FREDERICK T. SHELDON

9436 Polo Club Lane, Knoxville, TN 37922
http://www.csm.ornl.gov/~sheldon (US Citizen)
865-576-1339 office | 865-621-8908 cell | sheldonft@ornl.gov

PROFESSIONAL BEARING

Leadership in research that seeks advances in computing and communication theory, algorithms for computer, computational and cyberspace sciences, knowledge discovery and the architecture and design of software (especially for the creation of secure and dependable systems and information intelligence that meet *critical* national needs).

EDUCATION

University of Texas at Arlington, College of Engineering

Ph.D. in Computer Science	May 1996
MS in Computer Science	August 1988

University of Minnesota, Institute of Technology

Bachelor of Science in Computer Science	December 1983

University of Minnesota, College of Biological Science

Bachelor of Science in Microbiology	June 1977

EMPLOYMENT

Oak Ridge National Laboratory, Computational Science and Engineering Division From: 09/02 – Present

Senior Research Staff, Cyberspace Sciences and Information Intelligence Research Group (Q-clearance):

<u>Oversight of various R&D programs:</u> *Group Violent Intent Modeling* [DHS funded], *Weigh-In-Motion* (see ~sheldon/factsheets/WIM-wp.pdf) and *Mobile Automated Distribution and Support System* [DoD TransComm/G4 funded (~/MADSS-wp.pdf)], *Trusted Corridor* [ONR/DHS/EPA funded (~/IMRicS-wp.pdf)] and affiliation with NSF funded Cyber Trust Centers: *TRUST* [lead: UCB] and *TCIP* [lead: UIUC inside ITI]. <u>Internally funded projects include:</u> General Chair: *Cyber Security and Information Intelligence Research Workshop* [CSIIRW04-08] see http://www.ioc.ornl.gov/csiirw), *Threat Assessment and Risk Analysis* Management Framework (~sheldon/factsheets/TARA-fs.pdf), *SNORT+* (Snort with a Bayesian Plug-in: ~/SNORTplus-fs.pdf), *Intelligent Insider Threat Detection* (~/ITD-fs.pdf) System, *Radiological Source Tracking and Monitoring* (~/RadStraM-wp.pdf), *Cyber Security Econometrics* (~/CSE-p2.pdf [provisional patent filed May 10, 2008]), *Composing Attributes for Scalable Security* (~/CASS-q.pdf), *Heuristic Identification and Tracking of Insider Threat* (~/HIT-IT-fs.pdf and ~/HIT-IT-p2.pdf), *Multi-Level Evidence Based Intrusion Detection using a Bayesian Plugin* (~/SNORTplus-fs.pdf), *Maximizing Performance Availability Security and Survivability* (~/MaxPASS-q.pdf), *Dynamic Early Filtering of Internet Traffic* (~/DEFT-p2.pdf), *Trust-Based multi-Agent Security Services* (~/T-BASS-fs.pdf), *Adaptable Intelligent Malfeasance Detection* (~/AIMD-fs.pdf), *Dependable Survivable Critical Infrastructure* (~/DeSCI-fs.pdf). Mentoring of graduate students from the DHS scholars and fellows program (see http://www.orau.gov/dhsed/). Metrics: 9 journal articles, 4 edited books, 29 conference papers, 30 proposals/white papers, 9+ pre-proposals and numerous letters of faculty support.

DaimlerChrysler (RIC/AS): Research Info. & Communication / System Safety Period: 07/01 – 08/02

Stuttgart: Applied research in specification and modeling for logical/statistical verification/validation of safety properties (hazard analysis) and stochastic performance analysis (including diagnostics and performance measures) for vehicle hardware/software systems.

Washington State University, College of Engineering and Architecture Period: 06/99 – 09/02

Assistant Professor, School of Electrical Engineering and Computer Science

See the list of journal, conference, book articles and tutorials, as well as proposals and white papers, technical reports, invited articles and colloquium presentations, refereed software tools developed and title/description of (under-) graduate courses taught, student advisees and projects, professional service activities and specialized workshops/schools attended in the long version CV (http://www.ioc.ornl.gov/sheldon/intro.html).

University of Colorado, College of Engineering and Applied Science Period: 08/96 – 06/99

Assistant Professor, Computer Science Department

First tenure track position though initial teaching experience occurred fulfilling PhD residency requirements at the University of Texas at Arlington.

National Research Council, NASA Langley Research Center Period: 06/96 – 08/96

Research Associate (NRC Postdoc), Flight Electronics Technology Division: Formal specification of stochastic properties for an integrated air/ground system to support low visibility landing and surface operations at commercial airports. Investigated advanced design techniques for ensuring that high-performance computing

systems are produced in a timely fashion and meet stringent real-time reliability and fail-safe/secure requirements (1993-95 was supported by NASA Langley during final dissertation research phase).

University of Texas at Arlington, College of Engineering   Period: 01/93 - 05/96
Assistant Instructor, Computer Science and Engineering: Taught Methods in Software Engineering, Discrete Structures in Computer Science (+Pascal lab) and Formal Methods for Software. Dissertation title: Specification and analysis of stochastic properties for concurrent systems expressed using CSP, developed a CSP (process algebra) to Stochastic Petri net translation tool and investigated automated techniques for decomposition/composition of system models, and was supported by a prestigious NASA GSRP fellowship.

Lockheed Martin Aeronautics Company (formerly General Dynamics, FWD)   Period: 01/90 - 01/93
Engineering Specialist (promoted 1992), Avionics R&D: Secret clearance, PI for $2-million R&D project to define a generic Integrated Diagnostics (ID) Software Development Process to address problems associated with functional deficiencies of avionics software and software maturation using as a basis, the Software Development Integrity Program (Mil-Std-1803, plus Mil-Std-2167A, 2168, 1815 and 800-xx Series); developed a software engineering process model (to specify, develop and verify diagnostic software) and recommendations for updates to Mil-Std-1814; authored the Software Risk Management Practices and the F-22 Software/System Engineering Environments prime requirements document (System Segment Specification), provided tools training and participated on various proposal writing teams.

Lockheed Martin Aeronautics Company (formerly General Dynamics, FWD)   Period: 10/88 - 01/90
Senior Engineer, Advanced Avionics Development: Secret clearance, FS/X Japan tailoring F-16 derivative avionics systems components. Lead Engineer for YF-22 VMS Kernel and prime author of it's software requirements specification. Collaborated on the stores management operational flight program, built-in-test, software development plan, computer resource integration, processing architecture evaluations and white papers, computer data security, and communication interfaces. Developed memory usage estimation algorithm for various Ada compliers.

Raytheon (formerly Texas Instruments, DSEG)   Period: 9/87 -10/88
Test Engineer (promoted 1988), Test Automation Department: Secret clearance, on loan to Military Computer Systems as designer for built-in-test software on the Multipurpose Interface module for the Advanced Tactical Fighter (YF-22) Mission Display Processor using DoD-STD-2167.

Raytheon (formerly Texas Instruments, DSEG)   Period: 7/84 -09/87
Software Design Engineer, Avionics Systems/Radar Division: Secret clearance, designer for hardware fault diagnostic, built-in-self-test, calibration and acceptance test software for the Tornado Nose Radar. Various functionalities included terrain following/ ground mapping radar/ ECCM and the infrared imaging Lantern pod.

SELECTED AWARDS AND RECOGNITION
- 2009   HICSS Minitrack Chair: Cyber Security and Information Intelligence Research in Decision Technologies and Service Sciences Track
- 2008   Program Chair: 2nd DOE Grassroots Cybersecurity Community Town Hall Meeting at ORNL
- 2008   Invited Lecturer: Sixth Semester of UNESCO Chair: Discrete Mathematics and Logic: Foundations and Applications in Software Specification, Analysis and Design (Week 9: Cyber Security and Infrastructure Protection)
- 2008   Invited participant: Cyber Security Research Roadmap Workshop to expand the INFOSEC Research Council (IRC) Hard Problem List (HPL), sponsored by DHS conducted at SRI International
- 2008   Invited participant: Department of Homeland Security and Kauffman Foundation IT Security Entrepreneurs' Forum (ITSEF conducted at the Arrillaga Alumni Center, Stanford University)
- 2007   ACSAC Security Engineering Training and Certification
- 2007   UT-Battelle Project Management Training and Certification
- 2005-08 Program Chair: Cyber Security and Information Intelligence Research Workshop at ORNL
- 2004   Elected Senior Member IEEE
- 2000   Participant: Software System Safety Class (N. Leveson: SE Lab, MIT Aeronautics and Astronautics)
- 2000   European Edu Forum School Participant: Formal Methods & Performance Analysis (FMPA2000)
- 1997-98 ASEE Fellowship: Stanford/NASA Ames Summer Faculty Research Associate/Visiting Scholar
- 1996-97 Outstanding UTA Ph.D. Dissertation Award from UTA Chapter for the Society of Sigma Xi
- 1995-6   UTA College of Engineering, Dept. of CSE: Outstanding Research by a Ph.D. Student
- 1996   IEEE First Place Graduate Technical Paper Contest (Ft. Worth Sec) IEEE Region 5 cash award
- 1996   DARPA SBIR with UniSoft Inc., based on Sheldon's Ph.D. Dissertation ($100,000)
- 1996   National Research Council Associateship Award at NASA/LaRC ($84,000)
- 1994   University of Texas at Arlington's ACM Programming Contest Team Coach
- 1993   Runners-Up Best Paper at the Fourth Int'l Conf. on Applications of Software Measurement
- 1993-95 NASA Graduate Student Researchers Fellowship Recipient at LaRC ($66,000)
- 1988   Member of Upsilon Pi Epsilon Honor Society in the Computing Sciences

• 1986   Member of Tau Beta Pi International Engineering Honor Society

REFEREED JOURNAL ARTICLES (14) (Copies: http://www.csm.ornl.gov/~sheldon/pubs.html)

Kanamori, Y., Yoo, S-M, Gregory, D.A. and **Sheldon, F.T.**, "Authentication Protocol using Quantum Superposition States," *Int'l Journal of Network Security* (Accepted June 2007).

