4 hour Tutorial Session
2017 Oceans Conference, Anchorage, Alaska
18 September 2017

Navigation Sonar

1. Topic Overview

This tutorial is intended to introduce participants to new technological developments resulting in the creation of 3-dimensional multibeam forward-looking sonar that has the potential for multiple uses that include:

- Enhancing safety of navigation by expanding situational awareness below the waterline,
- Detecting hazards to navigation both attached to the bottom and suspended in the water column,
- Crowdsourcing high-resolution swath bathymetry for survey and navigation chart development, and
- Acquiring scientific data to assist scientists and communities in dealing with environmental change.

An overview of products that are presently available in the commercial marketplace, their purpose, and the organizations and people who use them will be presented. Technical aspects of Navigation Sonar will be presented including capabilities, resolution, and accuracy as an instrument to display a realistic portrayal of the underwater environment. Navigation Sonar can play a vital role in increasing the safety of ship navigation by enhancing the situational awareness of mariners in detecting hazards that may exist ahead in their path. Such capability can provide sufficient advance warning to avoid these hazards altogether, or to reduce speed and change course to lessen the severity of impact with shoals, reefs and other features that extend from the seabed as well as objects floating on the surface or suspended in the water column. This is especially relevant today across many areas of the globe that are poorly surveyed or not surveyed at all, and as new areas open to navigation where ships have rarely or never before ventured. Enhancements to environmental safety through the prevention of oil and chemical spills resulting from groundings and allision with floating hazards such as logs and debris, shipping containers and icebergs may also be possible. Other potential uses for Navigation Sonar include providing independently crowd sourced swath data for bathymetry and hydrographic survey, exploring new routes of transit, detecting and avoiding marine mammals, and the placement of aids to navigation and verifying they are watching properly. It can play a vital role in gathering data for ocean observing networks and mapping marine ecosystems in remote regions such as the Arctic. Analysis of the results of on-going research will be presented. Case studies of major shipping accidents will also be discussed along with the manner in which Navigation Sonar, had it been available and in use, may possibly have aided in their prevention. Examples of other uses will also be presented.

Current day practice in this field presently has very little involvement with the mariner community in general as the technology is fairly new and as yet, not widely available on vessels. However, its capability to increase situational awareness below the waterline for grounding prevention and obstacle avoidance is undisputed. There is presently no International Maritime Organization (IMO) mandate for Navigation Sonar as a carriage requirement for vessel navigation, yet vessels transiting the Arctic and Antarctic are voluntarily equipped with these devices to reduce risk in these poorly charted regions. Likewise, few vessels presently use this technology even when chartered for voyages specifically geared towards scientific data gathering. The material to be presented will illustrate capabilities and describe opportunities and initiatives to utilize large numbers of suitably equipped ships as vessels of opportunity to routinely gather large amounts of bathymetry, hazard information and other data useful to local communities, scientists, hydrographic agencies and aid to navigation authorities worldwide in expanding knowledge regarding the oceans and services provided to those who transit these areas.

2. Target Audience

The intended audience includes representatives of industry, academia and government from both the mariner and scientific communities. The baseline level and content of audience knowledge and skills are expected to range from new entries to experienced veterans in these professions that are interested in

learning about these relatively new products. The core learning objectives are to enable the audience to gain insight into the technologies behind Navigation Sonar and explore its versatility in performing navigation and scientific data acquisition. The broad appeal of this topic to a large number of Oceans '17 participants is anticipated to draw somewhere between 15 and 30 or more attendees to this tutorial.

3. Content Details

Outline of the Presentation:

Capabilities and Applications

A. Navigation Sonar – An overview (20 minutes)
B. Safety of Navigation (20 minutes)
C. Hazard Detection and Notification (20 minutes)
D. Case Studies of Groundings and Allisions (20 minutes)
E. Discussion and Questions (20 minutes)

Break (30 minutes)

Data Acquisition and Distribution

F. Bathymetry (30 minutes)
G. Ocean Observations (30 minutes)
H. Other (20 Minutes)
I. Discussion and Questions (20 minutes)

Summary and Conclusions (10 minutes)

4. Format

This tutorial is intended to stimulate dialog amongst attendees to exchange thoughts, ideas and experiences that relate to the use of Navigation Sonar across diverse applications. A traditional instructional format will be followed to present the capabilities and features of Navigation Sonar, and to relate experiences and first-hand accounts of its use. However, attendee interaction with the speaker as well as manufacturers that may be represented in the audience will be encouraged throughout the event. Both the mariner and scientific communities can obtain feedback on concerns regarding its effect on workload, training requirements and other matters. Likewise, dialog is expected to inform and alert manufacturers of user community concerns based upon questions, thoughts expressed and concerns voiced on these and other subjects.

