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THE VISUAL SIMULATION ENVIRONMENT TECHNOLOGY TRANSFER

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ABSTRACT

This paper describes how the Visual Simulation Environment (VSE) technology has been transferred into a commercial product. The VSE has been created under research funding, primarily from the U.S. Navy for over a decade. Orca Computer, Inc., with support from Virginia Tech, Naval Research Laboratory, Naval Surface Warfare Center Dahlgren Division, and Virginia Tech Corporate Research Center, has been successful in making the VSE technology transfer a reality. VSE is now a commercially available software product which is provided at no cost for use by U.S. Federal Government employees at government sites.

1. INTRODUCTION

The Visual Simulation Environment® (VSE) technology enables discrete-event, general-purpose, object-oriented, picture-based, component-based, visual simulation model development and execution for solving complex problems. The reader is referred to the following references for further information on VSE (Balci et al. 1997a, b, c, d; http://www.OrcaComputer.com).

Technology transfer, in simple terms, is the sharing of technology, developed usually at a government facility, with the public and/or private sector. U.S. Air Force (http://tto.wpafb.af.mil/TTO/techtran/whatxfer.htm) defines three types of technology transfer: *Technology Transition* is the movement of technology from a research and development laboratory to a first time application. This is called the vertical movement of technology. *Technology Transfusion* is the reuse of a particular technology in a follow-on application. This is called the horizontal movement of technology. *Technology Transfer* is the movement of technology from a government agency to the public and/or private sector. It is also called technology commercialization. This type of technology movement can be either vertical or horizontal.

Technology transfer/commercialization improves the national economical competitiveness and all parties involved, academia, industry, military and government, realize many benefits. The National Technology Transfer Center (NTTC) (http://www.nttc.edu/nttc.html) indicates that by taking technologies off laboratory shelves and putting them to work in U.S. businesses and industries, the taxpayers get even more benefits from their investments. NTTC provides technology transfer information and world wide web links at http://www.nttc.edu/gov/other/tech.html. The reader may visit this website for further information on technology transfer.

The purpose of this paper is to present the VSE technology transfer success story. An overview of research that has led to the creation of the VSE technology is presented in Section 2. Section 3 describes the technology commercialization activities of Orca Computer, Inc. and the roles of supporting organizations. Concluding remarks are given in Section 4.

2. OVERVIEW OF RESEARCH LEADING TO THE CREATION OF VSE

The ever-increasing complexity of simulation modeling creates the need for automated support throughout the *entire* model development life cycle. Such support can be provided in the form of an environment composed of integrated software tools providing computer-aided assistance in the development of a simulation model. Professors Osman Balci and Richard E. Nance started a research project in June 1983, under funding from the U.S. Navy, to pursue research in building a discrete event Simulation Model Development Environment (SMDE) (Nance 1983). The SMDE project has addressed a complex research problem: prototyping a domain-independent discrete-event SMDE to provide an *integrated* and comprehensive collection of computer-based tools to (Balci and Nance 1987a):

- offer cost-effective, integrated and automated support of model development throughout the entire model life cycle;
- improve the model quality by effectively assisting in the quality assurance of the model;
- significantly increase the efficiency and productivity of the project team; and
- substantially decrease the model development time.

Guided by the fundamental requirements identified by Balci (1986b), incremental development, evolutionary prototyping, and rapid prototyping approaches have been used to develop the prototypes of SMDE tools on a Sun computer workstation. The object-oriented paradigm, enunciated by the Conical Methodology (Nance 1987, 1994), has furnished the underpinnings of the SMDE research environment (the collection of tool prototypes). An overview of the SMDE architecture and prototype tools is given by Balci and Nance (1992).

In 1987, the research project began investigating visualization and increased emphasis on the use of the object-oriented paradigm. As a result, a Visual Simulation Support Environment (VSSE) research prototype was developed in April 1992 (Derrick 1988, 1992; Derrick and Balci 1994, 1995, 1997).

Based on the experience gained from the use of the SMDE and VSSE prototypes, development of the Visual Simulation Environment (VSE) started in August 1992 under the object-oriented software engineering environment of the Unix-based NEXTSTEP operating system. A fully functional research prototype of VSE was developed at Virginia Tech in July 1995 (Balci et al. 1995).

Contributors and their contributions to the SMDE, VSSE, and VSE projects at Virginia Tech are listed in Table 1.

3. VSE TECHNOLOGY TRANSFER

The research that has led to the creation of the VSE technology has been conducted, primarily through funding from the U.S. Navy between 1983 and 1995, at Virginia Tech Department of Computer Science and Systems Research Center.

Virginia Tech, founded in 1872, is the largest university in the state of Virginia with about 25,000 students. One of the leading universities in the nation in terms of technology transfer, Virginia Tech provides the services of the following organizations in order to facilitate technology transfer/commercialization.

Virginia Tech Corporate Research Center (VTCRC) is an economic development initiative of the Virginia Tech Foundation in cooperation with Virginia Tech. The VTCRC's mission is to build creative partnerships between Virginia Tech's world-class research programs and private/public enterprises. (http://www.g3.net/crc) VTCRC currently has over 50 tenant companies employing over 800 people.

Virginia Tech Intellectual Properties, Inc. supports Virginia Tech through maximizing the return to the University from its research investment by balancing the following: (a) income generated by licensing and other activities related to university intellectual property; (b) sponsored research funding from licensees; (c) creation of new or start-up businesses and jobs; and (d) dissemination of university expertise to society (http://www.vt.edu/admin/vtip/about.vtip.html).

