



Institute of Fluid Science, Tohoku University

**Report on
the 5th External Evaluation Committee Meeting**



TOHOKU
UNIVERSITY

April, 2019

Preface

The progress of science and technology over the past few decades has been tremendous, and these changes have not only affected people's lifestyles but also their awareness and standards of value. In the automobile industry, for example, there was first a race to develop electric vehicles, including hybrid vehicles, keeping the global environment in mind. As this race increased in intensity, waves of developments in autonomous cars slowly followed, and automobiles entered the age of CASE (a word coined by the CEO of Daimler AG at the 2016 Paris Motor Show, standing for Connected, Autonomous, Shared/Service, Electric). While issues such as legislation and social receptivity remain, we are entering an era in which people's perspectives in regards to automobiles have changed. These kinds of sudden changes are not limited to the automobile industry and are accelerating in many areas of society. The world is currently in a great era of change in terms of industrial and social structure. In Japan, meanwhile, a change of era, from Heisei to Reiwa, was determined in April 2019, and a receptiveness to change is apparent in society as a whole. It is within the context of this kind of a huge wave of change that the 5th External Evaluation Committee Meeting was held. On this occasion, there were eight External Evaluation Committee members including a female researcher, and there were also three members from overseas institutions. A wide range of current viewpoints were put forward, and the committee members who are active overseas provided suggestions that took into account the situation of academia overseas. Once more, I express my gratitude to each and every committee member.

Over the last six years, the External Evaluation Committee has regularly given highly positive evaluations to the research and educational activities of the Institute of Fluid Science as well as to its ideas for the future. Furthermore, the committee has also provided suggestions for making it a more advanced and active research institution. Differing viewpoints may result in an excessive number of suggestions and requirements. However, I believe that they serve as encouragement for the institute to become a place that bravely analyzes the present and interprets the future that seems uncertain at times.

Finally, during this external evaluation, I was able to experience for myself the highly precise situation analyses and forward-looking attitudes of Director Shigeru Obayashi and the other faculty members as well as the earnest preparations made by the institute's staff. I would like to express my respect for these people, and I pray for the further development of the Institute of Fluid Science.

April 2019

Toshio Kobayashi

Chairman of the 5th External Evaluation Committee

Table of Contents

1. Implementation of the 5th External Evaluation Committee Meeting	1
2. Outline of the Evaluation Method	4
3. List of Committee Members	5
4. Day Itinerary and Progress Table	6
5. List of Materials	7
6. Overall Evaluation and Suggestions	8

1. Implementation of the 5th External Evaluation Committee Meeting

Tohoku University set up the Institute of Fluid Science in 1989 by reorganizing the Institute of High Speed Mechanics, which was established in 1943, into twelve divisions and one research center, the Shock Wave Research Center. It was established with the mission of conducting research on the applications and scientific principles of fluids.

In accordance with the suggestions of the 1st External Evaluation Committee in 1995, six years after the reorganization, the institute revised its mission in 1998 to “Research on scientific principles of flow and those applications.” It was reorganized into a large division system in order to bring together research on flow phenomena that had been scattered across fields such as physical science, engineering, and life sciences and to rapidly develop research on the core domain of fluid science. Specifically, it was reorganized into four large divisions (with a total of 15 laboratories): “Advanced Flow,” which investigates the flow phenomena in a variety of extreme environments; “Intelligent Fluid Systems,” which aims to implement intelligence in fluids; “Non-Continuum Flow and Heat Transfer,” which elucidates micro heat-flow mechanisms; and “Complex Flow,” which extracts universality and regularity from complex flow phenomena. The Shock Wave Research Center, consisting of three research divisions, aims for the elucidation and interdisciplinary application of shock wave phenomena in complex media.

