Faculty Leave Proposal
Software as a Component in Safety Critical Systems

James Vallino
Department of Software Engineering

1. Overview

Daily interactions with software are an unavoidable fact of modern life. Some of these interactions are explicit, such as, when you are working at a personal computer reading e-mail, composing documents or finding information from the World Wide Web. In these situations most people would acknowledge that they are dealing with a piece of software. The predominant daily interactions with software are not as explicit however. With these interactions you do not have the perception that you are dealing with a "computer". Rather you perceive that you are using another piece of equipment, such as, a microwave oven to heat your meal, the brake pedal in your car to bring it to a stop at the next intersection, or a pacemaker which generates an imperceptible pulse to keep your heart beating in normal sinus rhythm.

Through history, engineers have designed and built machines that perform work for humans. Initially, the engineers harnessed the laws of mechanics to design mechanical controls for these machines. Over the last century non-programmable electrical and electronic controls supplanted the purely mechanical ones as the main controlling elements within the system. Within the last fifty years processors executing software programs have become more prevalent as the "decision making" components that maintain correct operation of the machines. Most of these processors are embedded systems hidden within another piece of equipment. Many are *real-time systems*. These are systems whose correctness is specified with time-dependent requirements. If incorrect operation of the machine could lead to the uncontrolled release of energy or toxins, interference with life-support functions, or a failure to alarm when a hazardous situation occurs the machine is considered part of a *safety-critical system*. The work I propose for my professional development leave will focus on safety-critical, real-time systems.

Through most of my industrial career I worked in the development of embedded and real-time systems. My PhD work in augmented reality built a system that augmented a user's perception of a real scene with synthetically generated visual elements and haptic (touch) sensing of those elements. This system required processing of images at video frame rates and the generation of real-time graphics and touch feedback. In my time here at RIT I have brought my interest in the real-time and embedded systems application domain into the classroom. I originated the idea to develop a Real-Time and Embedded Systems Lab along with a sequence of three courses that we will teach in the lab. Together with Co-PI Roy Czernikowski from the Department of Computer Engineering, we secured funding for the lab and course development by being awarded a $200,000 NSF Course, Curriculum and Laboratory Improvement (CCLI) grant. The two-year grant

began in July 2003 and will complete in June 2005. This grant work will segue into the work I propose for my Professional Development Leave.

Up to this point, none of my work in real-time and embedded systems has been with safety-critical systems. I propose to expand my expertise by using my Professional Development Leave to explore safety-critical systems and, more specifically, the software component in those systems. It is understood that safety has meaning only at the system level but a system is composed of many components. Each of those components contributes to, or more accurately detracts from, the overall safety of the system. I propose to explore software components within safety-critical systems to understand how software affects the safety of a system.

When you consider the engineering of software you can identify both design and process issues. RIT's undergraduate program in software engineering treats both of these areas with equal weight. The process side of safety-critical software development will include, among other activities, code inspections and careful measurement of the code coverage obtained during testing. Some of the process requirements are specified in regulations, such as, *RTCA/DO-178 Software Considerations in Airborne Systems and Equipment Certification* and *MIL-STD-882 Standard Practice for System Safety*. It is also in texts such as Nancy Leveson's *Safeware: System Safety and Computers*. My interest and general expertise is on the design side. I have discussed the design issues for safety-critical systems in the real-time and embedded systems courses using material from *Real-Time Design Patterns: Robust Scalable Architecture for Real-Time Systems*, Bruce Powel Douglass. I do not have a deep knowledge base for the techniques and methodologies that the engineer must adopt when designing and implementing software components in safety-critical systems. The activities I propose for this professional development leave will allow me to deepen my knowledge in this area.

2. Leave Activities

To accomplish this work I propose to undertake several activities through the year. These activities will commence in the summer of 2005 just prior to the academic year for which I am seeking professional leave support. I am planning to arrange three or at most four activities each of approximately three or four month duration. These activities include:

1. ASEE Summer Faculty Fellowship Programs. The ASEE sponsors two summer faculty fellowship programs. One, the Office of Naval Research (ONR) Summer Faculty Research Program (www.asee.org/summer), places faculty at ONR laboratories for a 10 week period during the summer. The second is the NASA Faculty Fellowship Program (www.asee.org/nffp) which operates similarly with NASA labs. Both of these organizations perform research to improve methods for developing real-time and safety-critical systems. I would look for a position in a group that specifically targets the development of software in this environment. The intention is to learn how these organizations address the safety quality requirements of these systems. I will apply to both programs. I have identified two ONR labs and groups at several NASA labs that align with my leave objectives.

