

# Brian Thomas Murray

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## **SUMMARY OF QUALIFICATIONS**

Engineering and management professional with experience in all aspects of trusted intelligent and cyber-physical system design, including fault-tolerant systems, system safety and safety-critical systems, and product cybersecurity. Early leader in the development of active safety and autonomous driving systems and technology.

Proven leader in growing and managing technical capability. Experienced in technology identification, strategic organization design, recruiting, hiring and operational management. Experience proactively and reactively adapting organizations to evolving customer and market needs and business realities. Experienced project manager with practical knowledge of internal development projects focused on business unit needs, academic research projects and US and EU government-funded projects. Experience teaching, consulting and networking with university and other institutions globally. Experience in aerospace, automotive and commercial/energy businesses.

Proven record of developing innovative concepts, proposing and leading projects that impact the business and the industry and participating in influential standards activities. Proven ability to obtain support and funding for projects.

## **PROFESSIONAL EMPLOYMENT**

|                  |   |
|------------------|---|
| 2015-Present     | ZF Friedrichshafen<br>Director, Global Safety and Security Excellence   |
| 2009             | United Technologies Research Center,<br>Group Leader, Embedded Systems and Networks Group   |
| 2008             | Delphi Steering, Electric Power Steering Division<br>Manager, System Safety and Vehicle Performance   |
| 2006             | Delphi Steering,<br>Manager, Vehicle Dynamics and Active Safety   |
| 2002             | Delphi Automotive Systems, Dynamics & Propulsion<br>Innovation Center<br>Manager, Innovation Center Brighton<br>Advanced Dynamics Systems and Integration |
| 1999-2000        | Delphi Automotive Systems, Steering Systems Division,<br>Manager, Research and Development  |
| 1996–<br>Present | University of Michigan<br>Adjunct Professor   |

- 1984-1999                      General Motors Research and Development Center  
Senior Staff Research Engineer
- 1982–  
1984                              Duke University  
Graduate Research/Teaching Assistant, developed key  
fault-tolerant system integration component for Lockheed.

### **EDUCATION**

- Dec. 1994                      THE UNIVERSITY OF MICHIGAN, Ann Arbor, MI  
Ph.D. in Computer Science and Engineering  
*Thesis: Hierarchical Testing Using Precomputed Tests for  
Modules*  
*Thesis advisor: Professor John P. Hayes*
- May 1984                      DUKE UNIVERSITY, Durham, NC  
MS in Electrical Engineering  
*Thesis: A Self-Testing Bus Monitor for TMR Fault-Tolerant  
Applications*  
*Thesis advisor: Professor Peter N. Marinos*
- May 1982                      ALBION COLLEGE, Albion, MI  
AB with majors in Physics and Mathematics

### **TECHNICAL INTERESTS AND EXPERTISE**

Product/production/IT cybersecurity technology, policies, processes, governance and engineering. Product safety, coordination and integration of proactive system safety and reactive safety measures. Autonomous systems and human-machine embedded systems and enabling technologies – particularly transportation systems. Safety case architectures for autonomous systems. Trustable systems: integrated requirements and technology for safety, security and availability; Software product line architecture for embedded systems; Automotive vehicle dynamics, chassis control systems and technology and integration, vehicle performance evaluation & testing, Distributed embedded systems: hardware and software architectures and communication strategies (wired and wireless), Model-based design and verification/validation of complex systems; Resilient system design.

### **RELEVANT MANAGERIAL & PROFESSIONAL EXPERIENCE**

#### **ZF Friedrichshafen**

- Director, Global Safety and Security Excellence
  - Develop and lead product cybersecurity strategy and governance organization
    - Cybersecurity engineering process, cybersecurity monitoring, vulnerability management, incident response, Safe and Secure Reference Architecture and countermeasures library, V&V strategy, organizational strategy, supply chain strategy, IT infrastructure linkage, ...
    - Represent ZF in US and international standards activities in cybersecurity. Technical Expert SAE/ISO 21434, ZF lead

