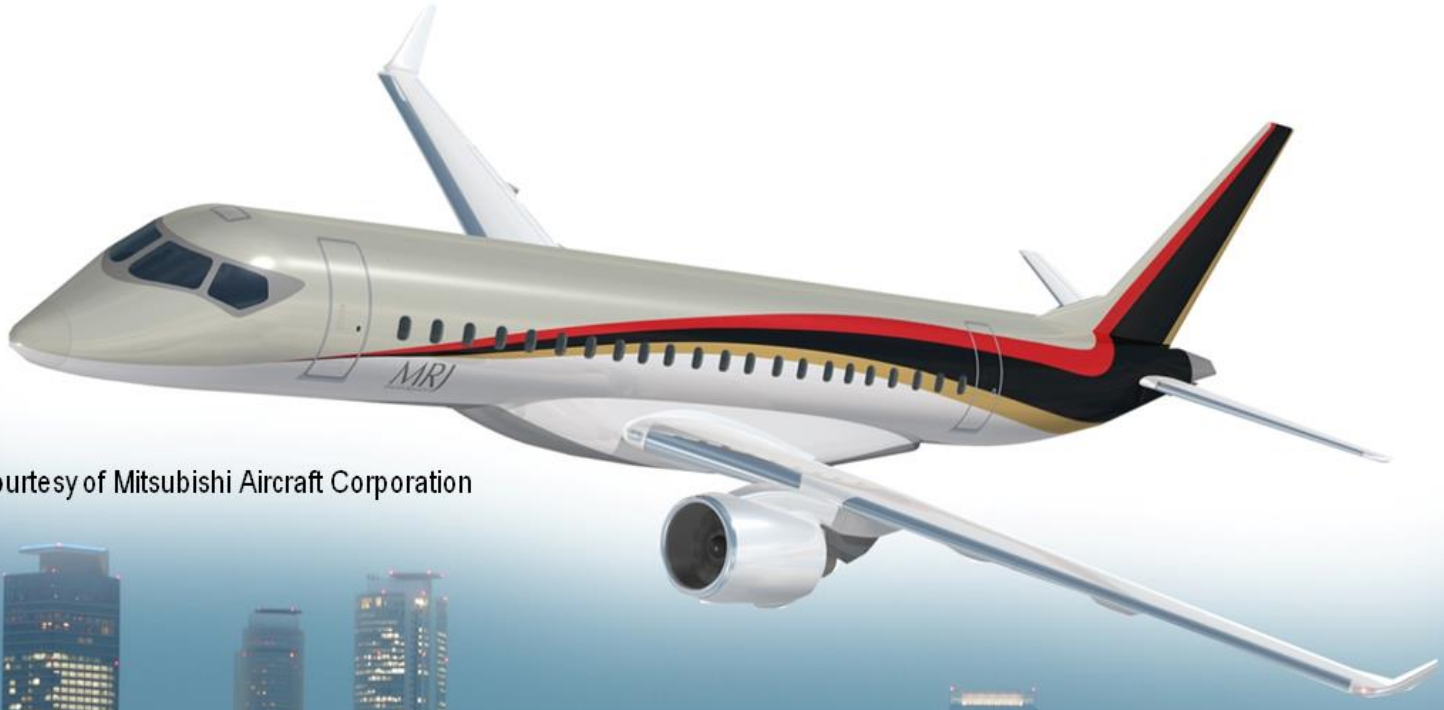
RENKEI

名古屋大学
NAGOYA UNIVERSITY

The 2014 RENKEI Japan-UK Joint Workshop on Aerospace Engineering

August 4-8, 2014
Nagoya University, Japan

Final Report



Courtesy of Mitsubishi Aircraft Corporation

Contents

Preface

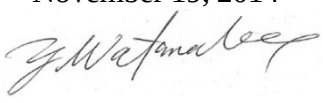
In March 2012, in order to promote inter-university and industry-academia collaboration in education and research, an academic consortium, "Research and Education Network for Knowledge Economy Initiatives (RENKEI)", was launched by six Japanese and six UK universities. RENKEI member universities form working groups to plan and execute various activities. For example, Researcher Development Schools were held at the University of Bristol (July 1-12) and Kyoto University (December 2-13) in 2013 with the theme "Urban Sustainability and Resilience".

Among the 12 member universities, four universities in the UK and four in Japan have undergraduate or graduate programs related to aerospace engineering, while the rest have at least mechanical engineering programs. In terms of industry, the UK is home to Rolls-Royce Holdings plc, the second largest aircraft engine maker in the world. On the other hand, Japan has Mitsubishi Heavy Industries, Ltd. (MHI), which recently developed a regional jet called the MRJ (Mitsubishi Regional Jet) and also plays an important role in production of the Boeing 787 Dreamliner by fabricating its main wings using composite materials. We therefore considered aerospace engineering to be a suitable and timely topic for RENKEI activity.

Nagoya University is located in the central production area in Japan, where automotive industries such as Toyota Motor Corporation and Mitsubishi Motors Corporation, and aircraft industries such as Mitsubishi Heavy Industries (MHI) and Kawasaki Heavy Industries are based. Indeed, the MRJ was developed, and the main wing of the Boeing 787 is produced, in Nagoya factories. Under these circumstances, Nagoya University, in collaboration with the University of Bristol and the University of Southampton, held a Workshop entitled "The 2014 RENKEI Japan-UK Joint Workshop on Aerospace Engineering" at Nagoya University. In RENKEI activity, collaboration with industry is very important. Therefore, in addition to the Working Group composed of professors from Nagoya University, the University of Bristol and the University of Southampton, an executive committee composed of professors from the Department of Aerospace Engineering of Nagoya University and a researcher from MHI was created to discuss the contents of this workshop. We hope that this workshop helps to further understanding of the latest aerospace engineering technologies in Japan and contributes to the promotion of future collaboration in education and research between universities in Japan and the UK.

Lastly, we would like to express our gratitude to the Nagoya Aerospace Systems Works of MHI, Shimadzu Corporation, the Japan Aerospace Exploration Agency (JAXA) for implementing lectures and factory visits, to RENKEI member universities for sending us their students and researchers, and to the British Council and the RENKEI Working Group for their valuable advice. We are also very grateful to RENKEI and the Mitsubishi UFJ Foundation for their financial support. Thanks also go to my colleagues of the National Composites Center and the Department of Aerospace Engineering of Nagoya University for all their assistance.

November 19, 2014



Yoshihito Watanabe
Trustee & Vice President
Nagoya University

1. Program

Aug. 3 (Sun)	
	Arrival at Nagoya 《Accommodation : *HOTEL ROUTE-INN Nagoya Imaike Ekimae*》 [Venue] *Restaurant "Gastou"*
18:00-19:00	**Orientation**
19:00-20:30	**Opening Reception**
Aug. 4 (Mon)	
	[Venue] *Lecture Hall, Noyori Materials Science Laboratory* **Invited Lectures**
09:00-09:55	① "Aircraft Industry in Japan – Flying into the Future" Mr. Shigefumi Tatsumi (Senior Vice President & Senior General Manager, Commercial Airplanes Division, Commercial Aviation & Transportation Systems, Mitsubishi Heavy Industries, Ltd.)
10:00-10:55	② "Current and Future of Composite-Materials in Aerospace Engineering" Professor Takashi Ishikawa (Director, National Composites Center, Nagoya University)
11:05-12:00	③ "Integration of Computational Fluid Dynamics with Experimental Fluid Dynamics" Mr. Shigeya Watanabe (Chief Engineer, Japan Aerospace Exploration Agency (JAXA))
12:00-13:20	**Lunch Break**
13:30	*Meet in front of Toyoda Auditorium*
14:30-17:00	**Factory Visit** Mitsubishi Heavy Industries/Nagoya Aerospace Systems Works
18:00-	**Free Time** Sightseeing in Nagoya City
Aug. 5 (Tues)	
	[Venue] *Meeting Room (3F), Venture Business Laboratory (VBL)*
09:00-15:30	**Laboratory Visits and Group Discussions:** Participants were divided into several groups depending on their study major. Each of these groups was assigned to a related laboratory at Nagoya University where they participated in experiments and discussions.
12:00-13:00	**Lunch Break**
15:45	*Meet in the VBL Meeting Room*
16:00-17:00	**Tour of National Composites Center (NCC)**
17:00-	**Free Time** Sightseeing in Nagoya City

Aug. 6 (Wed)	
	Bus Tour from Nagoya to Kyoto
09:00	*Meet in front of Toyoda Auditorium*
10:30-12:00	**Museum Visit**
	Kakamigahara Aerospace Science Museum
14:30-17:20	**Sightseeing in Kyoto**
	Kiyomizu-dera (temple)
18:00-	**Free time**
	Sightseeing in Kyoto
Aug. 7 (Thurs)	
08:30	*Meet at the Lobby of the Hotel*
9:30-11:30	**Factory Visit**
	Shimadzu Corporation
13:40-17:00	**Sightseeing in Kyoto**
	Kinkaku-ji (Golden Pavilion) and Nishijin Textile Center
17:00-	Bus Tour from Kyoto to Nagoya
Aug. 8 (Fri)	
	[Venue] *Venture Hall (3F), Venture Business Laboratory (VBL)*
9:30-11:30	**Ignite Session: Industry-Nagoya University Collaboration**
(9:30-10:05)	① Introduction of the Department of Aerospace Engineering, Nagoya University Professor Norihiko Yoshikawa (Nagoya University)
(10:10-10:45)	② Introduction of Global Project Leader Training Seminar Designated Associate Professor Kengo Hayashi (Nagoya University)
(10:55-11:30)	③ Introduction of Industry-Nagoya University Collaboration Professor Yuho Shishiyama (Nagoya University)
11:30-13:00	**Lunch Break**
12:30-	Registration (Visitors Only)
13:00-17:00	**Discussion on the Future RENKEI Activities**
	① Students' reports of group discussions on Aug. 5th
	② Free discussion on the next UK-Japan Joint Workshop on Aerospace Engineering in UK and the future RENKEI activities
17:00-18:30	**Free Time**
	[Venue] *Restaurant "Gastou"*
18:00-18:30	Registration
18:30-21:00	**Networking Dinner**
Aug. 9 (Sat)	
	Departure from Nagoya

2. Invited Lectures

Lecture 1

‘‘Aircraft Industry in Japan - Flying into the Future’’

Shigefumi Tatsumi
Senior Vice President & Senior General Manager
Commercial Airplanes Division
Commercial Aviation & Transportation Systems
Mitsubishi Heavy Industries, Ltd.