Sheldon, F.T., and Chung, Hong, "Measuring the Relations Among Class Diagrams to Assess Complexity," *Jr. of Software Maintenance and Evolution: Research and Practice,* 18:5 pp. 333-350 Sept./Oct. 2006.

Kanamori, Y., Yoo, S-M, and **Sheldon, F.T.,** "A Short Survey on Quantum Computers," *Int'l Jr. of Computers and Applications, ACTA Press Calgary* 28:3, pp. 227-233, 2006**.**

Mili, A., **Sheldon, F.T.,** Jilani, L.L., Vinkurov, A., Thomasian, A. and Ayed, R.B., "Modeling Security as a Dependability Attribute: A Refinement Based Approach," *Innovations in Systems and Software Engineering*, (*Springer London*, DOI: 10.1007/s11334-006-0023-7) Vol. 2, No. 1, pp. 9-48, March 2006.

Abercrombie, R.K., **Sheldon, F.T.**, Schlicher, R.G. and Daley, K.M., "Development of the Joint Weigh-In-Motion (WIM) and Measurement Reach Back Capability – The Configuration and Data Management Tool" SOLE Logistics Spectrum Magazine, 38:4, pp. 4-9, Dec. 2005.

Mili, A., **Sheldon, F.T.,** Mili, F. and Desharnais, J., "Recovery preservation: a measure of last resort," *Innovations in Systems and Software Engineering*, (*Springer London*, DOI: 10.1007/s11334-005-0004-2), Vol. 1, No. 1, pp. 54-62, Apr. 2005.

Sheldon, F.T. Potok, T.E., Krings, A. and Oman, P., "Critical Energy Infrastructure Survivability, Inherent Limitations, Obstacles and Mitigation Strategies," *Int'l Jr. of Power and Energy Systems –Special Theme Blackout, ACTA Press*, pp. 86-92, PowerCon Special Issue 2004

Sheldon, F.T. Potok, T.E. and Kavi, K.M., "Multi-Agent System Case Studies in Command and Control, Information Fusion and Data Management," *Informatica Int'l Journal,* Vol. 28, pp. 79-89, 2004.

Sheldon, F.T. and Kim, H.Y., "Testing Software Requirements with Z and Statecharts Applied to an Embedded Control System," *Software Quality Jr., Kluwer,* Vol. 12, Issue 3, pp. 231-266, 2004.

Sheldon, F.T., Jerath, Kshamta and Chung, Hong, "Metrics for Maintainability of Class Inheritance Hierarchies," *Jr. of Software Maintenance and Evolution, John Wiley and Sons*, 14:3, pp. 147-160, May/June 2002.

Sheldon, F.T., Xie, Gaoyan, Pilskalns, Orest and Zhou, Zhihe, "Survey of Rigorous Software Specification and Design Tools," *Software Focus, John Wiley and Sons,* 2:4, pp. 140-150, Winter. 2001.

Sheldon, F.T. and Greiner, S.A., "Composing, Analyzing and Validating Software Models to Assess the Performability of Competing Design Candidates," *Annals of Software Engineering (Spec. Issue Software Reliability, Testing and Maturity), Kluwer*, 8:1-4, pp. 239-287, 1999.

Kavi, K.M., **Sheldon, F.T.** and Reed, S.C., "Specification and Analysis of Real-Time Systems Using CSP and Petri Nets," *Int'l Journal of Software Engineering and Knowledge Engineering*, June 1996.

Sheldon, F.T., Kavi, K.M., Everett, W.W., Brettschneider, R., Yu, J.T., and Tausworthe, R.C., "Reliability Measurement: From Theory to Practice," *IEEE Software*, pp. 13-20, July 1992.

TUTORIAL BOOK / CHAPTERS (4)

"Towards Comprehensive Strategies that Meet the Cyber Security and Information Intelligence Challenges Ahead," Eds. **Sheldon, F.T.**, Abercrombie, R.K., Krings, A., and Mili, A., Proceedings of the 4th Ann. Cyber Security and Information Intelligence Research Workshop, *Association of Computing Machinery (ACM)*, May 14-15, 2008 (ISBN 978-1-60558-098-2, http://portal.acm.org/toc.cfm?id=1413140&type=proceeding&coll=portal&dl=ACM)

"Towards Comprehensive Strategies that Meet the Cyber Security Challenges of the 21st Century," Eds. **Sheldon, F.T.**, Krings, A., Yoo, Seong-Moo and Mili, A., Proceedings of the 3rd Ann. Cyber Security and Information Infrastructure Research Workshop, *published by Lulu.com and Oak Ridge National Laboratory*, May 14-15, 2007 (http://www.lulu.com/content/1022194).

"Beyond The Maginot Line," Eds. **Sheldon, F.T.**, Krings, A., Yoo, Seong-Moo, Mili, A. and Trien, J., Proceedings of the 2nd Ann. Cyber Security and Information Infrastructure Research Workshop, *published by Lulu.com at Oak Ridge National Laboratory*, May 10-11, 2006 (http://www.lulu.com/content/317060).

Kim, H.Y, Jerath, K. and **Sheldon, F.T.**, "Assessment of High Integrity Components for Completeness, Consistency, Fault-Tolerance and Reliability," Chapter in <u>Component-Based Software Quality: Methods and Techniques</u>, a book edited by Alejandra Cechich, Mario Piattini, and Antonio Vallecillo, *Springer LNCS Vol. 2693, Heidelburg*, pp. 259-86, 2003.

SELECTED REFEREED PROCEEDINGS (57)

Sheldon, F.T. Abercrombie, R.K., and Mili, A., "Methodology for Evaluating Security Controls Based on Key Performance Indicators and Stakeholder Mission," *IEEE Procs Hawaii Int'l Conf. on System Sciences (HICSS-42 CSIIRM), Waikola, Big Island, Hawaii*, Jan. 5-8, 2009.

Mili, A. and Sheldon, F.T., "Challenging the Mean Time to Failure: Measuring Dependability as a Mean Failure Cost," *IEEE Procs Hawaii Int'l Conf. on System Sciences (HICSS-42 CSIIRM), Waikola, Big Island, Hawaii*, Jan. 5-8, 2009.

Abercrombie, R.K., Sheldon, F.T. and Mili, A., "Synopsis of Evaluating Security Controls Based on Key Performance Indicators and Stakeholder Mission Value," *Proceedings 11-th IEEE High Assurance Systems Engineering Symposium, Nanjing, China*, December 3 - 5, 2008

Abercrombie, R.K., Hively, L.M., Scudiere, M.B. and **Sheldon, F.T.**, "Breakthrough Error Reduction in Portable, Low-Speed Weigh-In-Motion (Sub-0.1 Percent Error)," *Proceedings Int'l Conf. International Conference on Heavy Vehicles Incorporating Heavy Vehicle Transport Technology (HVTT 10) and Weigh-In-Motion (ICWIM 5), Paris,* J. Wiley, May 19-22. 2008.

Walker, R.M., Omitaomu, O.A., Ganguly, A.R., Abercrombie, R.K. and **Sheldon, F.T.**, "Multi-Modal Integrated Safety, Security & Environmental Program Strategy," *Proceedings 87th Transportation Research Board Annual Meeting, Wash. DC,* Jan. 13-17 2008.

Walker, R.M., Kopsick, D.A., Warren, T.A., Abercrombie, R.K., **Sheldon, F.T.**, Hill, D.E., Gross, I.G. and Smith, C.M., "Tracking and Monitoring of Radioactive Materials in the Commercial Hazardous Materials Supply Chain," *Proceedings* 15th Int'l Symposium on the Packaging and Transportation of Radioactive Materials, Miami,* Oct. 20-26 2007.

Mili, A., and **Sheldon, F.T.**, "Measuring Reliability as a Mean Failure Cost," *Proceedings IEEE HASE, Dallas, Nov.* 2007.

Lin, Chia-En, Kavi, K.M., **Sheldon, F.T.** and Abercrombie, R.K**.**, "A Methodology to Evaluate Agent Oriented Software Engineering Techniques," *Proceedings IEEE HICSS-40, Software Agents and Semantic Web Technologies Minitrack, Big Island HI*, Jan. 3-6, 2007 (nominated best paper).

Mili, A., Vinokurov, A., Jilani, L.L, **Sheldon, F.T.** and Ayed, R.B., "Towards an Engineering Discipline of Computational Security," *Proceedings IEEE HICSS-40, Secure Software Architecture, Design, Implementation and Assurance Minitrack, Big Island HI*, Jan. 3-6, 2007.