- representative in Auto-ISAC: Chair Information Sharing Standing Committee, Vice Chair Auto-ISAC Advisory Board
    - Support ZF interaction with customers on product cybersecurity
  - Provide leadership for System/Functional Safety globally
    - Responsible for system safety processes and governance
    - Develop strategies for the continuous incorporation and continued advancement of system safety on all ZF products
    - Engage with standards on autonomous safety process, e.g., UL 4600

### **United Technologies Research Center**

- Functional Management: Group Leader for Embedded Systems & Networks (ESN) Group
  - Manage resources and capability for distributed embedded systems technology development and insertion into UTC business units.
  - Established Embedded Intelligence office in Berkeley, CA and managed from 2011 to 2014
  - Designed and established ESN organization between East Hartford, CT and Berkeley, CA
    - Communication Systems. Intelligent Software Systems and Cyber-Physical Systems
  - Business development to fund ESN and UTRC growth
    - Support 6 UTC Business Units with diverse products
    - Identify and solicit projects with US DoD and DoE, support UTRC Ireland in pursuit of EU-funded projects
    - Identify and solicit internally funded research projects
  - Manage 5 laboratories, including Cyber-Physical Security lab and Wireless labs with anechoic chamber
  - Mentor for Embedded Systems in UTRC, Ireland
- Project Management/Principle Investigator roles
  - Cyber-Physical Security, 2011-2014
  - Carrier Common Software Architecture project, 2010 – winner of 2012 UTC Outstanding Achievement Award
  - UTRC DARPA META II project (\$3.8M, 18 people), 2011
  - UTRC DDR&E Software Producibility Project, 2011
- Selected technology development by the ESN group personally led or provided the initial leadership and focus
  - Cyber-Physical Security (Product Cybersecurity)
    - Support UTC business units with vulnerability assessments and secure development processes and architecture solutions
    - Developed corporate guidelines for security in products
    - Managed cybersecurity research and development portfolio
  - Software
    - ESN Initiated effort that continued throughout UTC to capture requirements via models and to verify systems using formal methods.
    - Software architectures to support product line variations and reuse of both software and hardware components, including building management system middleware and cloud scalable systems

- Re-engineering legacy software, including new tools and methods
    - TRL-indexed software process
  - Embedded Intelligence
    - Focus of the Berkeley, CA office
    - Software and hardware architectures and design tools for embedded systems with adaptive intelligence and machine learning
    - Majority of ESN employees supported large UTRC effort in Autonomous Systems sponsored by Sikorsky
    - Influence future embedded system architectures
- External partners and customers: DARPA, DoE, AFRL, ARL, UC Berkeley, UC Santa Barbara, USC, University of Pennsylvania, University of Connecticut, MIT, Georgia Tech Research Institute, IBM, LERO, CIT, ...

### **Delphi Corporation**

- Managed system safety for Delphi Steering Electric Power Systems production group, including strategy and process development, process compliance and program execution support for \$1B business and product safety concept development, including both mechanical and embedded systems, 2007-2009.
- Technical expert for the US on ISO TC22/SC3/WG16 working group to develop the ISO 26262 standard for functional safety in passenger vehicles.
- Developed technology and business strategy for automotive Active Safety (from Chassis organization) and Vehicle Dynamics products, including competency development, 2002-2007. Responsible for Advanced Vehicle Dynamics for Delphi Corporation. Technologies included: handling enhancement, rollover prevention, integrated stability control and automated driving (lane keeping, park assist). Supported Steering and Chassis (brakes and suspension) business units and multiple product lines.
- Developed testing strategies, test safety requirements and driver training program for testing autonomous and semi-autonomous vehicle systems.
- Established and led 3-group, 25-member Innovation Center in Brighton, Michigan as part of a multi-center R&D organization for Delphi Chassis and Steering Businesses, 2002-2007.
- Developed by-wire, dependable architecture strategies, part of a team to develop steer- and brake-by-wire as a product, 1999-2006.
- Participated in development of new approaches to model-based diagnostics and diagnostic system architectures, 2000-2003. Joint development project with Ohio State University.
- Partners and customers: BMW, GM, Ford, PSA, Renault, Fiat, NHTSA, IIHS, University of Michigan, Ohio State University, ...