Standard classroom facilities such as chairs and a podium are all that is required for this tutorial. Slides that may include video content will be used throughout the tutorial, requiring a projector and screen. No additional requirements are anticipated.

5. Additional Supporting Materials

- Dr. Wright has been an invited speaker at many maritime and aerospace forums having presented tutorials and training sessions, and he has authored over 70 journal articles and conference papers. A Curriculum Vitae for the presenter, Dr. R. Glenn Wright, is attached at the end of this proposal. His personal web page is located on LinkedIn and may be found at: https://www.linkedin.com/in/glenn-wright-564b8412/. He may be contacted via email at: glenn@gmatek.com, and also by telephone at 443-951-8001. A short biographical sketch of the presenter is provided below:

  Dr. Wright holds a BS degree in Electrical Engineering from the New Jersey Institute of Technology, MS in Computer Science from the Polytechnic Institute of New York, and a PhD in Maritime Affairs from the World Maritime University. He is President of GMATEK, Inc., and has over 39 years' experience in research and development pertaining to sensor-based systems in the aviation and maritime industries. He is also a Master Mariner and operates a research vessel out of Annapolis, Maryland investigating meteorological, oceanographic and electromagnetic phenomena.

- Bibliography:

Russell, Ian and **Wright, R. Glenn**. "Navigation Sonar: More than Underwater Radar. Realising the Full Potential of Navigation and Obstacle Avoidance Sonar". *International Hydrographic Review*. IHO Publication P-1. No. 17. May 2017.

Mehdi, Raza A.; **Wright, R. Glenn** and Baldauf, Michael. "3-dimensional Forward Looking sonar: Offshore Wind Farm Applications". European Navigation Conference, Helsinki, Finland. 31 May 2016.

Wright, R. Glenn, and Baldauf, Michael. 'Correlation of Virtual Aids to Navigation to the Physical Environment'. *TransNav, the International Journal on Marine Navigation and Safety of Sea Transportation*, 2016. Vol. 10, No. 2, pp. 287-299, DOI: 10.12716/1001.10.02.11

Wright, R. Glenn and Baldauf, Michael. 'Hydrographic Survey in Remote Regions: Using Vessels of Opportunity Equipped with 3-dimensional Forward-Looking Sonar'. *Journal of Marine Geodesy*. 2016. DOI 10.1080/01490419.2016.1245266.

Wright, R. Glenn and Baldauf, Michael. Arctic Environmental Preservation through Grounding Avoidance, *Sustainable Shipping in a Changing Arctic Environment*, Springer. London. 2016. In Press.

Wright, R. Glenn and Baldauf, Michael. "Physical Aspects of Virtual Aids to Navigation", Activities in Navigation – Marine Navigation and Safety of Sea Transportation; ed. Adam Weintrit, pp 61-68, 2015, CRC Press, London.

Wright, R. Glenn and Zimmerman, Cheryl. "Vector Data Extraction from Forward-Looking Sonar Imagery for Hydrographic Survey and Hazard to Navigation Detection", Proc. of *IEEE/MTS Oceans Conference*, Washington D.C., 19-22 October 2015.

Wright, R. Glenn and Baldauf, Michael. "A Georeferencing Approach to Real-Time Virtual Aid to Navigation Verification", in Proc. *ION GNSS+ Conference 2015*, Institute of Navigation, Tampa, FL, 14-18 Sep. 2015.

Wright, R. Glenn and Baldauf, Michael. "Arctic Environmental Preservation through Grounding Avoidance", in Proc. of *Safe and Sustainable Shipping in a Changing Arctic Environment (ShipArc 2015)*, Malmö, Sweden, 25-27 August 2015.

