Scott Young Harmon
982 Dancer Road, Camas Valley, OR 97416
(541) 445-9100, harmon@zetetix.com

SUMMARY OF CAPABILITIES

Demonstrated Ability to Solve Challenging Problems through Technical Creativity and Scientific Discipline

- Acquired extensive knowledge and experience in information technology ranging from device physics through artificial intelligence; built skills in applying mathematical modeling tools from discrete mathematics, abstract algebra, statistics and calculus
- Originated and executed more than 71 research and development (R&D) projects including 6 evaluation process developments, 10 studies and literature surveys, 11 mathematical model formulations, 14 measurement and analysis projects, 18 complex system architecture designs, and 20 new technology concept developments; applied the results from these projects to 75 different implementations and demonstrations
- Designed, performed, analyzed and reported on experiments exploring autonomous system navigation and guidance, semi-autonomous forces behavior, satellite rotation, information system architectures, and source code quality
- Edited an international standard on distributed simulation verification, validation and accreditation (VV&A), contributed 19 articles to US DoD guidance on simulation VV&A, edited glossaries on simulation fidelity and simulation VV&A, and compiled extensive literature surveys on robotics, mobile robots, autonomous systems, and verification and validation (V&V) of knowledge-based systems
- Organized and moderated 8 technical workshops on robotics research, mobile robotics, robot architectures and the science of simulation
- Authored and presented 109 technical publications on autonomous systems and robotics, complex system modeling and simulation, and software system quality measurement
- Provided technical expertise on software and simulation quality measurement, complex system modeling and simulation, and robotics and autonomous systems to 30 government and 14 industrial organizations

Experienced Successful R&D Business Management

- Aggregated over 40 years experience in proposing, planning, executing and reporting on R&D on complex information systems
- Formed and managed teams as large as 48 researchers in technical, project and line management roles
- Created advanced technology concepts and developed markets for them producing ~ $44M in revenue
- Founded and managed the NOSC Autonomous Systems Branch, Robot Intelligence International and Zetetix

ACCOMPLISHMENTS

Technical Accomplishments

Contributed to the 4 major technology areas shown in the table below

Major Areas and Timeframes of Technical Contributions

Technical Area	Timeframe	Publications
Software system quality measurement	1980-present	28
Complex system simulation	1992-2002	27
Robotics & autonomous systems	1977-1996	48
Solar energy	1974-1977	6

The sections below describe the specific contributions in these four technical areas. The reference numbers in this section correspond with the publication list numbering.

Robotics & Autonomous Systems

Contributed to the 4 technical areas of sensing and situation awareness, planning and control, communications and coordination, and architectures.

Applied these technical contributions to the USMC Ground Surveillance Robot, the Integrated Flexible Welding System, a mars sample return rover and military robotics

Also contributed to the robotics and autonomous systems technical community through participation in technical communications activities such as literature surveys and workshop organization

Sensing & Situation Awareness

- Designed and demonstrated an intelligent tactical situation analysis system, an acoustic obstacle detection system for a robotic Light Armored Vehicle (LAV), a non-imaging optical technique for measuring satellite rotation, an agent-based concept for detecting and tracking intrusions in computer networks, and a concept for sensing hazardous road conditions from a moving vehicle [64]
- Developed techniques for multi-sensor data fusion and knowledge-based position location and applied those techniques to the Ground Surveillance Robot (GSR) [36, 37, 55]

Planning & Control

- Designed and managed the implementation of a knowledge-based control system for an autonomous vehicle [22], a probabilistic reasoning network for robot planning [31, 44], a laser welding planning system [24], and an autonomous robot control system that maps multiple competing goals into multiple control axes [58]
- Reviewed and compared the available techniques for route planning to set the foundation for developing the route planner for an autonomous vehicle [25, 27]

Communications & Coordination

- Developed techniques for describing robot tasks [12] and implementing systems of cooperating robots (i.e., task description, communications protocols, command language, task allocation and monitoring, and dynamic coordination) [38, 51]

- Designed protocols to support robot communications [9], a command language to control a semi-autonomous planetary rover over limited bandwidth communications channels and long round trip delays [53], and an intelligent vehicle convoying system that uses inexpensive inter-vehicle laser communications.