### **General Motors Research Center**

- Led effort to develop one of the automotive industry's first system safety process, tools and dependable embedded system architecture strategy for GM and later Delphi, 1995-2000. Delphi and GM were consequently considered leaders in this area by the International System Safety Society. Was consistently responsible for system safety or system safety management 1995-2009.

- Led program to develop new approach to controller design for engine control based on event triggering; included many novel design approaches, including application-specific microprocessor and coprocessor design, hardware-software co-design, retargetable optimizing compilers and several new approaches to scheduling in real-time operating systems. 1991-1993.
- Developed theoretical and practical basis for generating tests for core-based integrated circuits (systems on chips) using pre-computed tests for modules, techniques developed have been widely adopted and expanded both in academia and industry, including use by Intel for Pentium III, 1985-1995. Subject of Ph.D. research and many highly cited papers.
- Initiated and conducted a cooperative development program between GenRad Corp. and General Motors. Developed strategy to incorporate pre-computed tests for modules into the Hitest™ test generator program (integrated circuits and circuit boards), 1985-1987. Worked in residence at GenRad location in Fareham, UK.
- Participated in development of IC design tool strategy for General Motors and Hughes Aircraft Corp.

#### **Duke University**

- Teaching assistant, microprocessors, 1983
- Research assistant, 1984
- Developed a novel, fully self-testing bus monitor integrated circuit for a Triple-Modular Redundant flight control system for Lockheed Corp., 1983-1984

#### **Albion College**

- Electronics technician, 1978-1982
- Academic programmer, 1981-1982

#### **Wohlert Corporation, Lansing, MI**

- Machinist, 1978-1979

### **PATENTS**

1. "Electric Power Steering System Having Fail-Safe Control Module," S. Gillman, J. Hoffman, B. Murray and W. Thomas, Patent No. 8,930,083, January 6, 2015.
2. "Cross Link Intra-Vehicular Data Communication Using a Field Coupled Transmission Line," B. Murray, C. Callewaert, Patent. No. 7,230,954, June 12, 2007.
3. "Self testing CMOS imager chip," F. Schauerte, B. Murray, J. Troxell, C. Stevenson, Patent No. 7,053,352, May 30, 2006.
4. "Model-Based Fault Detection and Isolation System," G. Rizzoni, A. Soliman, P. Pisu, S. Amberkar, B. Murray, Patent No. 6,766,230, July 20, 2004
5. "Back-Driveable Steer-by-Wire System with Positive Scrub Radius," J. Guldner, M. Krug, S. Bakaus, K-U Balszuweit, H. Smakman, C. Ebner, M. Graf, A. Schedl, P. Mescher, R. Disserr, J. Heinrichs, S. Millsap, B. Murray, D. Krukenkamp, M. Byers, Patent No. 6,786,296, September 7, 2004.
6. "Fault Detection and Isolation System and Method," G. Rizzoni, A. Soliman, P. Pisu, S. Amberkar, B. Murray, Patent No. 6,687,585, February 3, 2004.

7. "User-Configurable Steering Control for Steer-by-Wire Systems," M. Byers, B. Murray, S. Amberkar, Patent No. 6,678,594, January 13, 2004.
8. "Electric Caliper Hardware Topologies for a Safety System," R. Disser, P. Mescher, R. Perisho, J. D'Ambrosio, S. Millsap, S. Amberkar, J. Foust, J. Heinrichs, M. Byers, Patent No. 6,580,991, June 17, 2003.
9. "Multi-Module Control-by-Wire Architecture," B. Murray, J. D'Ambrosio, S. Millsap, M. Byers, R. Disser, J. Heinrichs, P. Mescher, J. Foust, Patent No. 6,424,900, July 23, 2002.
10. "A Built-in Method for Test Response Compaction and Verification of Digital Circuits," B. T. Murray, K. Chakrabarty, and J. P. Hayes, Patent No. 5,790,562, August 1999.