Wright, R. Glenn and Baldauf, Michael. "Enhanced Situational Awareness through Muli-Sensor Integration", in *Proc. 18th International Navigation Simulator Lecturers' Conference (INSLC 18)*, Buzzards Bay, Massachusetts USA, 2014. 40-59. ISBN 978-0-692-29012-5.

Wright, R. Glenn and Baldauf, Michael. "Improving the Safety of Polar Navigation – Contribution of New Technology and Training", in Proc. of *6th Arctic Shipping Summit*, Montreal, Canada, 18-19 March 2015.

R. Glenn Wright

Education

Ph.D Maritime Studies, 2017, World Maritime University, Malmö, Sweden
M.S. Computer Science, 1982, Polytechnic Institute of New York, Brooklyn, NY
B.S. Electrical Engineering Technology, 1978, New Jersey Institute of Technology, Newark, NJ
Business Administration, Certificate program, 1986, Georgetown University, Washington DC

Experience

Mr. Wright has over 39 years experience in industry and has led projects associated with sensor-based systems for electronic test, autonomous underwater and marine remotely operated vehicles (AUVs/ROVs), meteorological and oceanographic data systems, and surface navigation. He is a US Coast Guard licensed Master Mariner with additional ratings as Able Seaman-Special, Able Seaman-Sail, Lifeboatman, Wiper and Stewards Department; and Captain of a research vessel investigating communications, navigation, meteorological and oceanographic sensor data fusion. Mr. Wright is highly experienced both land and sea navigation involving electronic, celestial and dead reckoning; in radio and telecommunications and holds FCC licenses for General Radiotelephone Operator w/RADAR endorsement, GMDSS Operator and Maintainer, and Amateur Extra (KB3TTN).

He has successfully led commercial and Government projects for DOD (US Air Force and Army, Navy, Marine Corps and DARPA), National Oceanographic and Atmospheric Administration (NOAA), National Institutes of Health (NCI), International Agency for Research on Cancer (IARC), and NASA (KSC and LSC). Mr. Wright is widely published with over 70 technical papers and seminars, magazine articles and book chapters in IEEE and other forums. Mr. Wright holds one patent and has three patents pending. In addition, Mr. Wright has chaired and been active in various IEEE committees (SCC-20, 1231/32, P1391) for the development of sensor-based standards.

2013 –2016: World Maritime University, Malmo Sweden

Dr. Wright performed research in the development of Virtual Aids to Navigation for use in the Arctic and in tropical regions where physical aids to navigation cannot be placed due to ice movement and the inability to place sinkers and permanent moorings in sensitive coral reef environments.

2007 – Present: President, GMATEK, Inc., Annapolis, MD

Mr. Wright leads research and product development efforts in the communications and affiliated fields for marine, airborne and terrestrial applications. Areas of research include:

- 2011-present: Basic research, design, development and software-defined radio integration of algorithms for signals detection, identification and classification based upon source signatures and characteristics.
- 2013: Missile Defense Agency, Redstone Arsenal, AL, HQ0147-13-C-7327: Research and development efforts pertaining to counterfeit semiconductor detection using electromagnetic emission anomaly analysis.
- 2009-2014: Design, development and fabrication of electrical/magnetic/electromagnetic field micro-antennas for reception of 10MHz-12GHz near-field and direct radiation signals for robotic prober applications.
- 2009-2012: Ultra wideband, multi-element antenna design and development spanning 7MHz-32GHz for basic research in signal propagation related to oceanic tropospheric ducting.
- 2009-present: Development of integrated ships navigation systems featuring fusion of sensors for electronic charting, heads-up displays, low light/IR vision, voyage data recording and voyage planning tools, and meteorological and oceanographic data.
- 2008-09, US Army RDECOM, Durham NC, W911NF-08-C-0112: Terahertz antenna design and development using femptosecond-pulsed laser signal sources.

