Doug A. Bowman

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Appointments

Frank J. Maher Professor of Computer Science, Virginia Tech (2016-present)

Professor of Computer Science, Virginia Tech (2012-present)

Director, Center for Human-Computer Interaction, Virginia Tech (2011-present)

Senior Fellow, Institute for Creativity, Arts, and Technology, Virginia Tech (2018-present)

Fellow, Institute for Creativity, Arts, and Technology, Virginia Tech (2015-2018)

Associate Professor of Computer Science, Virginia Tech (2005-2012)

Visiting Researcher in Computer Science, University of California, Santa Barbara (August 2008 – July 2009)

Assistant Professor of Computer Science, Virginia Tech (1999-2005)

Education

Ph.D., Computer Science, Georgia Institute of Technology, August 1999

- Thesis Title: "Interaction Techniques for Immersive Virtual Environments: Design, Evaluation, and Application"
- Thesis Advisor: Dr. Larry F. Hodges, Georgia Institute of Technology
- Thesis Committee: Dr. Jarek Rossignac, Dr. Albert N. Badre, Dr. Gregory Abowd, Dr. Elizabeth T. Davis

M.S., Computer Science, Georgia Institute of Technology, 1997

B.S., Mathematics and Computer Science, Emory University, 1994

- Graduated summa cum laude
- Honors Thesis Title: "Performance Analysis of the Conch Concurrent Computing System"

Honors and Awards

- Best poster award, ACM Symposium on Spatial User Interaction (SUI), 2022, for the paper, "Integrating Traditional Input Devices to Support Rapid Ideation in an Augmented-reality-based Brainstorming" (with Tam Phan and Sang Won Lee).
- Honorable mention for best paper award, IEEE International Symposium on Mixed and Augmented Reality (ISMAR), 2022, for the paper, "Exploring the Impact of Visual Information on Intermittent Typing in Virtual Reality" (with Alexander Giovannelli and Lee Lisle).
- Virtual Reality Academy, inaugural class member, presented by the Visualization and Graphics Technical Committee of the IEEE Computer Society, 2022.

- First prize, 3DUI Contest held at the IEEE Virtual Reality conference, 2022 (with Lee Lisle, Feiyu Lu, Shakiba Davari, Ibrahim Tahmid, Alexander Giovannelli, Cory Ilo, Leonardo Pavanatto, Lei Zhang, and Luke Schlueter).
- Faculty Service Award, Department of Computer Science, Virginia Tech, 2022.
- ISMAR Career Impact Award, presented by the IEEE International Symposium on Mixed and Augmented Reality (ISMAR), 2021.
- Honorable mention for best paper award, ACM Symposium on Spatial User Interaction (SUI), 2021, for the paper, "Exploration of Techniques for Rapid Activation of Glanceable Information in Head-Worn Augmented Reality" (with Feiyu Lu and Shakiba Davari).
- First prize, 3DUI Contest held at the IEEE Virtual Reality conference, 2021 (with Lei Zhang, Feiyu Lu, Shakiba Davari, Nicolas Gutkowski, Lee Lisle, Luke Schlueter, and Ibrahim Tahmid).
- Society for Information Technology and Teacher Education (SITE) and National Technology Leadership Initiative (NTLI) Fellowship in Social Studies Education and Technology Paper Award. Presented at the College and University Faculty Assembly (CUFA) of the National Council for the Social Studies, 2017. For the paper "Making the Invisible Visible: Evaluating the Use of Mixed Reality to Teach a Forgotten Local History - School Segregation - with 5th Graders." With David Hicks, Aaron Johnson, Todd Ogle, Thomas Tucker, Stephanie van Hover, and Eric Ragan.
- At the Nexus award, ICAT Day 2017, Virginia Tech. Given to the ICAT Day exhibit that best exemplifies working at the nexus of science, engineering, arts, and design. For the project "Visualizing World War I through Mixed Reality." With Todd Ogle, Thomas Tucker, David Hicks, DongSoo Choi, David Cline, Erik Westman, Tanner Upthegrove, Zach Duer, and many students.
- Best paper award, 25th International Conference on Artificial Reality and Telexistence (ICAT 2015) and the 20th Eurographics Symposium on Virtual Environments (EGVE 2015), for the paper, "An Evaluation of the Effects of Hyper-Natural Components of Interaction Fidelity on Locomotion Performance in Virtual Reality" (with Mahdi Nabiyouni).
- Technical Achievement award in Virtual Reality, presented by the Visualization and Graphics Technical Committee of the IEEE Computer Society, 2014.
- First prize (people's choice), 2014 3DUI Contest held at the IEEE Symposium on 3D User Interfaces (with Felipe Bacim, Mahdi Nabiyouni, and Cristian Moral Martos).
- Honorable mention, best poster award, IEEE Symposium on 3D User Interfaces, 2014, for the poster "Designing Effective Travel Techniques with Bare-hand Interaction" (with Mahdi Nabiyouni and Bireswar Laha).
- Impact Award, GVU Center at Georgia Tech, 2012.
- Dean's Award for Research Excellence, College of Engineering, Virginia Tech, 2012.
- First prize, 2012 3DUI Contest held at the IEEE Symposium on 3D User Interfaces (with Felipe Bacim, Eric Ragan, Siroberto Scerbo, and Cheryl Stinson).
- Best poster award, ASNE Human Systems Integration Symposium, 2011, for the poster "The Effects of Visual Realism on Training Transfer in Immersive Virtual Environments" (with Cheryl Stinson, Regis Kopper, Siroberto Scerbo, and Eric Ragan).
- Best paper award, IEEE Symposium on 3D User Interfaces, 2011, for the paper "Rapid and Accurate 3D Selection by Progressive Refinement" (with Regis Kopper and Felipe Bacim).
- First prize, 2011 3DUI Grand Prize competition held at the IEEE Symposium on 3D User Interfaces (with Felipe Bacim, Cheryl Stinson, and Bireswar Laha).
- ACM Distinguished Scientist, named in 2010.

- First Prize, live category, 2010 3DUI Grand Prize competition held at the IEEE Symposium on 3D User Interfaces (with Felipe Bacim, Regis Kopper, Tao Ni, and Anamary Leal).
- Honorable Mention, Best paper award, Joint Virtual Reality Conference, 2009, for the paper "Higher Levels of Immersion Improve Procedure Memorization Performance" (with Ajith Sowndararajan, Eric Ragan, and Régis Kopper).
- IEEE Computer Society Distinguished Service Award, for service as the General Chair of the IEEE Virtual Reality Conference, 2008.
- Best Short Paper Award, ACM Symposium on Virtual Reality Software and Technology, 2007, for the paper "The Benefits of Immersion for Spatial Understanding of Complex Underground Cave Systems" (with Philip Schuchardt).
- Honorable Mention, Best paper award, CHI 2007, for the paper "Move to Improve: Promoting Physical Navigation to Increase User Performance with Large Displays" (with Robert Ball and Chris North).
- Faculty Fellow, College of Engineering, Virginia Tech, 2005-2007.
- Virginia Tech Researcher of the Week, June 16-20, 2003.
- National Science Foundation CAREER award, 2003-2008.
- Graduate Fellow, National Science Foundation, 1994-1997.
- President's Fellowship, Georgia Institute of Technology, 1994-1998.
- Senior thesis received highest honors, Emory University, 1994.
- Member, Phi Beta Kappa.
- Woodruff Scholar, Emory University, 1990-1994.
- Dean's List, Emory University, each semester 1990-1994.

Research Interests

- Three-dimensional (3D) user interfaces
- 3D interaction techniques
- Natural user interfaces (NUIs)
- Virtual environments (VEs), virtual reality (VR)
- Augmented reality (AR)
- User experience in AR/VR
- Immersive analytics
- The effects of level of fidelity in VR/AR
- Usability evaluation
- Human-computer interaction (HCI)
- Visualization
- Application domains: architecture, construction, history, mining, civil engineering, education, entertainment, training, military operations & planning, scientific visualization, serious games, visual analytics, robotics

FUNDED RESEARCH

External Grants and Gifts:

- Multi-Input Control for Mobile Augmented Reality. 12/22-12/26. Sole PI for Virginia Tech portion, with Tobias Höllerer (UCSB). Funded by the Office of Naval Research (ONR). Virginia Tech portion $741,423. Responsible for 100% of Virginia Tech portion.
- Virtual Inspection of Advanced Manufacturing via Process-Scale Digital Twins. 2/23-9/25. Sole PI. Funded by Lawrence Livermore National Laboratory (LLNL). $453,046. Responsible for 100%.
- Experiencing Civil War History Through Augmented Reality: Soldiers, Civilians, and the Environment at Pamplin Historical Park. 3/23-2/24. Co-PI, with Paul Quigley (PI), Kathryn Shively, Corinne Guimont, Todd Ogle, Kurt Luther, David Hicks, Thomas Tucker, and Zachary Duer. Funded by the National Endowment for the Humanities (NEH). $100,000. Responsible for $12,155.
- V2-23 High-Productivity Analytics. 1/23-12/23. Co-PI, with Chris North (PI) and Yalong Yang. Funded by the National Science Foundation through the SHREC IUCRC. $171,792. Responsible for 33%.
- V2-22 High-Productivity Analytics. 1/22-12/22. Co-PI, with Chris North (PI). Funded by the National Science Foundation through the SHREC IUCRC. $147,717. Responsible for 50%
- Computing Innovation Fellows 2021 Project. 1/22-12/23. Sole PI. Funded by the Computing Research Association through NSF. $276,134.
- Gift for augmented reality research. 2021. Funded by Adobe Research. $10,000. Responsible for 100%.
- Experiencing Civil War History Through Augmented Reality: Soldiers, Civilians, and the Environment at Pamplin Historical Park. 3/21-2/22. Co-PI, with Paul Quigley (PI), Corinne Guimont, Todd Ogle, Kurt Luther, David Hicks, Thomas Tucker, and Zachary Duer. Funded by the National Endowment for the Humanities (NEH). $30,000. Responsible for $3085.
- Virtually Co-Located Augmented Reality Spaces for Visualization, Training, and Navigation. 7/20-7/22. PI at Virginia Tech, with Bobby Bodenheimer (PI, Vanderbilt University), Sarah Creem-Regehr (University of Utah), Jeanine Stefanucci (University of Utah), Tobias Höllerer (UC Santa Barbara), Jason Orlosky (Augusta University), and Michael Nowatkowski (Augusta University). Funded by the Office of Naval Research (DURIP program). $316,596 (Virginia Tech portion $52,118). Responsible for 100% of the Virginia Tech portion.
- The Virtual Loupe: A Pilot Study Demonstrating the Use of Mixed Reality in Surgery. 8/20-7/21. PI at Virginia Tech, with James Thompson (PI at Carilion Medical Center). Funded by Carilion Medical Center Research Acceleration Program. $10,000. Not directly responsible for any funds.
- Evaluating Physical and Virtual Large Displays for Windows Productivity Beyond the Desktop. 1/20-12/20. Co-PI, with Chris North (PI). Funded by the Microsoft Productivity Research Program. $50,000. Responsible for 50%.
- Immersive Space to Think: 3D VR/AR Space for Sensemaking of Textual Data. 1/20-12/20. Co-PI, with Chris North (PI). Funded by the Laboratory for Analytic Synthesis (LAS). $103,078. Responsible for $14,998.
- Facilitating Mixed Reality Decision-Support Tools: Modeling, Collaborative Interaction, and Information Display. 9/19-9/22. Sole PI for Virginia Tech portion, with Tobias Höllerer (UCSB). Funded by the Office of Naval Research (ONR). (Virginia Tech portion $564,001). Responsible for 100% of Virginia Tech portion.