Subsequently, in accordance with the suggestions of the 2nd External Evaluation Committee, in 1999, a Center of Excellence (COE) program centered on the Shock Wave Research Center commenced in April 2000 as “the elucidation and interdisciplinary application of shock waves in complex media”; the “International COE of Flow Dynamics” was started as a 21st Century COE program in September 2003; and starting in 2004, the institute has held the International Conference on Flow Dynamics (ICFD) every year. In order to powerfully drive forward cooperative research between researchers via the large division system using the latest network systems and super computers, the Advanced Fluid Information Research Center was established in 2000. In order to accelerate interdisciplinary integration with other fields and integrated research on experiments and simulations, the Shock Wave Research Center was reorganized and expanded in 2003. As part of this, the Transdisciplinary Fluid Integration Research Center was established, and the International Symposium on Transdisciplinary Fluid Integration (TFI) was held annually from 2004 to 2012. From September 2000 to September 2003, an endowed research division called the Visualized Information Division was established, an endowed research division called the Keihin Advanced Technology Division for Environment & Energy was established from December 2003 to November 2006, and an

Industry–Academia Collaboration Office was established in 2003. Furthermore, the institute has held the International Symposium on Advanced Fluid Information (AFI) since 2001.

In accordance with the suggestions of the 3rd External Evaluation Committee that was carried out in 2006, the World Center of Education and Research for Transdisciplinary Flow Dynamics, which was expanded and enriched based on the accomplishments from the 21st Century COE program, was launched as a global COE program in July 2008. From April 2010 to March 2016, the joint usage/research center, the Fluid Science Research Center, was certified, and researchers from Japan and other countries cooperated with faculty members of the Institute of Fluid Science and started collaborative research in order to solve various serious problems in society with fluid science as the core. From April 2008 to March 2011, an endowed research division called the Shock Wave Interdisciplinary Application Division was established. Additionally, the Integrated Supercomputation System (Supercomputer System) was renewed in May 2011.

Subsequently, suggestions were received from the 4th External Evaluation Committee in 2012, and after a series of discussions within the institute, VISION2030 was formed in April 2015. Furthermore, the institute launched the Innovative Energy Research Center, building a unique framework through contributions toward earthquake disaster recovery, active involvement in solving energy problems, and the establishment of the Aircraft Computational Science Center. Moreover, it began recruitment for International Collaborative Research as an activity of the joint usage/research center, and this has been succeeded by the activity of the joint use/research center, the “Fluid Science Global Research and Education Hub” from 2016 onward. In April 2015, it collaborated with the Keihin Corporation and set up a collaborative research division dedicated to the fundamental technology of advanced vehicles and is planning to strengthen industry–academia collaboration. Starting in April 2018, as the second period of collaborative research, it began research on fundamental technology expected to be useful in the conversion of vehicles to electric power. Furthermore, in August 2018, it renewed the Integrated Supercomputation System (Supercomputer System) and began the operation of a system with a logical operating ability approximately 24 times that of the old system.

In these ways, this institute has built on the suggestions of the past four external evaluations to work as a global center for foundational and applied research related to fluid science, preparing the transmitting and integrating functions of research information. However, regular external evaluations are essential to make this position secure. Six years have already passed since the fourth external evaluation, and the environment surrounding the university is greatly changing. Therefore, we have decided to receive the

evaluation and advice of outside professionals regarding the present state and future ideas of the Institute of Fluid Science. The preparations for the external evaluation began in June 2018 with eight External Evaluation Committee members, consisting of universities (two inside the country, three overseas), public research institutions (two inside the country), and one company (inside the country). Three preparatory committee meetings were held, ending in November 2018, and examination of the items of evaluation and the preparation of materials for the External Evaluation Committee Meeting were carried out.

2. Outline of the Evaluation Method

For the evaluation related to research activities, we sent the “Institute of Fluid Science Research Activity Report Outline Booklet” and the “Institute of Fluid Science Research Activity Summary PowerPoint Material” to each evaluation committee member on October 26th, 2018 (sent by post to committee members inside the country and as PDFs to the committee members overseas). We prepared reference materials including the “Report of Research Activities,” “Reports of the Institute of Fluid Science,” “Report Conference Materials of Research Activities,” “Activity Report, Joint Usage/Research Center,” “Proceedings of the International Symposium on AFI,” “Reports of Integrated Supercomputation System,” and the “Report of Technical Services Division” at the venue on the day in question and designed them in a manner such that they could be perused freely.

