

# Takuto Ishimatsu, Ph.D.

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## EDUCATION

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**Massachusetts Institute of Technology** Cambridge, MA  
Ph.D. in Aeronautics and Astronautics, Jun. 2013 Overall GPA: 4.8/5.0  
Major in Space Systems and Logistics; Minor in Astrophysics Major GPA: 5.0/5.0  
Thesis: “Generalized Multi-Commodity Network Flows: Case Studies in Space Logistics and Complex Infrastructure Systems”  
Committee: Prof. Olivier de Weck (Chair), Prof. Jeffrey Hoffman, Prof. Yoshiaki Ohkami (Keio Univ.), Dr. Robert Shishko (JPL)  
Coursework: Astrodynamics, Satellite Engineering, Multidisciplinary Design Optimization, Systems Engineering, System Safety, Operations Research, Logistical & Transportation Planning, Control, Astrophysics, General Relativity  
S.M. in Aeronautics and Astronautics, Jun. 2008 GPA: 5.0/5.0  
Thesis: “Interplanetary Trajectory Analysis for 2020-2040 Mars Missions including Venus Flyby Opportunities”  
**The University of Tokyo** Tokyo, Japan  
M. Eng. in Aeronautics and Astronautics, Mar. 2006 GPA: 4.0/4.0  
Thesis: “Numerical Analysis of Aerodynamic Interference between Two Circular Cylinders using Overset Grid Method”  
B. Eng. in Aeronautics and Astronautics, Mar. 2004 GPA: 3.8/4.0  
Thesis: “Geometry and Aerodynamics of Hypersonic Flight Vehicle”  
Design Project: Reusable Tow Launch Spaceplane

## PROFESSIONAL EXPERIENCE

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**Massachusetts Institute of Technology** Cambridge, MA  
Postdoctoral Associate, Engineering Systems Division / Institute for Data, Systems, and Society Jun. 2013 – Present  
**The University of Tokyo** Tokyo, Japan  
Part-Time Lecturer, Graduate School of Frontier Sciences Apr. 2016 – Present  
Visiting Collaborative Researcher, Graduate School of Frontier Sciences Sep. 2015 – Mar. 2016

## RESEARCH EXPERIENCE

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**Graph-Theoretic Modeling Framework for Space Exploration Logistics** Sep. 2008 – Present  
MIT Strategic Engineering Research Group (SERG)  
Advisors: Prof. Olivier de Weck, Prof. Jeffrey Hoffman, Prof. Yoshiaki Ohkami (Keio Univ.), and Dr. Robert Shishko (JPL)

- Developed a graph-theoretic modeling method for optimizing space exploration logistics
- Demonstrated the method on the logistics planning for human exploration of Mars
- Mentored a Ph.D. student working on a follow-on study
- Exploring the next-generation strategy for space logistics infrastructure and transportation architecture

**National Power Network System (NPNS) Project** Jul. 2015 – Present  
Center for Complex Engineering Systems (CCES) at MIT and King Abdulaziz City for Science and Technology (KACST)  
Advisor: Prof. Olivier de Weck

- Developing a network flow model for evolving national power system in Saudi Arabia
- Analyzing the strategy for future investment in renewable energy infrastructure network
- Leading a team of 10 researchers from MIT and KACST developing the network model

**Strategic Sustainable Desalination Network (SSDN) Project** Jun. 2013 – Jun. 2015  
Center for Complex Engineering Systems (CCES) at MIT and King Abdulaziz City for Science and Technology (KACST)  
Advisor: Prof. Olivier de Weck

- Developed a time-evolving network flow model for national water/energy infrastructure network in Saudi Arabia
- Analyzed the strategy for future investment in water/energy infrastructure network focusing on solar desalination technology
- Developed a decision support system with graphical user interface and 3D map projection
- Led a team of 10 researchers from MIT and KACST developing the network model

**U.S. Intermodal Freight Transportation Network Analysis** Jun. 2013 – May 2014  
MIT Production in the Innovation Economy (PIE) U.S. Shipbuilding Study with U.S. Navy  
Advisors: Prof. Olivier de Weck and Dr. Eric Rebentisch

- Developed a comprehensive network flow model for U.S. domestic intermodal freight transportation
- Analyzing the North American Marine Highways concept and the impact of the Panama Canal expansion

**Sustainable Infrastructure Planning System (SIPS) Project**

Jan. 2012 – May 2013

MIT Center for Complex Engineering Systems (CCES) and King Abdulaziz City for Science and Technology (KACST)