- Impact of Interactive Holographic Scenes in Developing Engineering Students' Competencies in Sensing Technologies. 7/19-7/22. Co-PI with Abiola Akanmnu (PI, School of Construction), Farrokh Karimi (CEE), and Diana Bairaktarova (EngEd). Funded by the National Science Foundation (NSF) Improving Undergraduate STEM Education (IUSE) program. $299,976. Responsible for $21,816.
- Content Management for Always-On Augmented Reality Interfaces. 1/19-12/19. PI with Wallace Lages (SOVA) and Blair Macintyre (Georgia Tech). Faculty Research Award from Google Daydream AR/VR Research Program. $142,802. Responsible for $48,973.
- Beating the Speed-Accuracy Tradeoff with Progressive Refinement Techniques for Interaction in Head-Mounted Augmented Reality. 1/18-12/18. Sole PI. Faculty Research Award from Google Daydream AR/VR Research Program. $47,753. Responsible for 100%.
- 360 Degrees. 4/17-4/18. Co-PI with Joe Gabbard (PI, ISE), Todd Ogle (TLOS), and Thomas Tucker (SOVA). Funded by [unnamed company]. $279,999. Responsible for $12,874.
- View Management and User Interface Optimization for Wide-Area Mobile Augmented Reality. 1/17-12/19. Sole PI for Virginia Tech portion, with Tobias Höllerer (UCSB). Funded by the Office of Naval Research (ONR). (Virginia Tech portion $530,773). Responsible for 100% of Virginia Tech portion.
- Collaborative Analysis of Large-Scale Mixed Reality Data. 1/16-12/16. Co-PI with Joe Gabbard (PI, ISE). Funded by Microsoft. $100,000. Responsible for 50%.
- Augmented Reality Simulation for Design and Evaluation of Training Capabilities. 12/13 – 12/16. Sole PI for Virginia Tech portion, with Tobias Höllerer (UCSB). Funded by the Office of Naval Research (ONR). $644,796 (Virginia Tech portion $307,636). Responsible for 100% of Virginia Tech portion.
- EXP: Exploring the potential of mobile augmented reality for scaffolding historical inquiry learning. 8/13 – 7/15. PI, with David Hicks (Learning Sciences), Todd Ogle (Technology Enhanced Learning), and David Cline (History). Funded by the National Science Foundation (NSF) Cyberlearning Program. $549,039. Responsible for 63%.
- CGV: Small: Collaborative Research: Immersive Visualization and 3D Interaction for Volume Data Analysis. 8/13 – 7/17. PI, with Jake Socha (ESM) and David Laidlaw (CS, Brown University). Funded by the National Science Foundation (NSF) Human-Centered Computing Program. $499,901 (Virginia Tech portion $249,946). Responsible for 83% of Virginia Tech portion.
- II-NEW: Living Lab for Asynchronous and Synchronous Investigation of Virtual and Real Environments. 7/13-6/15. Co-PI, with Benjamin Knapp (PI), Yong Cao, Ico Bukvic, Nicholas Polys, and James Ivory. Funded by the National Science Foundation (NSF) Computing Research Infrastructure program. $585,510. Responsible for 13%.
- DARPA RC Team ViGIR. 10/12 – 6/15. Sole PI for Virginia Tech portion, with David Conner (TORC Robotics) and Oskar van Stryk (TU Darmstadt). Funded by the DARPA Robotics Challenge Program. $1M (Virginia Tech portion $329,603). Responsible for 100% of Virginia Tech portion.
- Virginia Tech Response to C4ISR and Information Dominance Research. 9/11 – 9/16. I was one of 60+ Virginia Tech faculty involved in the proposal. PI Troy Henderson (AOE). Funded by SPAWAR Pacific. $3,000,000. Not directly responsible for any funds.
- II-EN: Device and Display Ecologies. 2/11 – 1/14. Co-PI with Francis Quek (PI, CS), Thomas Martin (ECE), Chris North (CS), Tonya Smith-Jackson (ISE), Denis Gracanin (CS), and Michael Evans (Education). Funded by the National Science Foundation (NSF) Computing Research Infrastructure Program. $600,000. Responsible for 13%.
- Evaluating the Effects of Immersion on Naval Training Applications. 8/09 – 7/13. Sole PI for Virginia Tech portion, with Tobias Höllerer (UCSB). Funded by the Office of Naval Research

(ONR). $1,160,886 (Virginia Tech portion $509,814). Responsible for 100% of Virginia Tech portion.

- Development of Trauma Surgery Simulation Software. 1/07-12/07. Co-PI with Jeannette Capella (Carilion), Sydney Vail (Carilion), Donnelle Crouse (Carilion), Carol Gilbert (Carilion), Francis Quek (CS), and Dennis Kafura (CS). Funded by the Carilion Clinic, with matching funds from ICTAS and IBPHYS. $60,000. Responsible for 33%.
- CRI: Interfaces for the Embodied Mind. 3/06-3/08. Co-PI with Francis Quek (PI, CS), Woodrow Winchester (ISE), Yingen Xiong (CS), and Deborah Tatar (CS). Funded by the National Science Foundation (NSF) Computing Research Infrastructure Program. $400,000. Responsible for 20%.
- CRI: Versatile 3D Imaging and Visualization System. 3/06-2/08. Co-PI with Marte Gutierrez (PI, CEE), Julio Martinez (CEE), and Conrad Heatwole (BSE). Funded by the National Science Foundation (NSF) Computing Research Infrastructure Program. $162,571. Responsible for 20%.
- 3D Interaction and Information-Rich Virtual Environments for Building Security Visualization. 1/06-12/08. Sole PI. Funded by the Robert Bosch Research and Technology Center. $140,869. Responsible for 100%.
- Use of a Virtual Environment to Assess Real World Abilities in Older Adults Experiencing Memory Loss. 6/05-5/06. Co-PI with Karen Roberto (PI, Gerontology), Paul Diamond (UVa Medical School) and Mark Conaway (UVa Medical School). Funded by the Carilion Biomedical Institute. $29,760. Responsible for 52%.
- Virtual Environment Applications to Improve Mining Health and Safety Training. 6/05-5/08. Co-PI with Michael Karmis (PI, VCCER), Walid Thabet (BC), and Antonio Nieto (MinE). Funded by the National Institute of Occupational Safety and Health (NIOSH). $640,501. Responsible for 25%.
- Towards Boundless Display: Developing a Reconfigurable Research Testbed for Large-Scale, High-Resolution Visual Displays. 9/04-8/06. Co-PI with Chris North (PI), Steve Harrison, and Roger Ehrich (CS). Funded by the National Science Foundation (NSF) Research Resources Program. $230,067. Responsible for 25%.
- VEWL Usability Evaluation. 7/04-12/04. Sole PI. Funded by OpenTech, Inc. (sub-award of NIST grant). $6411. Responsible for 100%.
- ITR: Adaptive and Real-Time Geologic Mapping, Analysis, and Design of Underground Space (AMADEUS). 9/03-8/07. Co-PI with Marte Gutierrez (PI), Matthew Mauldon, Joe Dove (CEE), and Erik Westman (MinE). Funded by the National Science Foundation (NSF) Information Technology Research (ITR) program. $1,067,116. Responsible for 16%.
- CAREER: Domain-Specific 3D Interaction Techniques for Design and Construction tasks in Immersive Virtual Environments. 3/2003-2/2008. Sole PI. Funded by the National Science Foundation (NSF) CAREER program. $500,000. Responsible for 100%.
- Interactive Virtual Environments for Science and Engineering Education. 6/2002-5/2003. PI. Co-PIs were Mehdi Setareh (Arch.) and Srinidhi Varadarajan (CS). Funded by National Science Foundation (NSF) Course Curriculum and Laboratory Improvement (CCLI) program. $74,824. Responsible for 100%.
- Multi-Parametric Data Visualization on Workstation Clusters. 7/2001-12/2002. Co-PI with Srinidhi Varadarajan (PI, CS) and Ron Kriz (ESM). Funded by the Institute for Software Research. $101,001. Not directly responsible for any funds.

Virginia Tech Internal Grants:

- C3: COVID Comics, Cubed. 7/23-5/24. Co-PI with Emmy Waldman (PI, English), Rachael Paine (SOVA), Avery Wiscomb (SOVA), and Anna Feigenbaum. Funded by the Institute for Creativity, Arts, and Technology. $21,500. Responsible for $8000.
- Intelligent Augmented Reality for the Future of Work. 10/21-6/22. PI with Joe Gabbard (ISE), Hoda Eldardiry (CS), Jia-Bin Huang (ECE), and Nazila Roofigari-Esfahan (BC). Funded by the Institute for Critical Technologies and Applied Science. $10,000. Responsible for 100%.
- Intelligent Augmented Reality for the Future of Work. 6/21-5/22. PI with Joe Gabbard (ISE), Hoda Eldardiry (CS), Jia-Bin Huang (ECE), and Nazila Roofigari-Esfahan (BC). Funded by the Center for Human-Computer Interaction. $32,941. Responsible for $9917.
- Transforming Public Engagement with Underrepresented Stories through Humanities Sources and Immersive Experiences. 6/21-5/22. Co-PI with Ed Gitre (PI, History), Phyllis Newbill (CENI), and Chris North (CS). $23,000. Responsible for $14,000.
- Supporting Remote Design Critique of Physical Objects through Collaborative Augmented Reality. 5/20-8/20. PI with Sang Lee (CS), Wallace Lages (SOVA), David Hicks (School of Education), and Akshay Sharma (ID). Funded by the Institute for Creativity, Arts, and Technology. $9862. Responsible for 100%.
- Immersive Space to Think (IST): Combining Virtual Reality and Analytics for Improved Sensemaking. 11/17-12/18. PI with Chris North (CS), Nicholas Polys (ARC), Tanu Mitra (CS), and Mike Horning (COMM). Funded by the Data & Decisions Destination Area at Virginia Tech. $10,000. Responsible for 100%.
- Evaluating the Effectiveness of Virtual Environments for Decision Support in Construction Planning. 6/2002-5/2003. Co-PI with Walid Thabet (PI, BC). Funded by Virginia Tech ASPIRES program. $56,500. Responsible for 50%.
- Virtual Reality Exposure to Treat Phobias in Children and Adolescents. 6/2002-5/2003. Co-PI with Thomas Ollendick (PI) and Alison Shortt (Psychology). Funded by Virginia Tech ASPIRES program. $38,490. Responsible for 50%.