1990 – 2014: President, GMA Industries, Inc., Annapolis, MD

Mr. Wright lead research and development efforts in a number of different disciplines and application areas. A summary of recent significant efforts include:

Marine and Maritime

- USDoC/NOAA, Silver Spring, MD, 2004-2008, Contracts DG133R04CN0107 and DG133R05CN1243 PI: Lead efforts in the design, development, prototype fabrication, and production of enhanced vision instrumentation for the display of marine chart and sensor data for ship navigation. Efforts involved the design of integrated data projection and display hardware, plus the fusion of electronic vector charts with various ship sensors in a "heads up" display that projects obstacles in a ships path onto a transparent display.
- SPAWAR, San Diego, CA, 2004 to 2007, Contract N00039-02-C-0018 and Contract N00039-03-C-0075, Principle Investigator: Lead development for sensor fusion of extremely large oceanographic and meteorological data streams. Developed open source weather database and web application for users to retrieve weather data based on area of interest.
- USDoC/NOAA, Silver Spring, MD, 2002-2005, Contract 50DKNA190040 and DG133002CN0053, PI: Developed and applied neural networks for the recognition and extraction of text and symbols as part of an overall data compression scheme for digitized nautical charts. In addition, developed methods for extracting contour information that, when combined with text and symbols, create a vector product from scanned raster images that can form the basis for generating vector charts.
- US Navy SPAWAR, San Diego, CA, 2001-2005, Contract N00039-01-C-2235 and N00039-01-C-2225, PI: Research and development of high efficiency lossless data compression algorithms for variable precision data used in Navy satellite communications. Efforts include the design of efficient data conversion algorithms for lossless compression based on user specified data precision. Design and integration of Golomb, Arithmetic coding, adaptive context model prediction, and other compression algorithms for 1-D and 2-D data compression.
- USDoC/NOAA, Silver Spring, MD, 2002-2003, Contract DG1330-02-CN-0028, PI: Research and develop the approach necessary to identify all features within a digital raster chart. The method developed was a semi-automatic feature recognition system, based on an identification/validation approach.
- USAFRL, Rome, NY, 1999-2002, Contract F30602-98-C-0085 and F30602-99-C-0035, PI: Research in lossless data compression algorithms for satellite communications. Research and development of lossless data compression algorithms for use in satellite-based wide area networks. Research efforts include the design and integration of Rice, Huffman, LZ (bit and byte stream), and other compression algorithms optimized based upon data types and packet sizes. Issues involve analysis and formulation of network adapter protocols for intercepting data packets and performing compression in real time prior to passing along compressed packets in the data stream.
- USARL, Aberdeen, MD, 1995-1998, Contract DAAL01-95-C-0037 and DAAL01-96-C-0073, PI: Development of video and audio compression algorithms based upon subband coding and multiresolution techniques for use in soldier-portable test equipment.
- NASA Lewis Space Center, Cleveland, OH, 1994-1995, Contract NAS3-27364: Supervised the development of video compression algorithms using the pyramid transform for digital satellite communications.

Imaging

- Naval Air Systems Command, Patuxent River, MD, 2004-2009, contract N68335-05-C-0341: Lead engineer in the design and development of terahertz-based imaging equipment for the rapid assessment of damage and defects within aircraft composite materials. Efforts include design of man-portable femptosecond laser source combined with THz frequency source generation and sensing within a handheld transducer.
- NAVAIR, Patuxent River, MD, 2004 to 2008, Contract N68355-05-C-0014 and N68355-05-C-0341: Performed research and development of terahertz based imaging system for assessment of composite materials. Analysis of data for detection of foreign objects, hidden damage, and incipient damage.
- USARL, Adelphi, MD, 2001-2004, Contract DAAD17-01-C-0039 and DAAD17-02-C-0093, PI: Designed and developed an interactive game for the X-Box™ console to train soldiers in unfamiliar

urban scenarios through 3D modeling of areas using LIDAR data. Development includes a non-console application that allows users to import data and rapidly create virtual 3D urban settings.