2 patents pending.

## **PUBLICATIONS AND PRESENTATIONS**

### **Refereed Journal Articles**

1. Zhu, H., Murray, B., de Weck, O., Skelding, R., Shougarian, N., Zeidner, L., & Arnold, E. (2016, July). Adaptability Metric Analysis for Multi-Mission Design of Manufactured Products and Systems. In INCOSE International Symposium (Vol. 26, No. 1, pp. 2316-2330).
2. N. Kandasamy, J. P. Hayes, and B. T. Murray, "Dependable Communication Synthesis for Distributed Embedded Systems," *Journal Reliability Engineering & Systems Safety*, vol. 89, no. 1, pp. 81-92. Elsevier Publishers, July 2005.
3. Nagarajan Kandasamy, John P. Hayes, Brian T. Murray: Time-Constrained Failure Diagnosis in Distributed Embedded Systems: Application to Actuator Diagnosis. *IEEE Trans. Parallel Distrib. Syst.* 16(3): 258-270, 2005.
4. Barbara J. Czerny, Joseph G. D'Ambrosio, Paravila Jacob, Brian T. Murray, Padma Sundaram, "An Adaptable Software Safety Process for Automotive Safety-Critical Systems," 2004-01-1666, SAE 2004 Transactions Journal of Passenger Cars – Electronic and Electrical Systems, 2004.
5. Barbara J. Czerny, Joseph G. D'Ambrosio, Paravila Jacob, Brian T. Murray, "Identifying and Understanding Relevant System Safety Standards for Use in the Automotive Industry," 2003-01-1293, Journal of Passenger Cars – Electronic and Electrical Systems, 2003.
6. V. Iyengar, K. Chakrabarty, and B. T. Murray, "Deterministic Built-In Self-Testing of Sequential Circuits Using Precomputed Test Sets", *Journal of Electronic Testing: Theory and Applications*, Vol. 15, August/October, 1999.
7. H. Al-Asaad, J. P. Hayes, and B. T. Murray, "Scalable test generators for high-speed datapath circuits," *Journal of Electronic Testing*, Vol. 12, No. 1-2, pp. 111–126, February/April, 1998.
8. K. Chakrabarty, B. T. Murray, and J. P. Hayes, "Optimal Zero-Aliasing Space Compaction of Test Responses", *IEEE Trans. on Computers*, Vol. 47, No. 11, pp. 1171–1187, November, 1998.
9. K. Chakrabarty and B. T. Murray, "Design of Built-In Test Generator Circuits Using Width Compression", *Trans. on Computer-Aided Design*, Vol. 17, No. 10, pp. 1044–1050, October, 1998.
10. V. Iyengar, K. Chakrabarty, and B. T. Murray, "Huffman Coding of Test Sets for Sequential Circuits," *Trans. on Instrumentation and Measurement*, Vol. 47, No. 1, pp. 21–25, February 1998.

11. B. T. Murray and J. P. Hayes, "Hierarchical Test Generation using Precomputed Tests for Modules", *IEEE Trans. on CAD*, June 1990.

### **Books or Book Chapters**

1. Barbara J. Czerny, Joseph G. D'Ambrosio, Paravila Jacob, Brian T. Murray, Padma Sundaram, "An Adaptable Software Safety Process for Automotive Safety-Critical Systems," 2004-01-1666, SAE SP-1870, 2004.
2. Barbara J. Czerny, Joseph G. D'Ambrosio, Paravila Jacob, Brian T. Murray, "Identifying and Understanding Relevant System Safety Standards for Use in the Automotive Industry," 2003-01-1293, In-Vehicle Networks, Safety Critical Systems, Accelerated Testing and Reliability, SAE SP-1783.
3. S. Amberkar, J. D'Ambrosio, B. Murray, J. Wysocki, B. Czerny, "A System Safety Process for By-Wire Automotive Systems", in *Design and Technologies for Automotive Safety-Critical Systems*, SP-1507, SAE, 2000, pp. 69-74.
4. H. Al-Asaad, J. P. Hayes, and B. T. Murray, "Scalable test generators for high-speed datapath circuits," in *On Line-Testing for VLSI*, Kluwer Academic Publishers, Boston, 1998.