PUBLICATIONS

Books and Monographs:

1. LaViola, J., Kruijff, E., McMahan, R., **Bowman, D.**, and Poupyrev, I. *3D User Interfaces: Theory and Practice (2nd edition)*. Pearson, Boston, 2017.
2. **Bowman, D.**, Kruijff, E., LaViola, J., and Poupyrev, I. *3D User Interfaces: Theory and Practice*. Addison-Wesley, Boston, 2005. (Also translated to Japanese and Chinese)

Book Chapters:

1. **Bowman, D.**, Kopper, R., and Bacim, F. Effortless 3D Selection through Progressive Refinement. In Sherman, W. (Ed.). *VR Developer Gems*. AK Peters/CRC Press, New York, 2019, pp. 211-227. DOI: https://doi.org/10.1201/b21598
2. Apostolellis, P., **Bowman, D.**, and Chmiel, M. Supporting Social Engagement for Young Audiences with Serious Games and Virtual Environments in Museums. In Vermeeren A., Calvi L., Sabiescu A. (Eds.). *Museum Experience Design*. Springer Series on Cultural Computing. Springer, Cham, 2018, pp. 19-43. DOI: https://doi.org/10.1007/978-3-319-58550-5_2

3. McMahan, R., Kopper, R., and **Bowman, D.** Principles for Designing Effective 3D Interaction Techniques. In Hale, K. and Stanney, K. (Eds.). *Handbook of Virtual Environments: Design, Implementation, and Applications (2nd Edition)*, CRC Press, Boca Raton, Florida, 2015, pp. 285-311.
4. Steed, A. and **Bowman, D.** Displays and Interaction for Virtual Travel. In Steinicke, F., Visell, Y., Campos, J., Lécuyer, A. (Eds.), *Human Walking and Virtual Environments*. Springer, 2013.
5. **Bowman, D.** 3D User Interfaces. In Soegaard, M. and Dam, R. (Eds.), *The Encyclopedia of Human-Computer Interaction, 2nd Ed.*, The Interaction Design Foundation, Aarhus, Denmark, 2013. Available online at: http://www.interaction-design.org/encyclopedia/3d_user_interfaces.html
6. Thabet, W., Shiratuddin, M., and **Bowman, D.** Virtual Reality in Construction: A Review. In Topping, B. and Bittnar, Z. (Eds.), *Engineering Computational Technology*, Saxe-Coburg, Stirling, Scotland, 2002, pp. 25-52. Available at: http://people.cs.vt.edu/~bowman/papers/construction_book_chapter.pdf
7. **Bowman, D.** Principles for the Design of Performance-Oriented Interaction Techniques. In Stanney, K. (Ed.). *Handbook of Virtual Environments*, Lawrence Erlbaum, Mahwah, New Jersey, 2002, pp. 277-300. Available at: http://people.cs.vt.edu/~bowman/papers/hvet.pdf
8. **Bowman, D.** Conceptual Design Space: Beyond Walk-through to Immersive Design. In Bertol, D. *Designing Digital Space: An Architect's Guide to Virtual Reality*. John Wiley & Sons, New York, 1996, pp. 225-236.

Edited Books and Proceedings:

1. Fröhlich, B., **Bowman, D.**, and Iwata, H. (eds.). Proceedings of the IEEE Virtual Reality Conference (VR), 2006.
2. Kitamura, Y., **Bowman, D.**, Fröhlich, B., and Stürzlinger, W. (eds.). Proceedings of the IEEE Symposium on 3D User Interfaces (3DUI), 2006.
3. **Bowman, D.**, Fröhlich, B., Kitamura, Y., and Stürzlinger, W. (eds.). New Directions in 3D User Interfaces. Shaker-Verlag, 2005.
4. Thabet, W. and **Bowman, D.** (eds.). Proceedings of the Conference on Construction Applications of Virtual Reality, 2003.

Guest-Edited Special Issues:

1. Fröhlich, B. and **Bowman, D.** Guest Editors' Introduction: 3D User Interfaces. *IEEE Computer Graphics & Applications* (CG&A), vol. 29, no. 6, November/December 2009, pp. 24-25. DOI: http://dx.doi.org/10.1109/MCG.2009.113
2. **Bowman, D.**, Fröhlich, B., Kitamura, Y., and Stürzlinger, W. Current Trends in 3D User Interface Research. Introduction to Special Section on 3D User Interfaces. *International Journal of Human-Computer Studies* (IJHCS), vol. 67, no. 3, 2009, pp. 223-224. DOI: http://dx.doi.org/10.1016/j.ijhcs.2008.10.003
3. Fröhlich, B., **Bowman, D.**, and Iwata, H. Guest Editors' Introduction: Special Section on Virtual Reality. *IEEE Transactions on Visualization and Computer Graphics* (TVCG), vol. 13, no. 3, 2007, pp. 420-421. DOI: http://dx.doi.org/10.1109/TVCG.2007.70419
4. **Bowman, D.** and Billinghurst, M. Special Issue on 3D Interaction in Virtual and Mixed Realities: Guest Editors' Introduction. *Virtual Reality*, vol. 6, no. 3, 2002, pp. 105-106. DOI: http://dx.doi.org/10.1007/s100550200011

Dissertation and Thesis:

1. **Bowman, D.** Interaction Techniques for Common Tasks in Immersive Virtual Environments: Design, Evaluation, and Application. Ph.D. dissertation, Georgia Institute of Technology, 1999. Available at: http://people.cs.vt.edu/~bowman/thesis/thesis.pdf
2. **Bowman, D.** Performance Analysis of the Conch Concurrent Computing System. Undergraduate honors thesis, Emory University Department of Mathematics and Computer Science, 1994.

Refereed Journals:

1. Pavanatto, L., Lu, F., North, C., and **Bowman, D.** Multiple Monitors or Single Canvas? Evaluating Window Management and Layout Strategies on Virtual Displays. To appear in *IEEE Transactions on Visualization and Computer Graphics* (TVCG), 2024.
2. Pavanatto, L., Davari, S., Badea, C., Stoakley, R., & **Bowman, D.** Virtual Monitors vs. Physical Monitors: an Empirical Comparison for Productivity Work. *Frontiers in Virtual Reality*, *4*, 2023. DOI: https://doi.org/10.3389/frvir.2023.1215820
3. Gardony, A. L., Okano, K., Hughes, G. I., Kim, A. J, Renshaw, K. T., Sipolins, A., Whitig, A.W., Lu, F., & **Bowman, D.** Characterizing Information Access Needs in Gaze-Adaptive Augmented Reality Interfaces: Implications for Fast-Paced and Dynamic Usage Contexts. *Human–Computer Interaction*, 2023. DOI: https://doi.org/10.1080/07370024.2023.2260788
4. Giovannelli, A., Thomas, J., Lane, L., Rodrigues, F., and **Bowman, D.** Gestures vs. Emojis: Comparing Non-Verbal Reaction Visualizations for Immersive Collaboration. *IEEE Transactions on Visualization and Computer Graphics* (TVCG), Special Issue on Proceedings of IEEE ISMAR, 2023. DOI: https://doi.org/10.1109/TVCG.2023.3320254
5. Lisle, L., Davidson, K., Gitre, E., North, C., and **Bowman, D.** Different Realities: A Comparison of Augmented and Virtual Reality for the Sensemaking Process. *Frontiers in Virtual Reality*, vol. 4, 2023, 16 pages. DOI: https://doi.org/10.3389/frvir.2023.1177855
6. Ogunseiju, O., Akanmu, A., Bairaktarova, D., **Bowman, D.**, and Jazizadeh, F. Assessment of Interactive Holographic Scenes in Learning Applications of Sensing Technologies in Construction Education. To appear in *Journal of Civil Engineering Education*, 2023.
7. Davidson, K., Lisle, L., Whitley, K., **Bowman, D.**, and North, C. Exploring the Evolution of Sensemaking Strategies in Immersive Space to Think. *IEEE Transactions on Visualization and Computer Graphics*, 2022, 15 pages. DOI: https://doi.org/10.1109/TVCG.2022.3207357
8. Li, Y., Tahmid, I., Lu, F., and **Bowman, D.** Evaluation of Pointing Ray Techniques for Distant Object Referencing in Model-Free Outdoor Collaborative Augmented Reality. *IEEE Transactions on Visualization and Computer Graphics*, vol. 28, no. 11, 2022, pp. 3896-3906. DOI: https://doi.org/10.1109/TVCG.2022.3203094
9. Ogunseiju, O., Akanmu, A., Bairaktarova, D., **Bowman, D.**, and Jazizadeh, F. Mixed Reality Environment for Learning Sensing Technology Applications in Construction: A Usability Study. *Advanced Engineering Informatics*, vol. 53, 101637, 2022, 18 pages. DOI: https://doi.org/10.1016/j.aei.2022.101637
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10. Davari, S., Lu, F., and **Bowman, D.** Validating the Benefits of Glanceable and Context-Aware Augmented Reality for Everyday Information Access Tasks. In *Proceedings of the IEEE Conference on Virtual Reality and 3D User Interfaces* (VR), 2022, 9 pages.
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5. Phan, T., **Bowman, D.**, and Lee, S. Integrating Traditional Input Devices to Support Rapid Ideation in an Augmented-reality-based Brainstorming. In *Proceedings of the ACM Symposium on Spatial User Interaction* (SUI), 2022, Article no. 30, pp. 1-2. DOI: https://doi.org/10.1145/3565970.3567692 (Best Poster Award)
6. Lisle, L., Lu, F., Davari, S., Tahmid, I., Giovannelli, A., Ilo, C., Pavanatto, L., Zhang, L., Schlueter, L, and **Bowman, D.** Clean the Ocean: An Immersive VR Experience Proposing New Modifications to Go-Go and WiM Techniques. Contest abstract in *Proceedings of the IEEE Conference on Virtual Reality and 3D User Interfaces* (VR), 2022, 2 pages. DOI: http://doi.org/10.1109/VRW55335.2022.00311
7. **Bowman, D.**, Gabbard, J., Roofigari-Esfahan, N., Adapa, K., Auerbach, D., Britt, K., and Ilo, C. BuildAR: A Proof-of-Concept Prototype of Intelligent Augmented Reality in Construction. In *Proceedings of the 1st International Workshop on eXtended Reality for Industrial and Occupational Supports (XRIOS)* at IEEE VR, 2022, 5 pages.