Short Biography:

Shigefumi Tatsumi obtained his Bachelor of Engineering and Master’s degree at Tokyo University studying Aeronautics. After his graduation, he entered MHI Nagoya Aerospace System Works in 1981 and worked on Fighter Aircraft R&D at the Aerodynamics Research Section. Later, in 1989, he joined the F-2 Ground Support Fighter Engineering Team and acted as unit leader of the wing aerodynamics design. From 1992-1994 he was a Visiting Research Staff Member in the Department of Mechanical and Aerospace Engineering at Princeton University. Returning to MHI, he served as Director of Civil Aircraft Engineering Department from 2008-2011. Currently, since April 2014, he is serving as Senior Vice President & Senior General Manager of the Commercial Airplanes Division, Commercial Aviation & Transportation Systems. He specializes in aerodynamics, especially Computational Fluid Dynamics.

Abstract：

It has now become a big challenge for one company or country to develop a large commercial airplane. Japan has been working as an international partner for manufacturing and developing large commercial airplanes since the 1980s. Being one of the major airplane manufacturers in Japan, Mitsubishi Heavy Industries (MHI) has offices and factories around the globe, manufacturing components to take part in international collaboration. Now, Mitsubishi Aircraft Corporation and MHI are in progress developing their own airplane, called the Mitsubishi Regional Jet (MRJ) from the experience gained since the 1950s.

Contents：

1. International Collaboration of Aircraft Industry in Japan
2. MHI Commercial Airplane Division Global Structure Partnership
3. MHI’s Aircraft Development
4. Introduction on Mitsubishi Regional Jet
5. Mitsubishi Regional Jet’s Current Development Status

Aircraft Industry in Japan

～ Flying into the future

Senior Vice President & Senior General Manager
Commercial Airplanes Division
Commercial Aviation & Transportation Systems
Shigefumi Tatsumi

2014/08/04

MITSUBISHI HEAVY INDUSTRIES, LTD.

MITSUBISHI HEAVY INDUSTRIES, LTD.
Our Technologies, Your Tomorrow

Feature of Mitsubishi Regional Jet (MRJ)

Source : ©Mitsubishi Aircraft Corporation

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Lecture 2

‘‘Current and Future of Composite-Materials in Aerospace Engineering’’

Takashi Ishikawa

Professor, Department of Aerospace Engineering, Graduate School of Engineering,
Director, National Composites Center, Nagoya University

Short Biography:

Takashi Ishikawa obtained his PhD at the University of Tokyo in 1977 under the supervision of Professor Shigeo Kobayashi. He then joined the National Aerospace Laboratory (NAL), the former name of one part of the current Japan Aerospace Exploration Agency (JAXA), in 1978. His background is in the mechanics of composite materials, structural mechanics of composites and development of new composite materials. After he joined JAXA, he obtained a temporary position as a post-doc at the University of Delaware in the USA, where he invented the mechanics of textile composites. Mainly through this accomplishment, he was awarded the Medal of Excellence in Composite Materials by the Center of Composite Materials of the University of Delaware in 2008. When he returned to Japan and NAL, he expanded his research area to a wide variety of fields in composite mechanics. In 2001, he was appointed as the director of the Advanced Composite Technology Center of NAL, and later, in 2005, as Aviation Program Director of the newly-formed JAXA, which was the position of aeronautics technology leader in Japan, covering not only composites but the whole fields of aeronautics. He was finally appointed as the executive director of JAXA Aeronautics in 2008. After his retirement from JAXA, he was appointed as a professor of Nagoya University and the director of the National Composites Center in Japan, established at Nagoya University in April 2012, which is his current position.

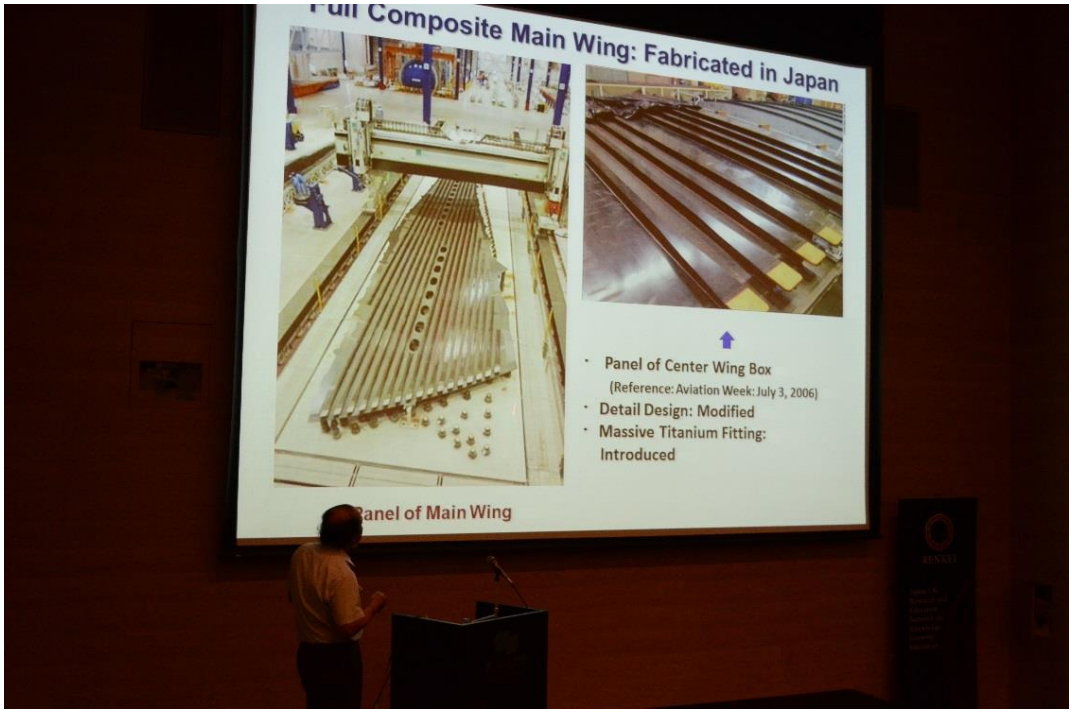
Abstract :

Advanced composites materials, mainly carbon fiber reinforced plastics (CFRP), play a key role in contributing to energy saving in aerospace vehicles. Particularly in aircraft, the ratio of composites weight to the total weight empty has reached 50% in recent aircraft. As the first example of recent composites research in Japan, the fatigue test results of the VaRTM aerostructure will be reported, in which delamination propagation was well predicted by the analysis. The next topic will be the development of VaRTM-Prepreg hybrid fabrication technology and its flight verification. Flight verification tests were conducted in the USA after the ultimate load tests on the ground. The third topic will be an introduction of lightening strike research to composite structures. This research is a trigger for the installation of a huge lightening strike test facility in NCC at Nagoya University. The next topic will be the development of new ceramic matrix composites for jet engine high temperature components. A good example of collaborative work between JAXA and Nagoya

University will be shown next: the impact behavior of carbon/epoxy composites for engine fan-blades. The final topic is an introduction of activities conducted at the National Composites Center in Japan, established here at Nagoya University in June 2013.

Contents：

1. Status and Application of Advanced Composite Materials to Recent Commercial Aircraft: B787 and A350
2. Status of JAXA's VaRTM Composites Research (Related to MRJ)
3. Introduction of Research of Lightening Strike Behavior
4. Fabrication of Ceramic Matrix Composites (SiC/SiC)
5. Introduction of Composites Research in Nagoya University



Lecture 3

"Integration of Computational Fluid Dynamics with Experimental Fluid Dynamics"

Shigeya Watanabe

Chief Engineer, Japan Aerospace Exploration Agency (JAXA)

Short Biography:

Shigeya Watanabe is a Chief Engineer for the Japan Aerospace Exploration Agency (JAXA). In 1987, he joined the National Aerospace Laboratory of Japan (NAL), one of the former bodies of JAXA, beginning his career in experimental fluid dynamics, especially hypersonics. He was a visiting researcher at the High Temperature Gasdynamics Laboratory of the Mechanical Engineering Department at Stanford University from 1996 to 1998. After this, he returned to JAXA as Lead of Advanced Technology Section in Wind Tunnel Technology Center in charge of research activities on new aerodynamic measurement technologies, such as Particle Image Velocimetry (PIV) and Pressure-Sensitive Paint (PSP). Before his present position, he served as Director of the Fluid Dynamics Group from 2009 to 2012 and as Director of the Wind Tunnel Technology Center from 2011 to 2013. Recently, he developed the Digital/Analog-Hybrid Wind Tunnel (DAHWIN), which is a system realizing the integration between Experimental Fluid Dynamics (EFD) and Computational Fluid Dynamics (CFD), as principal investigator. He has a B.S. and an M.S. in Aerospace Engineering from the University of Tokyo, Japan. He is a lifetime senior member and an international member of the Aerodynamic Measurement Technology Technical Committee in AIAA, and a member of the board of directors and a fellow of the Japan Society of Aeronautical and Space Sciences (JSASS).