Kanamori, Y., Yoo, Seong-Moo, and **Sheldon, F.T.,** "Bank Transfer on Quantum Channel with Digital Checks," *Proceedings IEEE Global Telecommunications Conference (GlobeCom), San Francisco CA*, 27Nov–1Dec. 2006.

Mili, A., Wu, Lan, **Sheldon, F.T.**, Shereshevsky, M. and Desharnais, J., "Modeling Redundancy: Quantitative and Qualitative Models," *ACS/IEEE Proceedings AICCSA-06 Dubai/Sharjah*, pp. 1-8, Mar. 8-11, 2006.

Mili, A. and **Sheldon, F.T.**, "Challenges in Computational Software Engineering," *Next Generation Software Engineering, Co-located Workshop at IEEE HICSS-39, Kauai, HI*, Jan. 4-7, 2006.

Kanamori, Y., Yoo, Seong-Moo, Gregory, D.A. and **Sheldon, F.T.,** "On Quantum Authentication Protocols," *Proceedings IEEE Global Telecommunications Conference (GlobeCom), Vol.3, pp. 1650-54, St. Louis, MO*, 28 Nov. – 2 Dec. 2005.

Abercrombie, R.K., **Sheldon, F.T.**, Schlicher, R.G. and Daley, K.M., "Development of the Joint Weigh-In-Motion (WIM) and Measurement Reach Back Capability (WIM-RBC) – The Configuration and Data Management Tool for Validation, Verification, Testing and Certification Activities," *Proceedings SOLE 2005, Orlando FL,* Aug. 16-18 (http://www.sole.org/).

Sheldon, F.T. and Mili, A. "Characterization of Software Quality Assurance Methods: Five Methods for Verification of Learning Systems," *Workshop on Verification, Validation and Certification of Neuro-Adaptive Controllers in Safety-Related Areas in Int'l Joint Conference on Neural Nets (http://faculty.uwb.edu/ijcnn05) July 31 – Aug. 5, 2005.*

Walker, R.M., **Sheldon, F.T.,** and Abercrombie, R.K., "Radiological/Nuclear detection, Identification and Monitoring of Domestic "In Commerce" Shipments (IMRicS) at Weigh Stations," *Proceedings of the Research and Development Partnerships in Homeland Security Conference*, Boston MA*, Apr. 26-28, 2005.

Sheldon, F.T., Walker, R.M. Abercrombie, R.K. and Kopsick, Deborah, "Radiological Source Surveillance and Tracking In Commerce," *Proceedings of the Research and Development Partnerships in Homeland Security Conference*, Boston MA*, Apr. 26-28, 2005.

Abercrombie, R.K., Beshears, D.L., Scudiere, M. B., Coats, J.E, and **Sheldon, F.T.,** "Weigh-in-Motion Research and Development Activities at The Oak Ridge National Laboratory," *Proceedings Int'l Conf. on Weigh-in-Motion*, Session 1b: WIM Technologies and Testing (Paper no. 56), Taipei, Feb. 26-28, 2005

Sheldon, FT, Walker, RM, Cline, RL, Phillips, SA, Schultz, FJ, Pinson, DB, Kopsick, D, and Pantaleo, J., "Tracking Radioactive Sources in Commerce," *Proceedings Waste Management Symposium, Tucson AZ*, Feb. 27-Mar. 3, 2005.

Sheldon, F.T., Batsell, S.G., Prowell, S.J., and Langston, M.A., "A Methodology to Support Dependable Survivable Cyber-Secure Infrastructures," *IEEE Proceedings HICSS-38, Security and Survivability of Complex Systems Minitrack, Big Island HI*, Jan. 3-6, 2005.

Mili, A., **Sheldon, F.T.**, Mili, F., Shereshevsky, M., and Desharnais, J., "Perspectives on Redundancy: Applications to Software Certification," IEEE Proceedings HICSS-38, Testing and Certification of Trustworthy Systems Minitrack, Big Island, Hawaii, Jan. 3-6, 2005.

Sheldon, FT, and Mili, A., "Characterizing Software Quality Assurance Methods: Impact on the Verification of Learning Systems," Presented at NIPS-2004 Workshop on Verification, Validation, and Testing of Learning Systems, Whistler, BC, Dec. 17-18, 2004.

Mili, A., **Sheldon, FT**, Mili, F. and Desharnais, J., "Recoverability Preservation, A Measure of Last Resort," Proceedings of Principles of Software Engineering, Buenos Aires, Argentina, Nov. 22-27, 2004

Sheldon, F.T., Potok, T.E., Loebl, A., Krings, A. and Oman, P., "Managing Secure Survivable Critical Infrastructures To Avoid Vulnerabilities," *Eighth IEEE Int'l Symp. on High Assurance Systems Engineering, Tampa Florida, pp. 293-96, Mar. 25-6, 2004.*

Sheldon, F.T. and Jerath, Kshamta, "Assessing the Effect of Failure Severity, Coincident Failures and Usage-Profiles on the Reliability of Embedded Control Systems," *ACM Symposium on Applied Computing, Nicosia Cyprus, pp. 826-33, Mar. 14-17 2004.*

Sheldon, F.T., Potok, T.E., Loebl, A., Krings, A. and Oman, P., "Energy Infrastructure Survivability, Inherent Limitations, Obstacles and Mitigation Strategies," *IASTED Int'l Power Conf. -Special Theme Blackout, New York NY, pp. 49-53, Dec. 10-12, 2003.*

Potok, T.E., Phillips, L., Pollock, R., Loebl, A. and **Sheldon, F.T., "**Suitability of Agent-Based Systems for Command and Control in Fault-tolerant, Safety-critical Responsive Decision Networks," *ISCA 16th Int'l Conf. on Parallel and Distributed Computer Systems (PDCS), Reno NV, pp. 283-90, Aug. 13-25, 2003*

Zhou, Z., **Sheldon, F.T.** and Potok, T.E., "Modeling with Stochastic Message Sequence Charts," IIIS Proceedings Int'l. Conf. on Computer, Communication and Control Technology (CCCT), Orlando, July 31 - Aug. 2, 2003

Potok, T., Elmore, M., Reed, J. and **Sheldon, F.T.**, "VIPAR: Advanced Information Agents Discovering Knowledge in an Open and Changing Environment," *Proceedings World Multiconference on Systemics, Cybernetics and Informatics, Session on Agent-Based Computing*, Orlando, pp. 28-33, July 27-30, 2003 –**best paper awarded**.

Elmore, M., Potok, T., and **Sheldon, F.T.**, "Dynamic Data Fusion Using an Ontology-Based Software Agent System," *Proceedings World Multiconference on Systemics, Cybernetics and Informatics Special Session on Agent-Based Computing*, Orlando, pp. 5-10, July 27-30, 2003.

Sheldon, F.T., Elmore, M.T. and Potok, T.E., "An Ontology-Based Software Agent System Case Study," *IEEE Proceedings Int'l Conf. on Information Technology: Coding and Computing,* Las Vegas, pp 500-06, Apr. 28-30, 2003.

Sheldon, F.T., Jerath, K., Pilskalns, O., Kwon, Y-J., Kim, W-H. and Chung, H., "Case Study: B2B E-Commerce System Specification and Implementation Employing Use-Case Diagrams, Digital Signatures and XML," *IEEE Proc Int'l Symposium on Multimedia SE [MSE 2002]*, Newport Beach, CA, pp. 106-113, Dec. 11-13, 2002.

Sheldon, F.T., Kwon, Y-J., Baik, Young-Wook and Jerath, K., "Case Study: Implementing a Web Based Auction System using UML and Components," *Proc Int'l Annual Computer Software and Applications Conference [COMPSAC 2002]*, Oxford England, pp. 211-16, Aug. 26-29, 2002.

Sheldon, F.T., Jerath, K., and Greiner, S.A., "Examining Coincident Failures and Usage-Profiles in Reliability Analysis of an Embedded Vehicle Sub-System," *Proc Ninth Int'l Conference on Analytical and Stochastic Modeling Techniques [ASMT 2002]*, Darmstadt Germany, pp. 558-563, June 3-5, 2002.

Sheldon, F.T. and Kim, H.Y., "Validation of Guidance Control Software Requirements for Reliability and Fault-Tolerance," *IEEE Proc Reliability and Maintainability Symp [RAMS 2002]*, Seattle, pp. 312-318, Jan. 2002.

Sheldon, F.T., Kim, H.Y., and Zhou, Z, "A Case Study: Validation of Guidance Control Software Requirements for Completeness, Consistency and Fault Tolerance," *IEEE Proc Pacific Rim Dependability Conference [PRDC 2001]*, Seoul, pp. 311-318, Dec. 2001.

Sheldon, F.T. and Jerath, K., "Reliability Analysis of an Anti-lock Braking System Using Stochastic Petri Nets," *Fifth Int'l Workshop on Performability Modeling of Computer and Communication Systems [PMCCS 2001]*, Erlangen, pp. 56-60, Sept. 2001.

Sheldon, F.T. and Zhou, Z, "Integrating the CSP formalism into Mobius Framework for Performability Analysis," *Fifth Int'l Workshop on Performability Modeling of Computer and Communication Systems [PMCCS 2001]*, Erlangen, pp. 86-89, Sept. 2001.

Sheldon, F.T. and Wang, S., "A Translation Tool (PCX) from PROMELA/Spin to C-Based Stochastic Petri Net Language (CSPL)," *Fifth Int'l Workshop on Performability Modeling of Computer and Communication Systems [PMCCS 2001]*, Erlangen, pp. 116-120, Sept. 2001.