### **Conference and Other Publications**

1. H. Zhu, M. Moulin, B. Murray, V. Fonoberov, I. Mezic, "System Analysis and Verification: A Comprehensive Approach and Case Study," Conference on Systems Engineering and Research, Redondo Beach, CA, March 2017.
2. B. J. Czerny, B. T. Murray and J. Miller, "Coordinating Cybersecurity and Safety and a Proposed Automotive Cybersecurity Integrity Level Classification Scheme," SAE Congress, May 2016.
3. B. J. Czerny, B. T. Murray and J. Miller, "Coordinating Cybersecurity and Safety through Systems Engineering," IQPC Automotive Security Summit, March 2016
4. B. J. Czerny, J. G. D'Ambrosio, B. T. Murray, "Safety Implications of Automotive Active Safety Systems," 26th International System Safety Conference, Vancouver, British Columbia, Aug. 25-29, 2008.
5. B. J. Czerny, J. G. D'Ambrosio, B. T. Murray, "Safety Implications of Automotive Active Safety Systems," 26th International System Safety Conference, Vancouver, British Columbia, Aug. 25-29, 2008.
6. Barbara J. Czerny, Joseph G. D'Ambrosio, Paravila Jacob, Brian T. Murray, Padma Sundaram, "Effective Application of Software Safety Techniques to Automotive Safety-Critical Systems," Society of Automotive Engineers, Inc., 2005.
7. Barbara J. Czerny, Joseph G. D'Ambrosio, Paravila Jacob, Brian T. Murray, Padma Sundaram, "Effective Application of Software Safety Techniques to Automotive Safety-Critical Systems," Society of Automotive Engineers, Inc., 2004 [Presentation].
8. Barbara J. Czerny, Joseph G. D'Ambrosio, Paravila Jacob, Brian T. Murray, Padma Sundaram, "A Software Safety Process for Safety-Critical Advanced Automotive Systems", 21st International System Safety Conference, Ottawa, Ontario, Aug. 4-8, 2003.
9. Barbara J. Czerny, Joseph G. D'Ambrosio, Paravila Jacob, Brian T. Murray, "Identifying and Understanding Relevant System Safety Standards for Use in the Automotive Industry," 2003-01-1293, SAE Congress, 2003.