The 5th External Evaluation Committee Meeting was held on November 6th, 2018 in the meeting room in Building No. 1 of the Institute of Fluid Science. First, an inspection of the research facilities and equipment began at 10:30 in the morning. After that, the External Evaluation Committee Meeting was held in the afternoon at 13:30, with a lunch break in between. At the start, one committee member, Toshio Kobayashi, was elected as the committee chairman. Next, a summary of the institute’s activities was divided into five categories and explained with the Institute of Fluid Science Research Activity Summary PowerPoint Material, and there was a hearing of opinions. An evaluation and a discussion were carried out based on this. A Q&A related to the explanation of the outline was also carried out in the evaluation and discussion, and we endeavored to give a more detailed and accurate explanation of the state of activities. The evaluation results of each committee member were submitted in writing after the External Evaluation Committee Meeting was held. Furthermore, the steering committee meeting held annually was held on the same day, and the steering committee members also attended the session for the explanation of the outline and discussion.

3. List of Committee Members

Name	Affiliation
◎ Toshio Kobayashi	Advisor, General Incorporated Foundation, Japan Automobile Research Institute Emeritus Professor, University of Tokyo
Hiroshi Takamatsu	Vice President, Kyushu University
Masaru Nakaiwa	Director-General, the Fukushima Renewable Energy Institute of the National Research and Development Agency, The National Institute of Advanced Industrial Science and Technology
Kozo Fujii	Professor, Faculty of Engineering at the Tokyo University of Science Emeritus Professor, National Research and Development Agency, Japan Aerospace Exploration Agency
Eiji Fukumoto	Managing Executive Officer, Hitachi Construction Machinery Co., Ltd.
Fumio Ouchi	Professor and Associate Chair of Materials and Engineering, University of Washington
Marie Pierre Favre	Vice President (in charge of international exchange), Institut National des Sciences Appliquées Lyon
Yiguang Ju	Robert Porter Patterson Professor, Princeton University

◎ = Chairman

4. Day Itinerary and Progress Table

Date and Time: November 6th, 2018 (Tuesday) 10:30–17:30

Location: Meeting Room, Building No.1, Institute of Fluid Science, Tohoku University

1. Inspection of facilities and equipment

- 10:30–12:00 (90 minutes)
- Realization work space
 - Shock wave research facility
 - Low-turbulence wind tunnel

(Lunch) 12:30–13:30 (60 minutes)

2. External Evaluation Committee

2-1. Opening of the meeting

13:30–13:40 (10 minutes) Shigeru Obayashi (Director)

2-2. Summary of Institute Activity

13:40–14:10 (30 minutes) General statement

Shigeru Obayashi (Director)

14:10–14:25 (15 minutes) Joint usage/Research center

Shigeru Obayashi (Director)

14:25–14:40 (15 minutes) Research organization with special features

Seiji Samukawa

(Head of Innovative Energy Research Center)

14:40–14:55 (15 minutes) International activities

Tetsuya Uchimoto (Head of Lyon Center)

14:55–15:10 (15 minutes) University/Industry collaboration, Contribution to society, Public relations

Hideaki Kobayashi (Deputy Director)

15:10–15:40 (30 minutes) Break

2-3. Q&A

15:40–16:40 (60 minutes)

2-4. Evaluation, discussion, general evaluation

16:40–17:25 (45 minutes)

2-5. Closing the meeting

17:25–17:30 (5 minutes) Shigeru Obayashi (Director)

5. List of Materials

Materials

- Implementation outline of the 5th External Evaluation Committee Meeting and the 10th Steering Committee Meeting
- Institute of Fluid Science Research Activity Report Outline Booklet
- Institute of Fluid Science Research Activity Summary PowerPoint Material
- The 5th External Evaluation Committee Meeting, Evaluation Sheet

Reference Materials (prepared in the venue as materials that can be freely perused)

- Report of Research Activities
- Reports of the Institute of Fluid Science
- Report Conference Materials of Research Activities
- Activity Report, Joint Use/Research Center
- Proceedings of the International Symposium of Advanced Fluid Information
- Reports of Integrated Supercomputation System
- Report of Technical Services Division

6. Overall Evaluation and Suggestions

The Institute of Fluid Science is a unique research institute of Japanese national universities which aims “Research on scientific principles of flow and those applications,” and it holds a long tradition—this year being the 75th since its establishment. During the last decade, it attained high evaluations internally and externally for its record of adopting COE and GCOE programs and for hosting the ICFD regularly, among other accomplishments. It also has a long history of external evaluations; the 1st External Evaluation Committee Meeting was held in 1995. This report promotes debate on the basis of detailed reports regarding six years of research activities, educational activities, joint use/research center activities, the state of international development, and future plans since the last External Evaluation Committee Meeting (the 4th, held in 2012) and summarizes the evaluations and suggestions of the External Evaluation Committee.