8. Gutkowski, N., Quigley, P., Ogle, J., Hicks, D., Taylor, J., Tucker, T., and **Bowman, D.** Designing Historical Tours for Head-Worn AR. In *Proceedings of the 1st IEEE International Workshop on Mixed Reality Implications on Cultural Heritage Experience (MrICHE)* at IEEE ISMAR, 2021, 9 pages.
9. Zhang, L., Davari, S., Gutkowski, N., Lisle, L., Lu, F., Schlueter, L., Tahmid, I., and **Bowman, D.** Fantastic Voyage 2021: Using Interactive VR Storytelling to Explain Targeted COVID-19 Vaccine Delivery to Antigen-Presenting Immune Cells. Contest abstract in *Proceedings of the IEEE Conference on Virtual Reality and 3D User Interfaces* (VR), 2021, 2 pages.
10. Ilo, C., Zeng, W., and **Bowman, D.** Virtual Loupes: An Augmented Reality Aid for Microsurgery. Poster abstract in *Proceedings of the IEEE Conference on Virtual Reality and 3D User Interfaces* (VR), 2021, 2 pages.
11. Li, Y., Hicks, D., Lages, W., Lee, S., Sharma, A., and **Bowman, D.** ARCritique: Supporting Remote Design Critique of Physical Artifacts through Collaborative Augmented Reality. Poster abstract in *Proceedings of the IEEE Conference on Virtual Reality and 3D User Interfaces* (VR), 2021, 2 pages.
12. Zhang, L. and **Bowman, D.** Designing Immersive Virtual Reality Stories with Rich Characters and High Interactivity to Promote Learning of Complex Immunology Concepts. In *Proceedings of the 6th Annual Workshop on K-12+ Embodied Learning through Virtual and Augmented Reality (KELVAR)* at IEEE VR, 2021, 4 pages.
13. Davari, S., Lu, F., Li, Y., Lisle, L., Zhang, L., Feng, X., Blustein, L., and **Bowman, D.** Integrating Everyday Proxy Objects in Multi-Sensory Virtual Reality Storytelling. In *Proceedings of the Everyday Proxy Objects for Virtual Reality Workshop* at CHI 2020, 5 pages.
14. Bandyopadhyay, P., Lisle, L., North, C., **Bowman, D.**, and Polys, N. Immersive Space to Think: The Role of 3D Space for Sensemaking. In *Proceedings of the Immersive Analytics: Envisioning Future Productivity for Immersive Analytics Workshop* at CHI 2020, 5 pages.
15. Lisle, L., Chen, X., Gitre, E., North, C., and **Bowman, D.** Evaluating the Benefits of the Immersive Space to Think. In *Proceedings of the Workshop on Everyday Virtual Reality* at IEEE Conference on Virtual Reality and 3D User Interfaces (VR), 2020, 7 pages.
16. Davari, S., Lu, F., and **Bowman, D.** Occlusion Management Techniques for Everyday Glanceable AR Interfaces. In *Proceedings of the Workshop on Everyday Virtual Reality* at IEEE Conference on Virtual Reality and 3D User Interfaces (VR), 2020, 7 pages.
17. Pavanatto, L., Lu, F., Davari, S., Harris, E., Folino, A., Imamov, S., Chekuri, S., Blustein, L., Lages, W., and **Bowman, D.** Get the Job! An Immersive Simulation of Sensory Overload. Contest abstract in *Proceedings of the IEEE Conference on Virtual Reality and 3D User Interfaces* (VR), 2020, 2 pages.
18. Lages, W. and **Bowman, D.** An Adaptive Interface for Spatial Augmented Reality Workspaces. Demo abstract in *Proceedings of ACM Symposium on Spatial User Interaction* (SUI), 2019. (Best demo award)
19. Davari, S., Li, Y., Lisle, L., Lu, F., Zhang, L., Blustein, L., Feng, X., Gabaldon, B., Kwiatkowski, M., and **Bowman, D.** Save the Space Elevator: An Escape Room Scenario Involving Passive Haptics in Mixed Reality. Contest abstract in *Proceedings of the IEEE Conference on Virtual Reality and 3D User Interfaces* (VR), 2019, pp. 1405-1406. DOI: https://doi.org/10.1109/VR.2019.8798051
20. Yu, R. and **Bowman, D.** Force Push: Exploring Expressive Gesture-to-Force Mappings for Indirect 3D Object Manipulation. Poster abstract in *Proceedings of IEEE Conference on Virtual Reality and 3D User Interfaces* (VR), 2018, pp. 733-734. DOI: https://doi.org/10.1109/VR.2018.8446453
21. Lages, W., Li, Y., and **Bowman, D.** Evaluation of Environment-Independent Techniques for 3D Position Marking in AR. Poster abstract in *Proceedings of IEEE Conference on Virtual Reality and 3D User Interfaces* (VR), 2018, pp. 615-616. DOI: https://doi.org/10.1109/VR.2018.8446055
22. Warren, L. and **Bowman, D.** User Experience with Semi-Natural Locomotion Techniques in Virtual Reality: the Case of the Virtuix Omni. Poster abstract in *Proceedings of the ACM Symposium on Spatial User Interaction* (SUI), 2017, p. 163. DOI: https://doi.org/10.1145/3131277.3134359
23. Nabiyouni, M. and **Bowman, D.** A Taxonomy for Designing Walking-based Locomotion Techniques for Virtual Reality. Workshop on Immersive Analytics, in *Companion Proceedings of the ACM*

Symposium on Interactive Surfaces and Spaces (ISS), 2016, pp. 115-121. DOI: https://doi.org/10.1145/3009939.3010076

24. Lages, W., Laha, B., Miller, W., Novotny, J., Laidlaw, D., Socha, J., and **Bowman, D.** Effects of field of regard and stereoscopy and the validity of MR simulation for visual analysis of scientific data. Poster abstract in *Proceedings of IEEE Virtual Reality* (VR), 2016, pp. 215-216. DOI: http://dx.doi.org/10.1109/VR.2016.7504730
25. Lages, W., Arango, G., Laidlaw, D., Socha, J., and **Bowman, D.** Designing capsule, an input device to support the manipulation of biological datasets. Poster abstract in *Proceedings of the IEEE Symposium on 3D User Interfaces* (3DUI), 2016, pp. 255-256. DOI: http://dx.doi.org/10.1109/3DUI.2016.7460067
26. Apostolellis, P., **Bowman, D.**, and Chmiel, M. Supporting Social Engagement for Young Audiences with Serious Games and Virtual Environments in Museums. In the proceedings of the workshop "Involving the Crowd in Future Museum Experience Design" at CHI 2016. https://museumsandcrowds.files.wordpress.com/2016/02/supporting-social-engagement-for-young-audiences_apostolellis.pdf
27. Lages, W., Nabiyouni, M., Tibau, J., and **Bowman, D.** Interval Player: Designing a Virtual Musical Instrument Using In-Air Gestures. Contest abstract in *Proceedings of IEEE Symposium on 3D User Interfaces* (3DUI), 2015, pp. 203-204. DOI: http://dx.doi.org/10.1109/3DUI.2015.7131771
28. Nabiyouni, M., Saktheeswaran, A., **Bowman, D.**, and Karanth, A. Comparing the Performance of Natural, Semi-Natural, and Non-Natural Locomotion Techniques in Virtual Reality. Poster abstract in *Proceedings of IEEE Virtual Reality* (VR), 2015, pp. 243-244. DOI: http://dx.doi.org/10.1109/VR.2015.7223386
29. Kohlbrecher, S., Conner, D., Romay, A., Bacim, F., **Bowman, D.**, and von Stryk, O. Overview of Team ViGIR's Approach to the Virtual Robotics Challenge. Abstract in the *IEEE International Symposium on Safety, Security, and Rescue Robotics*, 2013, pp. 1-2. DOI: http://dx.doi.org/10.1109/SSRR.2013.6719382
30. Singh, G., **Bowman, D.**, Hicks, D., Cline, D., Ogle, J.T., Johnson, A., Zlokas, R., and Ragan, E. CI-Spy: Using mobile-AR for Scaffolding Historical Inquiry Learning. Poster abstract in *Proceedings of IEEE International Symposium on Mixed and Augmented Reality* (ISMAR), 2014, pp. 73-74. DOI: http://dx.doi.org/10.1109/ISMAR-AMH.2014.6935444
31. Laha, B. and **Bowman, D.** Design of the Bare-Hand Volume Cracker for Analysis of Raw Volumetric Data. Workshop on Interactive Volume Interaction, IEEE Virtual Reality (VR), 2014.
32. Nabiyouni, M., Laha, B., and **Bowman, D.** Poster: Designing Effective Travel Techniques with Bare-Hand Interaction. Poster abstract in *Proceedings of IEEE Symposium on 3D User Interfaces* (3DUI), 2014, pp. 139-140. (honorable mention, best poster award) DOI: http://dx.doi.org/10.1109/3DUI.2014.6798859
33. Bacim, F., Nabiyouni, M., and **Bowman, D.** Slice-n-Swipe: A Free-Hand Gesture User Interface for 3D Point Cloud Annotation. Contest abstract in *Proceedings of IEEE Symposium on 3D User Interfaces* (3DUI), 2014, pp. 185-186. DOI: http://dx.doi.org/10.1109/3DUI.2014.6798882
34. Laha, B. and **Bowman, D.** Interactive Coarse Segmentation and Analysis of Volume Data with a Suite of 3D Interaction Tools. Workshop on Interactive Volume Interaction, IEEE Virtual Reality (VR), 2013.
35. Leal, A., Wood, A., and **Bowman, D.** Pixelbending: Using Nuanced, Continuous Gestures with Off-the-Shelf Tracking Devices. Workshop on Off-the-Shelf Virtual Reality, IEEE Virtual Reality (VR), 2013.
36. Laha, B. and **Bowman, D.** Volume Cracker: A Bimanual 3D Interaction Technique for Analysis of Raw Volumetric Data. Poster abstract in *Proceedings of IEEE Symposium on 3D User Interfaces* (3DUI), 2013, pp. 147-148. DOI: http://dx.doi.org/10.1109/3DUI.2013.6550221
37. Leal, A. and **Bowman, D.** 3D Sketching and Flexible Input for Surface Design: a Case Study. Poster abstract in *Proceedings of IEEE Symposium on 3D User Interfaces* (3DUI), 2013, pp. 149-150. DOI: http://dx.doi.org/10.1109/3DUI.2013.6550222