Architectures

- Designed advanced architectures for over 19 different information systems including an onboard computing system for a high-rate mine neutralization system, an automated tactical situation analysis system, fault tolerant wafer scale integration [11], a hybrid knowledge-based signal processing system that supports very large input volume rates [20], enterprise command, control, communications, computing and intelligence (C4I) system, a distributed blackboard for intelligent machines [21, 32-34, 47, 52], autonomous vehicle control [23, 44], a knowledge-based welding automation system [42], automation augmented teleoperated vehicle control, an agent-based large-area physical security system, a semi-autonomous planetary rover sensing, computing and control system [50], a simulation-augmented spacecraft ground operations system, a distributed nuclear power plant control system, an intelligent vehicle convoying system based upon laser inter-vehicle communications, intelligent intersections that actively control surrounding vehicle movement to prevent intersection accidents, an agent-based oil tanker damage control system, the robotic onsite support and intelligent ground control system for a semi-autonomous lunar observatory, intelligent semi-automated forces, object-oriented automated Navy command forces, advanced distributed simulations, and agent-based distributed computer network intrusion detection.
- Assessed the limitations of current autonomous system architectures and designed a concept for reconfigurable architectures to overcome those limitations [40, 41, 57, 59]
- Led a study evaluating the application of object-oriented techniques to systems architectures; developed an object-oriented architecture for large scale advanced distributed simulation systems based upon that study's results

Mars Sample Return Rover

- Designed the sensing, computing and control architecture for a semi-autonomous planetary rover [50]

Ground Surveillance Robot

- Led the development and implementation of the USMC Ground Surveillance Robot (GSR), a computer and sensor controlled armored vehicle [18, 28, 31, 39, 44]

Integrated Flexible Welding System

- Designed a knowledge-based welding automation system; led the development and implementation of multiple interacting expert systems for weld planning, robot path planning and designer interfaces for an intelligent laser welding system [24, 35, 42]

Military Robotics

- Studied the applications of robotics to military combat and performed analyses to identify the opportunities and limitations for robotics applications in military combat [14, 16, 17, 29, 49]

Mobile Robots & Autonomous Vehicles

- Served as Technical Editor, Journal of the Society of Robotics and Automation, Mobility and Navigation 1984-1987

- Conducted and published extensive surveys of autonomous submersibles [15], mobile robots [43, 45] and autonomous vehicles [46]
- Co-organized the NATO Advanced Research Workshops on Mobile Robots and Mobile Robot Implementation [48]

Robotics Surveys & Workshops

- Conducted and published extensive surveys of the technical literature in robotics [19] and European robotics research [26]; evaluated the state of the art in robot computing architectures
- Co-organized the ONR-London Workshop on Robotics [30] and four IEEE Workshops on Architectures for Intelligent Control
- Served as Exhibits Chairman for the 1994 International Conference on Robotics and Automation

Consulting

- Provided robotics and autonomous systems expertise to the following clients: Delco Electronics Corporation, FMC Corporation, General Motors Corporation, GM Office of General Counsel, Hughes Defense Systems, Hughes Space Systems Company, Hughes Training Inc., Jet Propulsion Laboratories, National Aeronautics and Space Administration, National Science Foundation, NAVSEA Robotics Technical Council, North Atlantic Treaty Organization, The Rand Corporation, US Army Engineering Topographic Laboratory, US Army Human Engineering Laboratory, US Army Research Laboratories, US Defense Advanced Research Projects Agency, US Defense Modeling & Simulation Office, US Defense Nuclear Agency, US Marine Corps (USMC), USMC Ground Air Telerobotic Systems Project Office, US Naval Electronics System Command, US Naval Sea Systems Command (NAVSEA), and US Office of Naval Research.

