

## Curriculum Vitae Dr. Russ Duren

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## Research Interests

Aerospace and avionics system design, optimization of legacy avionics systems, reconfigurable computing, real-time embedded systems, FPGA and embedded systems design methods, autonomous systems, fault-tolerant systems

## Education

- Ph.D. in Electrical Engineering, Southern Methodist University, Dallas, TX, 1991
- M.S. in Electrical Engineering, Southern Methodist University, Dallas, TX, 1986
- B.S. in Electrical Engineering, University of Oklahoma, Norman, OK, 1978

## Awards and Honors

- Twice nominated for Baylor **Outstanding Faculty Scholarship** Award, 2007 and 2008
- Invited to speak at the **National Academies** Decadal Survey of Civil Aeronautics
- Naval Postgraduate School **Outstanding Instructional Performance** Award, 2002
- 34th IEEE Midwest Symposium on Circuits and Systems, Myril B. Reed **Outstanding Paper** Award, 1991
- Southern Methodist University's Frederick E. Terman **Outstanding Electrical Engineering Graduate Student** Award 1990 - 1991
- **General Dynamics Doctoral Fellowship**, 1989 – 1991
- Eta Kappa Nu, Electrical Engineering Honor Fraternity, 1975 - 1977
- University Scholars Scholarship at the University of Oklahoma, 1973 – 1974

## Professional Experience

### Academic Experience

**Tenured Associate Professor, August 2003 – Present** (received tenure in May 2008)  
Department of Electrical and Computer Engineering, Baylor University, Waco, TX

Specialty: Computer Engineering

### *Accomplishments during 4 years at Baylor University*

- 3 journal papers
- 5 conference papers
- 1 invited presentation (to the National Academies Decadal Survey of Civil Aeronautics)
- 1 online trade journal article
- 2 additional conference presentations without associated papers
- Obtained over \$425,000 of research funding
- Helped establish a Master of Science degree program in Electrical and Computer Engineering

### *Details of Research Accomplishments at Baylor*

- Developed a FPGA-based reconfigurable computing cluster platform and ported the Linux operating system to the system. This system is being used to perform research into reconfigurable computing architectures, performance, and programming methods.
- Developed and characterized the performance of multiple circuits to explore the application of reconfigurable computing techniques to radar and sonar processing problems. Some of these applications have achieved speedups of 60 to 200 times over conventional solutions.
- Developed and delivered multiple VHDL circuit designs, including a SDRAM controller, for an experimental FPGA-based reconfigurable processor for a small satellite. The satellite was designed by a team that included members from the Naval Academy, the Naval Postgraduate School, and me.
- Developed a repartitioning of the MIL-STD-1553 message architecture that relieved a major problem limiting additional growth of the F/A-18 C/D avionics system and allowed for increased processing time during each time slice. This was incorporated into the F/A-18 C/D Mission Computer Flight Program by engineers at the F/A-18 Advanced Weapons Lab in China Lake, CA.
- Developed a software tool to optimize memory utilization in the F/A-18 C/D Mission Computer. This tool was delivered to the F/A-18 Advanced Weapons Lab. I am currently working to improve the optimization algorithm in collaboration with Baylor Computer Science faculty. We have proven the problem is NP-complete.
- Developed and published data compression algorithms compatible with legacy avionics systems.
- Evaluated various high-level language and graphical tools for the development of FPGA circuits, embedded systems, and replacements for legacy processors.
- Developed multiple VHDL implementations of a 32-bit RISC microprocessor for pedagogical use.

### **Associate Professor, August 1996 – Aug. 2003**

Department of Aeronautics and Astronautics, Naval Postgraduate School, Monterey, CA

- Developed and taught courses in Avionics and Software Engineering. Performed research in avionics, avionics systems, and reconfigurable computing, including projects related to the E-2C, EA-6B, F/A-18, V-22, and the JSOW GPS-guided weapon.
- Produced 10 conference papers, 5 technical reports, 1 trade magazine article, 2 invited conference presentations, and 10 additional conference presentations without associated papers.
- Obtained over \$750,000 of research funding.

