
- Japanese researchers also find it beneficial to work alongside highly skilled foreign researchers (for improving the quality of research, etc.).
- At present, foreign researchers may find the pay more beneficial due to the strong yen. (ICYS researchers had high salaries, but MANA post-doc pay scales have returned to those for regular posts. The effect is small, but it may offset the gain from the strong yen.)

● Research organization efforts regarding researchers in general
- There are opportunities for regular discussions and research exchanges with famous researchers, including Nobel Prize winners.
- There are systems for assignments to famous laboratories and double mentors, including with outside researchers.
- Salaries of permanently-employed researchers are reflective of annual assessments on research achievements. (This applies throughout NIMS.) Ability and pay are linked.
- There are internal research funds such as the Grand Challenge Program. These offer relief for foreign researchers who are at a disadvantage when competing for funding in Japan.

6 Effects of the Earthquake ~ Can foreign ratios be maintained after such unprecedented damage? ~

What foreigners in Japan did after last year's Great East Japan Earthquake is a key test for us to surmise whether foreign researchers truly are drawn to Japan. Figure 2 lists data to quantitatively show this. Figure 2 (A) compares the number of foreigners who visited Japan in April through September of 2010, the year before the earthquake, and the number who visited in April through September of 2011, after the earthquake. Foreign researchers took the same action as foreigners in general as the number of visits dropped dramatically in 2011 (especially among Europeans). Meanwhile, Figure 2 (B) shows the number of foreigners in the MANA program. Their number dropped by 30% in the first week after the earthquake, but factors such as evacuation calls from their home countries had a large effect. However, around 80% of foreign researchers returned a month after the earthquake, and six months after the earthquake 102 of the 114 who were in the program beforehand had returned. Among displaced researchers, although some had terms that ended at the end of March, after the earthquake almost all returned to Japan.

The data above shows that foreigners overseas who only had information from the media refused outright to come to Japan, but most of those who have experience living in Japan and have personal connections there tend to be attached to the country, despite the extreme circumstances due to the earthquake.

Moreover, Tsukuba City's "Proposal to Make Tsukuba Science City an International Center"[2] has compiled the below local trends and measures to take. Although this information concerns all research institutes in Tsukuba, we can presume that the same trends and positive effects from taking the measures

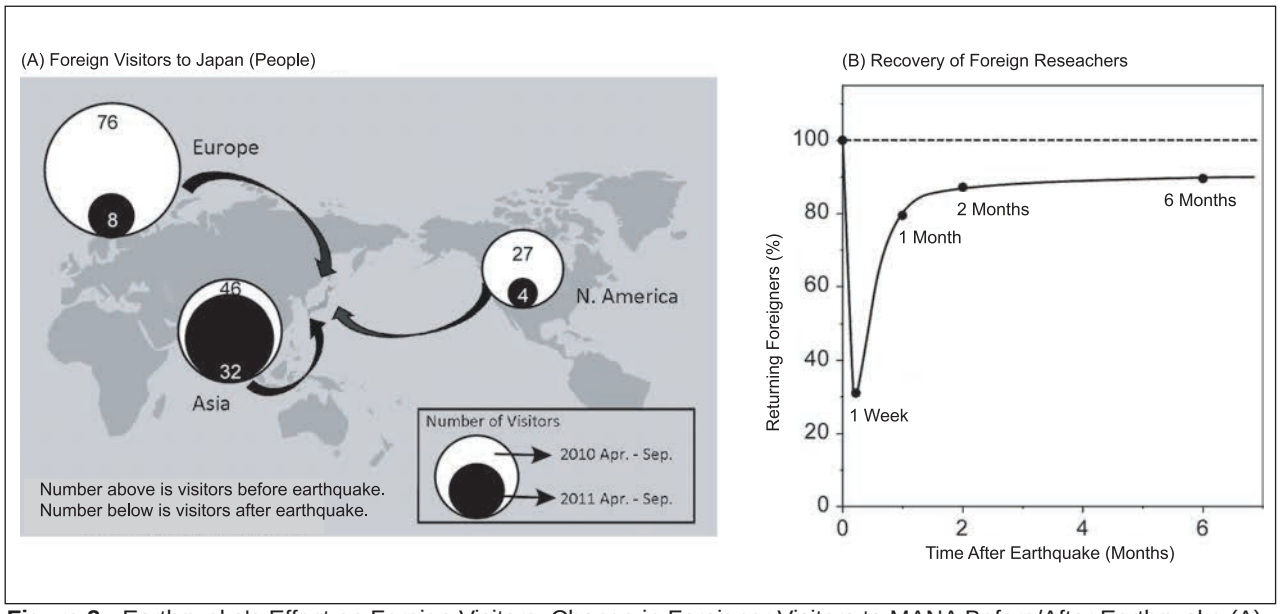

Figure 2 : Earthquake's Effect on Foreign Visitors: Change in Foreigner Visitors to MANA Before/After Earthquake (A) & Foreigner Researchers at MANA after Earthquake (B)

Compiled by the Science and Technology Foresight Center

also apply to MANA.