Complex System Modeling & Simulation

Solar Cell Charge Transport

- Constructed a model of the behavior of minority charge carriers in semiconductor junctions under high injection levels
- Applied this model to estimate free carrier lifetime from experimental measurements of solar cell capacitance [7, 8]

Torpedo Countermeasures

- Analyzed the available intelligence literature to develop a model that predicts the current threat and future trends in torpedo countermeasures

Military Command & Control

- Developed mathematical models to represent the effectiveness of command, control and communications (C3) systems [10, 13], the behavior of an enterprise C4I system, the behavior of military command and control (C2) systems, and the behavior of Navy command forces [61]
- Applied the model of military command and control systems to the design of computer generated forces [61]

Information Warfare

- Formulated a mathematical model of organization vulnerability to information warfare

Semi-Automated Forces

- Designed a military command forces simulation
- Contributed to the implementation and demonstration of intelligent semi-automated forces
- Developed a technique for evaluating the quality of semi-automated forces (SAFOR) representations
- Applied that technique to evaluate the SAFOR for the Simulation Network (SIMNET) [56, 60]

Human Behavior

- Formulated a mathematical model of human behavior based on the thermodynamic constraints on computational processes and neurophysiology
- Applied this model to represent the effects of emotions as well as other behavior moderators upon individual human behavior [83]
- Analyzed six different simulations of military operations to develop a taxonomy of requirements for human behavior representations [94]

Information Physics

- Developed a model of the thermodynamics underlying information system behavior [86-89]

Military Operations from SME Opinions

- Designed and contributed to the implementation of an intelligent semi-automated forces simulation
- Designed simulations of military command forces and Navy command forces
- Employed survey research techniques to collect subject matter expert opinions on military operations then constructed statistical models from the collected data to use as quantitative simulation referents
- Applied this approach to construct two validation referents for the Joint Warfare Simulation (JWARS) [91, 93, 99]
- Prepared a recommended practices standard for the U.S. Army that describes the technique for constructing simulation referents from SME opinions [101]

Distributed Information System Interoperability

- Contributed concepts for the designs of a run time infrastructure for the Defense Modeling and Simulation Office (DMSO) High Level Architecture (HLA) and an interoperable distributed maritime simulation structure [62]
- Developed and applied techniques for implementing interoperable distributed simulations of military operations
- Formulated a mathematical description of the interoperability constraints on interacting simulations [63, 65, 67, 72, 84, 90]
- Extended the mathematical description of the interoperability constraints on interacting simulations to interacting information systems [66]

Distributed Simulation Composition

- Developed an analytical technique to guide the implementation of distributed simulation executions using the DMSO HLA; applied this process to develop an HLA application decision framework [68, 69, 71]

- Originated and developed a concept for a versatile object-oriented simulation engine
- Designed an advanced scalable distributed simulation architecture; contributed concepts for the designs of a run time infrastructure for the HLA and a distributed maritime simulation structure [62]

Simulation Science

- Organized, moderated and documented the US DMSO/Army Workshop on the Scientific Exploration of Simulation Phenomena [92, 96]

Consulting

- Provided complex system modeling expertise to the following clients: Hughes Command and Control Systems Company, Hughes Electronics Corporation, Hughes Missile Systems Company, Hughes Radar Systems Division, Hughes Training and Simulation Systems Company, National Aeronautics and Space Administration, The Raytheon Company, US Army Model & Simulation Office, US Defense Advanced Research Projects Agency, US Defense Modeling and Simulation Office, US Joint Forces Command, US Navy Space and Naval Systems Command, US Navy SPAWAR Systems Center, and US Navy Warfare Environment Simulator Program

