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://tti.dpafb.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 Simula-
tion Support Environment (VSSE) research prototype
was developed in April 1992 (Derrick 1988, 1992;

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 environ-
ment of the Unix-based NEXTSTEP operating system. A
fully functional research prototype of VSE was devel-
oped 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 tech-
nology 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 univer-
sity 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 employ-
ing 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 fund-
ing 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 com-
mercial 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 univer-
sity research. Students educated in simulation and soft-
ware engineering at all levels (i.e., B.S., M.S., Ph.D.) are
making valuable contributions in their current profes-
sional positions in industry and academia. The names of
some of them can be found elsewhere in these Proceed-
ings. 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 Govern-
ment 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
ecomonomical 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

<table>
<thead>
<tr>
<th>Name</th>
<th>Degree†</th>
<th>Year</th>
<th>Contribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professor Richard E. Nance, Principal Investigator</td>
<td></td>
<td></td>
<td>(Barger 1986; Barger and Nance 1986)</td>
</tr>
<tr>
<td>Lynne F. Barger</td>
<td>M.S.</td>
<td>1986</td>
<td>(Beams 1991; Beams and Balci 1992)</td>
</tr>
<tr>
<td>James D. Beams</td>
<td>M.S.</td>
<td>1991</td>
<td>(Bertelrud 1995; Balci et al. 1995)</td>
</tr>
<tr>
<td>Anders I. Bertelrud</td>
<td>M.S.</td>
<td>1995</td>
<td>(Bishop 1989; Bishop and Balci 1990)</td>
</tr>
<tr>
<td>John L. Bishop</td>
<td>M.S.</td>
<td>1989</td>
<td>(Box 1984)</td>
</tr>
<tr>
<td>E. Joseph Derrick</td>
<td>Ph.D.</td>
<td>1992</td>
<td>(Balci et al. 1995)</td>
</tr>
<tr>
<td>Chuck M. Estebrook</td>
<td>B.S.</td>
<td>1996</td>
<td>(Frankel 1987; Frankel and Balci 1989)</td>
</tr>
<tr>
<td>Valerie L. Frankel</td>
<td>M.S.</td>
<td>1987</td>
<td>(Hansen 1984)</td>
</tr>
<tr>
<td>Robert H. Hansen</td>
<td>M.S.</td>
<td>1984</td>
<td>(Harrichunder 1994)</td>
</tr>
<tr>
<td>Rajendra Harrichunder</td>
<td>M.S.</td>
<td>1994</td>
<td>(Harrichunder 1994)</td>
</tr>
<tr>
<td>Matthew C. Humphrey</td>
<td>B.S.</td>
<td>1985</td>
<td>(Humphrey 1985)</td>
</tr>
<tr>
<td>Robert L. Moose, Jr.</td>
<td>Ph.D.</td>
<td>1987</td>
<td>(Moose 1983; Moose and Nance 1987a, b; Nance et al. 1984)</td>
</tr>
<tr>
<td>C. Michael Overstreet</td>
<td>Ph.D.</td>
<td>1982</td>
<td>(Nance and Overstreet 1987a, b; Overstreet and Nance 1985, 1986; Overstreet et al. 1987)</td>
</tr>
<tr>
<td>Fred A. Puthoff</td>
<td>M.S.</td>
<td>1991</td>
<td>(Puthoff 1991)</td>
</tr>
<tr>
<td>Ali Tuglu</td>
<td>M.S.</td>
<td>1995</td>
<td>(Tuglu 1995)</td>
</tr>
</tbody>
</table>

† 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

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

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.

ACKNOWLEDGMENTS

The research that has led to the creation of the Visual Simulation Environment technology since 1983 has been sponsored in part by the U.S. Navy under research grants totaling $1.2 million. Visual Simulation Environment is a registered trademark of Orca Computer, Inc. (http://www.OrcaComputer.com)

REFERENCES


Box, C. W. 1984. A prototype of the premodes manager. MDE Project Memorandum, Department of Computer Science, Virginia Tech, Blacksburg, VA.


### AUTHOR BIOGRAPHIES

**OSMAN BALCI** is an Associate Professor of Computer Science at Virginia Tech and President of Orca Computer, Inc., developer of the Visual Simulation Environment. He received B.S. and M.S. degrees from Bogazici University in 1975 and 1977, and M.S. and Ph.D. degrees from Syracuse University in 1978 and 1981. Dr. Balci is the Editor-in-Chief of two international journals: Annals of Software Engineering and World Wide Web; Verification, Validation and Accreditation (VV&A) Area Editor of ACM Transactions on Modeling and Computer Simulation; Simulation and Modeling Category Editor of ACM Computing Reviews; Associate Editor of INFORMS Journal on Computing; and serves on five other editorial boards. He is currently a member of the Defense Modeling and Simulation Office (DMSO) VV&A technical working group. Dr. Balci has been a PI or Co-PI on research grants and contracts sponsored by the U.S. Navy with a total funding of $1.2 million. His current research interests center on software engineering, visual simulation and modeling, and world wide web. Dr. Balci is a member of Alpha Pi Mu, Sigma Xi, Upsilon Pi Epsilon, ACM, IEEE CS, INFORMS, and SCS.

**ANDERS I. BERTELrud** is a Vice President of Orca Computer, Inc., developer of the Visual Simulation Environment (VSE). He received B.S. and M.S. degrees in Computer Science from Virginia Tech in 1993 and 1995. He is a member of Phi Beta Kappa, Upsilon Pi Epsilon, and ACM. He has been working on the development of VSE since September 1992.

**CHUCK M. ESTERBROOK** is a Vice President of Orca Computer, Inc., developer of the Visual Simulation Environment (VSE). He received a B.S. degree in Computer Science from Virginia Tech in 1996. He has been working on the development of VSE since September 1992.

**RICHARD E. NANCE** is the RADM John Adolphus Dahlgren Professor of Computer Science and the Director of the Systems Research Center at Virginia Tech. He is also Chairman of the Board of Orca Computer, Inc., developer of the Visual Simulation Environment. He received B.S. and M.S. degrees from N.C. State University in 1962 and 1966, and a Ph.D. degree from Purdue University in 1968. Dr. Nance was the founding Editor-in-Chief of the ACM Transactions on Modeling and Computer Simulation (1990-96). He served as Program Chair for the 1990 Winter Simulation Conference. Dr. Nance has received awards from the TIMS College on Simulation and ACM SIGSIM. He is a member of Alpha Pi Mu, Sigma Xi, Upsilon Pi Epsilon, ACM, IEEE, and INFORMS.