Abstract :

The development of an innovative system integrating CFD (Computational Fluid Dynamics) with EFD (Experimental Fluid Dynamics) called 'Digital/Analog-Hybrid WINd tunnel (DAHWIN)' will be presented. The objective of developing DAHWIN is to improve the efficiency, accuracy, and reliability of aerodynamic characteristics evaluation in aerospace vehicle developments through mutual support between EFD and CFD, utilizing the advantages of one side to mitigate the defects of the other side. DAHWIN is constructed as a system seamlessly connecting two large facilities, 2m x 2m Transonic Wind Tunnel for EFD and a supercomputer system for CFD. The function of this system consists of the optimization of test planning, accurate correction of the wind tunnel wall and support interaction effects, quasi-simultaneous monitoring of EFD data in comparison with corresponding CFD data, the most probable aerodynamic characteristics estimation based on both EFD and CFD data, and so forth. Some early applications of DAHWIN to practical wind tunnel tests showed the usefulness of DAHWIN in terms of increasing the efficiency and accuracy of both EFD and CFD.

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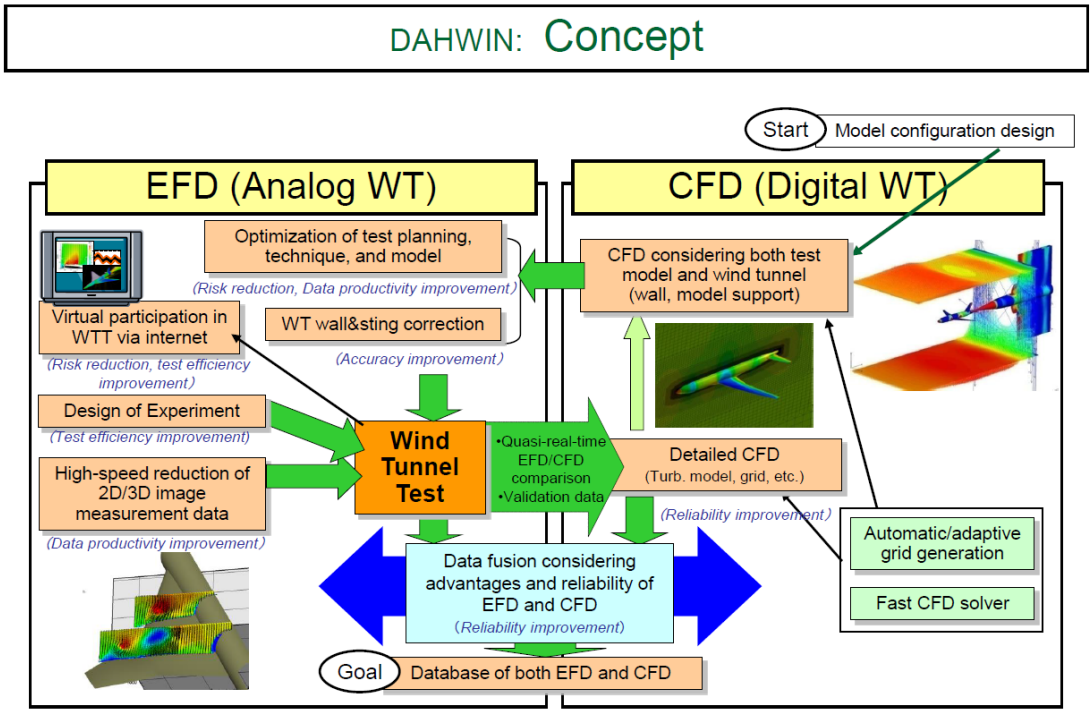


3. Laboratory Visits and Group Discussions

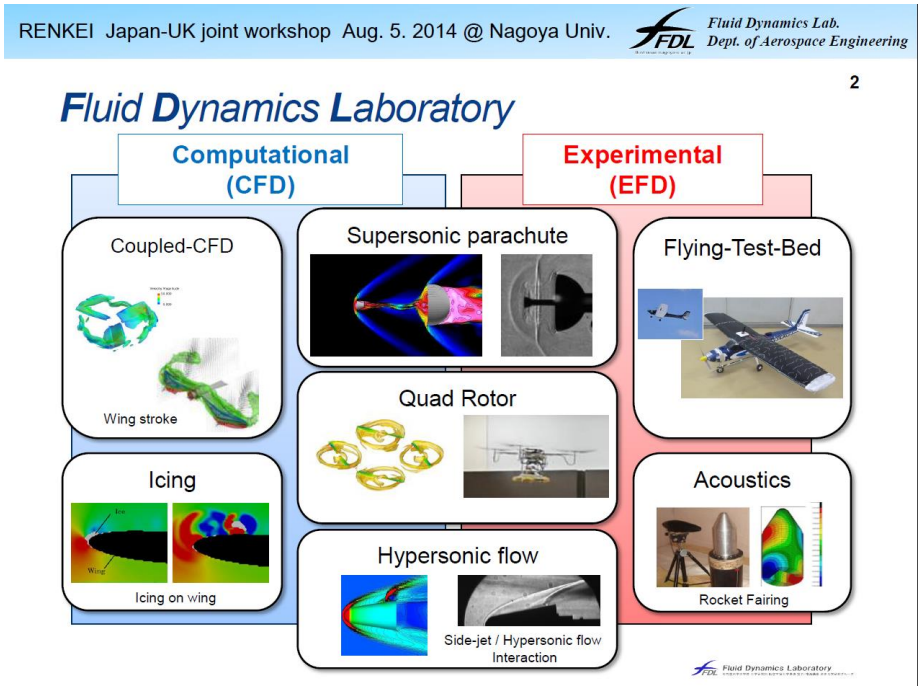
The Department of Aerospace Engineering at Nagoya University consists of two major laboratories: "Aerodynamics and Propulsion Laboratory" and "Structure and Control Laboratory". The former has *Fluid Dynamics Group*, *Ionized Gas Dynamics Group* and *Propulsion Energy System Engineering Group*. The latter has *Structure Mechanics Research Group*, *Control Systems Engineering Group*, and *Aerospace Vehicle Dynamics Research Group*.

3.1. Laboratory Introduction and Tour

In this session, the research activities of the following four groups were introduced by presentations and then laboratory tours were executed.

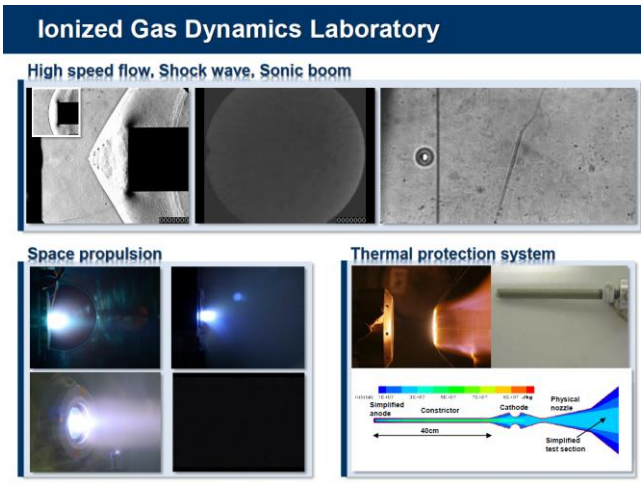
(a) Fluid Dynamics Group

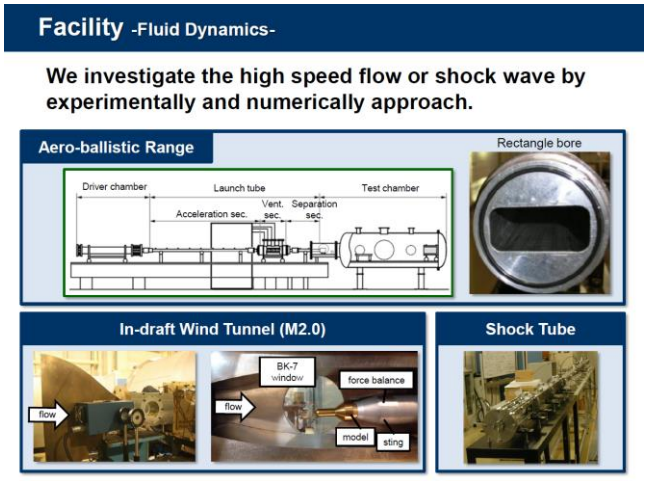
This group studies fluid dynamics related to aerospace engineering based on computational fluid dynamics (CFD) and wind tunnel experiments.

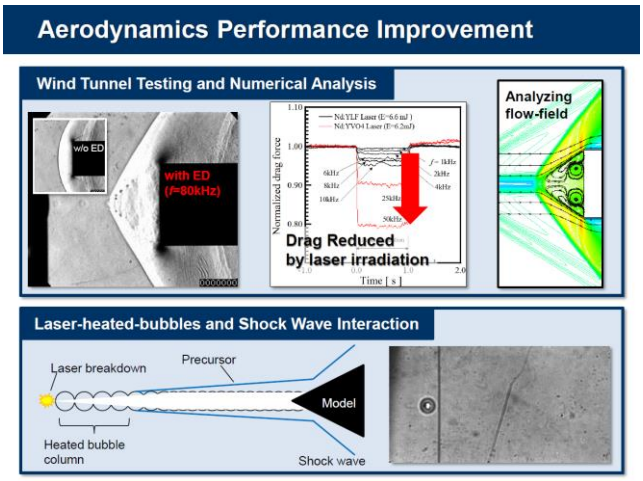


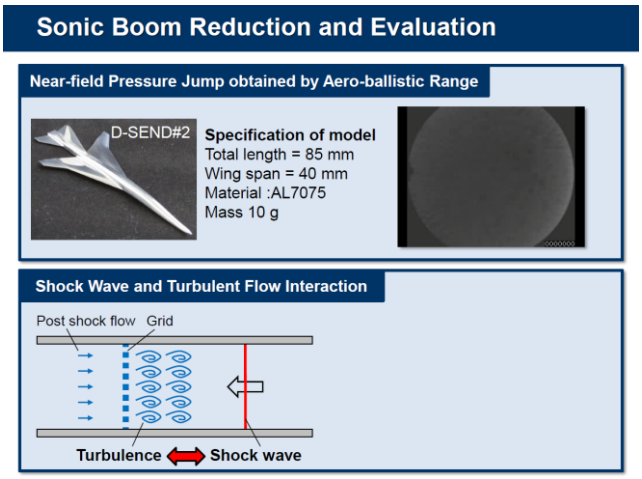
(b) Ionized Gas Dynamics Group

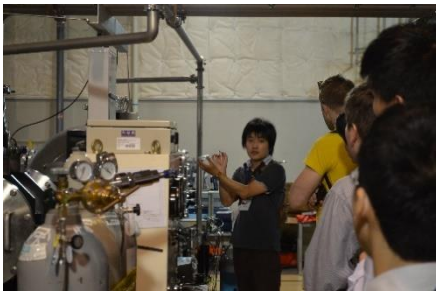
Flows with a high enthalpy are often accompanied by ionization and shock waves. Based on physical understandings this lab is aiming at a revolutionary breakthrough by utilizing their nonlinear characteristics in the hope that the results can be applied to aero/astronautics and propulsion field.