Software System Quality Measurement

Model & Simulation Evaluation

- Formulated the SISO Fidelity Conceptual Model by applying set theory to describe simulation representational capabilities [75, 78, 82]
- Developed a tailorable process for evidence-based verification and validation of simulations [79, 107, 108]; applied that process to the verification and validation of the Joint Operational Effects Federation (JOEF)
- Developed a composite model of the activities and tasks for empirical verification and validation of software and simulations [107]; applied that model to the planning of V&V activities for JEM, FASS, JWARN and JECP SPM
- Devised a technique for constructing quantitative referents from subject matter expert (SME) knowledge using survey research techniques; applied that technique to construct 2 validation referents for the Joint Warfare Simulation (JWARS) [91, 93, 99]; developed a recommended practices standard for the U.S. Army that describes this technique [101]
- Developed a technique for describing simulation representational capabilities using graph theory; demonstrated that technique on a turbine simulation and human behavior representations [105]
- Developed a process for risk-based verification, validation and accreditation of models and simulations [81]; applied this process to accredit four simulations (Joint Effects Model (JEM), Fleet Aerial Support Simulation (FASS), Joint Warning & Reporting System (JWARN), and the Simulation Environment & Response Program Execution Nesting Tool (SERPENT))
- Developed a technique for quantitative accreditation of models and simulations that estimates the uncertainties of the accreditation recommendations; applied that technique to the Joint Expeditionary Collective Protection (JECP) System Performance Model (SPM) and JEM accreditations

- Prepared guidance for risk-based accreditation for the US DoD and NATO [107], for objectively validating simulation compositions, and for verifying, validating and accrediting distributed simulations
- Prepared the fidelity section in the DMSO Essentials of Modeling and Simulation online course [102]
- Contributed to the US DoD Modeling & Simulation Verification, Validation and Accreditation (VV&A) Recommended Practices Guide (RPG) [104]; authored and edited core documents for the roles of Verification and Validation (V&V) Agent and Accreditation Agent for new simulation developments and legacy simulations; authored special topic sections on requirements, fidelity, validation, human behavior representation validation, federation VV&A, simulation credibility, and legacy simulation V&V); edited the VV&A RPG Glossary [104]
- Served as technical editor for the SISO Fidelity Glossary [74] and the IEEE Recommended Practice for Verification, Validation and Accreditation of Federations, IEEE Std. 1516.4 - 2007 [106]

Simulation Validation Process Evaluation

- Developed a technique for consistently assessing the maturity of simulation validation processes; applied this technique to evaluate the processes for validating nine different simulations (Joint Effects Model (JEM), Joint Reporting and Warning System (JWARN), Joint Operational Effects Federation (JOEF), Simulation Environment & Response Program Execution Nesting Tool (SERPENT), Synthetic Theater of War Operations Research Model (STORM), Joint Multi-Resolution Model (JMRM), Joint Theater Level Simulation (JTLS), Joint Conflict and Tactical Simulation (JCATS) and Joint Live-Virtual-Constructive System (JLVC)) [98, 100, 100, 109]

Information System Evaluation

- Developed a mathematical model that measures and predicts the effectiveness of command, control and communications (C3) systems [13]
- Developed a technique for analyzing reconfigurable system designs [59]
- Developed a technique for rigorously measuring, analyzing and comparing software system architectures; applied that technique to assess Joint Simulation System (JSIMS) architecture composability, Extended Littoral Battlespace (ELB) command, control communications, computing and intelligence (C4I) architecture options, Advanced Information Technology Services (AITS) Reference Architecture (RA) effectiveness and JSIMS architecture security [73, 76]
- Developed a standards-based, scientific approach to software verification and validation; applied this approach to nine projects for the Veterans Benefits Administration (Paperless Initiative, Chapter 33 – Automate GI Bill (CH33), CWNRS, Veterans On-Line Application (VONAPP), Veterans Benefit Management System (VBMS), VBMS – Rating (VBMS-R), Veteran Service Network (VETSNET), Benefits Gateway System (BGS), eBenefits)
- Developed a technique for representing and analyzing software and system requirements using graph theory; applied this technique to describe simulation representational capabilities [105]
- Developed a technique for quantitatively estimating software quality from its source code; applied this technique to 40 samples of source code encoded in C++, Java and PL/SQL from 3 Veterans Benefits Administration application projects (Chapter 33 –

Automate GI Bill, Veteran Service Network, Benefits Gateway System); constructed source code quality baselines for C, C++, Java and PL/SQL from the evaluation results