The institute’s researches are actively performed; the quality and quantity of the research results that have been produced cannot be criticized, and its further development from past accomplishments is highly praiseworthy. The research activities of a university are fundamentally the products of individual researchers’ ideas, and it is important to ensure an environment in which long-term academic research is allowed. However, the foundation and the field of application of fluid science are vast, and with only a bottom-up individual style of research, the results produced by the institute may appear vague. Research projects in engineering require cooperative efforts across a wide range of disciplines, demanding leadership on the part of the institute. The institute is concentrating its efforts on striking a balance between this individual process and the flow contributed by the institute, and we can acknowledge that it is producing results.

In order for the institute to go on enhancing its presence, both internally and externally, as a comprehensive research institution dedicated to fluid science, it is essential that it constantly pursues the creation of new research fields. With regard to VISION2030, which estimates possibilities up to the year 2030, we praise the fact that a plan has been laid out to link all the institute’s activities to problems pertaining to the global environment, population, demographic aging, resources, energy, food, and water. However, the year 2030 is not so far into the future. For research and management under VISION2030, it becomes important to increase the number of young top-level researchers, to clarify the fields that the institute will lead, and to prioritize partner institutions in Japan and overseas. As detailed below, the institute’s educational activities and its activities as an international hub are strong, and it is hoped that discussions on combining these with vigorous research activities, concretely showing the milestones and strategies for achieving the goals of VISION2030 and disseminating the ideas of the institute as a whole

will be carried out ahead of time.

Regarding educational activities, the institute has accepted a large number of graduate students relative to the number of faculty members. Moreover, its educational methods, based on an educational policy set up during a period when they were adopted by the COE and GCOE, are also evaluated highly. Additional original initiatives for nurturing researchers who are accepted throughout the world are also being carried out by implementing new programs that let students experience overseas presentations, networking with overseas universities for research stays, and the planning and participation of students in a yearly international conference, the ICFD. The ratio of the number of people in the second half of their doctoral course is significantly high in relation to the number of people in the first half of their doctoral course may be proof that the institute's graduate education is greatly regarded by the students.

The institute is actively engaged in international collaborations as the Fluid Science Global Research and Education Hub. The Innovative Energy Research Center has become a catalytic presence for academic collaboration between different fields, and the activities of the international bases of the institute, such as the Lyon Center, which include the provision of activity environments for young researchers and graduate students in many collaborative bases, are also evaluated highly. Furthermore, the ICFD, which has been held by the institute since 2004, has obtained over 600 participants from around the world, securing its position as a well-known international conference on fluid science. Through these activities, a significant amount of collaborative research is accomplished every year, and the results of this are shown in the form of an increase in papers with joint authorship. It appears that the institute is more than sufficiently fulfilling its roles as an international education and research base and as a research hub of fluid science in domestic and international collaborative research activities, and this deserves a high evaluation. It is hoped that it further develops the activities carried out through this international base and strives toward nurturing international researchers.

The management of the institute aims to incorporate opinions from third parties, such as the steering committee and to take into consideration a reduction in faculty members' non-research works. Appropriate policies are being carried out, especially in regard to the implementation of measures to reduce the burdens of faculty members by bolstering support on the administrative aspects of international activities through support by specialized staff and the participation of young faculty members in planning VISION2030.

A certain level of results has been obtained in terms of acquiring external funds, but there is an impression that the amount is small considering the number of well-known faculty members. The acquisition of a large project to replace the Global COE and the

acquisition of a large budget such as a Grant-in-Aid for Scientific Research (S) or a Grant-in-Aid for Specially Promoted Research are desired. Furthermore, the institute maintains distinctive shock wave facilities and large computer equipment that are not seen in other institutes, and it is hoped that the institute will acquire external funds to support its policy of pursuing techniques that integrate original experimental research and computational science research, putting in place an IoT-related simulation technology and putting the results into practical application.