2. Visit to a vendor of commercial tools used in safety-critical systems. In the real-time and embedded systems lab we use Wind River Systems's VxWorks operating system. I contacted our local account representative about a possible position during my leave. He expressed a willingness to find me a position in Wind River, the market leader for commercial real-time operating systems. A position in the group that develops their safety-critical platform solution appears ideal. The intention is to learn the approaches taken to assure compliance with safety regulations and overall performance of the system using VxWorks. Other organizations that I might consider for this activity are I-Logix – developer of Rhapsody a design automation tool for real-time and embedded systems that we use in the Real-Time and Embedded Systems lab and MontaVista – developer of a real-time variant of Linux.

3. Visit to an industrial organization that develops software for safety-critical systems. Visiting an industrial development organization will allow me to see the state of current practice in engineering software for safety-critical systems. In addition it will refresh the industrial experiences that I can bring into the classroom and relate to the course material. I often receive positive comments on course evaluations for the industrial examples that I use. For this activity I would like to visit an industrial organization that is delivering real-time safety-critical systems. The intention is to learn how the organization addresses safety quality attributes in its products. A particular question in my mind is the extent to which software process is the only thing brought to bear or if there are design aspects that the engineers actively consider. Which of the two are weighed more heavily? What are the design techniques that can be applied to assure that the safety qualities are addressed in the software? I have received a statement of interest from Alstom Transport Systems for me to visit with them (Appendix A). Alstom, a local Rochester company, develops train control systems for metropolitan and regional transit systems. In Rochester they do the engineering of the software in safety-critical embedded controllers that are part of the control systems. Our local Wind River Systems's account representative also expressed a willingness to help me locate opportunities for a visit at a company with whom he interacts (Appendix B).

4. Visit to an academic institution that has a current research and grant programs working with real-time and safety-critical systems. The final element of my professional development leave proposal is to visit an academic institution that has both curricular and research activity in real-time safety-critical systems. Embry-Riddle Aeronautical University (ERAU) is such an institutional. They have expressed a strong interest in me visiting (Appendix C). During a phone conversation we explored a number of possible projects that are of interest to me. Dr. Andrew Kornecki has an established grant program in real-time systems. He is also responsible for a sequence of courses in this area. There are opportunities for me to work on projects associated with on-going grants in safety-critical systems. This would provide me with a starting point for preparing new research grant proposals individually or jointly with ERAU. As a continuation of my curriculum development work in real-time systems we will write a joint grant to run a faculty workshop on real-time computing education.

Dr. Kornecki ran a workshop similar to this in 1996. The Computing Curriculum – Software Engineering volume identifies an upper-level elective area in real-time and embedded systems. There are no curricular details provided. An objective of a workshop would be to define model curricula for coursework in this area.

I have already made a number of initial contacts with potential sponsors of visits during my leave. In my discussion with Dr. Kornecki at Embry-Riddle we identified enough projects of mutual interest that I could easily spend the entire year visiting there. I will use that as a fallback if none of the other opportunities I mentioned previously materialize. This would however eliminate what I view as one of the strong points of this proposal. My proposal allows me to study software as a component in safety-critical systems in depth and breadth. I risk loosing breadth, in the form of the different perspectives of several organizations, if I spent the entire leave period working at Embry-Riddle.