10. R. Venkatasubramanian, J. P. Hayes, and B. T. Murray, "Low-Cost On-Line Fault Detection Using Control Flow Assertions", *Intl. On-line Testing Symposium*, pp. 137-143, 2003
11. Nagarajan Kandasamy, John P. Hayes, Brian T. Murray: Dependable Communication Synthesis for Distributed Embedded Systems. SAFECOMP 2003: 275-288.
12. Nagarajan Kandasamy, John P. Hayes, Brian T. Murray: Time-Constrained Failure Diagnosis in Distributed Embedded Systems. DSN 2002: 449-458.
13. Sanket Amberkar, Barbara J. Czerny, Joseph G. D'Ambrosio, Jon Demerly, Brian T. Murray, Michael Allocco, "Comprehensive Hazard Analysis of an Automotive Steer-by-Wire System", 19th International System Safety Conference, Fort Worth, Texas, Sept. 10-14, 2001.
14. S. Amberkar, B. Czerny, J. D'Ambrosio, J. Demerly, and B. Murray, "A Comprehensive Hazard Analysis Technique for Safety-Critical Automotive Systems", SAE 2001 Congress, March, 2001.
15. S. Amberkar, J. D'Ambrosio, B. Murray, J. Wysocki, B. Czerny, "A System Safety Process for By-Wire Automotive Systems", SAE paper 2000-01-1056, presented at 2000 SAE Congress, March, 2000.
16. B. Czerny, J. D'Ambrosio, B. Murray, "Providing Convincing Evidence of Safety in X-by-Wire Automotive Systems", in Proc. 5th Int. Symp. High Assurance Systems Engineering, November 15-17, 2000.
17. B. Murray, R. Steele, and H. Schubotz, "Dependable E/E System Drivers and Application Issues", in Proc. SAE Int. Congress on Transp. Electronics, 2000-01-C064, Oct 16-18, 2000.
18. M. Sultan, D. Eddy, and B. Murray, "Smart Sensors for Future Robust Systems", in Proc. SAE Int. Congress on Transp. Electronic6s, 2000-01-C055, Oct 16-18, 2000.
19. N. Kandasamy, J. Hayes, B. Murray, "Enhancing Flexibility in Distributed Safety-Critical Embedded Systems", in Proc. 21st IEEE Real-Time Systems Symposium, 27-30 November 2000.
20. S. Amberkar, B. Czerny, J. D'Ambrosio, B. Murray, J. Wysocki, "Automotive System Safety: Technologies for Dependable X-by-Wire Systems", in Proc. 18th System Safety Conference, 2000.
21. P. Pisu, G. Rizzoni, A. Soliman, S. Amberkar, B. Murray, and L. Jalics, "Model-Based Diagnostics for Vehicle Systems", ASME, 2000.
22. N. Kandasamy, J. P. Hayes, and B. T. Murray, "Tolerating Transient Faults in Statically Scheduled Embedded Systems," in Proc. IEEE Symp. Reliable Dist. Syst., pp. 212 - 221, 1999.
23. N. Kandasamy, J. P. Hayes, and B. T. Murray, "Scheduling Algorithms for Fault Tolerance in Real-Time Embedded Systems," in *Dependable Network Computing*, Avresky (Ed.), Kluwer Academic Publishers, 1999.
24. K. Chakrabarty, B. T. Murray, and V. Iyengar, "Built-In Test Pattern Generation for High-Performance, Core-Based Circuits Using Twisted Ring Counters", *IEEE VLSI Test Symposium*, April 1999.
25. N. Kandasamy, S. Jain, B. T. Murray, J. P. Hayes, "Active Fail-Safe System for Drive-by-Wire", In Proc. ISATA, 1999.
26. H. Al-Asaad, B. T. Murray, and J. P. Hayes, "Online BIST for Embedded Systems", *IEEE Design & Test of Computers*, Vol. 15, No. 4, pp. 17-24, October-December, 1998



27. V. Iyengar, K. Chakrabarty, and B. T. Murray, "Deterministic Built-In Self Testing of Sequential Circuits Using Precomputed Test Sets," *Proc. VLSI Test Symposium*, April 1998.
28. K. Chakrabarty, B. T. Murray, J. Liu, and M. Zhu, "Test Width Compression for Built-In Self Testing," *Proc. IEEE International Test Conference*, November 1997.
29. V. Iyengar, K. Chakrabarty, and B. T. Murray, "Test Set Encoding for Testing Sequential Circuits," *Proc. IEEE Instrumentation and Measurement Technology Conference*, pp. 1442–1447, May 1997.
30. V. Iyengar, K. Chakrabarty, and B. T. Murray, "Built-In Self-Testing with Complete Fault Coverage," *North Atlantic Test Conference*, May 1997.
31. B. T. Murray and J. P. Hayes, "Testing ICs: Getting to the Core of the Problem," *IEEE Computer*, November 1996.
32. H. Al Asaad, J. P. Hayes, and B. T. Murray, "Design of Scalable Hardware Test Generators for On-Line BIST," *Proc. International On-Line Testing Workshop*, 1996.
33. B. T. Murray, K. Chakrabarty, and M. C. Hansen, "Maximum Transparency Space Compaction (Or How to Get More Than 100% Fault Coverage)," *International Test Synthesis Workshop*, May 1996.
34. K. Chakrabarty, B. T. Murray, and J. P. Hayes, "Optimal Space Compaction of Test Responses," *Proc. International Test Conference*, pp. 834–843, October 1995.
35. K. Chakrabarty, B. T. Murray, and J. P. Hayes, "Synthesis of Built-In Self-Test Circuits With Complete Fault Coverage," *International Test Synthesis Workshop*, May 1995.
36. X. Hu, J. G. D'Ambrosio, B. T. Murray, D.-L. Tang, "Codesign of Architectures for Automotive Powertrain Modules," *IEEE Micro*, August, 1994.
37. X. Hu, J. G. D'Ambrosio, B. T. Murray, D.-L. Tang, "The Role of Analysis in Hardware/Software Codesign," *Proc. International Workshop on Computer-Aided Codesign*, 1993.
38. B. T. Murray and J. P. Hayes, "Test Propagation Through Modules and Circuits," *Proc. IEEE International Test Conference*, 1991.
39. "High-Level Test Generation for VLSI", D. Bhattacharya, B. T. Murray, and J. P. Hayes, *IEEE Computer*, April 16-14, 1989.
40. B. T. Murray and J. P. Hayes, "Hierarchical Test Generation using Precomputed Tests for Modules", *Proc. IEEE International Test Conference*, 1988.

