

THE OHIO STATE UNIVERSITY

Consortium of Ohio Universities on Navigation and Timekeeping (COUNT)

Industrial Affiliate Agreement for Basic Membership

This agreement, made _____ day of _____ 2012 by and between The Ohio State University, located in 1960 Kenny Road, Columbus, Ohio 43210, (hereinafter called OSU), and _____ located at _____ (hereinafter called AFFILIATE) is made under the following terms:

1. OSU will undertake specialized short courses and other services related to navigation and timekeeping as described in Attachment A, COUNT and Industrial Affiliate.
2. The program covered by this agreement shall begin upon receipt of membership fee and shall end _____.
3. It is agreed that the description of COUNT and Industrial Affiliates will govern the direction of the program until amended by authorized representatives of AFFILIATE and OSU.
4. For this program,
 - (a) AFFILIATE may select up to three (3) Participants for the short courses and other meetings organized by COUNT during the period of this Agreement. OSU and COUNT will furnish available facilities of space and laboratory equipment. Participant training will be conducted in collaboration with and under the supervision of COUNT Representatives. OSU Principal Investigator (PI) will be responsible for arranging and organizing these meetings.
 - (b) Arrange for COUNT to present one half-day short course at the AFFILIATE's facility during the period of this agreement. OSU will pay for the compensation, travel and other related expenses of the COUNT University Representative giving the short course. AFFILIATE will be responsible for organizing the short courses and the cost associated with organizing the short course.
5.
 - (a) AFFILIATE will pay to OSU the firm, fixed price of \$30,000.00 (U.S.) to cover the cost of the program upon execution of this agreement and prior to the arrival of Participants.
 - (b) Up to three Participants may attend each short and other meetings course held by COUNT during the period of this agreement.

(c) AFFILIATE and/or Participants shall be responsible for personal living expenses, insurance costs, and travel expenses for the program.

(d) AFFILIATE will notify the OSU PI of Participants selected for the program prior to the scheduled arrival of the Participants at the Columbus campus.

(e) Participants will receive no compensation from the University. As such, Participants will not be employees of OSU, nor be eligible for benefits provided by OSU to its employees. Also, unless accepted as students and enrolled in The Ohio State University, Participants will not be eligible for any of the benefits provided by the University for its students.

(f) AFFILIATE and Participants agree that Participants will abide by the policies and rules of The Ohio State University.

(g) AFFILIATE warrants that it is a corporate entity based in the United States.

6. AFFILIATE will indemnify, defend, and hold OSU and COUNT harmless against third party claims (including, without limitation, the parties' employees) for personal injury, death or loss of or damage to property caused solely by its negligence in the performance of this Agreement. AFFILIATE's obligations under this Clause are conditioned on receiving prompt notice of a claim from OSU and COUNT. The AFFILIATE will be entitled exclusively to control the defense. At the AFFILIATE's expense, OSU and COUNT will provide reasonable assistance in defense of the claim including, but not limited to, promptly furnishing the AFFILIATE with all relevant information within its possession or control. Because the AFFILIATE will provide the defense, the AFFILIATE will not be liable for any attorney fees or costs of OSU and COUNT. OSU and COUNT may participate in the defense, but in no event will the AFFILIATE be liable for OSU and COUNT's attorney fees or costs, OSU and COUNT may not enter into any settlement, assume any obligation or make any concession without the prior written approval of the AFFILIATE; which may not be unreasonably withheld, AFFILIATE's maximum liability under this Clause shall not exceed the payments AFFILIATE has made to OSU and COUNT in the year in which the claim occurred.

7. OSU may publish information derived from the program in scholarly publications; OSURF will not use the name of AFFILIATE in a scholarly publication without written consent.

8. AFFILIATE will not use directly or by implication, the name of The Ohio State University College of Engineering, The Ohio State University, or the name of any member of the staffs thereof; or any unpublished information or data relating to the program in any publicity or advertising unless a copy is submitted and written approval of the Executive Director of The Ohio State University Research Foundation is obtained.

9. Per Ohio Revised Code § 3345.14, all rights to and interests in discoveries, inventions, or patents which result from research or investigation conducted in any experiment station; bureau; laboratory, research facility, or other facility of The Ohio State University and/or OSU, or by employees of The Ohio State University and/or OSU acting

within the scope of their employment or with funding, equipment, or infrastructure provided by or through The Ohio State University and/or OSU, shall be the sole property of The Ohio State University.