3. Benefits

I see several direct benefits that will arise from work I propose to do on this leave. These are benefits for my own professional development and scholarly activity, RIT's Software Engineering program and the Golisano College of Computing and Information Sciences. These benefits include:

1. Foundations for coursework in safety-critical systems. Many real-time and embedded systems perform safety-critical roles within systems. I discuss safety concerns in the courses I teach in the Real-Time and Embedded Systems lab. The work I propose will allow me to relate that discussion to actual projects that I will work on as part of this leave. I have also proposed a technical elective course for the new SE Masters program titled Safety-Critical Systems and Software. At the Masters level a deeper study of the area is expected. This leave will provide me with that deeper understanding.
2. Foundation for scholarly activity in safety-critical systems. I have a solid foundation in real-time and embedded systems. My current scholarly work in this domain has been curricular. The overall objective of this proposal is to build my knowledge-base on engineering of software components in safety-critical systems. The industrial visits will expose me to the current practice. Participating in the ONR or NASA summer program and collaborative work at Embry-Riddle will show me some current research activities in this domain. I can use that as a base to continue scholarly activity after I return from leave.
3. Improve the potential for grant and contract work. One hoped for follow-on for faculty participating in the ONR or NASA summer programs is continued collaborative work with the host lab. I expect that continued contract work would derive from my proposed visits to industrial hosts also. Finally, my visit to Embry-Riddle will include the preparation of at least one joint grant proposal. Winning this grant would establish our track-record in this domain which is very important for continued grant awards.

4. Identification of RIT as a center for real-time and embedded systems curricular development. Our real-time and embedded systems course sequence has already established our program as a player in curricular development in that area. I will present this work at the Frontiers in Education conference at the end of October 2004. Sponsoring an NSF workshop on real-time computing education will provide additional visibility for RIT in this area.

4. Support

This proposal is for a full-year's leave at 50% pay during the 2005 (20051, 20052, 20053) academic year. The NASA Faculty Fellowship Program provides a weekly stipend and covers travel and relocation allowances. Since my 10 month academic year salary is paid over 12 months through the summer I consider this to also be support for my leave. In my discussions of professional development leave opportunities I have not discussed specifics of support with any of the organizations. Tom Hilburn at Embry-Riddle has told me that the department would be able to pay my travel expenses and provide a small stipend for work I would do in connection with one of their grants. Alstom Transport Systems has stated that they will consider remuneration during a possible visit to them. Again the details have not been worked out. I have analyzed my finances and fortunately for a one year period I do not need to replace the 50% salary reduction. In my conversations with the industrial organizations I am considering to visit I have stated that I want to uncover the opportunities for a visit first and then discuss supplementing my salary during leave. If I have several equally interesting opportunities from which to choose I may use compensation as the deciding factor.

5. Accomplishments, Outcomes and Achievements

During my professional development leave I would like undertake activities that will allow me to:

1. Identify the software engineering process and design techniques used by an organization developing safety-critical systems.
2. Show how safety regulations can influence the design of software.
3. Participate in the design and development of a safety-critical system.
4. Collaborate on an ongoing research project related to the engineering of software components within safety-critical systems.
5. Prepare at least one joint grant proposal with Embry-Riddle Aeronautical University.
6. Develop curriculum models for upper-level coursework in real-time and embedded systems.
7. Formulate a direction for continued grant and contract work at RIT after I return from leave.

6. Summary

The influence on software in our daily lives continues to grow. As prices decline it becomes cost effective to install processing elements in less and less expensive devices. Many of these devices are in safety-critical systems. The software that runs the device is a component in a safety critical system and contributes to the overall safety of the system.

I will use this professional development leave to study the software engineering of safety-critical systems. My proposed plan provides for study in both depth and breadth. I will gain depth because I propose to visit technical leaders in the area of safety-critical system development, such as, NASA and Wind River Systems. The leave also provides breadth because I have chosen to look at safety-critical systems from multiple perspectives: government research organization, industrial developer, software tool vendor, and academic institution. If this leave is approved I believe there will be direct benefit to RIT, my college and department in terms of increased prestige and visibility. The activities I will undertake will benefit both the software engineering undergraduate and graduate programs. Benefits will also come to Computer Engineering students through the co-listed courses I teach in the Real-Time and Embedded Systems lab. Finally, I look forward to using this leave to advance my scholarly activities via potential continued collaborations with NASA and Embry-Riddle Aeronautical University.