Personnel evaluation and open recruitment in terms of hiring of faculty members are evaluated to be appropriate. Clear policies have been designed with regard to performance evaluation and career path formation for young faculty as well. An issue to be addressed is that the number of overseas faculty members is low for an institute that is an international education and research base open to the world. The employment of world-class researchers as professors is desirable.

In regards to university/industry collaboration and contributions to society, the institute has put forward efforts such as establishing a University/Industry Collaboration Office and conducting public lectures and visiting lectures. It is hoped that these efforts will lead to an increased awareness in society alongside changes in the awareness of university research institute members.

(1) Research Activities

The Institute of Fluid Science is increasing its presence within the country and internationally as a comprehensive research institute dedicated to fluid science, and it is also widening its research domain from traditional high-speed fluid to energy, weather, materials, and biological fields. Furthermore, in VISION2030, it has prepared solutions for issues pertaining to the global environment, population, demographic aging, resources and energy, food, and water as next-generation targets and is planning to link all the research and activities that it carries out with these targets. While continuing to willingly emphasize research in respect of its status as a research institute, the institute has laid out a course of action that tries to strike a balance with the deep foundational academic research of individual faculty members. Here, we would like to focus on the future trends for the institute.

In the past, the institute has produced highly evaluated accomplishments such as the adoption of COE and GCOE programs, but even in the last six years, the quality and quantity of research results produced by the faculty members, including students, etc., have been faultless, and the further development of previous accomplishments is worthy of high praise. This is also clear from the many prizes awarded by specialized academic

societies in Japan and overseas to the institute's affiliated faculty members in these six years, including the Minister of Education, Culture, Sports, Science and Technology's Science and Technology Prize. Furthermore, the accomplishments of the 41 faculty members (including assistant professors) seen in 2018, including 11 prizes, 64 invited lectures, and 14 instances of being editors and editorial committee members of international academic journals, can also be evaluated positively. Overall, the research activities of the institute are evaluated to be robust and as raising its global level of recognition.

The ICFD hosted by the institute is widely considered the most important venue for exchanging information in fluid science, and in line with its development as an international center, the number of international papers with joint authorship also continue to increase. Leading the ICFD is valued as a great contribution to the recognition of Japan's potential in the field of fluid science. Additionally, while this has been taken up in the previous external evaluation committee meetings, we hope to see activities in which this is not limited to just the Institute of Fluid Science but that attention is paid to fluid science institutes throughout the country, raising the level of fluid science and its neighboring fields. We also hope to see efforts made toward further improving the profile of the institute. In the discussions of the external evaluation committee meeting, there were suggestions to examine areas such as efforts to effectively showcase impactful individual research results, endeavors to publish review articles in international journals of fields that the institute will attempt to lead in the future, the positioning of concrete activities aimed toward the fulfillment of VISION2030 and verifying their progress, and the diversification of fields of activity through the active expansion of the cross-appointment fellow system. Additionally, while a certain level of results has been achieved regarding the acquisition of external funding, which is a necessity for research activities, there is the impression that this amount is low considering the number of well-known faculty members. The construction of a strategy for acquiring a large project to replace the global COE and acquiring a large budget such as a Grant-in-Aid for Scientific Research (S) or a Grant-in-Aid for Specially Promoted Research is desired. Moreover, the institute maintains distinctive shock wave facilities and large computer equipment that are not seen in other institutes. Thus, we would hope for the acquisition of large-scale external funding and the pioneering of new fields that integrate original experimental research with computational scientific research.