- Applied concepts from discrete mathematics and irreversible thermodynamics to describe the phenomena underlying information system behavior [86-89]; applied this model to analyze information system security
- Developed a technique for characterizing the quality of a source code development process from evaluations of the source code it produces; applied that technique to evaluation of the VETSNET and BGS source code development processes
- Prepared guidance describing the implementation of the standards-based approach to software verification and validation

Intelligent System Evaluation

- Developed techniques for rigorously describing robot tasks [12], for quantitative evaluation of intelligent systems [70, 80], and for objectively validating and verifying knowledge-based simulations and human behavior representations
- Performed analyses to estimate the complexity of automation for nuclear weapons site security (NWSS); formally described the NWSS automation task
- Developed a technique for evaluating the quality of semi-automated force (SAFOR) representations; applied that technique to evaluate the SAFOR for the Simulation Network (SIMNET) [56, 60]
- Developed a technique for describing the computational requirements of complex robots; applied that technique to assess the current design limitations of complex robot computing systems [54]
- Conducted and published an extensive survey of the technical literature in verification, validation, evaluation & testing of knowledge-based systems [97]
- Prepared guidance and a tutorial to describe an objective KBS V&V process [77, 85, 95]

Consulting

- Provided software quality measurement expertise to the following clients: Boeing Company, Hughes Command and Control Systems Division, Hughes Systems Engineering Network Council, Hughes Training and Simulation Systems Company, Johns Hopkins University Applied Physics Laboratory, Joint Program Executive Office for Chemical and Biological Defense, National Aeronautics and Space Administration, US Air Force, US Army, US Army Model and Simulation Office, US Defense Modeling and Simulation Office, US DoD Modeling & Simulation Coordination Office, US Joint Forces Command, US Naval Surface Warfare Center, US Navy Space and Naval Systems Command, Veterans Health Administration, and Veterans Benefits Administration

Solar Energy

- Developed a technique for measuring minority carrier lifetime in semiconductor devices under high injection levels; applied that technique to characterize the behavior of solar cells under high illumination [7, 8]
- Developed a technique to characterize the illumination flux produced by solar concentrators; applied that technique to measure the flux profiles of plastic Fresnel lenses and the FMSC prototype concentrator [2, 6]
- Contributed to testing solar cells designed for solar concentrators [4, 5]

- Compiled a bibliography of photovoltaics that begins with the first report of the photovoltaic effect by Becquerel [3]
- Organized and reported on the underwater exploration of Montezuma Well in Arizona [1]

R&D Business Accomplishments

Extensive experience in R&D business development and project management that includes founding a branch at a Government R&D organization and two private companies

R&D Business Development Accomplishments

Generated a total of approximately $44M in R&D funding for the projects shown in the table below.

Revenue Generated from Projects Developed and Marketed

Project	Sponsor	Project Lifetime (in years)	Total Funding (in $)
Software Verification & Validation	VBA	4	16M
Synthetic Commander	DARPA	5	11M
Intelligent Welding Workcell	NAVSEA	3	5M
Advanced Techniques for Simulation Validation	DMSO	14+	4.5M
Autonomous Mobile Robot	USMC	6	4M
Analysis of Fuel-Fed Automobile Fires	GM	1	1M
Intelligent Synthetic Forces	Hughes IR&D	2	750K
Terrorist Behavior Simulation	DARPA	3	500K
Source Code Quality Measurement	VBA	4	340K
Hazardous Road Condition Sensor	GM IR&D	2	250K
Distributed Computer Intrusion Detection	Hughes IR&D	2	200K
Object-Oriented System Engineering Techniques	Hughes IR&D	2	150K
Interoperability Analysis	DARPA	2	100K
Physical Security Automation	DNA	1	75K
Information Physics for Information Assurance	DARPA	1	50K

- Founded and operated Robot Intelligence International as a robotics R&D business for 4 years and Zetetix as an information system R&D business for 16 years
- Founded and managed the Autonomous Systems Branch at the Naval Ocean Systems Center, San Diego, for 6 years
- Contributed to business development in information sciences, requirements modeling, mobile communications, process modeling, distributed simulation, robotics, software development, automotive electronics, systems engineering, and software quality evaluation
- Worked with a broad range of Government customers to develop markets for such concepts as organizational vulnerability assessment, human behavior modeling, information physics, an object-oriented simulation engine, and quantitative software quality evaluation