A. Alstom Transport Systems Supporting Letter

Gary REHM
Sent by: Gary REHM To: James HAROLD/USROC01/Transport/ALSTOM@GA
cc: James BALLIET/USROC01/Transport/ALSTOM@GA
bcc:
Subject: Re: Note expressing interest in a possible visit during my sabbatical
Transit North America
Phone: 585 783-2188
10/11/2004 09:37 AM

Jim,

Please pass along to Jim Vallino that we are interested in letting him spend his time with us during his sabbatical. As you know we have several activities going on in the product development area where embedded software is a major portion of the overall system design and is critical the safety of the final product design . There are many details that need to be worked out before any final agreement is reached. Some of these details are dependent on the timing of Jim's sabbatical, the status of the projects at that time and the renumeration that can be worked out.

Gary

:._____

B. Wind River Systems Supporting Letter

Subject: RE: Note expressing interest to help me find a position for sabba
tical
From: tom.wall@windriver.com
Date: Wed, 06 Oct 2004 10:55:40 -0700
To: james.vallino@ritvax.isc.rit.edu

Hello Jim,

I'd be more than happy to assist you in locating suitable engagements. As I've mentioned in our previous conversations I've may be able to provide you with appropriate contacts at the following companies who I know are actively developing products and applications using - "Software as a Component in Safety-Critical Systems". The companies are Lockheed Martin in Owego, BAE in Johnson City, Northrup Grumman in Buffalo, Rockwell Collins in Cedar Rapids and John Deere in Des Moines.

Please let me know when you'd like to engage with these companies and I'll provide you with contact information.

Regards,

Tom Wall
Account Manager
Wind River Systems
(585) 924 8570 desk
(585) 610 0687 cell
(585) 924 8419 fax
http://www.windriver.com

Tech Support -
(800) 872 4977
support@windriver.com

C. Embry-Riddle Aeronautical University Supporting Letter

From: massood Towhidnejad [mailto:towhid@erau.edu]
Sent: Monday, October 04, 2004 1:41 PM
To: James.Vallino@rit.edu
Cc: Massood Towhidnejad; Andrew Kornecki (e); Tom Hilburn
Subject: Possible Sabbatical Cooperation

Hi Jim,

We had a productive meeting on Friday discussing the possibility of you including a visit to Embry-Riddle in your sabbatical planning. We think your excellent credentials and background in real-time computing and embedded safety-critical software is a good match for our Department's interests and strengths.

We believe a joint project between you and the Embry-Riddle faculty will be mutually beneficial. Just to recap, the following is a list of some of the potential sabbatical activities we discussed:

1. Involvement in one of our current research projects (e.g., Research into Safety Critical Software Issues (Guidant Corporation), Software Quality Assurance (Veritas Corporation)

2. Work on a project in our Applied Engineering Center (e.g., embedded software issues related to flight testing, flight simulation, or general aviation propulsion or avionics).

3. Development of a joint ERAU/RIT grant proposal for research in to real-time, safety-critical systems. (FAA, NASA, NSF, industry, etc.)

4. Development of joint ERAU/RIT grant proposal to develop and implement a faculty workshop on real-time computing education. (NSF)

5. Interact with our faculty and students about areas of mutual interest (e.g., real-time computing course and projects, active and problem based learning, assessment, software engineering curriculum development and assessment).

As your planning progresses, we can narrow and better focus what sort of activities you might be involved with at Embry-Riddle. We look forward to your visit and please let me know if we can help in any way.

Best regards,

Massood

D. Curriculum Vitae

JAMES R. VALLINO
James.Vallino@rit.edu
http://www.se.rit.edu/~jrv

EDUCATIONAL EXPERIENCE

May 1998 — University of Rochester, Rochester, NY
Ph.D. Computer Science, Thesis - "Interactive Augmented Reality"

May 1995 — University of Rochester, Rochester, NY
MS Computer Science.

August 1976 — University of Wisconsin, Madison, WI.
MS Electrical Engineering.

June 1975 — Cooper Union, New York, NY.
BE Mechanical Engineering

ACADEMIC EXPERIENCE

12/97 to present Rochester Institute of Technology, Rochester, NY

Associate Professor (9/02 -)
Assistant Professor (12/97 – 9/02)
Department of Software Engineering (7/02 -)
Departments of Computer Science (50%) and Software Engineering (50%) (9/00 to 7/02)
Department of Computer Science (12/97 to 9/00)

Notable activities:

- Obtained NSF CCLI grant for development of laboratory and three-course sequence on Real-Time and Embedded Systems. Lab and courses are joint with Computer Engineering.
- Coordinated department's activities during ABET accreditation in 2002 and 2004.
- Major contributor in the development of the Java version of the CS first year sequence including an honors version of the courses,
- Converted two Software Engineering courses from traditional lecture/lab to studio format,
- As part of the First-In-Class project funded by Sun Microsystems, supervised the development of a debugger for Sun's KVM, a Java virtual machine that runs on Palm PDA's.