● Main reasons why foreigners return to their home countries

- Evacuation due to earthquake/nuclear accident (due to order from home country's embassy, etc.)
- Inability to sustain a normal lifestyle due to cut-off water, a lack of supplies, etc.
- Inability to continue research due to damaged research facilities/equipment

● Main reasons why foreigners come back to Japan

- Confirmation of the Tsukuba area's safety by environmental radiation data (area around public institutes)
- Confirmed restoration of access to the water supply and supply purchases
- Confirmed reopening of various businesses

● Measures taken concerning foreigners

- Six-language broadcasts on Radio Tsukuba (broadcasts in English, Chinese, Portuguese, Spanish, Korean and Arabic, contracted out by Tsukuba City, with information on radiation and daily concerns [purchases of water and food, etc.] from March 17 through April 15)
- (Open) lectures on radiation safety held in English
- Information provided at research institute websites, etc.
- Evacuation shelters opened for city residents, including foreigners
- Safety of individuals confirmed (by institutes)

7 Conclusion

This paper has cited the example of the Materials Nanoarchitectonics (MANA) program, part of the World Premier International Research Center Initiative (WPI), and its predecessor, the International Center for Young Scientists (ICYS) program, which have been implemented by the National Institute for Materials Science (NIMS), to analyze various data on the acceptance of foreign researchers and their research. The results revealed are as follows.

1) The application of these programs has made it possible to significantly increase the ratio of foreigners (to over half of all researchers).
2) These programs have greatly increased the host institute's world ranking (based on number of paper citations), and over half of the citations have been from papers produced by MANA projects, whose membership accounts for no more than one-fifth of all researchers.
3) These programs function as good career paths for researchers and they help the researchers transfer to better positions at other researcher institutes domestically and abroad, as well as get hired as permanent employees by the host institute.
4) While the number of foreign visitors to Japan dropped steeply after the Great East Japan Earthquake, over 90% of research officers in these projects returned to their workplace.
5) This trend was due to efforts to provide foreigners

with a comfortable lifestyle, remove linguistic barriers and teach foreign researchers about Japanese culture.

Although this experiment has only recently begun and it may yet be too early to make generalized conclusions, it certainly offers an extremely good reference. There are misgivings concerning the weak global presence of Japanese research institutes and those in emerging countries that are catching up, and pushing ahead further with research projects that create international settings as described in this paper should raise the rankings of many other research institutes in Japan. Japan should make its basic research more competitive internationally by strategically proceeding to create environments for international exchanges at research institutes.

Acknowledgements

The authors would like to extend their sincere gratitude to International Center for Materials Nanoarchitectonics Administrative Director Takahiro Fujita and all of his staff for providing internal data on the International Center for Young Scientists program and the International Center for Materials Nanoarchitectonics program, which was used to compile this report.

References

[1] NISTEP REPORT No.102, Study on the World's Top Class Research Centers in the U.S. (March 2007)

[2] Ministry of Education, Culture, Sports, Science and Technology, Council for Science and Technology, Document 4, "Proposal to Make Tsukuba Science City an International Center," (July 12th, 2011)

[3] "Message from Program Committee of the World Premier International Research Center (WPI) Initiative": http://www.mext.go.jp/a_menu/kagaku/toplevel/shiryo/07042012/001.htm

[4] MANA Center Director's Vision: http://www.nims.go.jp/mana/jp/about/message.html

[5] Tsukuba Science City Foreign Researcher Study Report: http://www.tsukuba-network.jp/kisodata/h23gaikokujinnkenkyuusya.pdf

[6] Written by the National Institute for Materials Science (NIMS), "The Struggles of International Center for Young Scientists Program Researchers from 27 Countries and Regions," planning by Nikkei BP (January 2008)

[7] Written by the International Center for Materials Nanoarchitectonics (MANA) program, "The Challenging Daily Life or how can I love Japanese culture," Bunkakobo, (October 2011)

Profile

Katsuhiko ARIGA
Affiliated Fellow, Science and Technology Foresight Center
Principal Investigator, International Center for Materials Nanoarchitectonics, National Institute for Materials Science
http://www.nims.go.jp/mana/people/principal_investigator/k_ariga/index.html

Engaging in research concerning supermolecular chemistry, surface science and nanotechnology, Ariga will turn 50 this year. He is continuously sharing novel ideas and informing the public about how science's value is not simply limited to its applications in everyday life, a mission that he feels is his destiny.

Hidenori GAMO
Visiting Researcher, Green Innovation Unit
http://www.nistep.go.jp/index-j.html

Gamo has engaged in research on display/lighting device applications and micro electron sources microfabricated from semiconductor film and carbon nanotubes at a corporate laboratory. During that time he has been involved in joint research as an outside/visiting researcher at the National Institute of Advanced Industrial Science and Technology, the National Institute of Materials Science and at universities. Gamo has served in his current post since April 2010. He was a member of the Japan Society for the Promotion of Science's 158th Committee on Vacuum Nanoelectronics and the Surface Finishing Society of Japan's scientific committee. PhD in engineering (Kyoto University).

(Original Japanese version : published in March/April 2011)