(2) Educational Activities

The Institute of Fluid Science accepts a large number of graduate students (up to 120 students in a year) relative to its number of faculty members. Moreover, its educational methods include notable original endeavors to nurture researchers who are accepted

throughout the world, such as the implementation of the Boeing Higher Education Program, which allows 50% of students in the Master's course experience overseas presentations; the use of networks with overseas universities; and the planning and participation of students in a yearly international conference, the ICFD. Moreover, companies have very high hopes regarding the institute's development of human resources due to the fact that it deals with engineering knowledge that is essential in a wide range of industrial fields. The institute also fulfills the role of providing engineering education that can play an active part in the world of industry, and its graduate education is well regarded. Many universities and graduate schools do not see an increase in the number of applicants for the doctoral course. At the institute, however, the fact that the number of people in the doctoral course is 30% more than the number people in the first half may be proof that the graduate education of the institute is being evaluated positively by the students. We would like the institute to keep nurturing international researchers and strive to improve the quality of its international education of students as well. We would like it to further drive education forward and nurture many more young researchers and engineers who tackle important issues in society as well as the future leaders and managers of research and development.

With regard to educational activities, a good system of cooperation appears to be maintained between the institute and the School of Engineering. It is hoped that, while demonstrating the appeal of its research to students, the institute will also strengthen its unique education policies and contribute to the development of future human resources. The Institute of Fluid Science is focused on graduate education, but there is a need to increase activities that communicate the appeal of science and engineering research to first- and second-year undergraduates, and, further, to high school students. Additionally, we would like to suggest identifying and examining data on graduates who have attained a degree (masters and doctorates) at the institute. Data that identifies students' post-graduation employment, research, and societal contributions will be an effective message to high school students and students who are progressing to graduate school, and as with its research achievements, it could also become an important factor in the evaluation of the institute as a whole.

(3) The Fluid Science Global Research and Education Hub

The Institute of Fluid Science undertakes various activities in its role as an international education and research center for fluid science. For example, the Innovative Energy Research Center has become a catalytic presence for academic collaboration that aims to develop research in new fields of energy. Moreover, the institute has constructed environments in many collaborating bases, including the Lyon Center, where young researchers and graduate students can stay at outstanding universities and research

institutions overseas to implement collaborative research with esteemed researchers. These will become great assets for the future of the researchers themselves and for the institute's activities as an international base. Furthermore, the ICFD, which been held by the institute since 2004, has obtained over 600 participants from around the world, securing its position as a well-known international conference on fluid science. Through these activities, extensive collaborative research is accomplished every year, as evidenced by an increase in the number of papers with joint authorship. The institute is more than sufficiently fulfilling its role as an international education and research hub for fluid science in domestic and international collaborative research activities.

While the budget for the General Collaborative Research Project that encourages collaborative research in a wide variety of fields inside and outside the country is small, management that focuses on pioneering new fields and paving the way for full collaborative research appears appropriate. However, preliminary experiments and raising funds for traveling expenses are often difficult with small-budget organizations, so it is likely time to discuss suitable measures for increasing research expenses.

(4) International Activities

International collaborative activities are evaluated as being actively developed. From the viewpoint of human resource development, the institute is raising its presence as an international research base through its deployment and acceptance of students and teaching staff. It has established the Global Collaborative Research and Education Center and is carrying out a variety of exchanges. Among these, the Mega Grant Project by Russian Government and the activities centered around the Lyon Center deserve special mention. Moreover, it is commendable that international collaboration has been produced in concrete forms such as the Core-to-Core program and ELyT Lab. We hope that going forward, the institute will continue activities that raise its global position, strengthen its network, and generate concrete results from international collaboration while promoting its young members.

There are concerns that there is a severe burden placed on the faculty members and researchers, as the institute's staff of only 40 is collaborating with a large number of universities and research institutions. As a result, there is a fear of a decline in research performance. We would like the emphasis of the activities to be narrowed down and the examination of measures that will ensure good results. Regarding such international activities and overseas offices, there is a need to always think about the balance of goals and results, and the role of the Liaison Office in the activities of the Global Collaborative Research and Education Center, in particular, should be made clear.

Regarding international development related to education, the institute is designing an

original education program with an international perspective. These endeavors should be further reinforced, and it is suggested that the institute should plan to expand the breadth and diversity of its research by using the Tohoku University Overseas Deployment Program and actively incorporating the Short-Term (up to two weeks) Overseas Experience Program aimed at graduate students.