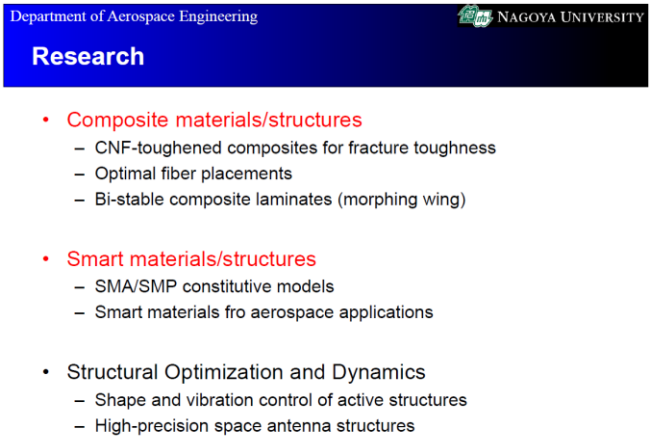


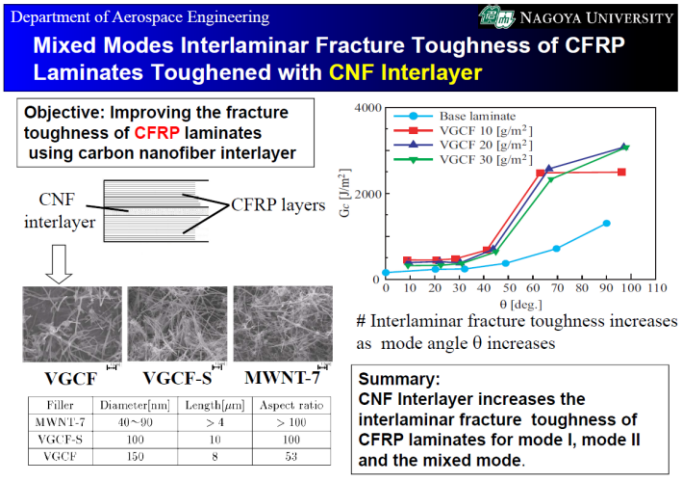


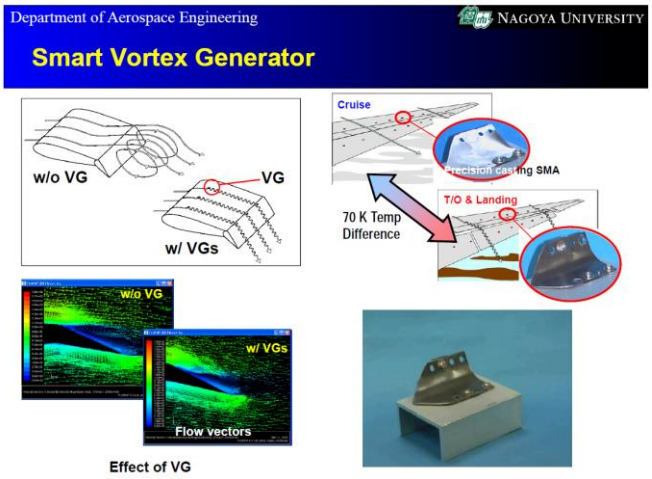


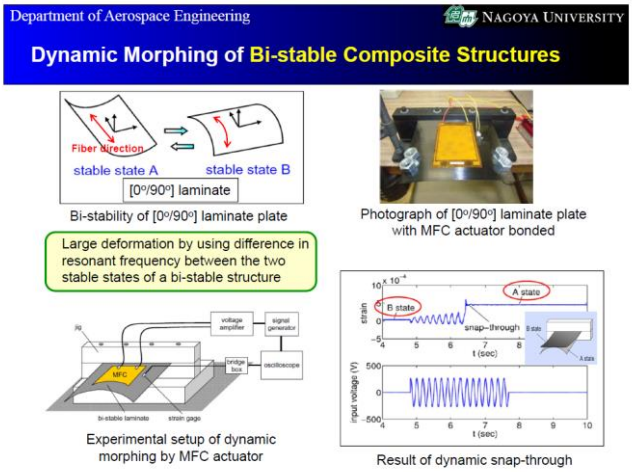
(c) Structure Mechanics Research Group

This group performs fundamental experiments and establishes theoretical models in order to understand phenomena of materials, structures, the fluid surrounding structures, etc. for designing materials and structures, and controlling vibration, noise, and the shape of structures. Also applies the obtained results to problems on aerospace vehicles and biomechanics.



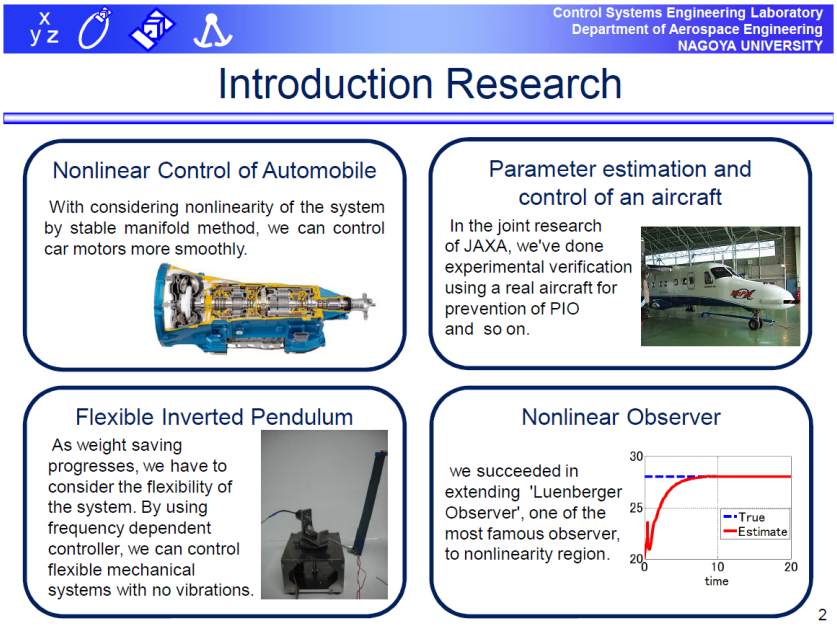


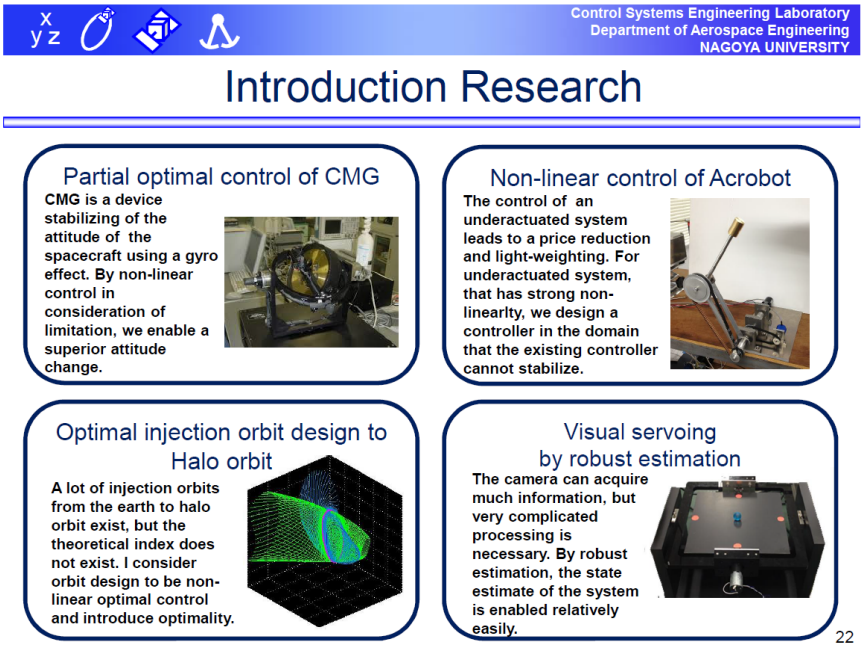


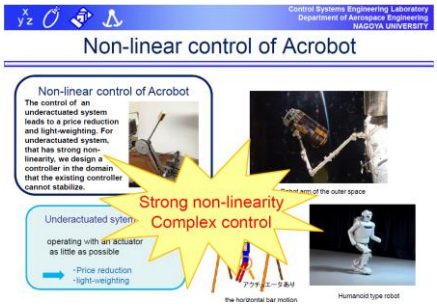


(d) Control Systems Engineering Group

Due to the increasing attention on unmanned aerial vehicles, aeronautical vertical take-off and landing vehicles, and flexible structures in space development, the requirements for control theory in aerospace engineering is becoming more diverse and complex. One of the challenges that signify these requirements is nonlinearity. In the Control System Engineering Group, all fundamental branches in the control engineering, such as prediction/estimation, control and identification, new control theories, computational methods and programs are studied for nonlinear system models using experimental verification.