Sheldon, F.T. Greiner, S.A., and Benzinger, M., "Specification, Safety and Reliability Analysis Using Stochastic Petri Net Models," *ACM Proc Tenth Int'l Wkshp on Software Specification and Design*, pp. 123-132 Nov. 5-7 2000.

Owens, D.A., and **Sheldon, F.T.,** "A Tool-based Approach to Distributed Database Design," *ACM Symposium on Applied Computing [SAC'99],* 10 refs., pp. 227-231, February 1999.

Sheldon, F.T. "Analysis of Real-Time Concurrent Systems Models Based on CSP Using Stochastic Petri Nets," *SCS Proc 12th European Simulation Multiconference,* pp. 776-783, 22 Refs., Manchester, UK, June 16-19, 1998.

Sheldon, F.T., Alspector, J. and Haefner, J. "Technical Education over Drive-able Distances using a Portable Classroom and Variable Bandwidth Communication Networks," *IEEE Proc Int'l Symp On Internet Technology,* Apr. 29 - May 1, 1998.

Sheldon, F.T., "Specification and Analysis of Stochastic Properties for Concurrent Systems Expressed Using CSP," Ph.D. Dissertation, *Computer Science and Engineering Dept., Univ. of TX at Arlington,* 260 Refs., May 1996 (Sigma Xi Scientific Research Society Outstanding Ph.D. Dissertation Award).

Kavi, K.M., and **Sheldon, F.T.,** "Specification and Analysis of Real-Time Systems Using CSP and Petri Nets," *IIT Proceedings 1st Conf. on Fault-Tolerant Systems (FTS'95),* Madras, India, Dec. 20-22, 1995.

Sheldon, F.T., and Kavi, K.M., "Linking Software Failure Behavior to Specification Characteristics II," *IEEE Proceedings Fourth International Workshop on Evaluation Techniques for Dependable Systems,* San Antonio, TX, 27 Refs., Oct. 1995.

Sheldon, F.T., Kavi, K.M., and Kamangar, F.A., "Reliability Analysis of CSP Specifications: A New Method Using Petri Nets," *AIAA Proc Computing in Aerospace 10,* San Antonio, TX, pp. 317-326, 16 Refs., Mar. 1995.

Kavi, K.M., **Sheldon, F.T.,** Shirazi, B. and Hurson, Ali R., "Reliability Analysis of CSP Specifications Using Petri Nets and Markov Processes," *IEEE Proc Hawaii Int'l Conf. on Systems and Sciences,* 10 Refs., Jan. 1995.

Kavi, K.M., and **Sheldon, F.T.,** "Specification of Stochastic Properties with CSP," IEEE *Proceedings Int'l Conference on Parallel and Distributed Systems,* Taiwan, ROC, pp. 288 - 293, 12 Refs., December 1994.

Sheldon, F.T., and Kavi, K.M., "Position Statement: Linking Software Failure Behavior to Specification Characteristics I," *IEEE Proceedings Third International Workshop on Integrating Error Models with Fault Injection,* Annapolis, MD, pp. 35-39, 19 Refs., April 1994.

Sheldon, F.T., Mei, Hsing, and Yang, S.M., "Reliability Prediction of Distributed Embedded Fault-Tolerant Systems," *IEEE Proc 4th Int'l Symp On Software Reliability Engineering,* pp. 92-102, 27 Refs., Nov. 1993.

Yang, S.M., Yoo, S.M., Kim, Y.S., Song, Y.J., and **Sheldon, F.T.,** "UTARK: An Object-Based Real-Time Kernel for Distributed Embedded Systems," *IEEE Proc CompEuro93* (Paris), pp. 392-399, May 1993.

Sheldon, F.T., Yang, S.M., and Bornejko, T.L., "Simulation-Based Analysis for Real-Time Systems Development," *IEEE Proc Automatic Testing Conference (AutoTestCon92),* pp. 361-366, 15 Refs., Sept. 1992.

Sheldon, F.T., Kavi, and Reese, R. "Software Reliability Modeling: A Case Study," *Proceedings General Dynamics Software Technology Conference,* San Diego, CA, pp. 29-1 to 29-14, 32 Refs., April 12, 1991.

Sheldon, F.T., and Kavi, K.M., "A Model for Estimating Software Reliability Based on Residual Defects," *IEEE Proc MidCon'90,* Dallas, TX, pp. 22-25, 11 Refs., September 1990.

Sheldon, F.T., and Kavi, K.M., "A Comparative Evaluation of Two New Advanced Microprocessor Architectures: *The N10 (i860) and the P10 (i960) further promote the RISC trend in 1989,*" *IEEE Proc MetroCon'90,* Arlington, TX, 13 pages, 25 Refs., February 1990.

Sheldon, F.T., and Kavi, K.M., "A New Software Reliability Model for Estimating Failure Rate Due to Residual Software Defects," *Proc ACM/IEEE Workshop on Applied Computing,* Stillwater, OK, pp. 7-13, 21 Refs., March 1989.

INVITED ARTICLES (6)

Sheldon, F.T. and Kim, H.Y, "Software Requirements Specification and Analysis Using Zed and Statecharts," *IEEE 3rd Wkshp on Formal Descriptions and Software Reliability,* San Jose, CA, Oct. 7, 2000.

Sheldon, F.T. and Dugan, D., "Stochastic Petri Nets and Discrete Event Simulation: A Comparative Study of Two Formal Description Methods," *IEEE 3rd Wkshp on Formal Descriptions and Software Reliability,* San Jose, CA, Oct. 7, 2000.

Sheldon, F.T., "Automatic Stochastic Analysis of CSP Specifications Using a CSP-to-Petri Net Translation Tool: CSPN," *IEEE Proc MetroCon* (2nd place Graduate Paper Contest), Arlington. TX, Feb. 1996.

Sheldon, F.T., Mei, Hsing, and Yang, S.M., "Reliability Prediction of Distributed Embedded Fault-Tolerant Systems," Invited paper and presentation in cooperation with ASQC and Centre for Software Reliability (City University, London), *Proc Fourth Int'l Conf. on Applications of Software Measurement,* 10 pages, 27 Refs., 0.5 hrs., November 1993 (**Awarded runners-up best paper**).

Sheldon, F.T., Yang, S.M., and Bornejko, T.L., "Position Statement: Simulation-Based Analysis for Real-Time Systems Development," *Proceedings of the NATO Advanced Study Institute on Real-Time Computing,* Springer-Verlag (Berlin), St. Maarten Netherlands Antilles, 6 Refs., October 4-19 1992.

Sheldon, F.T., "Software Development and Reliability Modeling: Software Life Cycle Model," *Masters Thesis, Computer Science and Engineering Dept., Univ. of TX at Arlington*, 89 pgs, 85 Refs., Aug. 1988.

PROPOSALS AND WHITE PAPERS (39)

Threat Assessment and Risk Analysis – Quantitative System, White Paper in response to BAA # 07-09 (TTA3) 27 June 2007, Period of performance 18 months, *Beth Bidwell (LMCO), F.T. Sheldon (ORNL) Ali Mili (NJIT) and Brian Witten (Symantec)*, ($1,500,000 Total) judged selectable.

A Scalable Visual Analytics Toolset for Cyber Security, White Paper in response to BAA # 07-09 (TTA4) 27 June 2007, Period of performance 36 months, *Mohamed Eltoweissy PI, Shawn A. Bohner, Denis Gracin, Chris North, Jung-Min Park (Virginia Tech.) and F.T. Sheldon (ORNL)*, ($1,656,251 Total).

Composing Attributes for Scalable Security (CASS), White Paper in response to BAA # 07-09 (TTA2) 27 June 2007, Period of performance 36 months, *F.T. Sheldon PI (ORNL) and Ali Mili (NJIT)*, ($2,000,000 Total).

Maximizing Performance, Availability, Security and Survivability (MaxPASS) White Paper in response to BAA # 07-09 (TTA7) 27 June 2007, Period of performance 36 months, *F.T. Sheldon PI (ORNL), Ali Mili (NJIT) and Axel Krings (Univ. of Idaho)*, ($2,000,000 Total).

Multi-scope Anomaly Detection System (MADS), White Paper in response to BAA # 07-09 (TTA2) 27 June 2007, Period of performance 36 months, *F.T. Sheldon PI (ORNL), Chin-Tser Huang* and Yong-June Shin *(Univ. of S. Carolina)* ($1,316,609 Total).

Intrinsically Assurable Resource Aware MANET (IARA-MANET), Full Proposal in response to BAA # 07-32 (DARPA/STO) 26 June 2007, Period of performance 18 months*, F.T. Sheldon PI (ORNL)*, *Chin-Tser Huang (Univ. of South Carolina), Anish Arora (Ohio State Univ.), Sandeep Kulkarni (Michigan State Univ.), Axel Krings (Univ. of Idaho) and Itamar Elhanany (Univ. of Tennessee),* ($2,450,000 Total).

Crisis Early Warning using Gaming and Strategy Evaluation, Full Proposal in response to BAA # 07-10 (DARPA/IPTO) 20 Feb. 2007, Period of performance 60 months, *F.T. Sheldon PI (ORNL)*, *R.R. Brooks (Clemson), Christopher Griffin (ARL, Penn State U.),* Steve Racunas (Stanford, ISLE) ($5,000,000 Total).