Here, we will append opinions from the committee members regarding international collaboration, overseas deployment, etc. True international collaboration is created from the connections between people. Although there are no problems in the present situation, we wish for further plans to have many researchers connect with projects in other countries, without overly relying on specific researchers. As time passes and people change, it may gradually lead to a loss of substance. We hope that activities are regularly examined to ensure that they are not conducted merely for form's sake. Another important point related to the overseas deployment of students is that Tohoku University has multiple overseas deployment programs, and the reactions of students toward them are sometimes unenthusiastic as they are gifted with too many similar opportunities. This appears to be a lack of gratitude, perhaps because faculty members, and not just students, have become too used to these benefits. In other universities, there are cases where students wish to apply for overseas deployment but are just not provided with that opportunity. The faculty members need to grasp such situations when they present themselves, and let the students know that they are being offered a unique learning environment. This kind of mutual understanding becomes the driving force for carrying out international development smoothly and effectively, and then students are able to engage in their research with a more global viewpoint. This is also an important part of education.

(5) Future vision (VISION2030)

That the Institute of Fluid Science is currently envisioning the year 2030 and setting up a future program for it is desirable and necessary. The institute was founded 75 years ago and has set out VISION2030 based on the accomplishments of this history and the fact that it has set out a plan to link all its activities to problems relating to the global environment, population, demographic aging, resources, energy, food, and water is commendable. Moreover, the participation of the young faculty members in the formation of VISION2030 is also evaluated positively. Considering that the year 2030 is not so far in the future, in addition to outlining the goals, it is important to set concrete milestones and strategies to help each cluster or faculty member implement and fulfill the goals. Concrete discussions that integrate these and spread the campaign of the institute as a whole may be needed in the near future. For example, clean water, collecting and using CO₂, data centers, smart cities, etc., may be added as research domains of the Innovative

Energy Research Center, and it is hoped that the young faculty members' concrete suggestions for times further into the future are taken up for discussion. Furthermore, explanations regarding consistency with the vision of Tohoku University as a whole would be desirable.

Research and management under VISION2030 requires further collaboration with other fields in Japan and overseas as well as integration with society. While these cannot be accomplished by the institute on its own, we strongly hope to see a description of the path through which the institute will lead the field. Having young faculty members participate in the formation of VISION2030 is a positive step, but, unfortunately, the participation of young members did not bring many ideas that older researchers could not have thought of. We hope that the institute and each one of the young researchers will apply more efforts to think carefully about the future of their own research and will proceed with a wide outlook and a high level of awareness toward their own research activities. As part of VISION2030, endeavors such as the practical application of cross-appointments, personnel management that works across departments, and participation for a fixed period of time in research activities of a different field may be effective.

(6) Operation

Research promotion and support organizations have been put in place by the Director, and the management will try to reduce the non-research workload of faculty members while taking into consideration the opinions of third parties, such as the external evaluation committee. Endeavors such as maximizing research activities and educational activities of faculty members through substantial support from the administrative side of international activities and from specialized staff, especially within areas where the institute leads, have been reinforced. With interdisciplinary domains and systems thinking becoming important in present times, there will be an increase in collaborative activities that go beyond the limits of the institute and its present research fields, such as collaborations with the Innovative Energy Research Center, the Core Technology Consortium for Advanced Energy Devices, the Working Group of Energy Strategy in Tohoku University, the Institute for Materials Research, and the National Institute of Advanced Industrial Science and Technology. Against this background, a show of leadership will be required. Leadership that produces greater results within a larger framework is desired.

On the other hand, virtual organizations for proceeding with the prioritization and integration of research as well as the abovementioned collaborations are increasing, and the management of the institute is becoming complex. There are many research fields in which the professors are holding concurrent posts, and faculty members are made to be

active as members of research clusters in addition to their own research fields. Ways to effectively proceed with the conferences and the paper work for the management of virtual organizations in a way that does not take up the time of young and middle-aged researchers, in particular, are important, as are ideas regarding their necessity. The Institute of Fluid Science's scale in terms of people may be classified as small in Japan, but it is certainly not in the category of small in the United States. Future management plans and the evaluation of optimization need to be addressed while considering international differences in the perception of scale with Japan. Young faculty members participated in the formation of VISION2030, but when thinking about future development, it is hoped that there will be further ideas regarding plans for young researchers to participate in discussions on the courses of action the institute should take and the systems that lead to stop-start progress on the part of young researchers. It is also hoped that policies will be examined from the viewpoint of producing outstanding results in each generation, including young members.