9/94 to 12/95 University of Rochester, Rochester, NY

Teaching Assistant

1/85 to 12/88 Brookdale Community College, Middletown, NJ

Adjunct Instructor. Taught Basic and C programming classes.

12/78 to 8/93 Monmouth County Park System, Middletown, NJ

Outdoor recreation instructor and trip leader. Taught classes in cross-country skiing, hiking, biking and canoeing.

9/75 to 5/76 University of Wisconsin, Madison, WI

Teaching Assistant**.** Received Excellence in Teaching Award

INDUSTRIAL EXPERIENCE

6/98 to 8/98 Xerox Corporation, Webster, NY

- Designed and implemented an augmented reality document viewer. This system tracked a piece of paper that the user held and augmented the image of the paper with web page content. The user navigated the web by pointing at hyperlinks on the page and speaking commands. The web browser ran in a virtual frame buffer and page images were copied into the texture memory of the Silicon Graphics workstation on which the system ran. These texture maps were applied to a polygon and rendered for correct merging with the live video image at the location of the real paper view.

1/86 to 8/93 Siemens Corporate Research, Inc., Princeton, NJ

- Completed feasibility study for Siemens Medical Systems (SMS) on options for development of a low cost teleradiology system. Study showed that cost and development time targets were achievable. Developed a prototype teleradiology application under MS Windows.
- Implemented a prototype video rate image processing system using a Datacube MV20. This system removed the effects of collimating the x-ray beam on a medical angiography system thus reducing patient and staff dosage while maintaining acceptable image quality for the procedure.
- Assisted Siemens Energy & Automation (SE&A) in development of product and marketing strategy for incorporating networked communications into current and future product lines. Outlined options for field bus and cell bus architectures. Educated SE&A personnel in OSI protocol standards. Developed prototype demonstration of networked communications on SE&A products using a sub-set of the PROFIBUS field bus standard.
- Investigated the emerging virtual reality technologies to determine applicability in Siemens Operating Companies. Assessed the potential for applying image processing techniques to improve features of the Siemens Analytical X-Ray Instruments x-ray diffractometers.
- Worked with Siemens semiconductor research organization to move SECS communications standard into their fabrication facilities. Developed real-time data gathering system for monitoring semiconductor processing. Wrote Application Note (published in the international SEMI standards manual) describing implementation of the SECS Messaging Standard, a mechanism for using SECS in an OSI protocol.
- Imaging Department representative on the Computer Council responsible for coordinating department computing resource requests and needs with the Computer and Network Administrators.

4/84 to 1/86 AVL, Inc., Tinton Falls, NJ

- Designed and implemented an interpreter system with ‘C’ like syntax to provide a user programmable graphics language on an IBM-PC/AT computer. Using lex and yacc for parsing, this system generated an interpreted and machine language run-time structure.
- One of two software engineers working on a bit-slice graphics engine. Contributed to design of the hardware architecture and microcode format. Designed and implemented a debugging system with interfaces to the hardware, a hardware simulator and the application programs.
- Project manager for the initial release of the AVL Starburst Computer Graphics System. Coordinated activities of nine software engineers in three project groups. Interacted with Product Planning and QA to determine product descriptions and gain final acceptance.
- Wrote device drivers for the AVL Startrak film recorder. Also provided test/diagnostic software and film calibration programs written in C.

11/77 to 4/84 AT&T Information Systems/Bell Laboratories, Holmdel, NJ

- Lead software engineer for the AT&T Personal Computer Terminal 510. Responsible for firmware architecture, terminal feature definition, assignment of coding and developing sections of the final assembly code. Wrote UNIX-C utilities for downloading executable code/symbol tables to the HP64000 development station.