38. Laha, B. and **Bowman, D.** Identifying the Benefits of Immersion in Virtual Reality for Volume Data Visualization. Workshop on Immersive Visualization, IEEE Virtual Reality (VR), 2012.
39. Ragan, E., Wilkes, C., Cao, Y., and **Bowman, D.** The Effects of Virtual Character Animation on Spatial Judgments. Poster abstract in *Proceedings of IEEE Virtual Reality* (VR), 2012, pp. 141-142. DOI: http://dx.doi.org/10.1109/VR.2012.6180921
40. Lee, C., Gauglitz, S., Höllerer, T., and **Bowman, D.** Examining the Equivalence of Simulated and Real AR on a Visual Following and Identification Task. Poster abstract in *Proceedings of IEEE Virtual Reality* (VR), 2012, pp. 77-78. DOI: http://dx.doi.org/10.1109/VR.2012.6180890
41. Bacim, F., Ragan, E., Stinson, C., Scerbo, S., and **Bowman, D.** Collaborative Navigation in Virtual Search and Rescue. Contest abstract in *Proceedings of IEEE Symposium on 3D User Interfaces* (3DUI), 2012, pp. 187-188. DOI: http://dx.doi.org/10.1109/3DUI.2012.6184224
42. Apostelellis, P., Laha, B., and **Bowman, D.** A Gaming Interface Using Body Gestures for Collaborative Navigation. Contest abstract in *Proceedings of IEEE Symposium on 3D User Interfaces* (3DUI), 2012, pp. 185-186. DOI: http://dx.doi.org/10.1109/3DUI.2012.6184223
43. Leal, A. and **Bowman, D.** Design Considerations for Fabric-Based Input for Surface Design. Poster abstract in *Proceedings of IEEE Symposium on 3D User Interfaces* (3DUI), 2012, pp. 149-150. DOI: http://dx.doi.org/10.1109/3DUI.2012.6184205
44. Stinson, C., Kopper, R., Scerbo, S., Ragan, E., and **Bowman, D.** The Effects of Visual Realism on Training Transfer in Immersive Virtual Environments. Poster presented at the ASNE Human Systems Integration Symposium, 2011. (Best poster award)
45. **Bowman, D.**, McMahan, R., Stinson, C., Ragan, E., Scerbo, S., Höllerer, T., Lee, C., and Kopper, R. Evaluating effectiveness in virtual environments with MR simulation. Marine Corps Warfighting Laboratory Workshop on Physiological Metrics of Immersion, 2011.
46. Bacim, F., Stinson, C., Laha, B., and **Bowman, D.** Building Blocks: A Novel Metaphor for Solving 3D Puzzles. . Contest abstract in *Proceedings of IEEE Symposium on 3D User Interfaces* (3DUI), 2011, pp. 127-128. DOI: http://dx.doi.org/10.1109/3DUI.2011.5759238
47. Kopper, R., Stinson, C., and **Bowman, D.** Towards an Understanding of the Effects of Amplified Head Rotations. *Proceedings of Workshop on Perceptual Illusions in Virtual Environments* at IEEE Virtual Reality (VR), 2011, pp. 10-15. Available at: http://people.cs.vt.edu/kopper/papers/PIVE.pdf
48. Lee, C., Bonebrake, S., Höllerer, T., and **Bowman, D.** A Replication Study Testing the Validity of AR Simulation in VR for Controlled Experiments. Poster presented at the IEEE/ACM International Symposium on Augmented and Mixed Reality (ISMAR), 2009. DOI: http://dx.doi.org/10.1109/ISMAR.2009.5336464
49. Ragan, E., Wilkes, C, **Bowman, D.**, and Höllerer, T. Simulation of Augmented Reality Systems in Purely Virtual Environments. Poster abstract in *Proceedings of IEEE Virtual Reality* (VR), 2009. DOI: http://dx.doi.org/10.1109/VR.2009.4811058
50. Chen, J., **Bowman, D.**, and Laidlaw, D. A Hybrid Direct Visual Editing Method for Architectural Massing Study in Virtual Environments. Poster abstract in *Proceedings of IEEE Symposium on 3D User Interfaces* (3DUI), 2009. DOI: http://dx.doi.org/10.1109/3DUI.2009.4811227
51. Wingrave, C. and **Bowman, D.** CHASM: Bridging Description and Implementation of 3D Interfaces. *Proceedings of the Workshop on New Directions in 3D User Interfaces* at IEEE Virtual Reality (VR), 2005, pp. 85-88. Available at: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.123.4454&rep=rep1&type=pdf
52. **Bowman, D.** and Raja, D. A Method for Quantifying the Benefits of Immersion Using the CAVE. *Presence-Connect* (online journal), vol. 4, no. 2, 2004.

53. Polys, N., **Bowman, D.**, and North, C. Information-Rich Virtual Environments: Challenges and Outlook. NASA Virtual Iron Bird Workshop, NASA Ames, 2004.
54. **Bowman, D.**, Gracey, M., and Lucas, J. Efficient, Intuitive User Interfaces for Classroom-Based Immersive Virtual Environments. Poster abstract in *Proceedings of IEEE Virtual Reality* (VR), 2004, pp. 219-220. DOI: http://dx.doi.org/10.1109/VR.2004.1310078
55. Parrott, M., **Bowman, D.**, and Ollendick, T. A Methodology for Designing Specific Animal Phobia Stimuli for Virtual Reality Exposure Therapy. *Proceedings of Cybertherapy*, 2004. (abstract)
56. Parrott, M., **Bowman, D.**, and Ollendick, T. An Immersive Virtual Environment for the Treatment of Ophidiophobia. *Proceedings of Cybertherapy*, 2004. (abstract)
57. Polys, N., **Bowman, D.**, Duca, K., Laubenbacher, R., and North, C. Interactive Visualization of Biological Databases Using Information-Rich Virtual Environments. Poster presented at Digital Biology: The Emerging Paradigm Symposium, National Institutes of Health, 2003.
58. Carroll, J., **Bowman, D.**, McCrickard, S., North, C., Pérez-Quiñones, M., and Rosson, M. Center for Human-Computer Interaction at Virginia Tech. *Proceedings of INTERACT: IFIP TC13 International Conference on Human-Computer Interaction*, 2003, pp. 1061-1062.
59. Pinho, M., **Bowman, D.**, and Freitas, C. Cooperative Object Manipulation in Immersive Virtual Environments. Paper presented at the Brazilian Thesis and Dissertations Forum in Computer Science, 2003.
60. Schafer, W., **Bowman, D.**, and Carroll, J. Map-Based Navigation in a Graphical MOO. *ACM Crossroads*, vol. 9, no. 1, 2002, pp. 8-15. DOI: http://dx.doi.org/10.1145/571758.571764
61. Wheeler, K. and **Bowman, D.** Evaluating an Educational Virtual Environment Application. Poster presented at the Annual Biomedical Research Conference for Minority Students, 2002.
62. **Bowman, D.** Immersive Design Tools for Virtual Environments. Technical sketch, ACM SIGGRAPH, 1995 (refereed abstract).

Non-refereed Publications:

1. Kopper, R., **Bowman, D.**, and Silva, M. A Human Motor Behavior Model for Distant Pointing Tasks. Technical Report TR-08-26, Computer Science, Virginia Tech, 2008. Available at: http://eprints.cs.vt.edu/archive/00001086/
2. Kopper, R., Silva, M., McMahan, R., and **Bowman, D.** Increasing the Precision of Distant Pointing for Large High-Resolution Displays. Technical Report TR-08-17, Computer Science, Virginia Tech, 2008. Available at: http://eprints.cs.vt.edu/archive/00001024/
3. Badillo, B., **Bowman, D.**, McConnell, W., Ni, T., and Silva, M. Literature Survey on Interaction Techniques for Large Displays. Technical Report TR-06-21, Computer Science, Virginia Tech, 2006. Available at: http://eprints.cs.vt.edu/archive/00000925/
4. Chen, J., **Bowman, D.**, Wingrave, C., and Lucas, J. Designing Explicit Numeric Input Interfaces for Immersive Virtual Environments. Technical Report TR-04-13, Computer Science, Virginia Tech, 2004. Available at: http://eprints.cs.vt.edu/archive/00000690/
5. **Bowman, D.**, Chennupati, B., Gracey, M., Pinho, M., and Wheeler, K. Using Virtual Environments in the Teaching of Computer Graphics. Technical Report TR-03-19, Computer Science, Virginia Tech, 2003. Available at: http://eprints.cs.vt.edu/archive/00000665/
6. **Bowman, D.**, Gracey, M., Lucas, J., Setareh, M,, and Varadarajan, S. Immersive Virtual Environments for University Education: Views from the Classroom. Technical Report TR-03-18, Computer Science, Virginia Tech, 2003. Available at: http://eprints.cs.vt.edu/archive/00000664/

7. Melanson, B., Kelso, J., and **Bowman, D.** Effects of Active Exploration and Passive Observation on Spatial Learning in a CAVE. Technical Report TR-02-15, Computer Science, Virginia Tech, 2002. Available at: http://eprints.cs.vt.edu/archive/00000602/
8. Wingrave, C., **Bowman, D.**, and Ramakrishnan, N. Personalized Nuance-Oriented Interaction in Virtual Environments. Technical Report TR-01-24b, Computer Science, Virginia Tech, 2001. Available at: http://eprints.cs.vt.edu/archive/00000570/
9. Wingrave, C., **Bowman, D.**, and Ramakrishnan, N. Affordances and Feedback in Nuance-Oriented Interfaces. Technical Report TR-01-22, Computer Science, Virginia Tech, 2001. Available at: http://eprints.cs.vt.edu/archive/00000546/
10. **Bowman, D.**, Ly, V., and Campbell, J. Pinch Keyboard: Natural Text Input for Immersive Virtual Environments. Technical Report TR-01-15, Computer Science, Virginia Tech, 2001. Available at: http://eprints.cs.vt.edu/archive/00000540/
11. **Bowman, D.** Interaction Techniques for Immersive Virtual Environments: Design, Evaluation, and Application. Presented at the Human-Computer Interaction Consortium (HCIC) Conference, 1998.
12. **Bowman, D.**, Wineman, J., and Hodges, L. Exploratory Design of Animal Habitats Within an Immersive Virtual Environment. Graphics, Visualization, and Usability Center Technical Report GIT-GVU-98-06, 1998. Available at: http://hdl.handle.net/1853/3443
13. **Bowman, D.** and Hodges, L. User Interface Constraints for Immersive Virtual Environments Applications. Graphics, Visualization, and Usability Center Technical Report GIT-GVU-95-26, 1995. Available at: http://hdl.handle.net/1853/3571
14. **Bowman, D.** and Hodges, L. WiMP (Widgets, Menus, and Pointing) Design Tools for Virtual Environments. Graphics, Visualization, and Usability Center Technical Report GIT-GVU-94-37, 1994. Available at: http://hdl.handle.net/1853/3603
15. Sunderam, V., Schmidt, B., Schmidt, M., Topol, B., Ferrari, A., and **Bowman, D.** The Conch User Interface. Emory University Department of Mathematics and Computer Science Technical Report CSTR-940301, 1994.