CPE Commander's Predictive Environment – Understanding the Battlespace, Full Proposal in response to BAA # 06-07-IFKA 15 Dec. 2006, Period of performance 12 months, *Christopher Griffin (ARL, Penn State U.), R.R. Brooks (Clemson) F.T. Sheldon (ORNL)*, ($400K Total).

PAINT Proactive Intelligence, Full proposal and briefing in response to AFRL BAA-07-01-IFKA (DEPV: a framework for dynamic intelligence gaming and strategy evaluation) 03 Dec. 2006, Period of performance: 31 Mar 2007 – 30 Sept. 2011, PI F.T. Sheldon (ORNL), Subcontractors: *Christopher Griffin (ARL, Penn State U.), R.R. Brooks (Clemson),* Estimated Cost: $500,000 per annum ($2,250,00 Total).

TANGRAM Intelligence Extraction, White paper submitted in response to AFRL BAA-06-04-IFKA (GAP FILLING TECHNOLOGIES) 30 SEPT 2006, Period of Performance: 1 June 2007 - 31 May 2010 (12 Months Base + 24 Months Option) *Christopher Griffin (ARL, Penn State U.), R.R. Brooks (Clemson) and F.T. Sheldon*, Estimated Cost: $550K/annum ($1.65M Total)

Relationship Inference and Behavior Analysis through a Logic of Disputants, White paper submitted in response to BAA 06-016-Trust 2 Automated Information Integration, *Christopher Griffin (ARL, Penn State U.), R.R. Brooks (Clemson) and F.T. Sheldon*, (ROM estimated cost $1.35M) July 2006

Relationship Inference and Behavior Analysis through a Logic of Disputants, White paper submitted in response to BAA 06-010-Trust 2 Context Aided Inferencing, Christopher Griffin (ARL, Penn State U.), R.R. Brooks (Clemson) and F.T. Sheldon, (ROM estimated cost $1.9M) Apr. 2006. Selected by ONR for presentation.

War Game Optimal Offensive Adversaries, White paper submitted in response to ONR solicitation 06-Q-5575 (BAA 06-Q-5570-TSWG), *Christopher Griffin (ARL, Penn State U.), R.R. Brooks (Clemson) and F.T. Sheldon*, (ROM estimated cost $850K) June 2006.

A Tool for Online Security Management, White paper submitted to DHS TSA in response to TSRDOS-BAA RED028 *A. Mili (NJIT) and F.T. Sheldon,* August 2005.

Strategic COTS Program Situation Inference (SCPSI), Submitted in response to the NSF Cyber Trust (06-517) program, *R.R. Brooks (Clemson) and F.T. Sheldon*, Nov. 2005.

Strategic COTS Program Situation Inference, submitted in response to DARPA IPTO BAA 05-51 Application Communities, *R.R. Brooks, F.T. Sheldon, B. Schlicher (EigenSoft Inc.)* (Requested $1.5M) Oct. 2005.

Novel Security Mechanisms for Mobile Code and Mobile Ad Hoc Network Environments, Proposal to the FY 2006 Director's R&D Fund, *M. Neergaard, F. Sheldon, R. Brooks (Clemson) and A. Mili (NJIT),* (Requested $435K), Sept. 2005.

Verifiable Architectures for Space Assembly Systems, *Proposal to HR&T BAA TB-0402 (NASA HQ) (PI: J. Schumann[1], A. Annaswamy[2] S. Dubowsky[2] R. Mah[1] and F. T. Sheldon[3], [1. Automated Software Engineering Group, NASA ARC, 2. MIT/ Mech. Eng. 3. CSED, ORNL])* $20M/4yrs. Requested (ORNL would get 650K), Sept. 2004.

Distributed SCADA Architecture for Advanced Power Grid Control, *Proposal to ORNL LDRD (Lab Directed R&D) (PI: S. Batsell[1], Co-PIs:* M. Shankar[1], F. DeNap[1], F. T. Sheldon[1], and Massoud Amin[2] *[1.Computational Sci. and Engrng Div., 2. Elec. and Computer Engrng, Univ. of Minnesota])* $545,000 requested, June 2004.

Collaborative Research: Practical Rigorous Software Design, *Proposal to NSF/CISE (04-552),* (PI: S. Prowell, U. Tenn. with Co-PI: **F.T. Sheldon** ORNL, M.A. Langston, and W.T. Swain U. Tenn., A. Esterline NCAT, J. Schumann NASA/ARC, and A. Hevner USF) $1,921,081 requested, May 19, 2004.

Critical Cyber-infrastructure Software for Security, Scalability and Survivability *Proposal to ONR (*in response to FY 2004 Special Competition for CIP/SW of the Multidisciplinary Research Program of the University Research Initiative BAA*)* (PI: M. Langston with Co-PI's **F.T. Sheldon** ORNL, D. Kafura Virginia Tech., and A. Esterline NCAT) $1,000,000 requested, Mar. 3, 2004.

Towards Refinement Based Verification of Online Adaptive Systems *Proposal to NSF/CISE (Highly Dependable Computing and Communications Systems Research program with NASA, nsf03-557)* (PI: **F.T. Sheldon**, with Co-PI's: M. Hinchey, NASA GSFC; A. Mili, NJIT) $640,000 requested, Feb. 27, 2004.

Autonomic Survivable Cyber-Secure Infrastructures *Proposal to NSF (Information Technology Research (ITR) program, nsf04012) (*Proposal #LOI2713*)*, (PI: M. Langston U. Tenn. with Co-PI's: **F.T. Sheldon,** ORNL; A. Krings B. Johnson and P. Oman, U. Idaho; A. Domijan, U. Florida, and D. Kafura Virginia Tech.) $4,000,000 requested, Feb. 24, 2004.

A Risk-Based Decision Support Framework for Foreign Animal and Zoonotic Disease Defense *Proposal to DHS*, (PI: S.R. Thompson UTK, with Co-PI's: **F.T. Sheldon** ORNL, and a group from Virginia Tech.) $5,400,000 requested, Feb. 9, 2004.

A Risk-Based Decision Support Framework for Foreign Animal and Zoonotic Disease Defense *Proposal to DHS*, (PI: S.R. Thompson UTK, with Co-PI's: **F.T. Sheldon** ORNL, and a group from Univ. of Maryland) $3,550,000 requested, Feb. 9, 2004.

A Risk-Based Decision Support Framework for Foreign Animal and Zoonotic Disease Defense *Proposal to DHS*, (PI: S.R. Thompson UTK, with Co-PI's: **F.T. Sheldon** ORNL, and a group from Iowa State Univ.) $2,415,000 requested, Feb. 9, 2004.

Self-Regenerative Cyber-Secure Infrastructure (SCI) Survivability Map, *Proposal to DARPA BAA03-44 (*DOE Proposal # 1868-HH56-X1*)*, (PI: **F.T. Sheldon**, ORNL, with Co-PI's: M. Langston, U. TN; A. Krings and P. Oman, U. Idaho) $1,317,000 requested, Nov. 25, 2003.

Shipboard Electronic Infrastructure Survivability Map *Proposal to ONR (National Naval Program for Naval Engineering – Modeling and Optimization BAA03-013a) (*DOE Proposal# 1866-S694-A1*)*, (PI: **F.T. Sheldon**, with A. Krings Prof. UI and P. Oman, Prof. UI) $1,598,000 requested, August 28, 2003.

Energy Infrastructure Survivability (EIS) Map, *Proposal to DOE Office of Energy Assurance (FWP EAES016, Program Mgr*. Donald W. Geiling, NETL*)*, (PI: **F.T. Sheldon**, with A. Krings, Prof. UI and P. Oman, Prof. UI) $498,000 requested, July 23, 2003.

Assurance of Software Requirements using IEC 61508 Safety Integrity Levels *Proposal to NASA IV&V Center* Software Assurance Research NRA SARP 0301 (see http://www.ivv.nasa.gov/business/research/SARP), (PI: **F.T. Sheldon**, with M. Hinchey, GSFC Director, and A. Mili Prof. NJIT) $480,000 requested, June 2003.

IAEA Consultancy Service for Software Quality Assurance Engineer *Proposal to IAEA,* DOE Proposal Number FERD-03-2261, for Software/Licenses, (PI: **F.T. Sheldon**, with: A. Stewart, T. Potok, and J. Treadwell) $513,000 requested, Feb. 2003.

Pre-Proposals / NOI at ORNL

PAINT Proactive Intelligence, White Paper submitted and accepted in response to AFRL BAA-07-01-IFKA (DEPV: a framework for dynamic intelligence gaming and strategy evaluation) 03 Dec. 2006, Period of performance: 31 Mar 2007 – 30 Sept. 2011, PI F.T. Sheldon (ORNL), Subcontractors: *Christopher Griffin (ARL, Penn State U.), R.R. Brooks (Clemson),* Estimated Cost: $500,000 per annum ($2,250,00 Total).

Affordable V & V of Autonomous, Adaptive Systems (Boeing Lead, and co-investigator organizations: NASA Ames [Schumann, J., Gupta, P.], NASA JPL [Barhen, J.], New Jersey Institute of Technology, and UT-Battelle [Sheldon, F.]) $5-15M potential funding. NOI Marked Excellent (2nd highest marking) by NASA HQ but denied.