Regarding budget, supercomputers take up a large part of the expenses of the operating grants (close to 40%); it is very important that their application produces results. With experimental and evaluation techniques undergoing remarkable change as well as computers, another issue is arranging investment plans with a long-term view toward cutting-edge experimental facilities.

(7) Personnel Affairs/Evaluation of Technical Staff

The employment of faculty members of the Institute of Fluid Science is managed appropriately, with a system of open recruitment and a considerable amount of time spent in faculty hiring. The ideas of fluidization and diversity of personnel affairs that were discussed in the previous external evaluation committee meeting have also been considered, and steady progress has been seen. Personnel evaluation is carried out on the basis of strict evaluation criteria, and clear policies have been constructed with regard to performance evaluation and career path formation for young faculty. The institute begins to examine research fields and select new candidates for positions two-and-a-half years before a professor's compulsory retirement. Also, the facts that associate and assistant professors are in limited term employment system and that associate and assistant professors of the research field are not left as they are after a professor's retirement are suitable as personnel management methods for a research institution.

Exchange of faculty members is also carried out with the School of Engineering, which is beneficial for both the institute and the School of Engineering.

The number of overseas faculty members in the institute is low for an international

education and research base open to the world. The employment of world-class researchers as professors is desirable. The number of female faculty members has increased over the last six years, but active efforts for continuing to increase the diversity of the faculty are needed. It is important to increase the number of applications of both overseas faculty members and female faculty members, and publishing job advertisements in *The Chronicle of Higher Education* can be considered a method to do this.

Moreover, ways to effectively make use of researchers after they have retired at the age of 65 need to be examined. Through this, it is hoped that the young faculty members' teaching burden will be reduced, and they can realize long-term stays overseas.

(8) University/Industry Collaboration, Public Relations

The institute's position of giving back to society, implementing its achievements in society, and conducting the necessary publicity activities for their achievements such as the establishment of the institute's own University/Industry Collaboration Office, have been recognized. There is steady progress in the establishment of a collaborative research division with Keihin Corporation in the application of patents and in increasing the number of private collaborative research. It is observed that efforts are being focused on industry-academia collaboration. However, there is great room for expansion in acquiring external funds and returning research achievements to both society and industry. It is hoped that from now on, the dissemination of information through graduate networks, consortiums, and symposiums will be strengthened and that efforts will be made in expanding industry-academia collaboration. There are also hopes that it will lead to results such as acquiring returns for the institute based on the profits of the company with which the collaborative research was carried out, such as patent guarantee deposit earnings through technology transfers, as well as changes in awareness of students regarding their involvement in society through the publicization of successful examples of collaborative research divisions. Moreover, although eight years have passed since the Great East Japan Earthquake, maintaining activities that contribute to the region through the research and development of technology related to earthquake recovery and the prevention and mitigation of disasters is desired.

(9) Contribution to Society

As a public research institution, the Institute of Fluid Science discloses its information to society as a whole, is aware of the importance of outreach activities, and actively communicates its research results to society, including results related to earthquake disaster recovery. So it can be evaluated as also putting effort into contributing to society.

Lectures for the general public, lectures in elementary schools, public documents, etc. are planned so that they are easy to understand for the general public, creating a favorable impression. Moreover, activities thought to be outside the original business of researchers such as various events aimed at elementary and middle school students and the opening of research facilities to the general public will continue with the awareness that they are very important in obtaining society's attention and expectations toward fundamental research.

The ongoing collaboration between the Institute of Fluid Science and Keihin Corporation also positively contributes to society. We hope that by communicating examples of successful industry-academia collaboration, there will be effects that lead to changes in students' awareness and changes in their recognition of their involvement with society. Issues such as global warming, decreasing birth rate, population aging, and the transformation of industrial structure are becoming more and more serious, and society is in an extremely significant era of change that includes the rapid progress of digital technology and start-up companies. We wish for the institute to improve its receptivity and sensitivity toward these changes and strengthen its ability to make contributions toward solving these problems.