Electronic Circuit Test and Diagnosis

- Naval Air Warfare Center, Lakehurst, NJ; 2011 - Present, N68355-11-C-0185: PI for efforts to re-host a printed circuit board (PCB) diagnostic system utilizing electromagnetic emissions (EME) to the Huntron Access 2 USB Robotic Prober. Efforts involved development and integration of diagnostic algorithms into the Huntron Workstation robotic control and analysis software, development of visualization software to display spatial and spectral imagery and overlay diagnostic recommendations onto the circuit board under test.
- USAF, OO-ALC, Hill AFB, UT, 2005 to 2010, FA8201-05-P-0998 and FA8201-07-C-0004: Principal Investigator for research on utilizing electromagnetic emissions as an electronic diagnostic tool. The EME (Electro-Magnetic Emission) signature of a malfunctioning component will be significantly different from a good one. Our objective is to develop an automatic EME measuring system that will check the pattern and magnitude of electromagnetic emissions from printed circuit boards.

USAF, OO-ALC, Hill AFB, UT, 2005 to 2010, FA8201-05-P-0998 and FA8201-07-C-0004: PI for research on utilizing electromagnetic emissions as an electronic diagnostic tool. The electro-magnetic emission (EME) signature of a malfunctioning component will be significantly different from a good one. Our objective is to develop an automatic EME measuring system that will check the pattern and magnitude of electromagnetic emissions from printed circuit boards.

- USAF, OO-ALC, Hill AFB, UT, 2005 to 2008, Contract No: FA8201-05-P-0997: Performed research and development of Laser-based broadband spectral imaging techniques for PCB and component failure detection. Investigation of joint application of terahertz, laser vibrometry, and NIR imaging techniques for component analysis and PCB prognostics.
- USAF, OO-ALC, Hill AFB, UT, 2005 to 2008, Contract FA8201-05-P-0996: PI for the development of fault identification of multi-layer printed circuit boards and electronic devices through non-intrusive testing techniques. Failure modes were categorized and catalogued for analysis using CMOS Digital X-Ray Imaging solutions.
- USAF, Hill AFB, UT, 2001-2004, Contract F42650-01-C-0171 and F42650-02-C-0080, PI: Developed infrared imaging system for non-destructive analysis of microelectronic circuitry. Introducing PXI platform for instrumentation and image acquisition management. Integrating motion control system for automated device handling.
- USAF, Ogden ALC, UT, 1999-2002, Contract F42650-99-C-0015 and F42650-00-C-0031, PI: Design and implementation of data mining and analysis software for avionics failure prognostics. Developed databases for data mining and data visualization of extremely large datasets of logistical failure information derived from automatic test equipment results. Efforts involved design and integration of several logistical databases using SQL-Server with neural network, statistical analysis, and data visualization software to discover trends that exist in the data and to derive the significance (if any) of these trends. Developed web pages that incorporate trend results obtained from neural networks, images obtained from data visualization routines, and statistical analysis identifying trends and anomalies in the data contained within the database.

Medical and Health Related

- National Cancer Institute, Bethesda, MD, 2001-2005, Grant 2R44CA91662, PI: Development of an on-line Registry of Tumors in Lower Animals (RTLA). The objective of this project was to design and implement a web site that allowed researchers to view, add and modify tumor data and images stored in a database. Efforts included designing progressive transmission algorithms combined with new data compression methods to achieve order of magnitude increases in effective bandwidth for viewing very high definition digital images.
- National Cancer Institute, Bethesda, MD, 1999-2001, Grant 1R43CA78099, PI: Research for the detection of tumors within digital mammograms. Efforts included the development and fusion of non-stationary multiresolution image decomposition with intelligent analysis using fractal imaging and

neural network-based pattern recognition. The approach uniquely considered optimal resolution for both human viewing as well as machine analysis of digital mammographic images to detect, segment, and identify specific regions where masses are identified as "suspicious" and worthy of investigation by a radiologist consultant and by ground truth data associated with images from existing digital mammography databases.