Automation of V&V, Safety Analysis, and Testing (Boeing Lead, and co-investigator organizations: NASA Ames, NASA JPL [Barhen, J], New Jersey Institute of Technology [Mili, A.], and UT-Battelle [Sheldon, F.]) $10-40M potential funding. NOI Marked Excellent (2nd highest marking) by NASA HQ but denied.

Affordable Fault Tolerance using Recovery Preservation (UT-Battelle Lead [Sheldon, F.], NASA Ames [Schumann, J., Gupta, P.], NASA JPL [Barhen, J], New Jersey Institute of Technology [Mili, A.], U. of TN [Parker, L., and Langston, M.]) $5-15M potential funding. NOI Marked Excellent (2nd highest marking) by NASA HQ but denied.

Flexible Affordable Multi-Agent System Synthesis (UT-Battelle Lead [Sheldon, F.], NASA JPL [Barhen, J], NASA Ames [Schumann, J., Gupta, P.], New Jersey Institute of Technology [Mili, A.], U. of TN [Parker, L.], U. of TX at Arlington [Kung, D] and U. of N. TX [Kavi, K]) $5-15M potential funding. NOI Marked Excellent (2nd highest marking) by NASA HQ but denied.

Intelligent Agent-Based Middleware and Synthetic Meaning for Knowledge Management of Sensor Network Data and Collateral Information, Proposal to DHS Threat and Vulnerability Testing and Assessment Sub-area (PI F.T. Sheldon, including J. Strand, and P. Porreca *Exemplar LLC) $6.1M requested July 2003*

Stochastic Modeling and Sensitivity for Critical Computer Networks Infrastructure, Proposal to TSWG-DAAD 03-T-0024 (R1087) (PI: F.T. Sheldon) $340,000 requested June 2003

Use Model Checkers to Analyze Semantic Graph Representations, Proposal to TSWG-DAAD 03-T-0024 (R1084) (PI: F.T. Sheldon) $900,000 requested June 2003

Statistically Significant Network Vulnerability Patterns, Proposal to TSWG-DAAD 03-T-0024 (R1086) (PI: F.T. Sheldon) $950,000 requested June 2003

Academic Funding (8 awards)

SEDS Laboratory Infrastructure Equipment Request, *Proposal to Intel Corporation*, (PI: **F.T. Sheldon,** SEDS Lab Director $15,850 requested, $10,850 awarded Mar'01) Nov. 2000.

SEDS Laboratory Infrastructure Software Request, *Proposal to Microsoft Research*, for Software/Licenses, (PI: **F.T. Sheldon**, SEDS Lab Director $15,976 requested, $15,976 awarded Apr'01) Nov. 2000.

Software Engineering for Dependable Systems (SEDS) Laboratory, *Startup funding and research assistantships* (PI: **F.T. Sheldon,** SEDS Lab Director, $250,000 awarded beginning Sept. '99 through June '02) Sept. 1999.

Brake-Safe, *Proposal to Daimler-Benz AG*, Model-based Specification and Analysis (safety and reliability) Using CSP and Stochastic Petri Nets, (PI: **F.T. Sheldon**: $10,850 requested, $10,850 awarded) Dec. 1998.

Technical Distance Learning Courseware, *Proposal to the Changing the Learning Paradigm through Technology Initiative (Source: Univ. of Colorado's Office of the President)*, (PIs: J. Alspector, **F.T. Sheldon** and J. Haefner: $15,500 requested, $11,100 awarded) Mar. 1998.

A Novel Approach to Model Based Validation of Fault Tolerant Systems: *DARPA SBIR Proposal*, (PI: F.T. Sheldon: $99,000 awarded) Sept. 1996.

Formal Specification of Stochastic Properties for an Integrated Air/Ground System to Support LVLASO: Low Visibility Landing and Surface Operations element of the Terminal Area Productivity program funded by the FAA: *Postdoc Proposal to the National Research Council Associateship Program at NASA Langley Research Center*, ($42,000/yr for 3 yrs awarded) Feb. 1996.

Simulation-Based Analysis for Real-Time Systems Development," *Fellowship Proposal to the NASA Graduate Student Researchers Program, Langley Research Center*, $22,000/yr for 3 yrs awarded on January 1993.

Industry Funding (1 award)

GIMADS (Task 29) Software Contract Change Proposal Technical Lead: researched, developed, coordinated, authored and promoted three CCP revisions (PI: **F.T. Sheldon** (Pgm. Mgrs Dick Clothier and Del Dos), $2.1M Awarded, *General Dynamics FWD* 1992).

TECHNICAL REPORTS (9)

R. K. Abercrombie, D. L. Beshears, L. M. Hively, M. B. Scudiere, F. T. Sheldon, J. L. Schmidhammer, J. Vanvactor, "Prototype Weigh-In-Motion Performance," ORNL/TM-2007/039 (ORNL/TM-2005/164: revision update from June 2005), October 2006

L. M. Hively, R. K. Abercrombie, F.T. Sheldon and M. B. Scudiere, "Error Reduction in Portable, Low-Speed Weigh-In-Motion (WIM)," ORNL/TM-2008/004, November 2008.

Brake-Safe Analysis Final Report: Safety and Reliability Analysis Using Stochastic Petri Nets (Author: **F.T. Sheldon**, *DaimlerChrysler FT3/AS Final Report which included the CSPL Specified Models Software Toolkit*, June 2000).

Composing, Analyzing and Validating Software Models, (Author: **F.T. Sheldon**, *NASA ARC / Stanford – ASEE Final Report which included the CSPN Software Toolkit*, August 1998).

Specification Based Stochastic Analysis and Diagnostics of Concurrent Embedded Systems, (Author: **F.T. Sheldon**, *ASEE Final Report*, August 1997).

A Novel Approach to Model Based Validation of Fault Tolerant Systems: Addresses the limitations and issues for modeling methods and tools developed specifically for stochastic analysis, performability evaluation, and solution methods suited to systems with low latency requirements and rare events (e.g., single independent and multiple coincident failures). Goal: develop a methodology and toolset for *specification and stochastic and performability analysis* of vital DoD systems (Author: **F.T. Sheldon**, *DARPA SBIR Final Report*: May 1997).

Engineering Modernization: *Unix-Based Software Engineering Environment Feasibility Study* of OSF/1 Open Systems Technology for avionics software development including requirements/risk analysis, characterize

critical capabilities, metrics, costs and performance criteria (Author: **F.T. Sheldon**, *General Dynamics FWD* 1991).

Domain Specific Software Architectures White-paper *DARPA Abstract Proposal* (Principal Author: **F.T. Sheldon**, *General Dynamics FWD* 1991).

Avionics Software Domain Analysis: *Engineering Modernization White Paper:* describing this emerging technology as applied to Avionics software synthesis and reuse (Author: **F.T. Sheldon**, *General Dynamics FWD* 1990).

COLLOQUIUM

Verification and Validation of Mission / Safety Critical Software, 2002 Colloquiums: Free Univ. Bozen, Italy July 15 | Swansea Univ., Wales Jul 5 | Oak Ridge National Lab, Knoxville June 27 | Univ. Nebraska Univ., Omaha June 26 | Virginia Tech., Blacksburg June 24 | Univ. of Southampton June 19 | Univ. de Liege, Institut Montefiore, Belgium May 27 | Univ. of Houston, Clear Lake, TX May 8 | Wayne State Univ., Detroit May 6 | Rochester Inst. Of Technology, New York, May 3 | London City Univ., Apr. 16 | Univ. of North Texas, Denton Feb. 7 | Univ. of Texas at Dallas, February 5 | Center for Communications Research, San Diego, CA Feb. 4 | Naval Post Graduate School, Monterey, CA, Jan. 29.

Verification and Validation of Mission / Safety Critical Software, Invited Talk Institut für Informatik – FB Mathematik und Informatik, Freie Universität Berlin, Oct. 1, 2001.

Software Engineering: Where we have been and where we are going, Invited Talk at Spokane Intercollegiate Research and Technology Institute (SIRTI) for the Washington Software Assoc., Nov. 14, 2000.

Brake-Safe Report, DaimlerChrysler, Stuttgart Germany, Safety and Reliability Applied Research Grp, July 1, 2000.

Composing, Analyzing / Validating Software Models to Assess the Performability of Competing Design Candidates Department of Computer Science, Purdue University, W. Lafayette, IN, April 12, 1999.

Using Models of Software to Assess the Performability and Reliability of Competing Design Candidates, Summer Faculty Research Review NASA-ASEE Ames Research Center, Moffitt Field, CA, August 10, 1998.

Work-In-Progress Report: Toolkit for Composing and Analyzing Models of Software and Systems., Three Invited Talks at NASA Ames Research Center –Automated Software Engineering group, June-Aug. 1998 (included students Chuck Rodacker and Shane Holloway).

Work-In-Progress Report: Prototype Open Toolkit for Composing and Analyzing Models of Software and Systems., Invited Talk at Fu Jen Catholic University, Taipei, Taiwan, April 1998.

Formal Specification Based Stochastic Analysis and Design of Safety-Critical Systems, Sponsored Talk at Mercedes Benz in Stuttgart, Germany, Jan. 1998.

Formal Specification Based Stochastic Analysis and Design of Safety-Critical Systems, Sponsored Talk at Technical Univ. of Berlin, Dept. of Computer Science, Germany, Dec., 1997.