Advisor: Prof. Olivier de Weck

- Developed a multi-layer network flow model for national water/energy infrastructure network in Saudi Arabia
- Analyzed the optimal strategy for future investment in water desalination network

**STPA: System Safety and Hazard Analysis**

Oct. 2009 – May 2012

MIT System Engineering Research Laboratory (SERL) and Japan Aerospace Exploration Agency (JAXA)

Advisor: Prof. Nancy Leveson

- Developed the detailed procedures for a new hazard analysis technique called STPA
- Demonstrated the feasibility and utility of STPA on JAXA's unmanned cargo transfer spacecraft HTV
- Led a team of 9 researchers/engineers from MIT and JAXA/JAMSS

**DARPA System F6 Program**

Jun. 2011 – Nov. 2011

MIT Space Systems Laboratory (SSL) and Aurora Flight Sciences

Advisors: Prof. David Miller and Prof. Olivier de Weck

- Explored the optimal cluster geometry of fractionated satellite systems
- Proposed a new configuration with minimal tracking effort and minimal probability of collision

**SpaceNet: Integrated Space Logistics Modeling and Simulation**

Sep. 2008 – Aug. 2009

MIT Strategic Engineering Research Group (SERG) and NASA Jet Propulsion Laboratory (JPL)

Advisors: Prof. Olivier de Weck and Dr. Robert Shishko (JPL)

- Analyzed interplanetary trajectories for Mars missions with Venus flyby options
- Developed a Mars use case in a discrete event simulation software called SpaceNet

**TEACHING EXPERIENCE****Optimal System Design**

Oct. 2015 – Jan. 2016

Co-instructor, Graduate School of Frontier Sciences, The University of Tokyo, Kashiwa, Japan

- Gave lectures on System Fundamentals, Multidisciplinary Design Optimization, and Network Models to 12 grad students
- Supported student teams for the JAXA's space debris removal project and the J-DeEP's ocean logistics hub project
- Created and graded assignments and final project presentations

**Active Learning Project Sequence (ALPS)**

May 2008 – Mar. 2013

Co-instructor, Graduate School of System Design and Management (SDM), Keio University, Yokohama, Japan

- Gave lectures on Design Structure Matrix (DSM), Design of Experiments (DOE), and System Safety to about 100 grad students
- Graded final project presentations and reports
- Supported other lectures from MIT, Stanford, and TU Delft

**System Project Management**

Sep. – Dec. 2008 &amp; Sep. – Dec. 2012

Teaching Assistant, Engineering Systems Division (ESD), MIT, Cambridge, MA

- Assisted about 70 grad students through class, office hours, and emails
- Graded assignments

**PUBLICATIONS****Journal Articles**

- **Ishimatsu, T.**, de Weck, O.L., Hoffman, J.A., Ohkami, Y., and Shishko, R., "Generalized Multicommodity Network Flow Model for the Earth-Moon-Mars Logistics System," *Journal of Spacecraft and Rockets*, Vol. 53, No. 1, 2016, pp. 25-38.
- **Ishimatsu, T.**, Leveson, N.G., Thomas, J.P., Fleming, C.H., Katahira, M., Miyamoto, Y., Ujiie, R., Nakao, H., and Hoshino, N., "Hazard Analysis of Complex Spacecraft Using Systems-Theoretic Process Analysis," *Journal of Spacecraft and Rockets*, Vol. 51, No. 2, 2014, pp. 509-522.
- **Ishimatsu, T.**, Hoffman, J., and de Weck, O., "Method for Rapid Interplanetary Trajectory Analysis using  $\Delta V$  Maps with Flyby Options," *Journal of the British Interplanetary Society*, Vol. 64, No. 6/7, 2011, pp. 204-213.
- **Ishimatsu, T.**, Grogan, P., and de Weck, O., "Interplanetary Trajectory Analysis and Logistical Consideration of Human Mars Exploration," *Journal of Cosmology*, Vol. 12, 2010, pp. 3588-3600.
- **Ishimatsu, T.**, Morishita, E., Okunuki, T., and Koyama, H., "Numerical Analysis of Aerodynamic Interference between Two Circular Cylinders Using the Overset Grid Method," *Transactions of the Japan Society for Aeronautical and Space Sciences*, Vol. 51, 2008, pp. 139-145.
- **Ishimatsu, T.** and Morishita, E., "Taylor-Maccoll Hypervelocity Analytical Solutions," *Transactions of the Japan Society for Aeronautical and Space Sciences*, Vol. 48, 2005, pp. 46-48.