- Designed and microcoded a bit slice processor to execute two dimensional graphics compression algorithms.
- Specified and supervised FCC Part 64J and Part 15 Compliance testing on AT&T Dimension System 75 & 85 business terminals and peripherals.

9/76 to 10/77 Ebasco Services Inc., New York, NY

- Designed and specified instrumentation and control systems for Arizona Public Service Cholla Units 2, 3 and 4. Responsible for integrating the plant computer with all subsystems in the power plant. Designed and performed several functional tests on analog control systems, control boards, and digital computer systems.

PATENTS

US6,408,257 Augmented-reality display method and system (18 June 2002)

PUBLICATIONS

J. Vallino and R Czernikowski, "Work-in-Progress: Multi-disciplinary Real-Time and Embedded Systems Laboratory and Course Sequence," *Frontiers in Education Conference*, Savanah, GA. October 2004.

M. Sebern, et. al., "Initial Experiences in ABET Accreditation of Software Engineering Programs," *Proceeding of the Frontiers in Education Conference*. Boulder, CO. November 2003.

J. Vallino, "Design Patterns: Evolving from Passive to Active Learning," *Proceeding of the Frontiers in Education Conference*. Boulder, CO. November 2003.

J. Vallino and K. N. Kutulakos, "Augmenting Reality Using Affine Object Representations." In *Fundamentals of Wearable Computers and Augmented Reality*, W. Barfield and T. Caudell, (eds.), Lawrence Erlbaum Associates, Mahwah, NJ, 2001.

J. Vallino, "Augmenting Reality Without Camera or Scene Calibration" in *Augmented Reality: Placing Artificial Objects in Real Scene*s, Reinhold Behringer, Gudrun Klinker, David W. Mizell, (eds.), A. K. Peters, Ltd., Natick, MA, 1999.

J. Vallino and C. M. Brown, "Haptics in Augmented Reality," *Proceedings of the IEEE International Conference on Multimedia Computing and Systems*, Florence, Italy, June 1999.

J. Vallino, "Interactive Augmented Reality," Ph.D. Thesis, Department of Computer Science, University of Rochester, Rochester, NY, April 1998.

K. N. Kutulakos and J. Vallino, "Affine Augmented Reality," *IEEE Transactions on Visualization and Computer Graphics*, v4 n1, pp 1-20, 1998.

K. N. Kutulakos and J. Vallino, "Non-Euclidean Object Representations for Calibration-Free Video Overlay," *Proc. International Workshop on Object Representation for Computer Vision*, April 1996.

K. N. Kutulakos and J. Vallino, "Affine Object Representations for Calibration-Free Augmented Reality," *Proc. IEEE Virtual Reality Annual Symposium*, April 1996, pp. 25-36.

K. N. Kutulakos and J. Vallino, "Affine Object Representations for Calibration-Free Augmented Reality," *Proc. ARPA Image Understanding Workshop*, February 1996.

J. R. Vallino, "Datacube MV200 and ImageFlow User's Guide," CS-TR 590 and NRL 95.3 National Resource Lab. for the Study of Brain and Behavior, Department of Computer Science, University of Rochester, June 1995.

R. Chou, P. Liu, J. Vallino and M-Y Chiu, "Behavior-based learning to control IR oven heating: preliminary investigations." In *Machine learning: from theory to applications. Cooperative research at Siemens and MIT*, S. J. Hanson, W. Remmele and R. L. Rivest, (eds.) Berlin: Springer-Verlag, 1993, pp. 229-40.

"E13-90 Standard for SEMI Equipment Communications Standard Message Service (SMS) Application Notes," in 1990 SEMI Standards, vol 2., Equipment Automation. Semiconductor Equipment and Materials Institute, 1990.

J. M. Baratz, et. al., "Letter to the Editor: Comment on 'A Prototype SECS Message Service for Communication in the Semiconductor Manufacturing Environment'," *IEEE Transaction on Semiconductor Manufacturing*, vol. 2, no. 4, pg 178, November 1989.

J. Vallino and T. Farlow, "Version Control Systems," in Accessing C Tips from the Experts, Strawberry Software, Inc., Ed. New York, Van Nostrand Reinhold, 1989.