3.2. Group Discussions

The participants are divided into the following three groups depending on their major field. They did experiments and discussed in each laboratory. The details of this activity was written in Section 7.1.

(a) Fluid Dynamics Group & Ionized Gas Dynamics Group

(b) Structure Mechanics Research Group

(c) Control Systems Engineering Group

4. Visits to Factories/Research Center/Museum

4.1. Mitsubishi Heavy Industries/Nagoya Aerospace Systems Works

[Company Introduction]

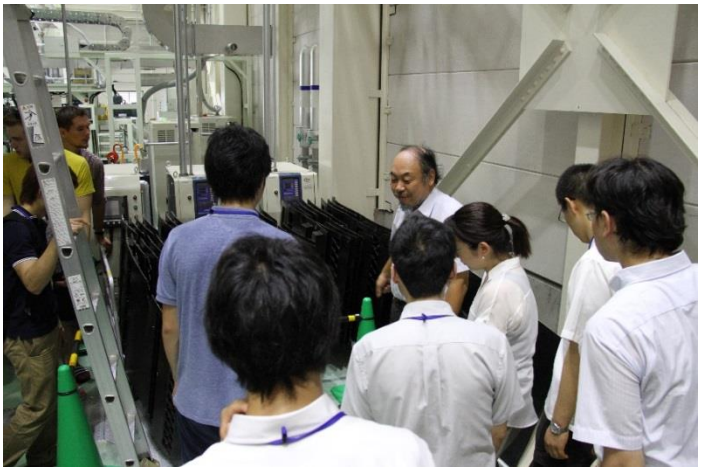
Mitsubishi Heavy Industries, Ltd. (MHI) is the largest heavy industry in Japan. MHI produces aerospace components, aircraft, automotive components, air conditioners, folklift trucks, hydraulic equipment, machine tools, missiles, power generation equipment, ships, and space launch vehicles. The corporate structure is composed of the following four domains: (1) Commercial Aviation & Transportation Systems Domain, (2) Energy & Environment Domain, (3) Integrated Defense & Space Systems Domain and (4) Machinery, Equipment & Infrastructure Domain. The Commercial Aviation & Transportation Domain includes the Shipping and Ocean Development Division, the Land Transportation Systems Division, the Commercial Airplanes Division, and the 787 Division. The Commercial Airplanes Division supplies the world's leading aircraft manufacturers – Boeing, Bombardier and Airbus – with civilian aircraft fuselage panels as well as cargo doors and other components. The 787 Division designs and manufactures the main wing box for the next generation, super-efficient 787 Dreamliner produced by the U.S.-based company Boeing. MHI is the first and currently only company in the world with in-house production lines capable of making passenger aircraft main wings from composite materials. (Referred to MHI Company Brochure ebook)

[Visited Factory] MHI Tobishima Plant

4.2. National Composites Center

"The National Composites Center" was established in April 2012 in Nagoya University as a center of academic-industrial-governmental alliance that aims to be a global research and development hub for composites. Its activities are as follows: (a) form a network and consortium that spans multiple industries, (b) learn about new developments through cooperation with universities and institutes, and (c) contribute to the development of human resources and small/medium sized companies.

Examples of current projects: (a) an automotive collaboration project
(b) an aircraft/windmill project



4.3. Kakamigahara Aerospace Science Museum

The Kakamigahara Aerospace Science Museum is one of the leading aerospace museums in Japan. The museum has over 25 aircraft on display including research aircraft, experimental craft, helicopters, human-powered aircraft, fighter jets, transport planes, and a reproduction of the first aircraft to fly in Japan (the 1910 " Hans Grade" Monoplane). Through the exhibits, visitors can understand aircraft development in Japan. Visitors can also climb aboard and explore some of the bigger aircraft.

Kakamigahara has a long relationship with aircraft. The adjacent Gifu Airbase opened in 1917 and is now the nation's oldest existing airbase. The factory of Kawasaki Heavy Industry exists in this city and has been manufacturing aircrafts here since 1922.

4.4. Shimadzu Corporation

[Company Introduction]

Shimadzu Corporation manufactures precision instruments, analytical instruments, measuring instruments, medical systems and equipment, aircraft equipment and industrial machinery. The company was established in 1875. At Shimadzu Corporation, X-ray devices, the spectrum camera, the electron microscope, and the gas chromatograph were developed and commercialized in advance of other Japanese companies. A historically notable event was the success of taking an X-ray photograph of a human hand in October 10, in 1896, which was only eleven months later after the production and detection of X-rays by Wilhelm C. Röntgen. In 2002, Koichi Tanaka, a long-standing employee, won the Nobel Prize in Chemistry for developing a method of mass spectrometric analysis of biological macromolecules. (Referred to Company website and Wikipedia)

[Visited Factories] (1) Sanjyo Works: Production of various aeroequipment for aircrafts
(2)Shimadzu Foundation Memorial Hall

In front of the statue of the founder, Genzo Shimadzu Sr.

Success of taking X-ray photograph

▸Visit of Prince Hironomiya and Princess Masako
▸Dr. Koichi Tanaka, the 2002 Nobel Laureate

5. Cultural Tours

In order to study Japanese culture and enjoy picturesque natural beauty, the participants visited Kyoto which was once the capital of Japan and the center of the nation's civilization for more than a thousand years, from 794 to 1868. They visited three popular tourist spots, Kinkaku-ji or Golden Pavilion, Kiyomizu-dera, and Nishijin Textile Center.

(1) Kinkaku-ji

Golden Pavilion

Japanese tea

(2) Kiyomizu-dera

(3) Nishijin Textile Center

Reeling silk off cocoons

Hand-weaving demonstration

Nishijin Silk fabrics

(4) Free time

Exploring old town in Kyoto

Okonomiyaki Party

Karaoke

6. Ignite Session

In this session, three speakers gave presentations about the collaborations between industries and Nagoya University. The aim of holding this session was to "ignite" active discussion in the next session on future RENKEI activities.

Presentation 1

"Introduction of the Department of Aerospace Engineering, Nagoya University"

Norihiko Yoshikawa : Professor of Micro-Nano Systems Engineering, and
Professor of Aerospace Engineering, Nagoya University

[Contents]

Professor Yoshikawa introduced the laboratories, staff and research of the Department of Aerospace Engineering, Nagoya University. This department was established in 1942. Its current composition is as follows:

1. Aerodynamics and Propulsion laboratory
   - Fluid Dynamics Group
   - Ionized Gas Dynamics Group
   - Propulsion Energy System Engineering Group
2. Structure and Control laboratory
   - Structure Mechanics Research Group
   - Control Systems Engineering Group
   - Aerospace Vehicle Dynamics Research Group
3. Aerospace Vehicle Design Engineering laboratory (in cooperation with JAXA)
   - Aerospace Vehicle Design Engineering Group
4. Eco Topia Science Institute Division of Energy Science
   - Environmental Heat Fluid Systems Group
5. Composite Engineering laboratory

For information on the research done at these laboratories, refer to Chapter 3.

Presentation 2

"Introduction of Global Project Leader Training Seminar"

Kengo Hayashi : Designated Associate Professor in Aerospace Education Program
Department of Aerospace Engineering, Graduate School of
Engineering, Nagoya University

[Contents]

1. Aircraft Development
2. Structure Work Share in Boeing Aircrafts
3. Market Demands
4. What is Global Project Leader ?
5. Aircraft Development Global Project Leader Training Seminar in NUAE

Presentation 3

"Introduction of Industry-Nagoya University Collaboration"

Yuho Shishiyama : Professor, Deputy Director General for Academic Research &
Industry-Academia-Government Collaboration, Nagoya University

[Contents]

Professor Shishiyama introduced the collaboration between Nagoya University and industries in the aerospace field, from the establishment of Nagoya University to the present.

1. Industry structure, increasingly high-tech aircraft production, supply chain of small and medium-sized companies, and business risks in this "Chubu" (Central Japan) Area.
2. Expectation of Nagoya University from industries regarding its contribution in the development of human resources and technology.
3. Recent initiatives and the future prospects of Nagoya University.

7. Students' Reports and Free Discussion on RENKEI Activities

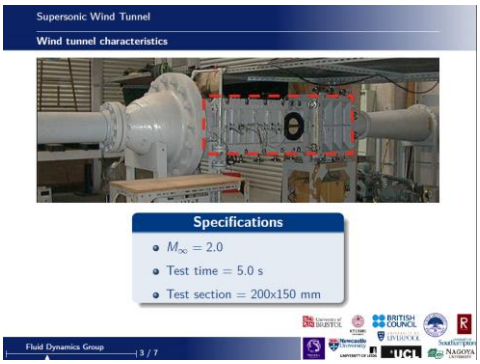
7.1. Students' Reports on Group Work

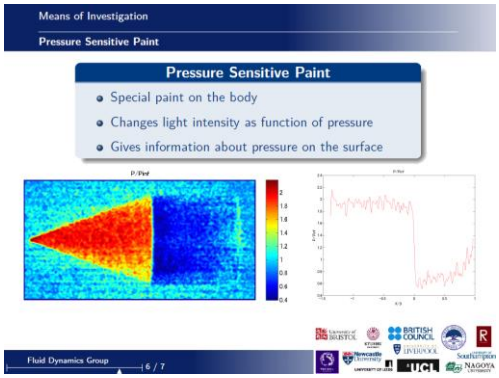
Each group reported on what they learned from the group work on August 5.