Nothing in this agreement anticipates AFFILIATE and/or its Participates conducting any research or investigation in any experiment station, bureau, laboratory, research facility, or other facility of university member of COUNT; nor is it expected or intended that AFFILIATE or its Participants will contribute any intellectual property to the Consortium, The Ohio State University, or OSURF. To further clarify, it is not anticipated that AFFILIATE will disclose any of its own intellectual property to the Consortium, The Ohio State University, or any other CONSORTIUM MEMBERS. If such disclosure does take place, it will be governed by a separate non-disclosure agreement, license agreement, or other appropriate agreement.

10. Where information that is considered to be proprietary and confidential by OSU is made available to or produced by Participants in connection with appointments under this agreement, such information will be specifically designated as proprietary and confidential at the time of disclosure. AFFILIATE agrees that Participants shall hold such information in confidence for the benefit of OSU and shall neither disclose it to others, including AFFILIATE or its affiliates, nor use it otherwise than for the purpose for which it was made available to or produced by him in connection with his appointment hereunder, until three years after the termination of appointments hereunder or until such information becomes public knowledge, without the prior express written permission of the Executive Director of OSU or his/her authorized delegate. Where information that is subject to license or regulation is made available to Participants in connection with appointments under this agreement, AFFILIATE agrees that Participants shall hold such information subject to such license or regulations.

11. It is expected that COUNT will be renewable annually, contingent upon having sufficient AFFILIATES to provide a viable operating budget. OSU will provide notice of request for renewal of this agreement to each CONSORTIUM MEMBER along with a proposed membership fee and work scope for the renewal period. AFFILIATE agrees to provide OSU with notice of intent to renew or not renew this agreement; however, AFFILIATE's failure to timely provide notice shall constructively be construed as a notice of intent to not renew the agreement. Payment of the renewal membership fee or authorized purchase order must be received by OSU by January 31st of the renewal year. In the event of dissolution of the CONSORTIUM, membership fees, if any, from prior periods that remain unexpended at the time of dissolution of the CONSORTIUM will be retained by the OSURF for further research and development in the area of navigation and timekeeping or related technologies.

OSU reserves the right to terminate the membership of an AFFILIATE, if, in the judgment of the COUNT Representatives and the Dean of the College of Engineering, the AFFILIATE is unable to benefit from its membership in COUNT or if the continued presence of the AFFILIATE at OSU is judged not to be in the best interests of the University or the AFFILIATE.

12. This agreement may be extended upon such terms as may be mutually agreed upon in writing by AFFILIATE and OSU.

13. This agreement shall be governed by the laws of the State of Ohio and the United States of America.

Agreed to and Accepted by:

COUNT Industry Affiliate

The Ohio State University

Name and title of signer

Name and title of Signer

Signature

Signature

Date signed

Date Signed

Attachment A

COUNT and Industrial Affiliates

COUNT: Precise navigation, accurate timekeeping, registration and geo-location have become requirements for modern day warfare, commercial aviation, agriculture, banking, emergency rescue efforts, etc. The demand for well trained students who are capable of developing the needed technology to meet these requirements is exploding. US industry and DoD need to keep their work force informed of the latest technological developments and breakthroughs to field the next generation systems in a timely fashion. Fortunately, there are many universities in the US who are very active in the areas of navigation, timekeeping, geo-location and registration. The Ohio State University (OSU) in Columbus, Ohio; Ohio University (OU) in Athens, Ohio; the Air Force Institute of Technology (AFIT) at WPAFB, Ohio, and Miami University in Oxford, Ohio are some of the top rated universities in undergraduate and graduate student education and research in these areas. These four educational institutes train more students in these and related areas than any other regional group of universities in the US. Their combined research funding in these and related areas exceeds ten million dollars per year. The research funding is provided by many different government agencies as well as private industry.

The faculty and researchers at the above mentioned universities have agreed to share their expertise for further training of undergraduate and graduate students as well as of employees of the US-based navigation industry. They have formed a **Consortium of Ohio Universities on Navigation and Timekeeping (COUNT)**. Under this consortium, they will be presenting short courses, holding workshops to share their latest research findings and exchange students on short term basis for system level training of the students. The short courses and workshops will be open to US-based industry personnel who are members (Industrial Affiliates) of the consortium.