Specification Based Stochastic Analysis and Diagnostics of Concurrent Embedded Systems, Invited Talk at NASA Ames Research Center, Moffitt Field, CA, 0.25 hrs., August 8, 1997.

Specification and Analysis of Stochastic Properties for Concurrent Systems Expressed Using CSP, Invited Talk at NASA Ames Research Center, Moffitt Field, CA, 1.0 hrs., July 2, 1997.

Specification and Analysis of Stochastic Properties for Concurrent Systems Expressed Using CSP, Sponsored Talk at University of Erlangen-Nurnberg, Modeling and Process Control Group, Department of Computer Science IV, Germany, 1.25 hrs., May 20, 1997.

Distributed Real-Time Systems Development: An Assessment, Sponsored Talk at Techniche Universitat (TU) Clausthal, Institute fur Informatik, Germany, 0.75 hrs., May 20, 1993.

Software Reliability Modeling: A Case Study, Proceedings, Integrated Diagnostics Design Technology Tools Conference, Ellicott City, Maryland, NSIA Sponsored, 0.75 hrs., pp. 146-159, May 3, 1991.

SOFTWARE RELIABILITY: Theory, Practice, and Controversy," *Proceedings Joint Logistics Management Committee General Membership and Integrated Diagnostics Meeting*, San Diego, CA, NSIA Sponsored., 0.75 hrs., 23 pages, Jan. 15, 1991.

Panel Moderator: "Software Reliability: Theory, Practice and Controversy," Panelists: Everett, W.W., AT&T Bell Labs; Yu, Jim, AT&T Bell Labs; Tausworthe, R., Jet Propulsion Lab; Brettschneider, R., Motorola; *ACM/IEEE Symposium on Applied Computing*, Fayetteville, AR, April, 1990.

Software Reliability and Quality Metrics, Invited Talk for *Dallas/Fort Worth Software Quality Association*, 1.5 hrs., Sheldon, F.T. and Whitfill, W.A., General Dynamics, *FWD*, March, 1990.

Estimating Failure Rate Due to Residual Software Defects and Software Quality Metrics," Talk for *Dallas IEEE Reliability Society*, 1.5 hrs., Sheldon, F.T. and Whitfill, W.A., General Dynamics, Oct. 1989.

REFEREED SOFTWARE

Integrating Message Sequence Charts (MSC) formalism into the Mobius Framework, developed by Zhihe "Bill" Zhou (for MS Thesis), and Frederick Sheldon at the Washington State Univ. (definition and design planned completion in Spr. 2002).

The CSPL Graphic Editor (CGE): Implementation of Graph Layout Algorithms and CSPL Parser, developed by Wen Wei (for MS Thesis), David Dugan (for MS Thesis) and Frederick Sheldon as an extension of previous work by Norbert Gravelle at the Univ. of Colorado (planned release Ver. 2.0 in Spring 2002).

A Translation Tool (PCX) from PROMELA/Spin to C-Based Stochastic Petri Net Language (CSPL): developed by Shuren Wang (for MS Thesis) and Frederick Sheldon as an extension of previous work by Chuck Rodacker at the Univ. of Colorado (prototype Ver. 1.0 released June 12, 2001).

A Translation Tool (CSPN) from <u>C</u>S<u>P</u> to <u>S</u>tochastic <u>P</u>etri <u>N</u>ets (CSPL): developed by F.T. Sheldon (for PhD research) and Krishna Kavi (from Scratch) at the Univ. of Texas at Arlington (prototype Ver. 1.0 released Jan. 1996, Ver. 2.0 released to NASA ARC ASE group Aug. 1998, and Ver. 3.0 released Dec. 1999).

TITLES OF COURSES TAUGHT

Software Specification and Analysis (CptS 580.1/483.1 – Spr00, Spr01)
Software Engineering Principles (CptS 422 – Fall99, Fall00)
Software Engineering (CS 330 – Spr98, Fall98, Spr99)
Software Requirements Analysis and Specification (CS 531 – Spr99)
Formal Methods of Software Systems Engineering (CS 533 – Spr97, Spr99)
Computer Architecture (CS 520/420 – Spr97, Fall97)
Software Design (CS 532 – Fall96, Fall97, Fall98)
Discrete Structures in Computer Science (CSE 2315/3315 was CSE 1442 – Fall93, Spr94, Fall94, Spr95)
Formal Methods: Software Systems (CSE 5312 substitute lectures – Fall95, Spr96)
Fundamentals of Software Engineering (CSE 3310 – Spr93)

DESCRIPTION OF COURSES TAUGHT

Software Specification and Analysis (CptsS 580.1/483.1 Taught on Wash. Higher Ed. Television – Spr00)

Introduction to formal methods used in software engineering: Formal mechanisms for specifying, validating and verifying the correctness, reliability and efficiency of software systems. The course will first introduce the broad area of formal methods including algebraic and model based specification techniques. The class will then focus on developing a working knowledge for using Z. A project will require the use of the Z language in developing a formal specification of a particular real world requirements specification. Outside readings are assigned that report on a range of independent experiments devoted to broadening the link between theory and practice (i.e., in the application of theories on an industrial scale) including case studies. Prerequisites include knowledge of modern programming languages, data structures, algorithms and discrete mathematics. There are two exams, a term paper and term project. Distribution of all required course materials will be via the web. Texts: *Using Z: Specification, Refinement, and Proof*, by Woodcock, J., and Davies, J. PH, 1996, and *Specification Case Studies (2nd Ed)*, by Hayes, I., PH, 1993.

Software Engineering Principles (CptsS 422 – Fall99)

See the objectives for "Software Engineering" as specified below.

Software Engineering (CS 330 – Spr98, Fall98, Spr99)

Course Objectives include understanding and knowing: (1) appropriate terminology and the process of developing a large software system. (2) factors that govern the selection of a process model and that affect process maturity, (3) concepts underlying the goals of all major software development and management activity, (4) how to use at least one technique applicable to every major software phase, and finally (5) the utilization of a various distance learning techniques to facilitate the above objectives. A Term project involves development teams of 4 - 7 participants including electronic (and hard copy) submission of software life-cycle artifacts (Software Requirements Specification, Preliminary and Critical Design Reviews, Design Notebook, Test Report, Users Manual and Product Demonstration). There are three exams, several quizzes and article reading homeworks that supplement lecture coverage and distribution of all required course materials will be via the web. Teams submit weekly progress reports via Email. Texts: Sommerville, I., Software Engineering, 5th ed., 1996, and Brooks, F. P. Jr., The Mythical Man-Month: Essays on Software Engineering, Ann. Ed., 1995.

Software Requirements Analysis and Specification (CS 531 – Spr99)

Students participate in a project involving the analysis and specification of major software. Coverage includes methods, techniques and tools that support various languages, notations and formalizations for composing and evaluating specification properties (unambiguous, completeness, consistency, etc.) Students are evaluated on their project work (initiative, innovativeness, etc.), and oral presentations (scored on individual and team basis using self and objective assessment methods), homeworks and exams. Prerequisite: Working knowledge of

modern programming languages, data structures, algorithms and discrete mathematics. Texts: Requirements Engineering: Processes and Techniques by Gerald Kotonya / Ian Sommerville, (John Wiley) Sept. 1998, and Requirements Engineering: A Good Practice Guide by Sommerville, Ian and Sawyer, Pete (John Wiley) 1997.

Software Systems Engineering Project Lab (CS 539 designed, never taught due to low enrollment)

Students participate in a project involving the development and production of a software system intended for external distribution and use. Duties include requirements and specification analysis and design, implementation, testing, quality assurance, configuration management and documentation. Projects come from the university and from outside sources. Students are evaluated on their project work (initiative, innovativeness, etc.), and oral presentations (scored on individual and team basis using self and objective assessment methods). Capstone course for the Masters of Software Engineering.

Formal Methods of Software Systems Engineering (CS 533 – Spr99)

Elements of discrete mathematics, formal mechanisms for specifying and verifying the correctness, reliability and efficiency of software systems, finite state machines, regular expression, assertions, algebraic and model based specification techniques including case studies (prerequisites include knowledge of modern programming languages, data structures, algorithms and discrete structures) Texts: Using Z: Specification, Refinement and Proof by Woodcock, J. and Davies, J. (Prentice Hall, Int'l 1996), Specification Case Studies by Ian Hayes 2nd ed. (Prentice Hall, Int'l 1993 - Opt'l), Application of Formal Methods by Hinchey, M.G., and Bowen, J.P. (Prentice Hall, Int'l 1995 - Opt'l) Formal Methods for Real-Time Computing Edited by C. Heitmeyer and D. Mandrioli (John Wiley, 1996 - Opt'l).

Formal Methods of Software Systems Engineering (CS 533 – Spr97)

Elements of discrete mathematics, formal mechanisms for specifying and verifying the correctness, reliability and efficiency of software systems, finite state machines, regular expression, algebraic and operational specification techniques, Petri nets and Markov modeling (prerequisites include knowledge of modern programming languages, data structures, algorithms and discrete structures) Text: Linz, P., An introduction to Formal Languages and Automata, Ross, S.M., Introduction to Probability Models, Marsan, A., et. al., Modeling with Generalized Stochastic Petri Nets.

