

Curriculum Vita - Nicholas F. Polys [npolys@vt.edu]

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Faculty Appointments

Director of Visual Computing in Advanced Research Computing, Virginia Polytechnic Institute and State University (2007-present)

Affiliate Research Professor in the Department of Computer Science, Virginia Polytechnic Institute and State University (2007-present)

Research Scientist in the Interdisciplinary Center for Applied Mathematics and the Center for Human-Computer Interaction at Virginia Polytechnic Institute and State University (2007-present)

Education

Ph.D., Computer Science - 2006

Virginia Polytechnic Institute and State University

- Dissertation: Display Techniques in Information-Rich Virtual Environments
- Advisors: Dr. Doug A. Bowman, Dr. Chris North,
- Committee: Dr. Scott McCrickard, Dr. Ken Livingston, Dr. Don Brutzman
- GPA: 3.88

B.A., Cognitive Science - 1996

Vassar College

- Thesis: The Universal Shaman and the Modern Mental Ontology
- Advisor: Dr. Ken Livingston

Honors and Awards

- ACM Service Awards for Web3D Symposium: General Chair (2008), Program Chair (2007)
- Outstanding Dissertation Award, VT Computer Science Department: 2006
- Gamma Beta Phi Honor Society, inducted 2005
- Upsilon Pi Epsilon Computer Science Honor Society, inducted 2004
- Universal Media, Winner "World Altering Contest" 1998
- Advanced Placement Scholar with Distinction, 1992

Research Interests

- Human Computer Interaction & Usability Engineering Methodology
- Virtual Environments & 3D User Interfaces
- Scientific Visualization & Medical Imaging
- Information & Interaction Architecture

Funded Research

- *Virtual Environments to Enhance Structures Understanding of Architects* (2009-2012) co-PI with Medhi Setareh, Brian Ermann, Jian Chen, Brett Jones. National Science Foundation, \$500,000; responsible for 25%
- *A Visual Interface for Smart Vehicle Networks* Institute for Critical Technologies and Applied Science (2008) \$ 65,000; responsible for 100%
- *Medical X3D* (2007) US ARMY TATRC, \$ 120,000; responsible for 10%
- *An X3D Loader for OpenSceneGraph* (2007). Naval Postgraduate School, \$ 6,000; responsible for 100%

Publications

Book Chapters

Polys, Nicholas F. "Publishing Paradigms with X3D" In: *Information Visualization with SVG and X3D*, (eds.) Chanomei Chen and Vladimir Geroimenko, Springer-Verlag, 2005.

Journals

Polys, Nicholas F., Bowman, D.A., and North, C., "The Role of Depth and Gestalt Cues in Information-Rich Virtual Environments" International Journal of Human-Computer Studies, Elsevier (forthcoming)

Polys, Nicholas F., Shinsaugh, Patrick. "Scaling to Big Science: Real Opportunities for Virtual Reality" Virtual Reality Special Issue on Scientific Visualization (submitted)

Polys, Nicholas and Brutzman, Don and Steed, Anthony and Behr, Johannes. Report from: Future Standards for Immersive: Report on the IEEE VR 2007 Workshop. *IEEE Computers Graphics & Applications* Vol. 28, Number 2, IEEE Computer Society, 2008.

D.A. Thorley-Lawson, V. H., K. Luzuriaga, A.S. Jarrah, R. Laubenbacher, K. Lee, **N.F. Polys**, E. Delgado-Eckert, M. Shapiro, K.A. Duca (2007). "A Virtual Look at Epstein-Barr Virus Infection: Biological Interpretations." PLOS Pathogens **3**(10): e137 doi:10.1371/journal.ppat.0030137.

Shapiro, M., K. A. Duca, K. Lee, E. Delgado-Eckert, A.S. Jarrah, R. Laubenbacher, **N.F. Polys**, V. Hadinoto, D. Thorley-Lawson, (2008). "A Virtual Look at Epstein-Barr Virus Infection: Simulation Mechanism." Journal of Theoretical Biology **252**(4): 633-648.

Bowman, D., Chen, J., Wingrave, C., Lucas, J., Ray, A., **Polys, N.**, Li, Q., Haciahmetoglu, Y., Kim, J., Kim, S., Boehringer, R., and Ni, T. (2006). "New Directions in 3D User Interfaces". International Journal of Virtual Reality **5**, 3-14.

Polys, N. F., Kim, S., and Bowman, D. A. (2007). "Effects of Information Layout, Screen Size, and Field of View on User Performance in Information-Rich Virtual Environments." Computer Animation and Virtual Worlds **18**(1): 19-38.