Industrial Affiliates: US industry can benefit from COUNT by joining the consortium as Industrial Affiliates. As an Industrial Affiliate, the industry pays an annual membership fee to COUNT. The funds collected through the membership fee will be used to develop new short courses, organize short courses and workshop, sponsor student training and research. An organization can join the consortium as Basic Industrial Affiliate, Donor Industrial Affiliate or Patron Industrial Affiliate. The membership fee for the three categories is respectively, \$30,000, \$50,000 and \$100,000 per year. A Basic Industrial Affiliate will be allowed to send three persons to the short courses and workshops organized by COUNT. A Donor Industrial Affiliate will be able to send five persons to the short courses and workshops; whereas, a Patron Industrial Affiliate will be able to send ten persons to the short courses and workshops. Some of the benefits of COUNT to Industrial Affiliates are listed below.

Benefits to Industrial Affiliates:

- At least five half-day short courses every year from the leading experts in the areas of navigation, timekeeping, registration and geo-location.

- Participate in annual workshops where the results of recent research will be presented and discussed.
- On-site (Industrial Affiliate's facility) short courses for Industrial Affiliates.
- Access to well trained undergraduate and graduate students who could be their future employees.
- Opportunity to discuss the technical problems and challenges with the leading experts as well as their peers.

COUNT Organization: The four universities, namely OSU, OU, AFIT and Miami University, have signed a memorandum of understanding to participate equally in the preparation and delivery of short courses and workshops. In addition, the four universities have agreed to make their undergraduate and graduate students as well as faculty and researchers working in the areas related to navigation and time keeping available for COUNT. Each member university will have at least one faculty/researcher involved in the consortium. These faculty/researchers will be called the University Representatives. The University Representatives will make all the decisions regarding the COUNT activities. The University Representatives will select a person who will be the Director of the consortium. For the year 2011-12, Prof. Frank van Graas of the Ohio University is the Director of COUNT. The other university representatives for 2011-12 are Profs. John Raquet and Mike Veth of AFIT, Prof. Dorota Brzezinska and Prof. Inder Gupta of OSU, and Prof. Jade Morton of the Miami University. Brief research resumes of these University Representative are attached at the end of this document.

The Ohio State University (OSU) will serve as the administrative lead for COUNT. The Industrial Affiliates will sign agreements with OSU to join COUNT.

The ElectroScience Laboratory at the Ohio State University, under the direction of Dr. Inder J. Gupta, will serve as the programmatic lead for COUNT.

COUNT Highlights:

- The Annual COUNT Workshop will be held at one of the four member universities at the beginning of Spring (late March / early April). For the 2011-12 year, the meeting place is Columbus, Ohio. The workshop will last for one and a half day.
- Following the workshop, five short courses will be delivered by the member universities. These short courses will last for two and a half days.
- CDs containing the workshop presentations and short course material will be distributed to the attendees at the beginning of the workshop.
- On the first day of the Annual Meeting, a banquet will be held. Industrial Affiliates, member universities and their students will be invited to the banquet to foster interactions between different groups. The banquet will be hosted by COUNT.
- On the evenings of the short courses, meeting areas will be provided to the attendees to interact with undergraduate and graduate students. Light refreshments will be provided during those hours.
- COUNT will provide refreshments and lunches on the days of the workshop and short courses.

COUNT Calendar and Dates:

- The COUNT year will coincide with US Government fiscal year, October 1st through September 30th.
- To participate in the Annual Meeting, Industrial Affiliates must pay their membership fee by January 31st.
- Current COUNT Members will be sent a new agreement on or before August 31st to join the consortium the following year.
- An announcement for the Annual Meeting will be emailed to the Industrial Affiliates 45 days before the meeting.
- The final agenda along with the meeting details will be mailed to the Industrial Affiliates three weeks before the Annual Meeting.

Frank van Graas (Ph.D., 1988, Ohio University) holds a Fritz J. and Dolores H. Russ Professorship in Electrical Engineering. At the Avionics Engineering Center, Dr. Van Graas is the Principal Investigator for an FAA-sponsored Global Positioning System (GPS) Co-Operative Research Agreement to investigate the Local Area Augmentation System (LAAS) for Aircraft Precision Approach & Landing. In addition, he is actively involved with multiple research efforts, including JPALS, Synthetic Aperture Radar performance, GPS/inertial integration, fault detection and isolation techniques, transform-domain GPS receiver design/implementation (software-defined radio), Loran-C, and terrain-referenced navigation. At Ohio University, Dr. Van Graas has been responsible for external research funding of more than \$20 million from FAA, NASA, and industry sponsors.