## Conference Papers

- Doufene, A., **Ishimatsu, T.**, Alhassan, A., Alsaati, A., de Weck, O., and Strzepek, K., “Large Scale Engineering Systems – Insight on Desalination for Agriculture in Saudi Arabia,” *INCOSE International Symposium 2016*, Edinburgh, Scotland, Jul. 2016. (accepted for presentation)
- Khiyami, A., **Ishimatsu, T.**, Alfaris, A., and de Weck, O.L., “A Graph Theoretic Framework for Integrated and Co-optimized Power System Planning,” *INCOSE International Symposium 2016*, Edinburgh, Scotland, Jul. 2016. (accepted for presentation)
- **Ishimatsu, T.**, Doufene, A., Alawad, A., and de Weck, O.L., “Desalination Network Model Driven Decision Support System: A Case Study of Saudi Arabia,” International Desalination Association World Congress 2015, San Diego, CA, Aug.-Sep. 2015.
- Chale-Gongora, H.G., de Weck, O., Doufene, A., **Ishimatsu, T.**, and Krob, D., “Planning an Itinerary for an Electric Vehicle,” *IEEE International Energy Conference (ENERGYCON)*, Dubrovnik, Croatia, May 2014.
- **Ishimatsu, T.**, de Weck, O., Hoffman, J., Ohkami, Y., and Shishko, R., “A Generalized Multi-Commodity Network Flow Model for Space Exploration Logistics,” AIAA 2013-5414, *AIAA SPACE 2013 Conference & Exposition*, San Diego, CA, Sep. 2013.
- **Ishimatsu, T.**, de Weck, O., Hoffman, J., Ohkami, Y., and Shishko, R., “A Graph-Theoretic Modeling Framework for Resource-Economy in Space Logistics,” AIAA 2012-5125, *AIAA SPACE 2012 Conference & Exposition*, Pasadena, CA, Sep. 2012.
- **Ishimatsu, T.**, Leveson, N., Fleming, C., Katahira, M., Miyamoto, Y., and Nakao, H., “Multiple Controller Contributions to Hazards,” *Proceedings of the 5<sup>th</sup> IAASS Conference*, Versailles, France, Oct. 2011.
- Fleming, C., **Ishimatsu, T.**, Miyamoto, Y., Nakao, H., Katahira, M., Hoshino, N., Thomas, J., and Leveson, N., “Safety Guided Spacecraft Design using Model-Based Specifications,” *Proceedings of the 5<sup>th</sup> IAASS Conference*, Versailles, France, Oct. 2011.
- **Ishimatsu, T.**, de Weck, O., Hoffman, J., and Ohkami, Y., “A Proposal for Graph-Theoretic Modeling Approach to Resource-Economy in Spaceflight Campaign Logistics,” AIAA 2011-7347, *AIAA SPACE 2011 Conference & Exposition*, Long Beach, CA, Sep. 2011.
- **Ishimatsu, T.**, de Weck, O., and Hoffman, J., “Mid-Course Plane-Change Trajectories Expanding Launch Windows for Mars Missions including Venus Flyby Opportunities,” AAS 11-520, *AAS/AIAA Astrodynamics Specialist Conference*, Girdwood, AK, Aug. 2011.
- **Ishimatsu, T.**, Leveson, N., Thomas, J., Katahira, M., Miyamoto, Y., and Nakao, H., “Modeling and Hazard Analysis using STPA,” *Proceedings of the 4<sup>th</sup> IAASS Conference*, Huntsville, AL, May 2010.
- **Ishimatsu, T.**, Hoffman, J., and de Weck, O., “Interplanetary Trajectory Analysis for 2020-2040 Mars Missions including Venus Flyby Opportunities,” AIAA 2009-6470, *AIAA SPACE 2009 Conference & Exposition*, Pasadena, CA, Sep. 2009.
- Colson, J.M., Cunio, P.M., Odegard, R., Ramirez, J., Sutherland, T., Brunet, G., Elkholy, T., Gardner, B., **Ishimatsu, T.**, Pasqual, J., and de Weck, O., “LIMIT: Lunar Infrared Modular Interferometric Telescope,” AIAA 2008-7674, *AIAA SPACE 2008 Conference & Exposition*, San Diego, CA, Sep. 2008.
- Cunio, P.M., **Ishimatsu, T.**, Keller, J., Khan, Z., Odegard, R., Waswa, P., and Landis, G.A., “Near-Term Mars Sample Return Using In-Situ Oxygen Generation,” AIAA 2007-6064, *AIAA SPACE 2007 Conference & Exposition*, Long Beach, CA, Sep. 2007.
- **Ishimatsu, T.** and Morishita, E., “Numerical Analysis of Interference between Two Circular Cylinders using Overset Grid Method,” *Proceedings of the 37<sup>th</sup> JSASS Annual Conference*, Tokyo, Japan, Apr. 2006.
- **Ishimatsu, T.** and Morishita, E., “Numerical Analysis of Interference between Two Circular Cylinders using Overset Grid Method,” *Proceedings of the 43<sup>rd</sup> Aircraft Symposium*, Nagoya, Japan, Oct. 2005.
- **Ishimatsu, T.** and Morishita, E., “Taylor-Maccoll Hypersonic-Limit Analytical Solution and Waverider Design,” *Proceedings of the 35<sup>th</sup> JSASS Annual Conference*, Tokyo, Japan, Apr. 2004.