Group 1

Theme : *Experiments on Visualization with Supersonic Wind Tunnel*

Members: Daniel Poole, Rene Steijl, Fulvio Sartor, Jack Weatheritt, Akira Iwakawa, Takahiro Tamba, Masato Taguchi

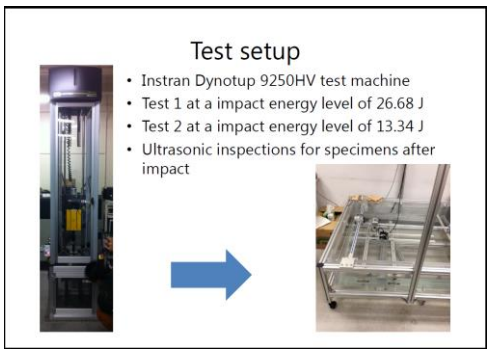


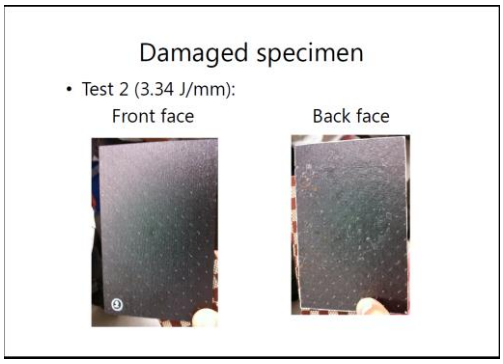


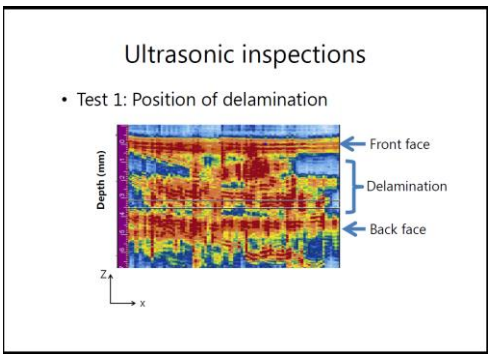
Group 2

Theme : *Impact Test of the CFRP Laminates*

Members: Xiaodong Xu, Bo Wang, Kenichi Tanigaki, Shinnosuke Takeda, Yuya Seo, Takahiro Morishita, Takayuki Sehara, Tomoyuki Watanabe



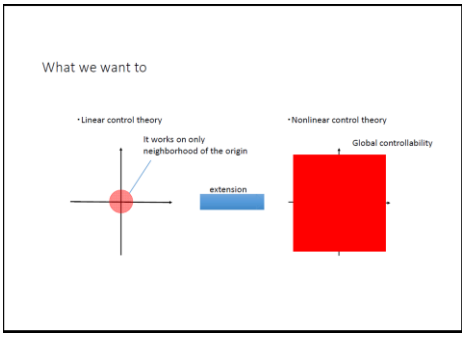


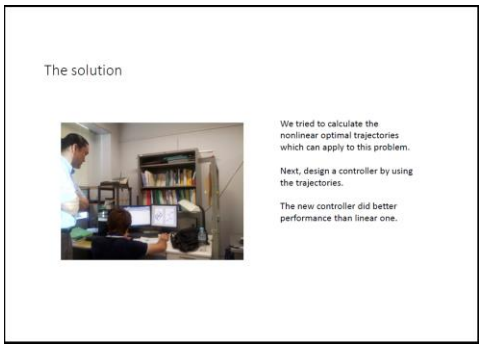


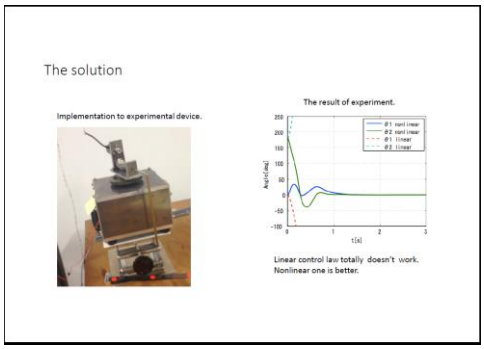
Group 3

[Topic] *Design New Controller*

[Members] Williem Johannis Eerland, Oliver Laslett, Akinori Harada, Qian Xu, Takamasa Horibe







7.2. Free Discussion on the Future RENKEI Activities

After the introduction of RENKEI by Ms. Azusa Tanaka, Head of Education of the British Council, the participants freely discussed present and future RENKEI activities.

8. Networking Dinner

A Networking Dinner was held in the evening on the last day of the Workshop. Professor Yoshihito Watanabe, Trustee (international affairs) and Vice-President of Nagoya University, gave the welcome address, and Professor Hideyo Kunieda, Trustee (research) and Vice-President of Nagoya University gave a toast. Mr. Patrick Bannister, Deputy Consul-General of the British Consulate-General Osaka, and Mr. Jeff Streeter, Director of the British Council Japan, gave guest addresses. The delegates from RENKEI member universities and the participating students all attended the networking dinner and had a very happy evening.

Prof. Watanabe

Prof. Kunieda

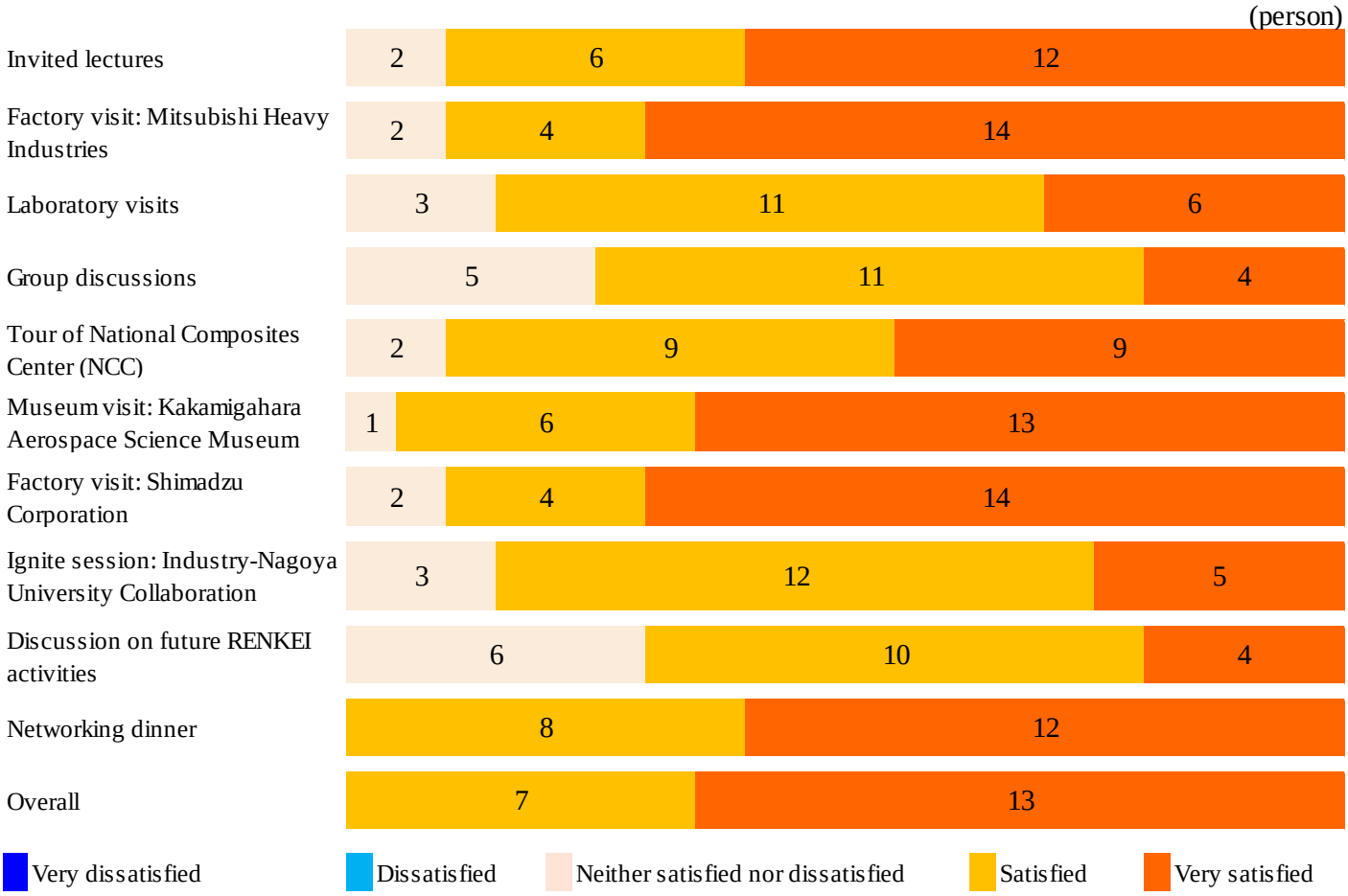
Mr. Bannister

Mr. Streeter

9. Results of Participant Satisfaction Survey

An online participant satisfaction survey was answered by all 20 students or young researchers participating in the 2014 RENKEI Japan-UK Joint Workshop on Aerospace Engineering after the workshop. Thanks to the many people who contributed to the workshop, this workshop received a lot of positive feedback from the participants as follows:

(1) Results of Participant Satisfaction Survey



(2) Reasons of Evaluation for Each Event

Reasons for high rating

Event	Reasons
Invited lectures	✧ Lectures were interesting and informative. ✧ Good choice of speakers discussing ongoing and future activities in Japan.
Factory visit: Mitsubishi Heavy Industries	✧ The trip was fascinating, well organized and a good length of time. ✧ A unique experience and something that I feel very privileged to be a part of. Not something that is necessarily possible (at least with the same transparency) in the UK. ✧ Very interesting and informative, particularly the visit to the launcher assembly and the launcher components shown to us.