PATENTS

1. Piemonte, P., Kienzle, W., **Bowman, D.**, Budhram, S., Sapre, M., Leizerovich, V., and de Rocha Rosario, D. Systems and methods for relative representation of spatial objects and disambiguation in an interface. US Patent US10558037B2, 2020, European Patent EP3491548A1, 2019.
2. Kienzle, W. and **Bowman, D.** Command Processing Using Multimodal Signal Analysis. US Patent 10,832,031, 2020.

ADDITIONAL SCHOLARLY OUTPUT

Significant Invited Lectures:

1. Lessons Learned from 15 Years of Fundamental Research on Immersive Training and Tactical AR. Keynote address at the Interservice/Industry Training, Simulation, and Education Conference (I/ITSEC), November 2023.
2. Designing Augmented Reality for the Future of Work. Keynote address at the International Symposium on Visual Computing (ISVC), October 2022.
3. User Experience Considerations for Everyday Augmented Reality. Cray Distinguished Colloquium at the University of Minnesota, November 2021.

4. User Experience Considerations for Everyday Augmented Reality. Keynote address at the IEEE International Symposium on Mixed and Augmented Reality (ISMAR), October 2021.
5. Preparing for an Always-On Augmented Reality Future. Keynote address at the ACM Symposium on Virtual Reality Software and Technology (VRST), November 2020.
6. Augmented Reality as the Future of Personal Computing. Frontiers in Virtual Reality Online Seminar Series, May 2020.
7. Augmented Reality as the Future of Personal Computing. ISTeC Distinguished Lecture at Colorado State University, October 2019.
8. Immersive Analytics Beyond Visualization. Dept. of Computer Science Distinguished Lecture at Colorado State University, October 2019.
9. Research Challenges in 3D User Interfaces for Extended Reality. XR Advance Lecture Series, January 2019.
10. Immersive Analytics Beyond Visualization. HCI keynote address at Graphics Interface (GI '18), May 2018.
11. User experience in the (new) VR and AR revolution. Distinguished Alumni lecture, Georgia Institute of Technology GVU Center, October 2016
12. Designing Reality and Magic: Explorations in Virtual and Augmented Reality. Distinguished Colloquium, University of Maryland Computer Science Department, September 2014.
13. Considering the Importance of Realism in Virtual Reality. Evans-Hall Lecture at Emory University, April 2013.
14. Reconsidering the Importance of Realism in Virtual Reality. Invited keynote address at the Joint Virtual Reality Conference (JVRC), Madrid, Spain, October 2012.
15. Simulating Mixed Reality Systems to Evaluate the Effects of Display Fidelity. Invited keynote address at the annual workshop of the Association Française de Réalité Virtuelle, Augmentée, Mixte et d'Interaction 3D (AFRV; French Association for Virtual, Augmented, and Mixed Reality and 3D Interaction), Paris, France, December 2010.
16. Simulating Mixed Reality Systems to Evaluate the Effects of Display Fidelity. Invited keynote address at the ChinaVR conference, Shanghai, China, October 2010.
17. VR and beyond: Increasing the Impact of VR and 3D Interaction Research in the Real World. Invited keynote address at the X Symposium on Virtual and Augmented Reality (SVR), João Pessoa, Brazil, May 2008.
18. VR and beyond: Increasing the Impact of VR Research in the Real World. Invited keynote address at the INTUITION international conference and workshop, Athens, Greece, October 2007.
19. Engineering in Three Dimensions: Immersive Virtual Environments, Interactivity, and 3D User Interfaces for Engineering Applications. Invited keynote address at the American Society of Civil Engineers (ASCE) GeoCongress, Atlanta, Georgia, March 2006.

Other Presentations and Talks:

1. An Introduction to AR/VR for Medical Training and Practice. Presentation to the Board of Directors of the American Academy of Orthopaedic Surgeons, June 2021.
2. Advancing Immersive Technology in Clinical Workflows with Gaze-Based Interfaces. With Cory Ilo and Waylon Zeng. Webinar presented by Varjo Technologies Inc., February 2021.
3. Beyond Zoom: Towards Effective Remote Collaboration in the COVID-19 Pandemic. With Yuan Li and Sang Won Lee. Virginia Tech Department of Computer Science seminar, October 2020.

4. User Experience for Everyday, Always-On Augmented Reality. Invited talk at the MAVRIC online conference, September 2020.
5. Immersive Analytics Beyond Visualization. Invited talk at the National Renewable Energy Laboratory, Golden, Colorado, July 2018.
6. Immersive Analytics Beyond Visualization. Invited lecture at the Keck Institute for Space Studies Symposium on Virtual and Augmented Reality for Space Exploration, Pasadena, California, January 2018.
7. Designing Reality and Magic: Explorations in Virtual Reality and 3D Interaction. Worcester Polytechnic Institute, Worcester, Massachusetts, April 2015.
8. Designing Reality and Magic: Explorations in Virtual Reality and 3D Interaction. Apple, Inc., Cupertino, California, October 2014.
9. Reconsidering the Importance of Realism in Virtual Reality. Tech talk at Walt Disney Imagineering, Glendale, California, November 2013.
10. Reconsidering the Importance of Realism in Virtual Reality. Virginia Tech Dept. of Computer Science seminar, September 2012.
11. Evaluating the Effects of Immersion in Mixed Reality. Virginia Tech Dept. of Computer Science seminar, November 2009.
12. Exploring the Effects of Immersion in Virtual Reality. Invited seminar at the National Institute of Aerospace, Hampton, Virginia, September 2009.
13. Using Spatial Mappings in Immersive Virtual Reality to Memorize Abstract Sequences of Information. Invited presentation for the UCSB "SCRAM" series on spatial cognition research, Santa Barbara, California, April 2009.
14. Exploring the Effects of Immersion in Virtual Reality. UCSB Computer Science Seminar, Santa Barbara, California, December 2008.
15. VEs at Virginia Tech: Immersive Virtual Environments for Mining and Engineering Applications. Invited presentation at the NIOSH Workshop on Virtual Reality in Mine Training, Pittsburgh, Pennsylvania, July 2006.
16. Usable 3D: User Interface Design for Virtual Environments. Invited talk at the Robert Bosch Research and Technology Center, Palo Alto, California, November 2005.
17. The NSF CAREER Program: Experiences and Lessons Learned. Virginia Tech CAREER Workshop, April 2004.
18. Research in Human-Computer Interaction and Visualization/Virtual Environments. Virginia Tech College of Engineering Northern Virginia Showcase, March 2004.
19. Virtual Environments for Architecture and Construction: Research Challenges in 3D User Interface Design. Invited talk at the Department of Computer Science, University of Iowa, November 2003.
20. Immersive VEs for University Education: Views from the Classroom. Virginia Tech Instructional Design Program, October 2003.
21. Virtual Environments Research at Virginia Tech. College of Engineering Discovery Seminar, September 2003.
22. Immersive VEs for University Education: Views from the Classroom. Virginia Tech Virtual Environments Research Group, February 2003.
23. Virtual Environments Research in Virginia Tech Computer Science. Presentation to Computer Science Department Advisory Board, October 2002.

24. Research Methods in the Design and Evaluation of 3D User Interfaces. Department of Computer Science Research Methods Class, October 2001.
25. Current and Recent Research in the 3DI Group. Virginia Tech Virtual Environments Research Group, September 2001.
26. 3D User Interface Design: Enabling Highly Interactive Virtual Environments. Invited talk at the Virtual Reality International Conference, June 2001.
27. The Design and Evaluation of Three-Dimensional Interaction Techniques. Virginia Tech Department of Computer Science, November 2000.
28. Environmental Design Education in an Immersive Virtual Environment. Graphics, Visualization, and Usability Center, January 1998.
29. Interaction Techniques for Immersive Virtual Environments: Design, Evaluation, and Application. Invited talk at the Human Interface Technology (HIT) laboratory, University of Washington, June 1997.
30. Immersive Design Tools for Virtual Environments. Graphics, Visualization, and Usability Center, March 1995.

Short Courses:

1. LaViola, J., Kruijff, E., Poupyrev, I., and **Bowman, D.** 3D User Interfaces: Design, Implementation, Usability. Full-day course presented at ACM CHI, Boston, April 2009.
2. Kruijff, E., **Bowman, D.**, LaViola, J., and Poupyrev, I. 3D User Interfaces: From Lab to Living Room. Full-day course presented at ACM CHI, Florence, Italy, April 2008.
3. Kriz, R. and **Bowman, D.** Visualization and Virtual Environments. Presented within "Tools for Research and Presentation" workshop, Faculty Development Institute (FDI), Virginia Tech, July 2003.
4. Lockhart, J., Kriz, R., Kelso, J., Arsenault, L., **Bowman, D.**, and Sforza, P. Visualization and Virtual Environments. Three-day workshop, Faculty Development Institute (FDI), Virginia Tech, May 2002.
5. **Bowman, D.**, Kruijff, E., LaViola, J., Mine, M., and Poupyrev, I. Advanced Topics in 3D User Interface Design. Full-day course presented at ACM SIGGRAPH, Los Angeles, California, August 2001.
6. **Bowman, D.**, Kruijff, E., LaViola, J., Mine, M., and Poupyrev, I. 3D User Interface Design: Fundamental Techniques, Theory, and Practice. Full-day course presented at ACM SIGGRAPH, New Orleans, Louisiana, July 2000.
7. **Bowman, D.**, Kruijff, E., LaViola, J., and Poupyrev, I. The Art and Science of 3D Interaction. Full-day tutorial presented at the IEEE Virtual Reality Conference, New Brunswick, New Jersey, March 2000.
8. **Bowman, D.**, Kruijff, E., LaViola, J., and Poupyrev, I. The Art and Science of 3D Interaction. Full-day tutorial presented at the ACM Symposium on Virtual Reality Software and Technology, London, UK, December 1999.
9. **Bowman, D.**, Kruijff, E., LaViola, J., and Poupyrev, I. The Art and Science of 3D Interaction. Full-day tutorial presented at the IEEE Virtual Reality Conference, Houston, Texas, March 1999.

Workshops co-organized:

1. Pavanatto, L., Biener, V., Kalamkar, S., Nouri, N., Grubert, J., and **Bowman, D.** 1st Workshop on Extended Reality for Knowledge Work (xrWORKS). Workshop at IEEE Conference on Virtual Reality and 3D User Interfaces, 2024.