## PRESENTATIONS

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### Invited Technical Talks

- “What is Humanity’s ‘Best’ Path to Mars?” Seminar at ispace inc., ispace inc., Tokyo, Japan, Feb. 2016.
- “Network Flow Modeling Method for Large-Scale Complex Systems,” Kashiwa Campus Science Camp, The University of Tokyo, Kashiwa, Japan, Jan. 2016.
- “What is Humanity’s ‘Best’ Path to Mars?” Seminar at Nishinari-Yanagisawa Laboratory, Research Center for Advanced Science and Technology, The University of Tokyo, Tokyo, Japan, Dec. 2015.
- “What is Humanity’s ‘Best’ Path to Mars?” JPL Seminar, NASA Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, Nov. 2015.
- “Network Flow Modeling Method for Large-Scale Complex Systems,” 2<sup>nd</sup> GTL Symposium, Kashiwa-no-ha Conference Center, Kashiwa, Japan, Oct. 2015.
- “A Network Flow Model for Space Logistics,” JAXA Seminar, Japan Aerospace Exploration Agency, Tsukuba, Japan, Jul. 2015.
- “Interdependent Network Flows in Land, Sea, and Space,” The University of Tokyo, Tokyo, Japan, Apr. 2015.
- “INFINIT: A Network Flow Model for Space Logistics,” JPL Seminar (WebEx), NASA Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, Jan. 2015.
- “Interplanetary Trajectory Analysis for 2020-2040 Mars Missions including Venus Flyby Opportunities,” 16.346 Astrodynamics (Guest Lecture), Massachusetts Institute of Technology, Apr. 2014.
- “Do We Need Gas Stations in Space?” Boston Japanese Researchers Forum (BJRF), Massachusetts Institute of Technology, Cambridge, MA, Nov. 2013.

- “Handling Multiple Controllers in STPA,” 1<sup>st</sup> STAMP/STPA Workshop, Massachusetts Institute of Technology, Cambridge, MA, Apr. 2012.
- “STAMP/STPA Advanced Tutorial – Unmanned Cargo Transfer Spacecraft,” 1<sup>st</sup> STAMP/STPA Workshop, Massachusetts Institute of Technology, Cambridge, MA, Apr. 2012.
- “Modeling and Hazard Analysis using STPA,” NASA IV&V Program, 2010 IV&V Annual Workshop, NASA IV&V Facility, Fairmont, WV, Sep. 2010.
- “STAMP/STPA Analysis for JAXA HTV Capture Safety,” MIT Industrial Liaison Program, 2010 MIT Information and Communication Technology Conference, Massachusetts Institute of Technology, Cambridge, MA, Apr. 2010.
- “Application of STAMP/STPA,” JAXA Model Based Engineering Workshop, Japan Aerospace Exploration Agency, Tokyo, Japan, Feb. 2010.
- “Numerical Analysis of Aerodynamic Interference between Two Circular Cylinders using Overset Grid Method,” 240<sup>th</sup> Fluid Dynamics Seminar, The University of Tokyo, Tokyo, Japan, Mar. 2006.