Virginia Tech Business/Technology Center provides support services for entrepreneurial companies.

Orca Computer, Inc. was founded in May 1995 at VTCRC by the authors for the purpose of transferring the VSE technology into a commercial product. Under funding from the Naval Research Laboratory through the Naval Surface Warfare Center Dahlgren Division, Orca started the commercial development of VSE on August 1, 1995. Table 2 shows the commercial VSE release dates and the hosting software/hardware platforms.

Since the research that has led to the creation of the VSE technology has been primarily funded by the U.S. Navy, the U.S. Federal Government has intellectual property rights to VSE Version 1.0. Therefore, VSE commercial version 1.0 is provided at no cost for use by U.S. Federal Government employees at Federal Government sites.

4. CONCLUDING REMARKS

The creation of VSE from research prototypes developed in the Simulation and Software Engineering Laboratory at Virginia Tech is an excellent example of the double return on investment from tax dollars invested in university research. Students educated in simulation and software engineering at all levels (i.e., B.S., M.S., Ph.D.) are making valuable contributions in their current professional positions in industry and academia. The names of some of them can be found elsewhere in these *Proceedings*. Moreover, the ideas and collective efforts of faculty and students have evolved into the basis for the VSE product, whose creation led to the founding of Orca Computer, Inc. As "icing on the cake," VSE Version 1.0 is available at no cost for use by U.S. Federal Government employees at government sites.

In our case, technology commercialization was the main reason why Orca Computer, Inc. was founded. As a result, Orca now hires people, pays taxes and contributes to the economical development of Southwest Virginia. The VSE technology transfer improves the national economical competitiveness in discrete-event simulation by way of the following business goals of Orca:

Table 1: Contributors to the SMDE, VSSE, and VSE Projects at Virginia Tech

Name	Degree†	Year	Contribution
Professor Osman Balci, Principal Investigator Professor Richard E. Nance, Principal Investigator			(Balci 1986a, b, 1987, 1988, 1989, 1990, 1994; Balci et al. 1990; Balci and Nance 1985, 1987a, b, 1989, 1992; Nance 1983, 1984, 1987, 1988, 1994; Nance and Arthur 1988; Nance and Balci 1984, 1987)
Lynne F. Barger	M.S.	1986	(Barger 1986; Barger and Nance 1986)
James D. Beams	M.S.	1991	(Beams 1991; Beams and Balci 1992)
Anders I. Bertelrud	M.S.	1995	(Bertelrud 1995; Balci et al. 1995)
John L. Bishop	M.S.	1989	(Bishop 1989; Bishop and Balci 1990)
Charles W. Box	B.S.	1984	(Box 1984)
E. Joseph Derrick	Ph.D.	1992	(Derrick 1988, 1992; Derrick and Balci 1994, 1995, 1997; Derrick et al. 1989)
Chuck M. Esterbrook	B.S.	1996	(Balci et al. 1995)
Valerie L. Frankel	M.S.	1987	(Frankel 1987; Frankel and Balci 1989)
Robert H. Hansen	M.S.	1984	(Hansen 1984)
Rajendra Harrichunder	M.S.	1994	(Harrichunder 1994)
Matthew C. Humphrey	B.S.	1985	(Humphrey 1985)
Robert L. Moose, Jr.	Ph.D.	1987	(Moose 1983; Moose and Nance 1987a, b; Nance et al. 1984)
C. Michael Overstreet	Ph.D.	1982	(Nance and Overstreet 1987a, b; Overstreet and Nance 1985, 1986; Overstreet et al. 1987)
Ernest H. Page, Jr.	Ph.D.	1994	(Page 1990, 1994)
Fred A. Puthoff	M.S.	1991	(Puthoff 1991)
Ali Tuglu	M.S.	1995	(Tuglu 1995)
Jack C. Wallace	M.S.	1985	(Wallace 1985, 1987; Wallace and Nance 1985)
Richard B. Whitner	M.S.	1988	(Whitner 1988; Whitner and Balci 1989)

† All degrees are in Computer Science at Virginia Tech

1. Lead in the creation of a component-based simulation marketplace so that simulation technology users can realize significant economic benefits through
   - reduced costs of simulation projects,
   - enhanced credibility of models and simulation results, and
   - expanded applicability of less expensive technology.
2. Increase automation and productivity in simulation model development enabling
   - improved correctness, reliability and maintainability of simulation models and results,
   - reduced time to develop and test simulation models, and
   - increased amortization of costs through simulation model component reuse.

Table 2: VSE Release Dates and Supported Platforms

Operating System	Hardware Platform	Date Shipping
NEXTSTEP / Mach Unix	Intel Pentium Sun SPARC HP PA-RISC	Nov. 1, 1996
OPENSTEP / Mach Unix	Intel Pentium	Mar. 1, 1997
Windows NT 4.0	Intel Pentium	Apr. 1, 1997
Windows 95	Intel Pentium	July 1, 1997
New Macintosh OS (Rhapsody)	PowerPC	1st Quarter 1998

3. Increase the productivity of simulation modeling teams by
   - permitting specialists in the application domain to create higher fidelity, more accurate model components, and
   - providing a focus on discourse in model specification at a level far more comfortable to application domain users than a programming language.
4. Broaden the markets for simulation software and U.S. model and component producers by promoting
   - the creation of systematically reusable simulation model components,
   - increased interoperability among simulation modeling software and non-simulation software products, and
   - the convenient and ready adaptation of simulation model components and the creating software by potential foreign users.

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