#### **Invited Talks and Presentations**

1. B. Murray, "Safety Interface to Cybersecurity," *Auto ISAC Summit*, December, 2017.
2. B. Murray, "Safety and Trust in Automated Driving," *Workshop on Safety and Control for Artificial Intelligence*, June 28, 2016.
3. B. Murray, "Hardware-Assisted Cyber Security in Automotive Systems," *IEEE Hardware-Oriented Security and Trust Workshop*, May 2016.
4. B. Murray, "Challenges in Automotive Security," *FICS*, Feb. 2016.
5. B. Murray, "Cyber-Security and Safety in Automated Driving," *CAR MBS*, August 2015.
6. B. Murray, "The Emerging Importance of Cyber-Physical Security," *Keynote, Processes, Methods & Tools for Cyber-Security-Aware Automotive Embedded Systems*, *SAE Congress*, 2013. Awarded Outstanding Oral Presentation by SAE.

7. B. Murray, "Cyber-Physical Security Challenges at United Technologies," 8<sup>th</sup> Cyber Security and Information Intelligence Research Workshop, January 10, 2013.
8. B. Murray, "Industry Capabilities and Needs in Cyber-Physical Systems Design and Manufacturing," Third Annual CPS PI Meeting, October 14, 2012.
9. B. Murray, "Complex Cyber-Physical System Design Challenges at United Technologies Research Center," February 15, 2012.
10. B. Murray and R. Skelding, "UTRC-DARPA META Project," MIT Engineering Design and Rapid Prototyping seminar, January 17, 2012.
11. B. Murray, "Efficient Coverage of Hazards in Safety-Critical Systems," SAE Congress, Detroit, MI, April, 2010. Awarded Outstanding Oral Presentation by SAE.
12. B. Murray, B. Czerny, "Active Hydraulics: Performance and Safety," Steering.Tech, Garching, Germany, April 1, 2008.
13. B. Murray, "Torque Overlay Systems and Features," ATA International Conference on Advanced Chassis Control," Bolocco, Italy, September 7, 2006.
14. N. Boules, B. Murray, and W. Heck, "Steer-by-Wire and Brake-by-Wire, Redundancies for energy, data communication, and function", presented at 42V Conference, March, 2000
15. B. Murray, J. P. Hayes, "Maximum Transparency Space Compaction (or How to Get More than 100% Fault Coverage)", International Test Synthesis Workshop, 1996.
16. B. Murray, J. P. Hayes, "Synthesis of Built-In Self-Test Circuits with Complete Fault Coverage," International Test Synthesis Workshop, 1995.
17. B. Murray, J. P. Hayes, "Synthesis for k-Transparency: A DFT Approach for Hierarchical Test Generation", International Test Synthesis Workshop, 1994.
18. B. Murray, J. P. Hayes, "Type Algebra, A Method for Representing Fault Information", Hierarchical Test Generation Workshop, 1993.
19. B. Murray, J. P. Hayes, "High-Level Test Generation for Complex Systems", 2nd. Annual IpoCSE Research Review, 1991.
20. B. Murray, J. P. Hayes, "A Methodology for High-Level Test Strategies", IEEE Design-for-Test Workshop, 1987.