Polys, Nicholas F. and Bowman, Doug A., "Desktop Information-Rich Virtual Environments: Challenges and Techniques." Virtual Reality **8**(1): 2004, 41-54.

Conference Proceedings

Polys, Nicholas F., Visamsetty, S., Battarechee, P. Tilevich, E. , “The Value of Patterns in Deep Media Scenegraps”. SEARIS Workshop, *IEEE Virtual Reality 2009*, IEEE Press. 2009.

Hossain, S., Akbar, M., **Polys, N.**, , “Storytelling and Clustering for Cellular Signaling Pathways”. *Proceedings of International Conference on Information and Knowledge Engineering (IKE)* Las Vegas, NV 2009.

N.W. John, M. Aratow, J. Couch, D. Evestedt, A.D. Hudson, **N. Polys**, R.F. Puk, A. Ray, K. Victor, Q. Wang, “MedX3D: Standards Enabled Desktop Medical 3D.” *Medicine Meets VR (MMVR)* 2008.

Polys, Nicholas F., Shapiro, Michael., Duca, Karen, “IRVE-Serve: A Visualization Framework for Spatially-Registered TimeSeries Data”. *The Web3D 2007 Symposium*, ACM SIGGRAPH.

Polys, Nicholas F., & Ray, Andrew, “Supporting Mixed-Reality Interfaces through X3D Specification”. Workshop on Mixed-Reality Interface Specification, *Proceedings of IEEE Virtual Reality*, IEEE Press. 2006.

Murthy, U., Burbey, I., Kwon, G., **Polys, N.**, Vincent, P., and Pérez-Quiñones, M. (2006). “Re-finding from a Human Information Processing Perspective”. *SIGIR Workshop on Personal Information Management*, Seattle, ACM Press.

Polys, Nicholas F., Kim, S., Bowman, D.A. “Effects of Information Layout, Screen Size, and Field of View on User Performance in Information-Rich Virtual Environments” *Proceedings of ACM Virtual Reality Software and Technology 2005*. Monterey, CA: ACM SIGGRAPH. 2005.

McCrickard, S., Wahid, S., Lee, J., **Polys, N.** “Use and Reuse in Information and Interaction Design” *Proceedings of HCI-International 2005*, Las Vegas, Nevada. LEA Associates. 2005.

Polys, Nicholas F., Bowman, Doug A., North, Chris. “Information-Rich Virtual Environments: Challenges and Outlook”. *Proceedings of NASA Virtual Iron Bird Workshop* (Day 2, paper, ppt & video), NASA Ames 2004. <http://ic.arc.nasa.gov/vib/>

Polys, Nicholas F., Bowman, D., North, C., Laubenbacher, R., Duca, K., “PathSim Visualizer: An Information-Rich Virtual Environment for Systems Biology”. *Proceedings of the Web3D 2004 Symposium*, ACM SIGGRAPH 2004.

Polys, Nicholas F., North, C., Bowman, D., Ray, A., Moldenhauer, M., Dandekar, C., “Snap2Diverse: Coordinating Information Visualizations and Virtual Environments”. *Proceedings of Visualization and Data Analysis*, International Society for Optical Engineering (SPIE) 2004.

Bowman, D., North, C., Chen, J., **Polys, N.**, Pyla, P., and Yilmaz, U., Information-Rich Virtual Environments: Theory, Tools, and Research Agenda. in *Proceedings of ACM Virtual Reality Software and Technology*. 2003. Osaka, Japan: ACM SIGGRAPH. 2003

Polys, Nicholas F. “Stylesheet Transformations for Interactive Visualization: Towards a Web3D Chemistry Curricula”. *Proceedings of the Web3D 2003 Symposium*, ACM SIGGRAPH. 2003.

Brutzman, Don, Kass, Michael, **Polys, Nicholas F.** “X3D Content Examples, Editing, Conformance Suite and Software Development Kit”. *Sketches and Applications*, ACM SIGGRAPH 2001.

Posters

Polys, N.F., Duca, K.A., North, C., Bowman, D. , Laubenbacher, R. “Information-Rich Virtual Environments for Biomedicine.” Poster. *Computational Cell Biology*, Lennox MA, 2005.

Polys, N. F., Duca, K. A., Laubenbacher, R., Bowman, D. A., North, C. "Interactive Visualization of Biological Databases using Information-Rich Virtual Environments", Poster. *Digital Biology: The Emerging Paradigm*, NIH 2003. <http://staff.vbi.vt.edu/pathsim/NIHposter.pdf>

Other Publications

Polys, Nicholas F., Shupp, Lauren , Volpe, J., Glina, V. and North, Chris (2006) "The Effects of Task, Task Mapping, and Layout Space on User Performance in Information-Rich Virtual Environments". Technical Report TR-06-12, Computer Science, VT.