- International Agency for Research on Cancer (IARC), Lyon, France, 1999-2003. PI: Designed software and methods for the acquisition of text and images from the over 80 volumes of the IARC Monographs on the Evaluation of Carcinogenic Risks to Humans from paper and various electronic formats. Monograph data was formatted into searchable Adobe PDF files and released on CD-ROM and by subscription over the Internet for worldwide use by researchers.
- National Cancer Institute, Bethesda, MD, 1995-2003, Grant 2R44CA63890, PI: Development of a database for the Survey of Compounds Tested for Carcinogenic Activity, providing unprecedented on-line access to cancer research results published in the world's literature over many decades. Summaries of this literature are contained within Public Health Service publication PHS-149, most of which was previously unavailable for general distribution due to out of print volumes and/or are limited in production. Efforts included the development of new methods for the acquisition and optical character recognition of cancer research data, along with new capabilities for longitudinal search of experiment data for cancer research on a wide variety of rodent, fish, canine and other species.

Nanotechnology

- USAF, OO-ALC, Hill AFB, UT, 2003 to 2007, Contract F42650-03-P-2753 and FA8201-04-C-0093: Researched potential for replicating existing aircraft system functions at nanoscale levels. This project includes identifying targeted systems and designs that would be most beneficial to replace, understanding the capabilities and limitations of discrete components used, identify any risk potentials, and then design and test a prototype nanoscale device that encompasses the feasibility of the research.
- USAF, OO-ALC, Hill AFB, UT, 2002 to 2006, Contract F42650-02-P-1940 and F42650-03-C-0045, PI: Research and development efforts for the application of nanoscale sensors in a "sea-of-needles" method of testing for printed circuit boards. This approach performs functional testing that eliminates the need to have a pre-existing model of a circuit board while automating much of the development process. The resulting approach facilitates novel testing approaches not possible with current generation or planned architecture test
- USAF, Hill AFB, UT, 2003-2007, Contract FA8201-04-C-0093, PI; Lead research and development efforts into the design, fabrication, test and evaluation of nanotechnology-based devices and systems used to retrofit existing functionality within F-16 aircraft. Specific efforts include functionalization of carbon nanotube-based electronics and their integration into cohesive system designs.
- USAF, Hill AFB, UT, 2003-2004, Contract F42650-03-P-2753: Researching potential for replicating existing aircraft system functions at nanoscale levels. This project includes identifying targeted systems and designs that would be most beneficial to replace, understanding the capabilities and limitations of discrete components used, identify any risk potentials, and then design and test a prototype nanoscale device that encompasses the feasibility of the research performed.
- USAF, Ogden ALC, UT, 1999-2003, Contract F42650-99-C-0016 and F42650-00-C-0030, PI: Investigation and design of molecular test equipment for use within integrated circuits. Display technology development for interface to nanotube-based sensors comprising a portion of molecular test equipment embedded within integrated circuits. Performed design and integration of displays as the representative for GMAI in the Liquid Crystal Institute Industrial Partnership Program at Kent State University, Kent OH. Also, performed design and development of carbon nanotube-based sensors for metal and organic compound detection within integrated circuits.

Materials and Chemistry

- USAF, Wright-Patterson AFB, OH, 2004-2005, Contract FA8650-04-M-5021: Research and development for a coating for aircraft composite parts that indicates areas affected by impact damage. The coating allows maintenance personnel to use CCD cameras or portable fluorometers to locate and

quantify impacts that occurred during flight, thereby highlighting areas for more scrupulous inspection or repair without compromising the aircraft's low profile paint design.

- Marine Corps Systems Command, Quantico, VA, 2002-2006, Contracts M67854-03-C-5006 and M67854-04-C-4000: Lead efforts to successfully replace the ten different types of explosives that comprise the canine explosive kit set, with operationally inert replacements. The results obtained support the premise that compounds begin to smell alike when their molecular vibrational energies overlap; the more these energies overlap, the more similar the smell. A US patent was issued based upon this work.

Other

- AT&T Bell Laboratories, Middletown, NJ, 1990-1994, PI: Development of autonomous agents for detecting and correcting errors within legacy databases. Several projects were undertaken within AT&T Network Systems and AT&T Bell Laboratories, and Nippon Telegraph and Telephone.