### Industrial Experience

#### **Engineer VI, June 2005 – Present**

DCS Corporation, Headquartered in Alexandria, VA

- Performed and supervised multiple research and development projects related to the F/A-18 C/D avionics system specifically, and to avionics systems in general. Examples include:
  - Researched and documented “choke points” in the F/A-18 C/D avionics architecture. Suggested a modification in the communication architecture that eliminated a major obstacle to continued growth of the avionics system.
  - Developed and documented procedures for verifying real-time performance of the Operational Flight Program (OFP) for the F/A-18 C/D Mission Computer.
  - Developed a software tool to optimize the use of memory in the F/A-18 C/D Mission Computer.
  - Developed and characterized multiple compression routines to improve communications over the MIL-STD-1553 data bus.
  - Researched and characterized Computer-Aided Design (CAD) tools for use in the development of avionics hardware and software.
  - Researched and documented methods of extending the life of the legacy avionics system, including methods for replacing the AYK-14 processor while minimizing the impact to the associated software.

**Consultant, August 1996 – Present**

Russ Duren and Associates.

- Consulted on a variety of engineering proposals and legal cases.

**Lead Engineer, August 1983 – August 1996**

Lockheed Martin Aeronautics Company, Fort Worth, TX. (When I started working for this company it was General Dynamics, Fort Worth Division. Later it was acquired by Lockheed which then merged to become Lockheed Martin.)

- Served as the Lead Engineer for the F-22 Stores Management System (SMS) Modular Hardware Design group. In this position I was responsible for technical performance of a team of 12 engineers reporting to me on a full-time basis and many others reporting to me on a part-time basis. I was also responsible for estimating and meeting schedule and budget for the design group.
- Designed, debugged, qualified and supported a variety of avionics modules and test equipment which performed mission-critical and safety critical functions including:
  - Embedded controllers
  - Interfaces for multiple parallel and serial interface standards
  - High current switching
  - Audio and video digitization and signal processing
- Other assignments involved avionics development for F-16 and F-111 aircraft and classified programs. As part of these assignments, I was involved with every part of the life-cycle of avionics systems, including bid and proposal, specification, preliminary design, detailed design, integration, testing and verification, qualification and reliability testing, full scale production, field support, and system upgrades.
- Performed and later supervised detailed circuit design including digital and analog circuits for mission-critical and safety-critical systems.

**Engineer, April 1979 – August 1983**

RTEC Systems Corporation, Bedford, TX

- Designed and programmed test equipment for telecommunications systems.

**Engineer, June 1978 – April 1979**

Texas Instruments, Inc., Lubbock, TX

- Component engineer for LED and LCD watches.

**Design Skills**

- Digital hardware design using VHDL, Verilog, and Impulse C
- Application of FPGAs to reconfigurable computing and digital signal processing
- Embedded system design with a variety of processors including the 8051, Atmel AVR, PowerPC and Xilinx MicroBlaze families
- Design of custom microprocessors
- Digital signal processing, digital filtering, adaptive filtering, image processing
- Neural networks, machine learning, artificial intelligence and software agents
- Analog design at audio through video frequencies
- Avionics system design
- Avionics interface standards including MIL-STD-1553, MIL-STD-1760, and ARINC 429
- Avionics design standards including DO-178, DO-254, MIL-STD-498
- System engineering
- Software engineering and programming
- Real-time systems and RTOS

## Computer-Aided Design Tools

- Various digital CAD tools including Xilinx ISE, Xilinx EDK, Xilinx System Generator, ModelSim, and Synplicity synthesis tools
- Programming with Ada, Basic, C, C++, Fortran, Pascal, and multiple assembly languages
- Multiple operating systems including Microsoft Windows, Palm OS, and Linux
- Multiple specification, development and debugging tools and environments
- MathCAD, MATLAB, Simulink