J. Vallino, "Product Watch - PVCS 2.0," *PC Tech Journal*, vol. 6, no. 10, pp. 131-132, October 1988.

J. Vallino, "Product Watch - MKS RCS 4.2c," *PC Tech Journal*, vol. 6, no. 10, pp. 132-136, October 1988.

J. Vallino, "Product Watch - Seidl Version Manager 2.0, TLIB 4.02," *PC Tech Journal*, vol. 6, no. 3, pp. 141-146, March 1988.

J. Vallino, "Tracking Code Modules," *PC Tech Journal*, vol. 4, no. 9, pp. 50-70, September 1987.

J. Vallino, "Tech Notebook 76 - Environment Variables," *PC Tech Journal*, vol. 5, no. 5, pg. 51, May 1987.

J. Vallino, "Tech Notebook 69 - Environment Expansion," *PC Tech Journal*, vol. 4, no. 11, pg. 49, November 1986.

J. R. Vallino and J. J. Skiles, "SWITCH - An Intelligent 256-Point Contact and Voltage Monitor for Computer Use," *IEEE Transactions on Industrial Electronics and Control Instrumentation*, vol. IECI-25, no. 2, pp. 141-145, May 1978.

J. L. Stephenson, et. al., "Video Detection and Tracking of Tracer Particles in a Model Packed-Bed Reactor," *IEEE Transactions on Instrumentation and Measurement*, vol. IM-26, no. 2, pp. 88-91, June 1977.

PRESENTATIONS

"Design Patterns: Evolving from Passive to Active Learning," Rochester Institute of Technology, Department of Software Engineering Colloquium, October 2003.

"Collaborative Learning in GCCIS: The Good, the Bad and the Ugly," Rochester Institute of Technology, Faculty Institute on Teaching and Learning, May 2003.

"There's Something to It…Reflections from the XP Universe Conference," Rochester Institute of Technology, Department of Computer Science, Colloquium Series, 25 October 2001.

"Real-time Java," SUNY – Geneseo, Department of Computer Science, Seminar Series, 8 March 2001.

"Real-time Java," Rochester Java User's Group, 18 January 2001.

"University Research Threads," Kodak Engineering Conference, 28 September 2000.

"Real-time Java," Kodak Engineering Conference, 28 September 2000.

"Object-Oriented Programming," Rochester Institute of Technology College and Careers Day, 5 August 2000.

"Real-time Java," ACM Rochester Section Monthly Meeting, 13 June 2000.

"Real-time Java," Rochester Institute of Technology, Department of Computer Science, Colloquium Series, 11 May 2000.

"Augmented Reality Document Viewer," Rochester Institute of Technology, Department of Computer Science, Colloquium Series, 4 April 2000.

"Object-Oriented Programming," Rochester Institute of Technology College and Careers Day, August 1999.

"Haptics in Augmented Reallity," IEEE International Conference on Multimedia Computing and Systems, June 1999.

"Interactive Augmented Reality," RIT Center for Imaging Science Colloquium Series, 9 December 1998.

"We Don't Need No Stinkin' Calibration," First IEEE International Workshop on Augmented Reality, November 1998.

"Haptics in Augmented Reality," IEEE Western New York Image Processing Workshop, 18 September 1998.

"Interactive Augmented Reality," SUNY – Geneseo, Department of Computer Science, Seminar Series, 17 September 1998.

"Interactive Augmented Reality," ACM Rochester Section Monthly Meeting, 21 May 1998.

"Interactive Augmented Reality," Rochester Institute of Technology, Computer Science House Seminar Series, 9 May 1998.

"Interactive Augmented Reality," Rochester Institute of Technology, Department of Computer Science, Colloquium Series, 13 April 1998.

"Object-Oriented Programming in Java," Rochester Institute of Technology, Community College Conference, 17 March 1998.

"Interactive Augmented Reality Using Uncalibrated Cameras," IEEE Western New York Image Processing Workshop, 19 September 1997.

"Augmenting Reality with Minimal Calibration," Rochester Institute of Technology, Department of Computer Science, Colloquium Series, 20 February 1997.

"Augmenting Reality with Minimal Calibration," SUNY – Geneseo, Department of Computer Science, Seminar Series, 15 April 1996.