2. Gutkowski, N., **Bowman, D.**, Ogle, J., and Bautista Isaza, C. Designing Head-Worn AR Experiences for Cultural Heritage. Workshop at Digital Past Conference, online, 2021.
3. **Bowman, D.**, Fröhlich, B., Kitamura, Y., and Stürzlinger, W. New Directions in 3D User Interfaces. Workshop at IEEE Virtual Reality, Bonn, Germany, 2005.
4. Fröhlich, B., Kitamura, Y., and **Bowman, D.** Beyond Wand and Glove Based Interaction. Workshop at IEEE Virtual Reality, Chicago, 2004.
5. Broll, W., Schaefer, L., Höllerer, T., and **Bowman, D.** The Future of VR and AR Interfaces. Workshop at IEEE Virtual Reality, Yokohama, Japan, 2001.
6. Loftin, R., **Bowman, D.**, Cohen, P., Hix, D., Metaxas, D., and Rosenblum, L. Perceptual and Multi-Modal Interfaces. Workshop at IEEE Virtual Reality, New Brunswick, New Jersey, 2000.

Panels:

1. Peck, T., Bodenheimer, B., **Bowman, D.**, Lok, B., Nedel, L., and Steed, A. "Virtual Reality Curriculum." Panel presented at IEEE Virtual Reality (VR), Osaka, Japan, 2019 (refereed).
2. Figueroa, P., **Bowman, D.**, Suma, E., and Steed, A. "15 Years of Lessons from IEEE VR." Panel presented at IEEE Virtual Reality (VR), Greenville, SC, 2016 (refereed).
3. Figueroa, P., **Bowman, D.**, Suma, E., and Steed, A. "15 Years of Lessons from IEEE VR." Panel presented at the VR Developers Conference (VRDC), San Francisco, 2016 (refereed).
4. Jacobsen, J., Wingrave, C., **Bowman, D.**, Brooks, F., Jacob, R., LaViola, J., and Rizzo, A. Reconceptualizing "Virtual Reality": What is VR? Panel presented at IEEE Virtual Reality (VR), Waltham, MA, 2010 (refereed).
5. LaViola, J., **Bowman, D.**, Lok, B., Swan, E., Interrante, V., and Ellis, S. User Studies in VR: What Can We Learn From Them and What Are They Good For? Panel presented at IEEE Virtual Reality (VR), Reno, 2008 (refereed).
6. Hirose, M., **Bowman, D.**, Stuerzlinger, W., and Kitamura, Y. 3D User Interfaces: Present and Future. Panel presented at IEEE Symposium on 3D User Interfaces (3DUI), Reno, 2008 (invited).
7. May, R., Arya, P., **Bowman, D.**, Schmidt, G., and Sullivan, A. Challenges to Applying Virtual Reality Technology and Techniques to Visual Analytics. Panel presented at IEEE Virtual Reality (VR), Alexandria, 2006 (refereed).
8. Wingrave, C., **Bowman, D.**, Schmalsteig, D., Mine, M., Feiner, S., and Swan, E. Mixed Reality Interaction: The Continuum from Virtual to Augmented Reality. Panel presented at IEEE Virtual Reality (VR), Los Angeles, 2003 (refereed).

Demonstrations:

1. **Bowman, D.**, Gracanin, D., Wingrave, C., Chen, J., Polys, N., Ni, T., Kopper, R., and Kim, J. 3D Interaction Group Research. Lab exhibit at IEEE Virtual Reality (VR), 2006 (refereed).
2. Kooper, R., Watson, B., Hodges, L., Newton, G., Kessler, D., **Bowman, D.**, and Rothbaum, B. Overcoming Phobias Using Virtual Reality. Digital Bayou at ACM SIGGRAPH, 1996 (refereed).

Videos:

1. **Bowman, D.** and Hodges, L. WiMP Design Tools for Virtual Environments. Video proceedings of the IEEE Virtual Reality Annual International Symposium (VRAIS), 1995 (refereed).

ADVISING AND MENTORING

Post-Doctoral scholars:

1. Jerald Thomas, 2022-2023. Currently at University of Wisconsin-Milwaukee.
2. Gurjot Singh, 2014-2016. Currently at Fairleigh Dickinson University.

Current Ph.D. students:

1. Shakiba Davari, Ph.D. expected 2024.
2. Leonardo Pavanatto Soares, Ph.D. expected 2024.
3. Kylie Davidson, Ph.D. expected 2024 (co-advisor with Chris North).
4. Ibrahim Tahmid, Ph.D. expected 2025.
5. Cory Ilo, Ph.D. expected 2025.
6. Logan Lane, Ph.D. expected 2025.
7. Alexander Giovannelli, Ph.D. expected 2025.
8. Cherelle Conner, Ph.D. expected 2026.

Completed Ph.D. students:

1. Francielly Rodrigues, Ph.D. 2024 (from National Laboratory for Scientific Computing (LNCC), Brazil; I served as official co-advisor). Dissertation title: Advancing 3D Manipulation in Virtual Reality: Design and Evaluation of High-Precision Techniques and a Comprehensive Taxonomy.
2. Feiyu Lu, Ph.D. 2023. Dissertation title: Glanceable AR: Towards a Pervasive and Always-On Augmented Reality Future. Available at: http://hdl.handle.net/10919/115795. Currently at JP Morgan Chase.
3. Lorance (Lee) Lisle, Ph.D. 2022. Dissertation title: Immersive Space to Think: Immersive Analytics for Sensemaking with Non-Quantitative Datasets. Available at: http://hdl.handle.net/10919/113759. Currently at Virginia Tech National Security Institute.
4. Yuan Li, Ph.D. 2022. Dissertation title: Assisting Spatial Referencing for Collaborative Augmented Reality. Available at: http://hdl.handle.net/10919/110363. Currently at Apple.
5. Lei Zhang, individual interdisciplinary Ph.D. 2021. Dissertation title: Investigating Interactivity and Storytelling in Immersive Virtual Reality for Science Education. Available at: http://hdl.handle.net/10919/107808. Currently at Kennesaw State University.
6. Run Yu, Ph.D. 2019. Dissertation title: Designing Coherent Interactions for Virtual Reality. Available at http://hdl.handle.net/10919/93268. Currently at Magic Leap.
7. Wallace Lages, Ph.D. 2018. Dissertation title: Walk-Centric User Interfaces for Mixed Reality. Available at http://hdl.handle.net/10919/84460. Currently at Northeastern University.
8. Panagiotis Apostolellis, Ph.D. 2017. Dissertation title: Evaluating Group Interaction and Engagement using Virtual Environments and Serious Games for Student Audiences in Informal Learning Settings. Available at http://hdl.handle.net/10919/77413. Currently at University of Virginia.
9. Mahdi Nabiyouni, Ph.D. 2017. Dissertation title: How Does Interaction Fidelity Influence User Experience in VR Locomotion? Available at http://hdl.handle.net/10919/74945. Currently at start-up.
10. Felipe Bacim, Ph.D. 2015. Dissertation title: Increasing Selection Accuracy and Speed through Progressive Refinement. Available at http://hdl.handle.net/10919/56658. Currently at Apple.
11. Bireswar Laha, Ph.D. 2014. Dissertation title: Immersive Virtual Reality and 3D Interaction for Volume Data Analysis. Available at https://vtechworks.lib.vt.edu/handle/10919/51817.

12. Eric Ragan, Ph.D. 2013. Dissertation title: Supporting Learning through Spatial Information Presentations in Virtual Environments. Available at: http://hdl.handle.net/10919/23207. Currently at University of Florida.
13. Cha Lee (UCSB, co-advisor), Ph.D. 2012. Dissertation title: Mixed Reality Simulation.
14. Ryan McMahan, Ph.D. 2012. Dissertation title: Exploring the Effects of Higher-Fidelity Display and Interaction for Virtual Reality Games. Available at: http://scholar.lib.vt.edu/theses/available/etd-12162011-140224/. Currently at University of Central Florida.
15. Tao Ni (co-advisor with Chris North), Ph.D. 2011. Dissertation title: A Framework of Freehand Gesture Interaction: Techniques, Guidelines, and Applications. Available at: http://scholar.lib.vt.edu/theses/available/etd-09212011-230923/.
16. Régis Kopper, Ph.D. 2011. Dissertation title: Understanding and Improving Distal Pointing Interaction. Available at: http://scholar.lib.vt.edu/theses/available/etd-07012011-195812/ Currently at University of North Carolina-Greensboro.
17. Yi Wang, Ph.D. 2010. Dissertation title: Design and Evaluation of Contextualized Video Interfaces. Available at: http://scholar.lib.vt.edu/theses/available/etd-08252010-125536/
18. Chadwick Wingrave, Ph.D. 2008. Dissertation title: Concept-Oriented Design in Chasm: Conversational Domain Language Inspired 3D User Interface Design and Development. Available at: http://scholar.lib.vt.edu/theses/available/etd-08082008-140724/ Currently at Conquest Creations, LLC.
19. Andrew Ray, Ph.D. 2008. Dissertation title: The Interaction Framework for Innovation: A Method to Create Reusable Three-Dimensional Interaction Techniques. Available at: http://scholar.lib.vt.edu/theses/available/etd-05132008-210808/ Currently at Radford University.
20. Jian Chen, Ph.D. 2006. Dissertation title: Design and Evaluation of Domain-Specific Interaction Techniques in the AEC Domain for Immersive Virtual Environments. Available at: http://scholar.lib.vt.edu/theses/available/etd-11072006-200403/ Currently at the Ohio State University.
21. Nicholas Polys, Ph.D. 2006. Dissertation title: Display Techniques in Information-Rich Virtual Environments. Available at: http://scholar.lib.vt.edu/theses/available/etd-06152006-024611/ (Won CS Department Outstanding PhD Dissertation Award). Currently at Virginia Tech.
22. Wendy Schafer, Ph.D. 2004. Dissertation title: Enhancing Distributed, Spatial Collaboration: An Investigation of Representation Techniques. http://scholar.lib.vt.edu/theses/available/etd-04222004-142351/ (Won CS Department Outstanding PhD Dissertation Award).
23. Marcio Pinho, Ph.D. 2002 (from Federal University of Rio Grande do Sul, Brazil; served as official co-advisor). Dissertation title: Cooperative Object Manipulation in Immersive Virtual Environments. Available at: http://www.inf.pucrs.br/grv/projects/CollabVE/index.html. Currently at Pontifical Catholic University of Rio Grande do Sul.

Current M.S. students:

1. Daniel Stover, M.S. (ECE) expected 2024.

Completed M.S. students:

1. Nicolas Gutkowski, M.S. 2021 (co-advisor with Todd Ogle). Thesis title: Designing Cultural Heritage Experiences for Head-Worn Augmented Reality.
2. Nathaniel Llorens, M.S. 2021 (co-advisor with Sang Won Lee). Thesis title: Evaluating Collaborative Cues for Affinity Diagramming Tasks in Augmented Reality.