## Funded Research

- Co-Principal Investigator, “F/A-18 Avionics Research,” Sponsor: DCS Corporation via funding from the Naval Air Warfare Center-Weapons Division at China Lake, \$296,469 over 3 years, June 2006-May 2009.
- “F/A-18 Avionics Architecture,” Sponsor: The Naval Postgraduate School via funding from the Naval Air Warfare Center-Weapons Division at China Lake, \$65,000. December 2003 – October 2004.
- “F/A-18 C/D Avionics Architecture Study,” Sponsor: The Naval Air Warfare Center-Weapons Division at China Lake, \$210,000, October 1999-December 2003.
- Note: The above 3 contracts represent **sustained funding** from the same source for a period spanning from October 1999 to May 2009.
- “Experiment Design for a Reprogrammable Satellite,” Sponsor: Naval Postgraduate School, \$34,403, 2004-2006.
- “Signal Processing with a Reconfigurable Computer,” Sponsor: Naval Postgraduate School, \$29,246, 2003-2005.
- “E-2C UESA (UHF Electrically Scanned Array) Studies,” Sponsor: NAVAIR, \$20,000, 2002.
- Co-Principal Investigator with LCDR Dean Wilson (thesis student), “Analysis of Tracking Characteristics and ID Contributions of Diverse Systems and Data Sources for Multiple Source Integration (MSI),” Sponsor: Naval Air Warfare Center-Aircraft Division, \$40,000, 2000-2001.
- Co-Principal Investigator, “Vortex-Ring State Warning System Research and Validation,” Sponsor: Office of Naval Research, \$40,000, 1999-2000.
- Co-Principal Investigator, “Rapid Air-Ground Retargeting,” Sponsor: PMA-201, Conventional Strike Weapons, \$167,000, 1998-2000.
- Co-Principal Investigator with LCDR David Varnes (thesis student), “Pilot and Crew Aids for the H-60 Helicopter,” Sponsor: Office of Naval Research, \$25,000, 1999.
- Co-Principal Investigator, “An Unmanned Air Vehicle Ballistic Missile Launcher Detection and Destruction System,” Sponsor: Institute for Joint Warfare Analysis, \$100,000, 1998.
- “Virtual Prototyping of Avionics Systems,” Sponsor: Naval Air Systems Command, Maritime Avionics Subsystems and Technology (MAST) Program, \$45,000, 1997-1999.
- Co-Principal Investigator, “Avionics Laboratory Recapitalization Grant,” Sponsor: Naval Postgraduate School, \$25,000, 1998.
- Co-Principal Investigator, “Passive Sensor-Based Control of Nonlinear Autonomous Systems,” Sponsor: Office of Naval Research, \$62,113, 1997.

## Journal Papers

**Duren, R. W.**, Marks, R. J., II, Reynolds, P. D. and Trumbo, M. L., “Real-Time Neural Network Inversion on the SRC-6e Reconfigurable Computer,” *Neural Networks, IEEE Transactions on*, vol. 18, pp. 889-901, May 2007.

**Duren, R.** “Options for Upgrading Legacy Avionics Systems,” *AIAA Journal of Aerospace Computing, Information, and Communication*, 2006 vol. 3 no. 6, pages (251-259)

Fouts, D. J., Macklin, K. R., **Duren, R. W.**, and Zulaica, D. P., "Electronic Warfare Digital Signal Processing On COTS Computer Systems With Reconfigurable Architectures," AIAA Journal of Aerospace Computing, Information, and Communication, 2005 vol. 2 no. 10, pages (414-429)

## Best in Conference Paper

**Duren, R.** and Peikari, B., "A New Neural Network Architecture for Rotationally Invariant Object Recognition," Proceedings of the 34th Midwest Symposium on Circuits and Systems, Volume I, pp. 320-323, Monterey, CA, 14-17 May 1991. **Selected as Best Paper in Conference.**

## Invited Presentation to the National Academies

**Duren, R.**, "Avionics Research Challenges," presented at the National Academies Decadal Survey of Civil Aeronautics, Washington, DC, 15 November 2005.

## Conference Papers

**Duren, R.** and Thompson, M., "Application of Data Compression to the MIL-STD-1553 Data Bus," Proceedings of the 2008 IEEE Aerospace Conference, Big Sky, MT, 1-8 March 2008.

**Duren, R.**, Stevenson, J. and Thompson, M., "A Comparison of FPGA and DSP Development Environments and Performance for Acoustic Array Processing," Proceedings of the 50th IEEE International Midwest Symposium on Circuits and Systems, Volume I, pp. 320-323, Montreal, Canada, 5-8 August 2007.

Reynolds, P.D., **Duren, R.W.**, Trumbo, M.L., and Marks, R.J., II, "FPGA implementation of particle swarm optimization for inversion of large neural networks," Proceedings of the 2005 IEEE Swarm Intelligence Symposium, Pasadena, CA, 8-10 June 2005, pp. 389-392.