Dr. Van Graas conducted the first real-time GPS attitude and heading flight experiment on a DC-3 in May of 1991, and the first kinematic dual-frequency GPS autoland flight tests using NASA Langley Research Center's Boeing 737 in May of 1993. In October of 1994, a code-phase Differential GPS system designed by Dr. Van Graas was the first system of this type to satisfy both sensor accuracy and Total System Error requirements for Category IIIb automatic landing operations using a Boeing 757 aircraft operated by the United Parcel Service. The first prototype Local Area Augmentation System (LAAS) for Category III was completed by his research team in 1997 and successfully flight-tested at the William J. Hughes Technical Center in Atlantic City using FAA's Boeing 727. The architecture and performance of this system forms the basis for the next generation of aircraft landing systems. In 1996, he was the 6th recipient of the *Johannes Kepler Award* for “sustained and significant contributions to satellite navigation,” from the Satellite Division of The Institute of Navigation. In June of 2001, he was elected to *Fellow Membership* in the U.S. Institute of Navigation. In June of 2002, he received the *Colonel Thomas L. Thurlow Award* for “outstanding contribution to the science of navigation,” from The Institute of Navigation. He is an Ohio University Presidential Research Scholar, Past President of The Institute of Navigation, Key Technical Advisor for FAA’s LAAS program, Member of the Executive Board of the IEEE/ION Position, Location, and Navigation Symposium, and Meetings Chair for the ION.

Dr. Van Graas’ teaching responsibilities include a sequence of undergraduate and graduate courses in electronic navigation systems. He has been a Visiting Professor at Delft University of Technology, The Netherlands, and Leeds University, United Kingdom. He has lectured extensively in the United States and Europe and he was a lecturer for the first NATO AGARD lecture series in Russia in 1996. He has graduated more than 13 Ph.D. and 30 M.S. students and currently advises 7 Ph.D. and 7 M.S. students. He has authored or co-authored approximately 100 navigation-related publications, including two book chapters.

Dorota A. Grejner-Brzezinska (PhD, 1995, The Ohio State University) is an Assoc. Prof. in Geodetic Science, and leader of the Satellite Positioning and Inertial Navigation (SPIN) Laboratory at OSU. Her research interests cover kinematic positioning with GPS, GPS/inertial integration, multi-sensor mobile mapping technology, personal navigation, precision orbit determination for GPS/LEO (low earth orbiter), polar geodesy and robust estimation techniques. In the past 11 years, she has been actively involved in multiple research efforts in broad areas of positioning and navigation, where she made important contributions to areas such as developing and implementing new algorithms for GPS orbit determination and earth rotation parameter estimation with GPS (GODIVA, 1995), GPS/inertial integration for direct georeferencing of imaging sensors (NASA-sponsored Airborne Integrated Mapping System, AIMS™, 1998), and algorithm and software implementation in support of the National Geodetic Survey (NGS) network-based RTK and Rapid-Static (OPUS-RS) solutions based on the national CORS network (MPGPS, 2005).



During her academic career, she published over 170 journal and proceedings papers, numerous technical reports and three book chapters on GPS and navigation, and led over 20 research projects sponsored by DOD, NASA, NGS, NGA, NSF, Federal DOT, Ohio DOT, and industry with a total budget of over \$9 million. She is the recipient of the 2006 Institute of Navigation (ION) Thurlow Award for “*outstanding contributions to the science of navigation,*” the 2005 U.S. Geospatial Intelligence Foundation Academic Research Award, given for “*research contributions aimed at promoting the geospatial intelligence tradecraft and developing a stronger community among those who apply spatial data and geoprocessing to national security objectives.*” She is also a recipient of three ION Best Paper Awards, the 2005 ESRI Award for Best Scientific Paper in Geographic Information Systems, the 2003 OSU College of Engineering Lumley Research Award, and the OSU Kaarina and Weiko A. Heiskanen Senior (2001) and Junior (1993) Awards; she was a Fulbright Scholar, 1990-95.

Dr. Brzezinska is actively involved in professional activities at national and international levels. She is chair of the International Association of Geodesy (IAG) Sub-Commission 4.1, *Multi-sensor Systems*, co-chair of IAG Study Group 4.1, *Pseudolite Applications in Positioning and Navigation*, and chair of International Federation of Surveyors (FIG) Task Force 5.3.1, *Mobile Mapping Systems*. She is a member of the ION Council, where she serves as the Eastern Region Member-at-Large, and chair of a Sub-committee of the ION Outreach Committee on *Cooperation w/ Other Professional Societies*. Prior to that she was Land Representative of the ION Council, and also served as Program Chair, Track Chair and Session Chair at several ION meetings.