Burbey, I., Kwon, G., Murthy, U., **Polys, N.** and Vincent, P. (2005). "Human Information Processing with the Personal Memex", CORR-the Computing Research Repository:
<http://arxiv.org/abs/cs.HC/0606107> .

Harris, Sally, "PathSim: Scientists model interaction of viruses and immune system", Virginia Tech Research Magazine Fall 2004. <http://www.research.vt.edu/resmag/fall2004/PathSim.html> .

Polys, Nicholas F. "Techniques of Perception in VRML", "European Web3D- Company Profiles" "The X3D Initiative". 3DeZine, 2000 -2001.

Polys, Nicholas F. "Supplying your XML Toolkit" – IBM DeveloperWorks 1999

Teaching Experience

- 2008** **Virginia Polytechnic Institute and State University Instructor:**
- CS 5784, *Information Visualization* (CS Graduate Level)
 - *Deep Media for Research and Education* Faculty Development Institute (FDI)
 - *High Performance Computing Bootcamp (w/ UVa)*
- 2007** **Virginia Polytechnic Institute and State University Instructor:**
- CS 2984, *Media Computation* (CS Freshman/Sophomore Level)
 - *Deep Media for Research and Education* Faculty Development Institute (FDI)
 - *High Performance Computing Bootcamp (w/ UVa)*
 - Graduate short course: *Introduction to Computational Science*
- 2006** **Virginia Polytechnic Institute and State University Instructor:**
- CS 3724, *Introduction to Human-Computer Interaction* (CS Junior/Senior Level)
 - *Deep Media for Research and Education* Faculty Development Institute (FDI)
- 2003- 2005** **Virginia Polytechnic Institute and State University GTA**
UNIX for sophomore CS majors: responsible for weekly labs and grading, office hours
- Guest Lecturer at Virginia Tech and Naval PostGraduate School:**
topics include *Information Visualization, Virtual Environments*
- Web3D Symposium Course Presenter:**
Engineering Virtual Environments with X3D,
Techniques of Perception with X3D
- 2000-2002** **SIGGRAPH Course presenter:**
Introducing X3D

Web3D Symposium Course Presenter:

*X3D Architecture & Overview,
Web3D Graphics Publishing with X3D*

Professional and Research Experience _____

2006 – 2007 Virginia Polytechnic Institute and State University – Blacksburg, VA

Postdoctoral Associate: Research Computing

- Developed Visual Computing solutions for research scientists
- Ran faculty and graduate development workshops for 3D visualization

Selected Projects

- Mathematics: generated VR, images, and movies of large space structure energetics simulation
- Biochemistry: generated VR, images, and movies of Myoglobin Oxygen transport mechanism (molecular dynamics simulation)

2005 – 2006 Virginia Polytechnic Institute and State University – Blacksburg, VA

Graduate Research Assistant

- Virtual Reality Assessment of Independent Living Skills and Mild Cognitive Impairment in Elderly Populations - Interface and Content Developer: built stimuli and testbed system for immersive CAVE assessment tool - Carilion Biomedical Institute funding.

Selected Projects

- Personal Memex – expert interviews and prototype for personal digital memory system for high-functioning and disabled populations
- Intelligent Document Filtering - implemented multiple evaluators for machine learning in text retrieval
- Principle author of a \$1.25 million grant proposal to NIH BISTI program - intended for Biomedical IRVE development and HCI research; scored 195 (21.7 percentile) but not funded

2003 – 2005 Virginia Bioinformatics Institute – Blacksburg, VA

Graduate Research Assistant

- PathSim project - Visualization and Deployment Lead: designed and developed data processing and information-rich virtual environment interfaces for a large, agent-based immunological simulation - NIH funding
- Mblast – Software Engineer: analyzed and optimized a Formal Concept Lattice Algorithm for gene expression analysis

Selected Projects

- STKE Cellular Signaling – Project Lead, Interface Programmer: designed and developed graphical interface for direct manipulation of Boolean queries using Java Swing and MySQL database populated by web crawler agent
- Usability Engineering project for design of an online notification system; highest user subjective evaluations

1999-2002 VirtuWorlds LLC – New York, NY; Amsterdam, NL

Chief Technical Officer, Founder

- Designed and implemented content management and delivery systems for Web3D assets and environments
- Technology adapted and used by Merck, Pfizer, and Georgia State U.
- Editor-In-Chief the 3D-eZine online Web3D industry portal

- 2000-2001** **Yoe Studio** – Peekskill, NY
Web Programmer, Designer
 - Implemented and maintained commercial, data-driven, personalized websites