Surratt, M., Loomis, H. H., Ross, A. A., and **Duren, R.**, "Challenges of Remote FPGA Configuration for Space Applications," Proceedings of the 2005 IEEE Aerospace Conference, Big Sky, MT, 5-12 March 2005.

**Duren, R.**, Fouts, D., and Zulaica, D., "Performance Comparison of CORDIC Implementations on the SRC-6E Reconfigurable Computer" presented at the 2003 MAPLD International Conference, Washington, D.C., 9-11 September 2003.

**Duren, R.** "Options for Upgrading Legacy Avionics Systems," Proceedings of the 21st Digital Avionics Systems Conference, pp. 12.C.2.-1-12, Irvine, CA, 27-31 October 2002.

Hutchins, R. G, Wilson, D., Allred, L. K., and **Duren, R.**, "Alternative Architectures for IMM Tracking of Maneuvering Aircraft," Proceedings of SPIE, Volume 4728, August 2002.

Schmidt, L. V. and **Duren, R.**, "Wing Induced Drag," Proceedings of the AIAA Atmospheric Flight Mechanics Conference, Monterey, CA, 5-8 August 2002.

**Duren, R.**, Couch, M. and Wood, E. R., "An Analysis Of 'Vortex Ring State' Encounters From Flight Test Data With Application To An Onboard Warning System," Proceedings of the 57th American Helicopter Society (AHS) Annual Forum, Washington, DC, 9-11 May, 2001.

Hendricks, S. and **Duren, R.**, "Using OPNET to Evaluate Fibre Channel as an Avionics Interconnection System," Proceedings of the 19th Digital Avionics Systems Conference, pp. 4.C.1-1-8, Philadelphia, PA, 7-13 October 2000.

Varnes, D., **Duren, R.** and Wood, E. R., "An Onboard Warning System to Prevent Hazardous 'Vortex Ring State' Encounters," Proceedings of the 26th European Rotorcraft Forum, pp. 88-1-22, The Hague, The Netherlands, 26-29 September 2000.

**Duren, R.**, "Development of a Small Rotary-Wing Autonomous Vehicle," Proceedings of the 18th Digital Avionics Systems Conference, pp. 6.A.2-1-8, St. Louis, MO., 24-29 October 1999.

Barnaby, J. and **Duren, R.**, "Development of a Standard Interface for a New Generation of Miniature Stores," Proceedings of the 18th Digital Avionics Systems Conference, pp. 1.C.1-1-7, St. Louis, MO., 24-29 October 1999.

Varnes, D. and **Duren, R.**, "Pilot and Crew Aids for the H-60 Helicopter," Proceedings of the 18th Digital Avionics Systems Conference, pp. 4.D.4-1-8, St. Louis, MO., 24-29 October 1999.

**Duren, R.** and Peikari, B. "A Comparison of Second-Order Neural Networks to Transform Based Methods for Translation and Orientation Invariant Object Recognition," in Neural Networks for Signal Processing - Proceedings of the 1991 IEEE Workshop, pp. 236-245, Princeton, NJ, 30 September – 2 October, 1991.

## Technical Reports

Brewer, B. E., Kurdian, A. H. and **Duren, R.**, "Tactical Considerations in Choosing an Electrically Scanned Array for Incorporation in the E-2C Hawkeye," 18 April 2002.

**Duren, R.**, "F/A-18 C/D Avionics Architecture Upgrade Study Status Report," 26 January 2001.

**Duren, R.**, "F/A-18 C/D Avionics Architecture Upgrade Study: An Introduction to CPU Tech," 12 January 2001.

**Duren, R. W.**, "Report on Previous Studies Related to the EA-6B Follow-on Platform," paper provided to the Airborne Electronic Attack (AEA) Analysis of Alternatives (AoA) Technical IPT, June 5, 2000.

**Duren, R.** and Tyo, S., "Report on F-18 E/F EMI Susceptibility Due to Effectiveness of Composites for EM Shielding," 13 October 1999

## Online Trade Journal Article

**Duren, R.**, "Low Cost Reconfigurable Computing Cluster Brings Millions of Reconfigurable FPGA Gates to Students," FPGA and Structured ASIC Journal, 9 December 2008, Available online at [http://www.fpgajournal.com/articles\\_2008/20081209\\_mentor.htm](http://www.fpgajournal.com/articles_2008/20081209_mentor.htm)

## Trade Magazine Article

Varnes, D., **Duren, R.** and Wood, E. R., "Detecting the Vortex Ring State," Rotor & Wing, Vol. 34, No. 1, pp. 60-65, January 2000.