Dr. Brzezinska’s teaching responsibilities include undergraduate and graduate courses in least squares adjustment and GPS. She has offered invited seminars and workshops in the United States and abroad, at the University of New South Wales, Sydney, Australia, at the National Chiao Tung University and the National Cheng Kung University in Taiwan, and the University of Seoul, Korea. Since October 1999, when she became faculty at OSU, she graduated one Ph.D. and 6 M.S. students, and currently advises 1 M.S. and 10 Ph.D. students.

Inder (Jiti) Gupta (Ph.D., 1982, The Ohio State University) is a Research Professor in the Electrical and Computer Engineering Department of The Ohio State University. His research group typically involves four to six graduate students, junior faculty and researchers. He is part of the GPS Joint Program Office team for evaluation of GPS user equipment involving AJ systems and antennas. He is also part of JPALS antenna bias working group. He was President of the Antenna Measurement Techniques Association (AMTA) during 1997 and served as its Technical Coordinator during 1995 and 1996. Currently, he manages the EM Range Consortium at The Ohio State University ElectroScience Laboratory. Many US aerospace companies are members of this consortium and many government organizations are regular attendees at the consortium meetings. He has authored more than a hundred journal articles and conference papers. He is the recipient of the IEEE Antenna and Propagation Society's 1991 H.A. Wheeler Applications Prize Paper Award. He is also the recipient of the OSU College of Engineering Lumley Research Award for 1991, 1998 and 2005. **He is Edmond S. Gillespie Fellow of AMTA.**



Dr. Gupta has more than twenty-five years experience in engineering research and is a world-known expert on adaptive antenna technology and RFI suppression systems. He was **elected a Fellow of the IEEE** for “contributions to the theory and advancement of compact ranges for accurate electromagnetic measurements and for analysis and applications of adaptive antennas.” He was also **elected a Fellow of the Institute of Navigation** for “contributions to the theory and development of adaptive antennas for satellite navigation.” During his graduate studies at the Ohio State University, he demonstrated a relationship between the adaptive performance of antenna arrays and their underlying EM characteristics. This work led to the prediction of the performance of adaptive arrays and an algorithm to select element locations of adaptive arrays. Later, he developed adaptive arrays for multiple simultaneous desired signals, for weak interfering signals and for pulsed interfering signals. Recently, he has performed complete analyses of spatial processing techniques, signal processing techniques, combination of spatial and signal processing techniques and joint (spatial and signal) processing techniques for interference suppression in a GPS receiver. He established the implementation requirements for these techniques and studied the effects of platform on airborne adaptive antennas for GPS receivers. In 2003, his group developed a new ground plane for the measurement of GPS antennas. The ground plane is being used in ADAP program. Last year, he developed a new reduced size CRPA for GPS receivers. The CRPA is only 4.25” in diameter and has six antenna elements. It can receive signals from 1150 MHz to 1600 MHz and has good axial ratio over the whole upper hemisphere. He also developed a new approach to find the STAP based AE weights. These weights lead to good SINR while removing the antenna induced carrier phase and code phase biases. Currently, under an Air Force program he is developing AJ approaches for repeater and spoofer kind of jammers. Under a NAVAIR STTR, he is developing non-planar CRPA to enhance the AJ performance near horizon so that one can receive signals from low elevation satellites. Under an AFOSR program, he is developing techniques to characterize the phase center of CRPA in the presence of interfering signals.