Event	Reasons
Laboratory visits	✧ Good array of equipment and very impressive facilities. ✧ Good demonstration of the range of activities and in the afternoon a good chance of a more detailed discussion/introduction. ✧ Relevant research and opportunity to work with other students was great.
Group discussions	✧ We could discuss deeply and create better relationships with participants. ✧ The experimental activities in Nagoya were demonstrated in a good and informative way. Some more information on more theoretical, numerical work not involving experimental activities would have been a good addition. ✧ There was little chance of group discussions but those that did happen provided a good chance for constructive talks.
Tour of National Composites Center	✧ The equipment was fascinating. ✧ Following on from the previous invited lecture, the tour showed the main facility in a good way.
Museum visit: Kakamigahara Aerospace Science Museum	✧ It was very interesting to see aeroplanes with unique technical points together with people studying the same major (aerospace engineering). ✧ A really good, relevant visit that complemented the themes. ✧ Great museum. Very good to see such a good and quite exhaustive selection of Japanese projects, making it rather unique in the world.
Factory visit: Shimadzu Corporation	✧ This was a very interesting visit. I feel that I gained real insight into Japanese manufacturing corporations.
Ignite session: Industry-Nagoya University Collaboration	✧ I got interested in research at Nagoya University.
Discussion on future RENKEI activities	✧ The discussions were fruitful and insightful. ✧ We could discuss future RENKEI activities enthusiastically. ✧ Good chance to feedback the good and bad points of the week.
Networking dinner	✧ Very well organized and excellent standard of food. ✧ A very good round-off to an amazing week.
Overall	✧ Excellent chance to engage with Japanese students and observe the aerospace industry in Japan. The extra activities such as sightseeing were a nice addition and provided us with a chance to see the cultural side of Japan. Spending time with other students in the evening provided another opportunity to view a more leisurely side of Japan at restaurants and bars. Overall, an excellent week for my personal development. ✧ It was an extremely well organized workshop, if anything, it left a good impression of Japan. ✧ There were a lot of chances to talk with participants with different academic and cultural background.

Reasons for low rating

Event	Reasons
Invited lectures	✧ Topic was good but the presentations were a little bit long.
Factory visit: Mitsubishi Heavy Industries	―
Laboratory visits	✧ It should have been longer. ✧ I was working on the side receiving the visitors. The plan changed a few days before, so it was hard to prepare. ✧ I was disappointed because preparation was not enough.
Group discussions	✧ Lack of time. ✧ Should be more prepared and organized. ✧ There was quite a difference in expertise between participants.
Tour of National Composites Center	―
Museum visit: Kakamigahara Aerospace Science Museum	✧ The stay was too long.
Factory visit: Shimadzu Corporation	―
Ignite session: Industry-Nagoya University Collaboration	✧ I think that here an input from the UK visitors presenting their activities would have been helpful to make it more informative from both sides. ✧ Perhaps a little more industry focus?
Discussion on future RENKEI activities	✧ I think that here an input from the UK visitors presenting their activities would have been helpful. ✧ The questions were too broad to answer. ✧ The direction of the discussion is too broad to discuss.
Networking dinner	✧ It should be more casual style in order to talk more freely.
Overall	―

(3) Participants' Impression Regarding This Workshop

- ✧ Rare opportunity to interact between Japan and UK in aerospace engineering.
- ✧ I thought the workshop was very well structured and struck a great balance between formal and informal activities.
- ✧ A long-term view to establishing links was taken, with a significant focus on getting to understand Japan, Japanese culture and academia in Japan. This 'long' plan was evident from the choice of participants the workshop was targeting.
- ✧ Very interesting, but in order to start future collaborations you have to involve more research associates, lecturers, and professors, and less master's students.

(4) Activities Participants Were Interested In and Reasons

- ✧ Seeing H-IIB at Mitsubishi Heavy Industries was a highlight for me, this was a fascinating opportunity to see a working component of JAXA.
- ✧ The discussions at the University, the laboratory tours as well as the Aerospace Museum visit were really good from a professional point of view, while the more cultural visit to Kyoto provided a good chance to get to understand Japan better.
- ✧ Mostly the invited lectures, but I also appreciated the factory and laboratory visits; I had never seen a rocket directly before. Therefore, the visit to the rocket plant of Mitsubishi Heavy Industries was very interesting.

- ✧ Tour of National Composites Center. It was my first time to see how to manufacture composite components for the industry.
- ✧ It was a great combination of cultural experience, visiting the industry and visiting Nagoya University. The entire week was filled with interesting activities.

(5) Activities That Participants Thought Need to Be Improved

- ✧ I think that the first day needs the participants' introduction and the networking dinner. Orientation, longer introduction of participants and Networking.
- ✧ Group discussions: they were only about Nagoya University, nobody talked about what they were doing in other Japanese/British universities.
- ✧ Group discussion should be more prepared, and discussion time should be longer for the preparation for presentations.
- ✧ The discussions on the last day regarding future collaboration would really benefit from taking a more two-way approach in presenting research activities and by having participants more senior in role than Master or PhD student level.
- ✧ I suggest that relevant participants give talks to industry partners to share cutting edge research.

(6) Comments/Suggestions on This Workshop

- ✧ I think meetings involving more people at a more senior level would have helped. I appreciate the longer-term objective and hence the choice to also invite Master's and PhD students; however, for the part of the workshop on research collaborations I think that especially from the UK side (with PhD students sometimes younger than even the Master students in Japan), it would have been useful to limit the workshop to Post-docs and lecturers.
- ✧ There was not much time to discuss other participants' work from other universities.

(7) Willingness to Participate in the RENKEI Workshop on Aerospace Engineering if it is Held in the Future

All 20 students responded that they would like to participate in the RENKEI Workshop on Aerospace Engineering if it is held in the future.

(8) Comments/Suggestions for Future RENKEI Workshop

- ✧ This workshop is not only an opportunity for gaining aerospace knowledge but also good communication between Japan and UK. We should continue this workshop.
- ✧ For the UK return visit, a similar format should be used. However, slightly more focus should be put on sharing our work.
- ✧ Overall a very good experience. The main suggestion I would like to make is the one regarding the participants and the decision to include Master's and PhD students.

10. Participants' List and Short Biographies

Name	Institution	Faculty	Year
Daniel Poole	University of Bristol	Aerospace Engineering	D2
Xiaodong Xu	University of Bristol	Aerospace Engineering	D4
Akinori Harada	Kyushu University	Aeronautics and Astronautics	D2
Bo Wang	Kyushu University	Aeronautics and Astronautics	D2
Fulvio Sartor	University of Liverpool	Engineering	Research Associate
René Steijl	University of Liverpool	Engineering	Lecturer
Akira Iwakawa	Nagoya University	Aerospace Engineering	Assistant Professor
Takamasa Horibe	Nagoya University	Aerospace Engineering	M1
Masato Taguchi	Nagoya University	Aerospace Engineering	D1
Takahiro Tamba	Nagoya University	Aerospace Engineering	M2
Qian Xu	Nagoya University	Earth and Environmental Sciences	M2
Kenichi Tanigaki	Osaka University	Mechanical Science and Bioengineering	Assistant Professor
Yuya Seo	Osaka University	Mechanical Science and Bioengineering	B4
Shinnosuke Takeda	Osaka University	Mechanical Science and Bioengineering	M1
Takahiro Morishita	Ritsumeikan University	Science and Engineering	D1
Takayuki Sahara	Ritsumeikan University	Science and Engineering	M1
Tomoyuki Watanabe	Ritsumeikan University	Science and Engineering	M2
Willem Johannis Eerland	University of Southampton	Aerodynamics and Flight Mechanics	PGR
Oliver Laslett	University of Southampton	Aerodynamics and Flight Mechanics	D1
Jack Weatheritt	University of Southampton	Engineering and the Environment	D2

20 participants in total

University of BRISTOL

Daniel Poole

I obtained a first-class honours degree in Aerospace Engineering (Masters) at the University of Bristol in 2012. I am currently studying for my PhD in the Fluids and Aerodynamics Research Group at the University of Bristol, looking into efficient methods of performing aerodynamic optimization using CFD solutions. My research interests include optimization, CFD methods and applications to flow control devices.

Xiaodong Xu

Mr Xiaodong Xu is a Ph.D. student in the ACCIS Research Centre at the University of Bristol. His research interest is testing and modelling scaled coupons to understand the size effects in notched composite laminates. He obtained his bachelor's degree in Naval Architecture at Harbin Engineering University, and his master's degree in Ocean Engineering at Shanghai Jiaotong University. He worked for ClassNK (Nippon Kaiji Kyokai) as a plan approval engineer before going to the UK.

KYUSHU UNIVERSITY

Akinori Harada

Akinori Harada received BE and ME degrees from Kyushu University, Japan, in 2011 and 2012 respectively. He is currently a doctoral program student in the Department of Aeronautics and Astronautics at Kyushu University. He is also a Research Fellow of the Japan Society for the Promotion of Science, since 2014. His research interests include optimal control, Dynamic Programming, flight dynamics and ATM / CNS (Air Traffic Management / Communication Navigation and Surveillance). He has designed optimal trajectories for passenger aircraft, a reentry vehicle and a supersonic glide experiment vehicle with Dynamic Programming. He is currently engaged in research for extending DP's scope of application.

Bo Wang

I am a D2 student in the Department of Aeronautics and Astronautics at Kyushu University, Japan. Before I entered Kyushu University, I obtained my bachelor's degree in Engineering Mechanics from Northwest Polytechnical University, China, and conducted a study of buckling phenomenon on composite laminates as a graduation thesis in 2009. After this, I passed the graduate examination at Northwest Polytechnical University, China, and started an analysis of compressive failure modes on composite stiffened panels as my master's research topic. I obtained my master's degree in Solid Mechanics in 2012.Subsequently, I came to Japan to pursue a doctoral degree at Kyushu University, and my new research topic is the mechanical properties of composite laminates with fiber waviness. I hope to successfully complete my doctoral education there.

UNIVERSITY OF LIVERPOOL

Fulvio Sartor

Dr Fulvio Sartor received his master's degree at the Aeronautical Engineering University "La Sapienza of Rome", Italy, in 2011, specializing in aerodynamics. Between 2011 and 2013 he worked at the Fundamental and Experimental Aerodynamic Department of ONERA, France, on the unsteadiness of shock-wave/boundary-layer interactions. His work focused on experimental investigation, numerical analysis and theoretical formulation of shock-induced separation, including stability analysis on separated transonic flows. He obtained his doctoral degree at Aix Marseille Université in 2014. He is currently a Research Associate at the University of Liverpool, United Kingdom, working at the Centre for Engineering Dynamics of the School of Engineering. He is involved in the BuColic project founded by the European Union's Seventh Framework Programme for the Clean Sky Joint Technology Initiative.