R&D Project Management Accomplishments

Managed approximately 149 person-years of labor in the R&D projects shown below

Staffing and Project Lifetimes for the R&D Projects Managed

Project Goals	Staffing (in people)	Project Lifetime (in years)
Construct and demonstrate intelligent synthetic forces	5	5
Develop new software & simulation development standards	6	4
Convert an armored vehicle to an autonomous ground robot	8	3
Develop an integrated planning and perception system for cooperating autonomous vehicles	7	3
Integrate expert systems with an automated welding workcell	6	3
Design and implement a teleoperated vehicle computing system	4	2
Develop technology to prevent fatalities from fuel-fed vehicle fires	8	1
Develop, test and demonstrate a hazardous road condition sensor	3	2
Assess the capabilities of object-oriented systems engineering techniques	2	2
Measure and analyze the behavior of semi-automated forces for SIMNET	2	2
Analyze the application of robotics to military tasks	1.5	2
Implement an agent-based computer intrusion detection system	2	1
Analyze the application of robotics to nuclear weapon storage security	2	1

- Organized and co-organized eight workshops on mobile robots, mobile robot implementation, robotics state of the art, architectures for intelligent control, and scientific exploration of simulation phenomena (i.e., simulation science)
- Managed the Autonomous Systems Branch at the Naval Ocean Systems Center ($2.5M/yr, 15 professionals), San Diego; the Computational Intelligence Department ($4M/yr, 15 professionals); and the Information Sciences Laboratory ($12M/yr funding, 48 professionals) at the Hughes Research Laboratories
- Cooperated and coordinated with senior executives in the U.S. Navy, NASA, General Motors, Hughes Electronics and the US Department of Defense to develop long-term R&D strategies in robotics, telecommunications, information sciences, distributed simulation, systems engineering, information assurance, and simulation VV&A

EXPERIENCE

Education

Developed literature research skills, working knowledge of both scientific and engineering disciplines, and expertise in non-equilibrium thermodynamics, mathematical modeling, computer simulation, structured computer programming and physical experimentation

- M.S., Mechanical Engineering, Arizona State University, 1977
- B.S., Physics, Arizona State University, 1974

Thesis: Measurement of Minority Carrier Lifetime in Silicon Solar Cells under High Illumination

Employment

The table below shows the positions I have held during and since leaving graduate school.

Positions, Employing Organizations and Periods of My Employment

Position	Employing Organization	Period
Founder & Owner	Zetetix, Camas Valley, OR	2016-Present
Chief Scientist	Innovative Management Concepts, Inc., Dulles, VA	2013-2016
Founder & Owner	Zetetix, Camas Valley, OR	1997-2013
Chief Scientist	Advanced Telecommunications, Inc., San Diego, CA	1995-1997
Laboratory Manager	Hughes Research Laboratories, Malibu, CA	1994-1995
Project & Department Manager	Hughes Research Laboratories, Malibu, CA	1993-1994
Project Manager	Hughes Research Laboratories, Malibu, CA	1992-1993
Sr. Member of the Technical Staff	Hughes Research Laboratories, Malibu, CA	1990-1993
Founder & Owner	Robot Intelligence International, San Diego, CA	1986-1990
Project & Branch Manager	Naval Ocean Systems Center, San Diego, CA	1980-1986
Electrical Engineer	Naval Ocean Systems Center, San Diego, CA	1977-1980
Research Assistant	Arizona State University, Tempe, AZ	1974-1977

Programming Languages

Univac & PDP-11 assembly languages, PL/M, C, C++, Basic, FORTRAN, PL/SQL, Java, Ada, Lisp, OPS5, Rosie, HTML, XHTML

Professional Associations

American Association for the Advancement of Science, American Physical Society, American Society of Mechanical Engineers, Sigma Xi, Institute of Electrical and Electronics Engineers: Society of Systems, Man and Cybernetics, Computer Society