Computer Architecture (CS 420/520 – Spr97, Fall97)

Specification and logical design of digital computer systems. Examines the functional basis of structures including control, memory hierarchy, *real* instruction set architectures, processor design (pipelining, microprogramming, arithmetic), I/O and peripherals, communications and networking. Text: Heuring, V.P., and Jordan, H.F., Computer Systems Design and Architecture.

Software Design (CS 532 – Fall96, Fall97, Fall98)

Covers principles underlying a variety of methodologies and tools for design of sequential, parallel and distributed software systems, design language, viewpoints, graphical representations, data abstraction, data dictionaries, data flow analysis and structured design, and object-oriented design. Text: Witt, B.I., et. al., Software Architecture and Design; Budgen, D., Software Design; Rumbaugh, J., et. al., Object-Oriented Modeling and Design.

Fundamentals of Software Engineering (CSE 3310 – Spr93)

Software engineering principles, processes and techniques; software development approaches focusing on functional analysis and functional design methods; configuration management, implementation strategies, and testing; team project involving reverse engineering and forward engineering of a discrete event simulation environment. Text: Chris Gane and Trish Sarsen, Structured Systems Analysis: Tools and Techniques; Alan M. Davis, Software Requirements: Objects, Functions and States; selected videos and periodical articles.

Discrete Structures in Computer Science (CSE 2315/3315 [originally 1442] Fall93, Spr94, Fall94, Spr95)

Propositional and predicate logic, mathematical proof techniques, sets, combinatorics, functions and relations, Boolean algebra, graphs, graph algorithms, finite state machines, regular expressions, automata and formal languages, computability, complexity. A weekly three hour compulsory programming laboratory meets for implementation of a requiring assignment associated with the lecture topics. Text: Judith L. Gersting, Mathematical Structures for Computer Science.

Formal Methods: Software Systems (CSE 5312 substitute lectures 1995-6)

Abstractions used to build correct, reliable, and efficient systems. Formal techniques for specifying abstractions and for defining hierarchies of computation, regular expressions and context-free languages; formal logic and proof techniques as they relate to computer science. Texts: Sudkamp, Languages and Machines: An introduction to the Theory of Comp. Sci.; R. E. Davis, Truth, Deduction and Computation: Logic and Semantics for CS.

STUDENT ADVISEES

Major Advisor (Washington State University)

David Dugan (Co-Advisor with Anneliese Andrews) – MS: (Graduated Spr05]) eCGE: A Multi-Platform Petri Net Editor

Kshamta Jerath – MS: Reliability Analysis of an Anti-lock Braking System Using Stochastic Petri Nets Incorporating Coincident Failures (Spr01 – Spr02])

Zhihe "Bill" Zhou – MS: Integrating the Message Sequence Charts (MSC) Formalism into Mobius Framework for Performability Analysis (Sum00 – Dec02)

Hye Yeon Kim – MS: Validation of Guidance Control Software Requirements Specification for Reliability and Fault-Tolerance (Fall00 – Spr02)

Rick Mahoon – MS Project (Tricities): Formal Verification of discrete Relay Ladder Logic Programs Using PROMELA (Fall00 – Spr01])

Shuren Wang – MS: PCX A Tool for Translating PROMELA Specified Models into SPNs (Spr00- Spr01])

Wen Wei – MS Software Engineering: Adaptation and Implementation and Integration of Graph Layout Algorithms for a Petri Net Graphical Editor (Fall99 - graduated Spr01)

Stefan Greiner – PhD (Co-advisor): Univ. of Erlangen, Germany, SW Performance Modeling (Wtr00)

Major Advisor (University of Colorado)

Norb Gravelle – MS Software Systems Engineering: Petri Net Graphical Editor for C-Based Stochastic Petri net Lang. (CSPL) (Spr98-Spr99)

David Owens – MS Software Systems Engineering: Design for Data Integrity for a Distributed Database System (Spr99-Spr98)

Committee Member

Mohamed Abdelgalil Imam – PhD: Physical Modeling and Characterization of Sub-micron SOI and Bulk MOSFET Devices (F00).

Myron Berg – MS: Pattern Detection of TINA's Canonical Representation (used Petri Nets) (Spr98)

Dixon L. Miller – MS: Software Cost Estimation (Spr98)

John Robert Billups IV – MS: Identification and Visualization of Emotions in Music (F97)

Ann Zweig – MS: Language-Independent Requirements Language Displayer (F97)

Doug Collins – MS: Off Board Simulator (OBSim): Object Oriented Design (Spr97)

Monica L. Midkiff IV – MS: SW System in C/Unix Comparison with one in Foxbase/PC (Spr97)

William B. Camp – MS: Execution Mechanism for a Train Intersection (Spr97)

PROFESSIONAL SERVICE ACTIVITIES

Service Activities and Material Gifts

- Computer Science Host for Visiting Prospective Graduate Students (2001) WSU
- Computer Science CSAB Accreditation Committee Participant and Pullman POC (2000) WSU
- Computer Science Strategy and Planning Committee Secretary (2000) WSU
- Huie-Rogers Endowed Chair Search Committee Chair (2000- 2001) WSU
- Computer Science Search Committee (2000) WSU
- Computer Science Curriculum Committee (2000) WSU
- School of EECS Liaison to Owen Science and Engineering Library (2000) WSU
- Computer Engineering Curriculum Committee (1999-2000) WSU
- Transportation and Traffic Committee member (1997-98) UCCS
- Obtained $20,000 Software Gift-in-Kind from Mercedes Benz (1998) UCCS
- CS Undergraduate curriculum and SSE graduate curriculum committee (1996-97) UCCS
- Computer Science Newsletter: *Cyberdog,* Editor (1996 and 97) UCCS
- Active participant in the Dean's (on campus) Advisory Committee Meetings (1996-97) UCCS
- Very active participant in the *Software Engineering Series Certificate Program* (taught Introduction to S/E, Software Design and helped with Configuration Management) for Spr.'97 UCCS
- Obtained $16,000 donation of UltraSparc1 Workstation from Sun / UniSoft Consult Fall'96 UCCS
- Obtained $2,000 donation of reference books from O'Reilly and Associates, Inc. (Sept. '96) UCCS

Reviewer

National Science Foundation
IEEE Transactions on Computers
IEEE Software
Proceedings of the IEEE
Journal of Systems and Software
IEEE Transactions on Aerospace and Electronic Systems
Design Automation for Embedded Systems
Kluwer Academic Publishers
IEEE Int'l Symp on Software Reliability Engineering
IEEE Pacific Rim Int'l Symp on Fault Tolerant Systems

Society for Computer Simulation

Editorship

2004-Present *Associate Editor,* Int'l Journal of Power and Energy Systems, IASTED, Calgary Canada

Software Reliability Engineering Case Studies, Book published by IEEE CS Press, distributed at the International Symposium on Software Reliability Engineering, November 1997

Program Committee Member

2005 – Present, Program Chair: Annual Cyber Security and Information Infrastructure Research Wkshp (CSIIRW 2005, 06, 07)

2001 IEEE Pacific Rim Int'l Symp on Dependable Computing (PDRC)

1997 IEEE Int'l Symp on Software Reliability Engineering and Session Chair (Process and Quality Track)

1996 IEEE High-Assurance Systems Engineering Workshop

1996 IEEE 3rd Symposium on the Assessment of Software Tools

Professional Organization Membership

IEEE Senior Member

IEEE Computer Society (since 1985)

IEEE Technical Committee on Software Engineering (since 1995)

IEEE Reliability Society (since 1987)

Association of Computing Machinery (since 1995)

American Institute of Aeronautics and Astronautics (since 1992)

Dallas/Fort Worth Association for Software Engineering Excellence (since 1988)

SPECIALIZED WORKSHOPS AND SCHOOLS

Invited Participant, "Software System Safety," Aljoya Conf. Center, Seattle, WA, July 23-27, 2000 taught by Nancy G. Leveson who is a faculty in the Aeronautics and Astronautics department at MIT; including membership in the Safety Club (http://sunnyday.mit.edu/safety-club/).

Invited Participant, "Formal Methods and Performance Analysis: 1st Euro-Summer School on *Trends in Computer Science"* July 3-7, 2000, Nijmegen, the Netherlands, Supported by the European Commission, Research DG, Human Potential Programme, High-Level Scientific Conferences, HPCF-CT-1999-00186, *organized by the Formal Methods and Tools Group, University of Twente.*

Invited Participant, Fifth NASA Langley Workshop, 13-15 June 2000. Lfm2000 was held 13-15 June 2000 at the Radisson Fort Magruder Hotel & Conference Center in historic Williamsburg, Virginia. It was the fifth in a series of meetings begun in 1990 by the formal methods team at NASA Langley Research Center with the primary purpose of bringing together formal methods researchers and practicing engineers in an environment in which each group can learn from the other.

TECHNICAL SPECIALTIES

Platforms

Unix/Linux, MacOS and Windows XP

Areas of Specialty in Software Engineering

System specification, modeling, refinement and performability analysis

Software requirements specification and analysis

Software architecture/design, formal methods and tools

Software reliability and diagnostics

Application Domains

Cyber Security and Information Infrastructure

Multi-Agent Systems

Real-time embedded systems and safety critical avionics applications

Fault-tolerant techniques and diagnostics (BIT/BIST/testability)

Operating systems and interfaces

Hardware/software co-design

Programming Languages

C (adv), C++ (inter), Java (inter), Pascal (adv), Ada (inter), Assembly (adv)

LANGUAGES

English and German (basic)