### Invited Non-Technical Talks

- “Encouragement of Study Abroad,” Japanese Graduate Student Association in the US, US Graduate School Lecture Series, Kyushu University, Fukuoka, Japan, Dec. 2015.
- “Encouragement of Study Abroad,” Japanese Graduate Student Association in the US, US Graduate School Lecture Series, Kyushu University, Fukuoka, Japan, Dec. 2013.
- “Do We Need Gas Stations in Space?” High School Lecture Series, Harvard University, Cambridge, MA, Jul.-Aug. 2013.
- “Encouragement of Study Abroad,” Japanese Graduate Student Association in the US, US Graduate School Lecture Series, Kyushu University, Fukuoka, Japan, May 2012.
- “Intro to Shogi (Japanese Chess),” Japanese Association of MIT, MIT Independent Activities Period (IAP) Class, Cambridge, MA, Jan. 2012.
- “Encouragement of Aerospace Engineering,” Super Science High School (SSH) Lecture Series, Jonan High School, Fukuoka, Japan, Aug. 2010.

## PROFESSIONAL SERVICE

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### International Advisory Board

- *Journal of the British Interplanetary Society* Feb. 2012 – Present

### Reviewer

- *Journal of Aerospace Information Systems*, 2015
- *Advances in Space Research*, 2015
- *Journal of Aerospace Engineering*, 2014, 2015
- *Transactions of the Japan Society for Aeronautical and Space Sciences*, 2011, 2012
- *Journal of Spacecraft and Rockets*, 2011, 2012

## SKILLS

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**Languages:** Japanese (native), English (business), German (2 years of undergrad courses)

**Software:** MATLAB/Simulink, C, Java, L<sup>A</sup>T<sub>E</sub>X, Microsoft Office, Processing, CPLEX, Mathematica, Vensim, STK, Tecplot, Git, Illustrator, Photoshop, Dreamweaver, Cubase

**Experiment:** Wind Tunnel, 3D Map Projection

## HONORS/AWARDS

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- Best of 2015 MIT Spotlights Jan. 2016
- MIT Today’s Spotlight “To save on weight, a detour to the moon is the best route to Mars” Oct. 2015
- Research Assistantship, MIT Sep. 2008 – May 2013
- Teaching Assistantship, MIT Sep. – Dec. 2008 & Sep. – Dec. 2012
- Japanese Government Scholarship, Ministry of Education, Culture, Sports, Science and Technology Sep. 2006 – Jun. 2008
- Logo Design Award for Department of Aeronautics and Astronautics, The University of Tokyo Nov. 2004
- 1st Grade Certificate for Mathematics, Mathematics Certification Institute of Japan Nov. 2003
- Shuyukan Award (1st Place in Academic Performance), Shuyukan High School Mar. 2000

## MEDIA COVERAGE

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- Wide media coverage (interviews and 400+ news articles) including MIT News, Forbes, Fox News, Yahoo! News, Discovery News, Daily Mail (UK), Yomiuri (Japan), and Der Spiegel (Germany) for the *Journal of Spacecraft and Rockets* paper “Generalized Multicommodity Network Flow Model for the Earth-Moon-Mars Logistics System” Oct. 2015

## ACTIVITIES

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- Mentor, The Mars Society's Gemini Mars Design Competition Dec. 2015 – Present
- Mentor, NASA International Space Apps Challenge, Boston Hackathon Apr. 2014
- Shogi (Japanese Chess) Tutor Jan. 2010 – Mar. 2013
- Public Relations, Japanese Association of MIT Jun. 2007 – May 2012

## INTERESTS

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- Acoustic Guitar/Electric Guitar/Bass Guitar/Piano/Keyboard/Drums/Singing
- Music Composition and Recording
- Shogi (Japanese Chess)
- Mathematics
- Basketball

## REFERENCES

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### **Olivier de Weck**

Professor  
Department of Aeronautics and Astronautics, Institute for Data, Systems, and Society  
Massachusetts Institute of Technology  
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### **Jeffrey Hoffman**

Professor of the Practice  
Department of Aeronautics and Astronautics  
Massachusetts Institute of Technology  
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### **Yoshiaki Ohkami**

Executive Advisor / Former Dean / Professor  
Graduate School of System Design and Management  
Keio University  
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### **Robert Shishko**

Principal Systems Engineer / Economist  
Project Systems Engineering & Formulation Section  
Jet Propulsion Laboratory  
California Institute of Technology  
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### **Nancy Leveson**

Professor  
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## CITIZENSHIP

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Japan (U.S. Permanent Resident)