1980 – 1990: Director, Prospective Computer Analysts, Inc., Roslyn NY and Arlington, VA

Prior to GMAI, Mr. Wright worked for Prospective Computer Analysts, Inc., of Roslyn, NY and Arlington, VA, for 10 years, where he served as the Director of their Washington, D.C. operations. He served as PI on DOD and NASA projects related to knowledge based system development, automated knowledge acquisition, and software verification and validation. His accomplishments include development of automated knowledge acquisition for knowledge-based system development supporting launch vehicle test and diagnosis, development of a knowledge-based system approach for verification and validation of test program sets, lead engineer in support of the F/A-18 avionics suite support equipment program manager at the Naval Air Systems Command in Washington, DC. He also performed as engineer for test program development for weapon systems on the US Army Apache helicopter and M1A1 tank.

Technical and managerial services were rendered on a variety of assignments with PCA, relating to all aspects of Automatic Test Equipment (ATE) design, development, test and acquisition. All assignments required extensive customer interface with US Navy, Air Force and Army activities in addition to the Royal Australian Air Force and the McDonnell Douglas, Grumman, RCA, Sperry and Harris Corporations. Mr. Wright held positions of increasing responsibility and authority as Senior Engineer, Program Manager and Technical Director. Major efforts include managing the development of a new Air Force MATE tester and supervising a staff of engineers, analysts and support personnel in work efforts associated with supporting the acquisition of Navy Automatic Test Equipment and Test Program Sets. Additional responsibilities as Technical Director included business development, proposal development and management, and administrative duties associated with personnel management.

In addition, Mr. Wright contributed towards the development of NAVAIR policy for support equipment software concerning IEEE SCC-20-ATLAS language and automatic test program generator ATPG/HITS.

1978 – 1980: Engineer, Harris Corporation, PRD Division, Syosset, NY

Prior to working at PCA, Mr. Wright began work in 1978 at the PRD Division of the Harris Corporation in Syosset, NY, where he designed hardware interfaces to F-14 aircraft avionics and software for testing both circuit cards and aircraft weapon systems.

Mr Wright developed F-14 Tactical Air Reconnaissance Pod (TARPs) weapon-level assembly and circuit board Test Program Sets utilizing the VAST and CAT-IIID Automatic Test Equipment. Program development was in the VITAL and Basic languages and responsibilities included all phases of development including hardware and software design, integration, debug and selloff.

Another project undertaken was the development of an on-line failure diagnostic monitoring system to detect faults in computer peripherals associated with a mainframe computer system. This effort was with regard to the US Army DAS-3 program and involved fault signature analysis, definition of system interface requirements and critical monitor/interrogation point selection.

Professional Society Affiliations

Institute of Electrical and Electronics Engineers (IEEE) – Senior Member

- Active member since 1983.

- Member IEEE SCC-20 committee, SCC-20 AI-ESTATE committee.
- Chair IEEE P1391 Committee on Knowledge-based System Interoperability

Institute of Navigation (ION) – Member since 2006.
The Nautical Institute (UK) – Associate Fellow
Royal Institute of Navigation (UK) - Associate Fellow

Patents Issued and Pending

- "Method of Producing Energetically-Inert Pseudoscents of Explosive Materials, and Compositions thereof". US Patent # 7,694,628 issued 13 April 2010.
- "Method of Diagnostic and Prognostic Failure Determination using Electromagnetic Emissions". Patent pending. Application #61403320 filed 14 September 2010.
- "Method and Apparatus for Diagnosing Printed Circuit Board Failures using Electromagnetic Emissions. Patent pending. Application #13605964 filed 6 September 2012.
- "Non-contact Circuit Board Component Fault Isolation based upon Signal Propagation and Demodulation Characteristics". Patent pending. Application #61698585 filed 8 September 2012.
- "Virtual Dynamic Aids to Navigation". Patent pending. Application # 62378691 filed 24 August 2016.
- "Method of Virtual Aid to Navigation Verification using Georeferencing". Patent pending. Application # 62218306 filed 14 September 2015.