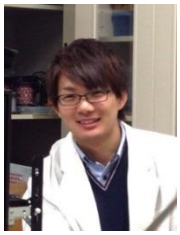
René Steijl

René graduated from Delft University of Technology with a master's degree in Aerospace Engineering in 1997, specializing in computational fluid dynamics of hypersonic flow. His interest in aerodynamics as well as computational methods was further developed while working towards a PhD degree at the Technical University of Delft and the University of Twente. He was awarded the PhD in December 2001. Following this, he decided to pursue an academic career, the first step of which was a Postdoctoral position at the Technical University of Munich, focusing on numerical modeling of multi-phase flows. In 2004, he moved to the UK to work as a postdoctoral research associate in the field of computational fluid dynamics for rotorcraft, first at the University of Glasgow and from 2005 at the University of Liverpool. In June 2010 he was appointed as lecturer in the School of Engineering at the University of Liverpool, focusing his research on the development and application of computational fluid dynamics methods for high-speed, multi-scale and rarefied flows, as well as continuing to work on CFD modeling of rotorcraft aerodynamics and aero-elastics. For the multi-scale flows, he has developed a multi-physics flow simulation framework which includes methods based on the kinetic Boltzmann equation and molecular dynamics as well as various continuum-flow methods. His teaching involves courses in aerospace propulsion, aerodynamics, and fluid dynamics as well as spaceflight.

NAGOYA UNIVERSITY

Akira Iwakawa

Mr. Iwakawa received his bachelor's degree in Engineering Science from Kyoto University, Japan in 2008. He received his master's Degree in the Department of Aeronautics and Astronautics from the University of Tokyo, Japan in 2010. He finished the doctoral program without dissertation in the Department of Aerospace Engineering, Nagoya University, Japan in 2014. He became an Assistant Professor in the Department of Aerospace Engineering, Nagoya University in April 2014 and is currently working toward completing his Ph.D. thesis. He is interested in both aircraft and spacecraft; his major is propulsion systems like electric propulsion or fluid dynamics. Currently, he is engaged in the research on magneto-plasma-dynamic thrusters and fluid dynamics for improving efficiency of high-speed flight.



Takamasa Horibe

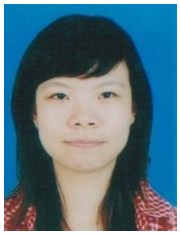
I obtained my bachelor's degree in aerospace engineering at Nagoya University. My research interest is control system engineering and working on the study of energy-based nonlinear control. Now I am in the second year of my master's degree program at the same university; I am currently focusing on research on nonlinear optimal control of underactuated mechanical systems. In addition, I am active in extracurricular activities. I established a student organization named NAFT. The first project we launched at NAFT was to take a video of the blue Earth from a high altitude. The project was a success and gained some media attention. NAFT now has financial support from the Boeing Company and is launching many projects with research institutions in the aerospace field.

Masato Taguchi

Mr. Taguchi obtained his BS in Physics at Shizuoka University, as well as his MEng in Aerospace Engineering. He worked as an internship student in DLR (German Aerospace Centre) for three months in 2013. He is currently a Ph.D. student at Nagoya University. His research is mainly on high-speed gas dynamics, doing wind tunnel tests of supersonic and hypersonic flows. His recent interests toile in aerodynamic interactions in hypersonic flow and experimental investigations on fluid and structure interaction in supersonic flow (e.g. supersonic parachute). He also handles measurements with molecular sensors (e.g. Pressure Sensitive Paint; PSP, Temperature Sensitive Paint; TSP).

Takahiro Tamba

I am a graduate student of Nagoya University majoring in compressible fluid dynamics, and studying drag reduction of supersonic transport by laser energy deposition. A wave drag is one of the biggest problems of supersonic transport, but it can be reduced by modulation of the shock wave caused by the interaction between the shock wave and hot bubbles generated by laser energy deposition. In my research, I investigated the interaction between a shock wave and bubble column to realize practical drag reduction by laser energy deposition. I obtained my bachelor's degree at Nagoya University, investigating laser breakdown induced by a short-pulse laser energy deposition in low pressure.



Qian Xu

Ms. Xu graduated from Dalian University of Foreign Languages, China, majoring in software technology. After graduating, she worked as a sales assistant in an international trading company. Coming to Japan provided a good chance to pursue her field of interest, biological oceanography. She is now a master's student in the laboratory of Satellite Biological Oceanography, Nagoya University, focusing on phytoplankton distribution. She is currently studying the relationships between environmental factors and phytoplankton variations using ocean color remote sensing, and expects to use the data of the second generation Global Imager (SGLI) of the GCOM-C1 satellite, JAXA in the near future. With a keen interest in future aircraft development, Qian feels very lucky to be able to work with the members of this workshop and expand her knowledge on different aspects.

大阪大学
OSAKA UNIVERSITY

Kenichi Tanigaki

Kenichi TANIGAKI (born in Shiga, Japan) is an Assistant Professor at the Graduate School of Engineering Science, Osaka University. He graduated from Osaka University in 2008. He received his master's degree from the Graduate School of Engineering Science, Osaka University in 2009. From the same University, he was awarded a Ph.D in the field of Mechanics of materials and Solid-state physics in 2011. From April 2011 to March 2012 he was a JSPS Research Fellow PD. In April 2012, he was appointed as an Assistant Professor at Osaka University. His research interests include Elastic constants and Impact behavior of materials, Mechanical propertiues of grain boundaries, and Biomimetics of plants.

Yuya Seo

I am a member of Kobayashi laboratory of Osaka University, which mainly researches impact engineering. My research involves investigating the effects of joint part connecting two different bars on the propagation of stress waves using FEM analysis. Contact surface often produces reflected waves. Sometimes, superposition of reflected waves causes severe accidents; I am trying to invent joint parts which don not generate reflected waves for more a stable structure under impact load.

Shinnosuke Takeda

Currently enrolled in a master’s program at the Graduate School of Engineering Science. I received my B. Engineering degree from the School of Engineering Science, Osaka University. My research theme is DEM (Discrete Element Method) simulation of high-speed impact and penetration of a projectile into a granular medium.

RITSUMEIKAN

Takahiro Morishita

Takahiro Morishita received his master's degree from the Graduate School of Mechanical Engineering at the University of Fukui, Japan. He is currently a doctoral student in the Graduate School of Science and Engineering, Ritsumeikan University, Japan. His main research interest is multiaxial low cycle fatigue under non-proportional loading.

Takayuki Sahara

Takayuki Sahara obtained his Bachelor of Science degree in Mechanical Engineering from Ritsumeikan University, Japan. He is currently working on his master's degree in Mechanical Engineering at Ritsumeikan University, and expects to graduate in March 2016.

Tomoyuki Watanabe

Tomoyuki Watanabe graduated with a BSc in Mechanical Engineering from Ritsumeikan University, Japan. He is currently working on his master's degree in Mechanical Engineering at the same university, and is due to graduate in March 2015.

UNIVERSITY OF Southampton

Willem Johannis Eerland

Completed bachelor and masters in Aerospace Engineering at Delft University of Technology. My specialization was Control and Simulation. Currently a PGR at Southampton University, working on a project focusing on analyzing trajectories around airports. Research interests are focused on artificial intelligence, control systems and model estimation. General engineering and computer science subjects are also subjects of interest.

Oliver Laslett

I graduated from the University of Sheffield with an MEng in aerospace engineering, mainly focusing on control systems for aerospace applications. My work led to industry collaborations with Rolls Royce, developing data-driven models for prognostics of GTEs and later application of prognostic methods to munitions systems for QinetiQ. I am now undertaking a PhD through the Institute for Complex System Simulation, working with the Computational Engineering and Design group and furthering my knowledge of dynamical systems modeling, my current research involves the application of numerical methods for dynamical systems to stochastic magnetization dynamics.

Jack Weatheritt

Master of mathematics from Durham University, member of the Institute of Complex Systems Simulation. Specialist subjects revolve around Computational Fluid Dynamics, in particular developing turbulence resolving approaches affordable for industrial applications. The development process is achieved via novel genetic optimisation approaches.

List of Members who supported this Workshop

Working Group in RENKEI

Institutions	Name	Title
Nagoya University	Yoshihito Watanabe	Professor, Trustee (International Affairs) and Vice-President
Nagoya University	Yukio Ishida	Designated Professor
University of Southampton	S. Mark Spearing	Professor, Pro Vice-Chancellor (International)
University of Southampton	Ben Jones	Aerospace Collaboration Manager, Research and Innovation Services
University of Bristol	Nishan Canagarajah	Professor, Dean of Engineering
University of Bristol	Michel Wisnom	Professor, Director of ACCIS

Executive Committee in Nagoya University

Institutions	Name	Title
Nagoya University	Yukio Ishida	Designated Professor
Nagoya University Hakuryo Eng., Co. Ltd.	Minoru Kobayashi	Designated Professor, Department of Aerospace Engineering, and President, Hakuryo Engineering, Co. Ltd. (MHI Group)
Nagoya University	Kouichi Mori	Associate Professor, Department of Aerospace Engineering

Academic Consortium 21 (AC21) Office (Nagoya University's Contact Point for RENKEI)

Institutions	Name	Title
Nagoya University	Yoshihito Watanabe	Professor, Trustee (International Affairs) and Vice-President, and Director of AC21 General Secretariat
Nagoya University	Ayako Ido	Associate Professor, Project Coordinator of AC21 General Secretariat

International Affairs Department, Nagoya University

Institutions	Name	Title
Nagoya University	Hirohito Saigusa	Director, International Affairs Department
Nagoya University	Akihiko Noda	Director, International Planning Division
Nagoya University	Tomoko Deguchi	Section Head, International Planning Division
Nagoya University	Miho Kito	Staff, International Planning Division

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