Yu (Jade) Morton (Ph.D., 1991, The Pennsylvania State University) is an Associate Professor in Electrical Engineering, and founder and leader of the newly established Signal Processing and Navigation (SPAN) Laboratory at Miami University. Her research areas include software receiver techniques, sensor array signal processing and digital beam forming, ionosphere modeling and radar remote sensing, and GPS applications. She is a frequent user of the UHF/VHF incoherent scatter radar at the Arecibo Observatory in Puerto Rico since 1986 and has carried out numerous research projects on ionosphere electron density profiles and other parameter measurements and modeling under normal conditions and during geomagnetic storms. While a post-doctoral research fellow at the University of Michigan in the early 1990's, she successfully identified the upper atmosphere global dynamics pattern using the data provided by the High Resolution Doppler Imager on board the Upper Atmosphere Research Satellite. Following an extended absence from the academia for family reasons, she returned in 2000 as a faculty member at Miami University to participate in the establishment of a new Electrical and Computer Engineering department. She received three consecutive summer faculty fellowship awards from AFOSR and AFRL. She has worked closely with colleagues at the Reference Receiver Technology Branch of the AFRL Sensors Directorate at Wright Patterson Air Force Base on several research projects including mitigation of GPS receiver self-interference, UWB-GPS interference evaluations, and GPS interference mitigations using integrated multi-antenna array front end, digital beam forming techniques, and a software receiver. She has published over forty technical papers. Her recent research efforts have led to grants from AFOSR, AFRL, the Dayton Area Graduate Studies Institute (DAGSI), and NSF. She is the lead author of a 2004 ION-GPS Best Paper Award and the recipient of the 2005 Miami University School of Engineering and Applied Science Outstanding Researcher Award.



Dr. Morton has contributed to the strong presence of navigation-related topics in the undergraduate curriculum at Miami. Three technical elective (Introduction to Navigation, Introduction to GPS, and Software GPS receiver) courses have been offered at Miami since the establishment of the new ECE Department in 2004. She has advised an array of undergraduate senior capstone projects, NASA Ohio Space Grant projects, and ION Undergraduate Scholarship projects in the field of navigation with topics ranging from an autonomous lawn mower, passive stereo vision ranging, real-time GPS tracking of Miami Metro Buses, neural network modeling of ionosphere electron density distributions, etc. She has presented invited seminars and workshops in the US and abroad in GPS receivers, software receiver techniques, and integrated software GPS receiver and digital beam formers. She received a 2005 Miami University Learning Technology Teaching Excellence Award.

Dr. Morton has been actively involved and contributed to professional services. She was the executive secretary, vice chair, and is now the chair of the ION Dayton Section. She is a member of the technical committee of the IEEE Microwave Theory & Technology Society Digital Signal Processing subgroup and a member of the executive team of the International Association of Chinese Professionals in Global Positioning Systems. She served on a NSF proposal review.

John F. Raquet (Ph.D., 1998, The University of Calgary) is an Associate Professor of Electrical Engineering at the Air Force Institute of Technology (AFIT), where he is also the Director of the Advanced Navigation Technology (ANT) Center. The ANT Center consists of 19 faculty members, 5 staff members, and over 40 students working to solve a wide variety of navigation problems. Dr. Raquet directly supervises the research of 8-12 MS and PhD students, and he is also responsible for teaching all of the GPS-related classes at AFIT. He has a multidisciplinary background, teaching in an electrical engineering department but having degrees in geomatics engineering (Ph.D., University of



Calgary, 1998), aero/astro engineering (SM, Massachusetts Institute of Technology, 1991), and astronautical engineering (BS, US Air Force Academy Distinguished Graduate, 1989). He has published over 70 navigation-related conference and journal papers and taught 16 navigation short courses to a number of different organizations. Dr. Raquet has been an active participant in the Institute of Navigation, and he has served as a session chair, program chair, track chair, and general chair of ION conferences, and on the ION Council as Central Region Vice President, Eastern Region Vice President, and Outreach Chair. He received the 2002 Institute of Navigation Early Achievement Award, the 1994 International Test and Evaluation Association (ITEA) Time-Space Position Instrumentation Data Collection and Electro-Optic Test and Evaluation Award, and the 1989 John von Neumann Award (presented to the top cadet in the Astronautical Engineering Department at the U.S. Air Force Academy).

Dr. Raquet has over seventeen years of experience in navigation-related research and development. During his graduate studies at MIT, he developed autonomous docking algorithms for the Space Shuttle. He then proceeded to the 746th Test Squadron at Holloman Air Force Base where he was instrumental in the development of a new aircraft flight reference system that combined inertial, differential GPS, and ground transponder measurements to provide high-accuracy truth data for testing other navigation systems. He was selected to teach at AFIT and sent for a PhD to the University of Calgary, where he pioneered the use of a network of reference receivers for near cm-level GPS accuracy over large coverage areas. His core algorithm has been implemented and deployed in many systems throughout the world. In 1998, he began in his current position as an AFIT professor, and he has pursued many different research areas including image-aided inertial navigation, navigation using signals of opportunity, pseudolite/beacon-based navigation, GPS multipath mitigation, space navigation, precision differential GPS, and GPS receiver design.