- 1996-1999** **Transcendent Recordings** – Poughkeepsie, NY
Vice-President of Production, Webmaster
 - Led digital productions for numerous artists w/ independent record label

- 1992-1996** **Vassar College** Computer Center – Poughkeepsie, NY
Information Technology Consultant
 - Worked with faculty, staff, and students to support computing and networking

Professional & Community Activities ---

Director

- Web3D Consortium Board (2000-2009), Secretary (2007-2009)

Chair

- General: Web3D Symposium 2008
- Program: Web3D Symposium 2007
- Tutorials: Web3D Symposium 2006
- Workshops: IEEE Virtual Reality 2007
- Publicity: IEEE Virtual Reality 2008
- Finance: IEEE Virtual Reality 2009, 2010
- Working Group: Web3D Consortium User Interface (2006-present)

Workshop Organizer

- Future Standards for Immersive VR (IEEE VR 2007, 2008)
- X3D User Interfaces (Web3D Symposium 2004, 2005)
- Medical X3D Web3D Symposium (Web3D Symposium 2005)
- Portable Information Spaces (HCI International 2004)

Key Contributor

- Web3D X3D Specification (2000-present)
- Web3D Medical Working Group (2006-present)
- VT 3D Interaction Research Group
- Web3D Software Development Kit (SDK) (2000-2002)

Member

- Web3D Consortium (2000-present)
- ACM (2003-present)
- IEEE (2004-present)
- SIGGRAPH Online Committee (2000, 2001)

Reviewer

Web3D, VIS, VAST, InfoVis, 3DUI, IEEE VR, SVR, SIGGRAPH, International Journal of Human-Computer Studies, Virtual Reality, Computer Graphics and Applications, Computers & Graphics, Information Visualization

Liaison

- DICOM medical imaging standards - WGs 11, 17, 23 (2006-2009)

Speaker, Juror, Panelist

- NSF Student Panel: 'Making a Career in VR' IEEE VR 2006
- ACM & SIGGRAPH Local Chapters events: Boston, NY, DC, San Francisco (2001-present)
- VR Art: Stuttgarter Filmwinter MultiMedia Festival (2000)

Technical skills

- **Certified by:** VT IRB board for Human Subjects Research and Ethics
- **Fluent in:** X3D, VRML, Java, C++, Perl, UNIX, SQL, XML & XSLT, (x)HTML, PHP, ECMA, *numerous* commercial and open-source applications for modeling and visualization

Personal Information

- Happily married to Katherine Mills Polys since 1996
- Performing musician and songwriter since 1992: guitar, banjo, vocals
- Hobbies: fly-fishing, canoeing, hiking, camping
- Other Interests: mathematics of natural forms, evolutionary computation, presence

Selected References

Primary

Dr. Terry Herdman

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Mathematics
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Secondary

Dr. Don Brutzman

*Moves Institute, Naval Postgraduate
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Dr. Karen Duca

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Pathobiology
VA-MD College of Veterinary Medicine
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Research Statement

Through my research in Virtual Environments and Information Visualization, I have employed both 'basic' and 'applied' science. In the former, I examined fundamental questions about the nature of human perception and cognition in an attempt to discover principles that apply to interactive, information-rich environments. These principles find manifestation and application in the engineering processes of 'applied' science, where solutions must be found for a specific problem or domain. Each approach has value on its own, but real progress only happens when they are used together. In the field of Computer Science especially, the combination of methods is crucial in order to keep pace and relevance with technological development. Fundamental advances drive new systems and new systems open up new fundamental questions.

My PhD research has examined the nature of Human-Computer Interaction (HCI) in integrated information spaces – a common situation where patterns and relationships exist between spatial, abstract, and temporal information. We have termed this union of virtual environments and information visualization research 'Information-Rich Virtual Environments' (IRVEs). Specifically, my work has focused on design techniques to combine these information types and the roles of different perceptual cues in comprehension, mental workload, and task performance. This research has led to interesting and applicable results for a number of emerging display technologies.

First, how do IRVEs support scientific insight and problem solving? Through user-centered design, I evolved my techniques through a visualization system for immunologists to analyze data from a large-scale agent-based simulation. The system provides unique facilities to display and explore spatially-registered timeseries data in the context of anatomy and is in use today at the Virginia Bioinformatics Institute. Second, understanding what data models and software functionalities are important for IRVEs – what are the requirements of next-generation information architectures and standards technologies such as X3D and the Semantic Web? Many of my techniques have either informed or been integrated into the international standard of X3D, creating a more capable language for graphics and interaction. Lastly, my interest in the cognitive aspects of virtual environments has been applied to develop an immersive psychological and independent-living assessment environment for elderly populations with Mild-Cognitive Impairment.