List of Publications

- Russell, I., **Wright, R.G**. "Navigation Sonar: More than Underwater Radar. Realising the Full Potential of Navigation and Obstacle Avoidance Sonar". *International Hydrographic Review*. IHO Publication P-1. No. 17. May 2017.
- Mehdi R.A., **Wright R.G.** and Baldauf M. "3-dimensional Forward Looking sonar: Offshore Wind Farm Applications". European Navigation Conference, Helsinki, Finland. 31 May 2016.
- **Wright, R.G**. and Baldauf, M.: 'Virtual Electronic Aids to Navigation for Remote and Ecologically Sensitive Regions', *Journal of Navigation*, 2016. pp. 1–17. doi: 10.1017/S0373463316000527.
- **Wright R.G**., Baldauf M.: 'Correlation of Virtual Aids to Navigation to the Physical Environment'. *TransNav, the International Journal on Marine Navigation and Safety of Sea Transportation*, 2016. Vol. 10, No. 2, pp. 287-299, DOI: 10.12716/1001.10.02.11
- **Wright R.G**., Baldauf, M.:'Hydrographic Survey in Remote Regions: Using Vessels of Opportunity Equipped with 3-dimensional Forward-Looking Sonar'. *Journal of Marine Geodesy*. 2016. DOI 10.1080/01490419.2016.1245266.
- **Wright R.G**. and Baldauf, M. Arctic Environmental Preservation through Grounding Avoidance, *Sustainable Shipping in a Changing Arctic Environment*, Springer. London. 2016. In Press.
- **Wright R.G.**; Baldauf, M.; "Physical Aspects of Virtual Aids to Navigation", Activities in Navigation – Marine Navigation and Safety of Sea Transportation; ed. Adam Weintrit, pp 61-68, 2015, CRC Press, London.
- **Wright R.G.**; "Spectroscopic Electromagnetic Analysis Approach to Non-Contact Circuit Board Test and Diagnosis". Autotestcon, National Harbor, MD. 3-5 November 2015. pp. 173-180.
- **Wright R.G.**; Zimmerman C.; "Vector Data Extraction from Forward-Looking Sonar Imagery for Hydrographic Survey and Hazard to Navigation Detection", Proc. of *IEEE/MTS Oceans Conference*, Washington D.C., 19-22 October 2015.
- **Wright R.G.**; Baldauf, M.; "A Georeferencing Approach to Real-Time Virtual Aid to Navigation Verification", in Proc. *ION GNSS+ Conference 2015*, Institute of Navigation, Tampa, FL, 14-18 Sep. 2015.
- **Wright R.G.**; Baldauf, M.; "Arctic Environmental Preservation through Grounding Avoidance", in Proc. of *Safe and Sustainable Shipping in a Changing Arctic Environment (ShipArc 2015)*, Malmö, Sweden, 25-27 August 2015.
- **Wright R.G.,** Baldauf M.: "Enhanced Situational Awareness through Muli-Sensor Integration", in *Proc. 18th International Navigation Simulator Lecturers' Conference (INSLC 18)*, Buzzards Bay, Massachusetts USA, 2014. 40-59. ISBN 978-0-692-29012-5.

- **Wright R.G.**; Baldauf, M.; "Improving the Safety of Polar Navigation – Contribution of New Technology and Training", in Proc. of *6th Arctic Shipping Summit*, Montreal, Canada, 18-19 March 2015.
- **Wright R.G.**; Baldauf, M.; "Collaborative Navigation through the Establishment and Distribution of Electronic Aids to Navigation in Real Time", in Proc. *Joint Navigation Conference*, Institute of Navigation, 16-19 June 2014, Orlando, FL.
- **Wright R.G.**, "Circuit card test and diagnosis using electromagnetic emission analysis," in *AUTOTESTCON, 2012 IEEE* , vol., no., pp.324-329, 10-13 Sept. 2012.
- **Wright R.G.**, "Multiresolution sensor fusion approach to PCB fault detection and isolation," Proc. Autotestcon *2008 IEEE* , vol., no., pp.41-46, 8-11 Sept. 2008.
- **Wright R.G.**, "The Merger of Imaging and Nanotechnology in Threat Reduction, Security, and Antiterrorism", in Proc. *Systems and Software Technology Conference*, Salt Lake City, UT. May 2006.
- **Wright R.G.**; Kirkland, L.V., "Circuit board testing through multispectral signal analysis," in *Autotestcon, 2005. IEEE* , vol., no., pp.752-758, 26-29 Sept. 2005.
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