## Invited Presentations

**Duren, R.**, Wood, E. R. and Couch, M., "NPS Vortex Ring State Definition and Safety Data Review," Rotorcraft Aeromechanics Workshop, Patuxent River, MD, 18-19 July 2000.

Wood, E. R., Couch, M. and **Duren, R.**, "NPS Research on Vortex Ring State," Rotorcraft Aeromechanics Workshop, Patuxent River, MD, 18-19 July 2000.

## Presentations

**Duren, R.**, Reynolds, P. and Ottewell, B., "Implementation of Large Neural Networks on the SRC-6e Reconfigurable Computer," Classified Advanced Technology Update Conference, Naval Postgraduate School, Monterey, California, July 15, 2004.

**Duren, R.**, Fouts, D., and Zulaica, D., "Algorithm and Programming Considerations for Embedded Reconfigurable Computers," Seventh Annual Workshop on High Performance Embedded Computing (HPEC 2003), MIT Lincoln Laboratory, Lexington, MA, 22-25 September 22-25, 2003.

**Duren, R.**, Couch, M. and Wood, E. R., "An Analysis of "Vortex Ring State" Encounters from Flight Test Data with Application to an Onboard Warning System," presented by request to a DoD committee investigating "Tiltrotor Aeromechanics Phenomena," NASA Ames Research Center, June 18, 2001.

**Duren, R.**, "F/A-18 C/D Avionics Architecture Upgrade Study," F/A-18 Advanced Weapons Laboratory Combined Country Conference (AWL C3): Building Synergies – A Look to the Future, NAWCWD, China Lake, CA, 6 - 7 March 2001.

**Duren, R.**, "F/A-18 C/D Avionics Architecture Upgrade Study," F/A-18 Advanced Weapons Laboratory Mission Systems Review, 21 February 2001.

Varnes, D., **Duren, R.** and Wood, E. R., "Development of a Helicopter Vortex-Ring State Warning System Through a Moving Map Display Computer," presented at Boeing Helicopters, Inc., La Mesa, AZ, 26 May 2000.

Varnes, D. and **Duren, R.**, "Vortex Ring State Warning System," presented by the request of Col. Nolan Schmidt, USMC, the V-22 Program Manager, to PMA-275. The charts were e-mailed to PMA-275 and presented by phone on 19 May 2000.

Varnes, D. and **Duren, R.**, "Development of a Helicopter Vortex-Ring State Warning System Through a Moving Map Display Computer," presented to Ms. Susan Bales, Director, Naval Fleet/Force Technology Innovation Office, Monterey, CA, 29 September 1999.

Varnes, D. and **Duren, R.**, "Development of a Helicopter Vortex-Ring State Warning System Through a Moving Map Display Computer," presented to representatives from PMA 299, Patuxent River, MD, 12 September 1999.

**Duren, R.** and Kaminer, I., "Sensor Based Control of UCAV Autonomous Landing," ONR Meeting on Basic Research on Intelligent Autonomous Air Vehicles, Stanford University, Stanford, CA, 23-24 September 1997.

## Faculty Activities

- Worked on an Avionics Strategic Initiative and a PhD Strategic Initiative
- Served on two department search committees 2006-2008
- Participated in preparation for ABET and SACS accreditation
- Session Organizer for the 2005 and 2006 IEEE Aerospace Conference
- Chairman of Committee on Engineering Honors Program, Baylor 2004
- Member of the Software Engineering Committee, Baylor, 2003 - 2004
- Member of the Retirement, Insurance and Special Functions Committee, NPS, 2001 - 2002
- Departmental Representative to the Faculty Council, NPS, 1997 - 2001
- Member of the Naval Postgraduate School Faculty Executive Board, 1997 - 1998
- Exhibits Chairman for the 1998 IEEE International Symposium on Circuits and Systems
- Committee Chairman on Information Security Procedures and Secure Computing Laboratory Policies, NPS 1998

## Professional Affiliations

- American Institute of Aeronautics and Astronautics (AIAA)
- American Society of Engineering Education (ASEE)
- Institute of Electrical and Electronic Engineers (IEEE) - Senior Member