Research and development of IRVEs will continue to have an impact across industries and domains. The volume and complexity of heterogeneous data continues to grow, and scientists, engineers, and designers will continue to require better analytic and visualization tools to manage it in a useful way. There are a number of specific applications where the benefit of IRVEs can be seen. For example, in the fields of biology and medicine, scientists examine the properties and relationships of structures, from cells to tissues to gross anatomy. Similarly, in chemistry, astronomy or architecture, understanding the spatial nature of processes is crucial for insight - using IRVEs can reduce the cognitive distance between the investigator and their data. Additionally, the principles and techniques of IRVEs could be fruitfully applied to educational spaces, as in the multimedia software and curricula that train and educate new scientists and practitioners.

My direction of basic research for the future will be further exploration of the perceptual and cognitive impacts of IRVE interface designs across desktop, large-scale, and immersive displays. This involves continued iteration of designs and experimentation through the methods of Usability Engineering, specifically toward multi-modal, embodied, and 3D user interfaces. However, it is crucial not only to improve designs, but also to make them practical. For this reason, future research should also include application development with researchers in other domains.

Collaborations and development with medical and biochemical experts will be especially fruitful for IRVEs. Such multi-disciplinary collaboration will lead to next-generation information tools further leveraging of XML for data interchange, providing web-services to high-performance computing systems, and pushing the visualization and interface capabilities of open standards. Lastly, I am a firm believer in the open source software movement, which has provided a powerful means to develop and deploy new tools with robust functionality and low financial cost.

Teaching and Advising Statement

Over the last six years, I have been fortunate to have the opportunity to teach students and professionals from a range of backgrounds at a variety of levels. The content has ranged from the fundamentals of computing to the methods of usability engineering to the use of cutting-edge graphics technologies. These experiences have made it clear that I want to include a significant teaching component in my career.

My philosophy centers around preparing students for critical thinking and communication. While fundamentals such as algorithms, data structures, software engineering, and programming languages are essential in producing capable graduates, the methods of assessing and applying technologies to real-world problems will prepare them for the challenging and changing world of Computer Science. I believe that this flexibility to adapt requires a strong base in engineering methodology as well as technical writing and presentation. In terms of innovation and creativity, I am a strong advocate of exposing students to the many multi-disciplinary connections of modern computing such as cognitive psychology, artificial intelligence, and information and interface design.

My specific teaching experiences began in the areas of system languages such as UNIX, publication technologies such as XML and server-side processing, and the building of real-time 3D graphics applications for virtual reality and information visualization. In general, these courses focused on what functionalities the technology exposed, the pitfalls and strategies in using those technologies effectively, and assignments or projects that gave the opportunity to practice those strategies. It is a crucial responsibility of the teacher to provide the proper context (i.e. strengths and limitations) of various technologies and techniques. This responsibility has been manifested most recently as Instructor for a junior-level course at VT, Introduction to Human Computer Interaction.

While I am knowledgeable in core CS areas such as programming, databases & data structures, user interface software and web technologies, my goals for teaching include courses on: 'Human-Computer Interaction', 'Usability Engineering', 'Information and Interaction Design', 'Graphics and Scene graphs', and 'Information Architectures' (i.e. networked publication and delivery). For multi-disciplinary areas or team-taught courses such as in the areas of Cognitive Science, I am especially interested in teaching topics of human and machine performance for perception and action, and knowledge and reasoning.

In addition, I am committed to guiding students along the paths that inspire and engage them. Inciting and enabling their fascination and passions may be the most valuable tools a teacher can give. I have advised both undergraduates and graduates in research projects while at Virginia Tech. The undergraduates learned about IRVE software engineering and system integration while the graduates developed and ran an IRVE usability study. In advising both of these projects, I successfully led students to complete research of international relevance and quality.

Through this experience, I have learned the value of providing clear goals for pedagogy and projects and using 'progressive disclosure'. This approach gives students a specific problem but does not specify the means of realization in full detail. Instead, their understanding evolves step-by-step: as new questions arise, new resources are provided. This is an opportunistic methodology that helps reduce overload and confusion. In many cases the solutions discovered are novel, and would not have been found if the means had been pre-ordained. This underscores my commitment to building critical thinking skills in students so that they may effectively develop and deploy the latest computing technology.

As a graduate of both a small liberal arts college and a large state university, I have experienced a range of class sizes and teaching styles. No matter the scale, the best have something in common - the passion and humor of the professor. It is this tradition I hope to continue at your institution.