### **SELECTED ADDITIONAL TRAINING**

|           |  |
|-----------|--|
| 1994 -    | RENSAELER POLYTECHNIC UNIVERSITY, Troy, NY<br>MS in Engineering Science, Management of Technology<br>(not completed)                               |
| 2007      | Six Sigma Green Belt, Design for Six Sigma Green Belt<br>classwork   |
| 2003-2009 | Test Driver Training Program, Delphi Corporation<br>(founder/developer)<br>Level 2 Limit Handling Certification at GM's Milford Proving<br>Grounds |

Extensive in-house management training including multiple courses in personnel management and media training.

## **HONORS AND PRIZES, HONORARY SOCIETIES**

SAE Forest McFarland Award, 2019  
Outstanding Oral Presentation, SAE Congress, 2013  
Outstanding Achievement Award, United Technologies, 2012  
Outstanding Oral Presentation, SAE Congress, 2010  
Great Job Award, United Technologies Research Center, 2009  
Delphi Steering Innovation Center Staff Award for Low-Angle Quadrasteer, 2004  
SAE Presentation/Paper Award for "Effective Application of Software Safety  
Techniques to Automotive Safety-Critical Systems," 2004  
GM Doctoral Dissertation Program (competitive program)  
Phi Beta Kappa  
Eta Kappa Nu  
Sigma Xi  
E. T. S. Walton Award for the Outstanding Senior Physics Student (Albion College)  
Albion College Fellow  
Albion Presidential Scholarship

## **JOINT FACULTY POSITIONS**

### **The University of Michigan, Ann Arbor, MI**

#### **Courses Taught**

- Advanced Computer Architecture
- Digital System Testing

#### **Graduate Students (Co-Advisor/Thesis Committee)**

- Hussain Al-Asaad, University of Michigan, graduated 1998, currently Assistant Professor, University of California, Davis.
- Nagarajan Kandasamy, University of Michigan, graduated 2003, currently Assistant Professor, Drexel University.
- Rajesh Venkatasubramanian, University of Michigan, graduated 2005.

## **PROFESSIONAL ACTIVITIES**

*Chair*, Auto ISAC Information Sharing Standing Committee

*Vice Chair*, Auto ISAC Advisory Board

*Technical Expert*, SAE/ISO 21434

*Member*, Editorial Board for the SAE International Journal of Transportation Safety.

*Invited Editor*: Committee on Electronic Vehicle Controls and Unintended Acceleration.

*Testified*: Committee on Electronic Vehicle Controls and Unintended Acceleration. This committee was commissioned by the National Academies' Transportation Research Board on a request from NHTSA to investigate how NHTSA might meet growing challenges posed by automotive electronics in the wake of recent concern over the possibility of unintended acceleration.

*Session Organizer and Session Chair*: Safety-Critical Systems Session, SAE Congress, 2001-2018

*Session Organizer*: Cybersecurity for Cyber-Physical Automotive Systems Session, SAE Congress, 2015-2018

*Judge*: SAE Isbrandt Automotive Safety Engineering Award, 2003-2015

*Technical Expert*, ISO 26262 (2008-2009)

*Session Organizer*: SAE Dynamics and Stability Conference, 2006

*Editorial Board*: Journal of Electronic Testing Theory and Applications

*Program Committee*, 1995–1998 International Test Synthesis Workshop

*Session Chair*: 1997 International Test Conference

*Reviewer*: International Test Conference, IEEE Transactions on CAD, IEEE Transactions on Computers, IEEE Transactions on VLSI, SAE

*Member*: Institute for Electrical and Electronics Engineers, International System Safety Society, SAE International

## **RECENT VOLUNTEER ACTIVITIES**

Usher and leader of COVID 19 safety team for Holy Family Catholic Church

Mentor, ZF FIRST Robotics Team, Cornerstone Health and Technology High School, Detroit