3. Tam Phan, M.S. 2021 (co-advisor with Sang Won Lee). Thesis title: Integrating Traditional Tools to Enable Rapid Ideation in an Augmented Reality Virtual Environment.
4. Leonardo Pavanatto Soares, M.S. 2019 (from Pontifical Catholic University of Rio Grande do Sul, Brazil; I served as official co-advisor).
5. Lawrence Warren, M.S. 2017. Thesis title: The Effect of Interaction Fidelity on User Experience in Virtual Reality Locomotion. Available at: http://hdl.handle.net/10919/83403
6. Siroberto Scerbo, M.S. 2015.
7. Cheryl Stinson, M.S. 2013. Thesis title: Virtual Reality for Sport Training. Available at: http://hdl.handle.net/10919/23179
8. Ajith Sowndararajan, M.S. 2008. Thesis title: Quantifying the Benefits of Immersion for Procedural Training. Available at: http://scholar.lib.vt.edu/theses/available/etd-07152008-140837/
9. Ryan McMahan, M.S. 2007. Thesis title: Exploring and Evaluating Task Sequences for System Control Interfaces in Immersive Virtual Environments. Available at: http://scholar.lib.vt.edu/theses/available/etd-06132007-143300/ (Won CS Department Outstanding Masters Thesis Award).
10. Brian Badillo, M.S. 2007. Thesis title: Migrating Three Dimensional Interaction Techniques. Available at: http://scholar.lib.vt.edu/theses/available/etd-05072007-141647/
11. Dheva Raja, M.S. 2006. Thesis title: The Effects of Immersion on 3D Information Visualization. Available at: http://scholar.lib.vt.edu/theses/available/etd-06072006-140038/
12. John Lucas, M.S. 2005. Thesis title: Techniques for Selecting Multiple Objects in Virtual Environments. Available at: http://scholar.lib.vt.edu/theses/available/etd-04192005-111302/ (Won CS Department Outstanding Masters Thesis Award)
13. Dhruv Manek, M.S. 2004. Thesis title: Effects of Visual Displays on 3D Interaction in Virtual Environments. Available at: http://scholar.lib.vt.edu/theses/available/etd-07102004-223917/
14. Ameya Datey, M.S., 2002. Thesis title: Experiments in the Use of Immersion for Information Visualization. Available at: http://scholar.lib.vt.edu/theses/available/etd-05092002-151043/
15. Chad Wingrave, M.S., 2001. Thesis title: Nuance-Oriented Interfaces in Virtual Environments. Available at: http://scholar.lib.vt.edu/theses/available/etd-08212001-155720/

Thesis and dissertation committees:

1. Mengting Ge (Ph.D., Landscape Architecture, expected)
2. Cassidy Nelson (Ph.D., Industrial & Systems Engineering, expected)
3. John Luksas (M.S., Industrial & Systems Engineering, expected)
4. Nanlin Sun (M.S., Creative Technologies, expected)
5. Cameron Moore (M.S., Computer Science, 2022)
6. Hye-Sung Moon (M.S., Industrial & Systems Engineering, 2022)
7. Setor Zilevu (Ph.D., Computer Science, 2022)
8. Alex Krasner (M.S., Computer Science, expected)
9. Archi Dasgupta (Ph.D., Computer Science, 2021)
10. Yanshen Sun (M.S., Computer Science, 2020)
11. JooYoung Whang (M.S., Computer Science, 2020)
12. Payel Bandyopadhyay (M.S., Computer Science, 2020)
13. Johannes Novotny (Ph.D., Computer Science, Brown University, 2020)

14. John Wenskovitch (Ph.D., Computer Science, 2019)
15. Ayat Mohammed (Ph.D. Computer Science, 2018)
16. Lauren Bradel (Ph.D. Computer Science, 2015)
17. Jia Wang (Ph.D. Computer Science, Worcester Polytechnic Institute, 2015)
18. Jeff Cashion (Ph.D. Computer Science, University of Central Florida, 2014)
19. Chao Peng (Ph.D. Computer Science, 2013)
20. Haeyong Chung (Ph.D. Computer Science, 2015)
21. Seung-In Park (Ph.D. Computer Science, 2013)
22. Ji-Sun Kim (Ph.D. Computer Science, 2013)
23. Alex Endert (Ph.D. Computer Science, 2012)
24. Christopher Andrews (Ph.D. Computer Science, 2011)
25. Tovi Grossman (Ph.D., Computer Science, University of Toronto, 2008)
26. Mehmet Dasiyici (M.S. Computer Science, 2008)
27. Brian Sciacchitano (M.S. Computer Science, 2008)
28. Sarah Peck (M.S. Computer Science, 2008)
29. Joseph Gabbard (Ph.D. Computer Science, 2008)
30. Niklas Elmqvist (Ph.D., Computer Science, Chalmers University of Technology, 2007; I served as the "opponent")
31. Beth Yost (Ph.D. Computer Science, 2007)
32. Robert Ball (Ph.D. Computer Science, 2006)
33. Lauren Shupp (M.S. Computer Science, 2006)
34. Régis Kopper (M.S., Computer Science, Pontifical Catholic University of Rio Grande do Sul, 2006).
35. Christa Chewar (Ph.D. Computer Science, 2004)
36. Jacob Somervell (Ph.D. Computer Science, 2004)
37. Christopher Collins (M.S. Mechanical Engineering, 2004)
38. Ali Ndiwalana (M.S. Computer Science, 2003)
39. Mohammed Fairuz Shiratuddin (M.S. Building Construction, 2003)
40. Vineet Kamat (Ph.D. Civil Engineering, 2002)
41. Ravikiran Vatrapu (M.S. Computer Science, 2002)
42. Wes Lloyd (M.S. Computer Science, 2001)

Graduate independent study students:

1. Shakiba Davari (Spring 2020)
2. Alex Kalita (Spring 2003)
3. Ali Ndiwalana (Spring 2003)
4. Brian Melanson (Summer 2002)
5. Matthew Gracey (Summer 2002)
6. Balaprasuna Chennupati (Fall 2001)

Undergraduate research students:

1. Daniel Stover (Fall 2022 – Spring 2023)
2. Dillon Cutaiar (Fall 2019 – Spring 2020)
3. David Thames (Spring 2019)
4. Noah Miller (Spring 2019)
5. Kalila Simpson (Fall 2017 – Spring 2018)
6. Sophia Kobelja (Fall 2017)
7. Alec Alderman (Spring-Fall 2017)
8. Emmet Hobgood (Spring-Fall 2017)
9. Carly Burroughs (Spring 2017)
10. Samee Khan (Spring 2017)
11. Jarret Delle Donne (Spring 2015)
12. Chris Wakeley (Spring 2015)
13. Fintan Kelly (Spring 2015)
14. Brian Wright (Fall 2014 – Spring 2015)
15. Philip Schuchardt (Spring 2007 – Spring 2008)
16. Brandon Linton (Spring 2005 – Fall 2005; won best poster award at College of Engineering Undergraduate Research Symposium)
17. Cris Kania (Spring 2005)
18. Curtis Wilkes (2004-2007)
19. Ryan McMahan (Spring 2004)
20. Craig Mackie (Fall 2003 – Spring 2004)
21. Ryan Schlesinger (Fall 2003)
22. Daniel Larimer (Fall 2003)
23. Robert Hoffman (Spring 2003)
24. Peter Camponola (Spring 2003)
25. Jason Cowden (Spring 2003 – Spring 2004)
26. Saqib Sheikh (Spring 2002)
27. Jonathan Berkowitz (Fall 2002)
28. Matthew Parrott (Spring 2002)
29. Christopher Rhoton (Fall 2001)
30. Joshua Campbell (Spring 2001)
31. Vinh Ly (Spring 2001)
32. Matthew Campbell (Spring 2000)
33. Manu Sporny (Spring 2000)

Visiting Scholars:

1. Francielly Rodrigues (2022-2023)
2. Leonardo Pavanatto Soares (Summer 2018)

3. Regis Kopper (2009-2010)
4. Marcio Pinho (2000-2001)

Summer Interns:

1. Surya Madhan (Summer 2018)
2. Farid Sultani (CHCI Research Experiences for Undergraduates (REU) Program, Summer 2006)
3. Latasa Anderson (Virginia Tech Minority Academic Opportunities Program (MAOP), Summer 2003)
4. Kristin Wheeler (Virginia Tech Minority Academic Opportunities Program (MAOP), Summer 2002)

TEACHING

- Department of Computer Science, University of California, Santa Barbara
  - CS 290I (Immersion in Virtual and Augmented Reality): I developed this new graduate course to supplement my sabbatical research at UCSB. Students discussed the theory of immersion as a framework for understanding VR, AR, and other technologies on the MR continuum. The class included a major literature review project and a research project in which students designed and ran experiments on the effects of immersion.
- Department of Computer Science, Virginia Tech
  - CS 2204 (Unix): I was responsible for revamping this course (formerly CS 1206) in Fall 2001. I developed all new lectures, laboratory assignments, quizzes, and programming assignments.
  - CS 3724 (Human-Computer Interaction): In this project-based course, teams of students gain both theoretical and practical experience with a complete usability engineering process including requirements analysis, design, prototyping, and evaluation.
  - CS 4204 (Computer Graphics): This senior-level class is focused on the basic theory of computer graphics, providing students with the details of the process of 3D rendering. Students also complete 3-4 practical programming assignments using openGL.
  - CS 4634 (Design of Information): This course, a senior elective, teaches students about effective design of information-oriented interfaces such as websites. Topics include information architecture, user interface design, and visual design. Teams of students complete a semester project involving a significant website design and implementation.
  - CS 4784 (HCI Capstone): Senior undergraduates participate in a semester-long design and evaluation project with a real client. Students learn practical application of HCI design and usability engineering principles, and gain experience with project management.
  - CS 4984 (3D User Experience Design): Senior undergraduates participate in a semester-long design project using VR or AR technologies. Students learn best practices for UX design and methodology with immersive technologies.
  - CS 5754 (Virtual Environments): I developed this course as a special topics course in Spring 2000, and have taught it almost every year since. Both graduate and undergraduate students take this course, which is an overview of the technology, design issues, applications, and research challenges for VEs. Students help to lead discussions of important research papers, and also complete a semester project of their own choosing.
  - CS 6724 (3D Interaction): I developed this graduate seminar in Fall 2004. The class focuses on 3D user interfaces as a special subtopic of human-computer interaction. We discuss the

distinctive characteristics of 3D UI technology, design, and evaluation, using the latest research results. Students also gain practical design and implementation experience in the 3DI laboratory.

- CS 6724 (Natural User Interfaces): This is a graduate seminar class focusing on the design of user interfaces using "natural" gestures and motions in 2D and (particularly) 3D space. The course focuses on deep reading and discussion from multiple disciplinary perspectives, and includes a semester long design and prototyping project.

- Instructor, College of Computing, Georgia Institute of Technology
  - CS 4753 (Human-Computer Interaction, Winter 1999): As a graduate student at Georgia Tech, I was solely responsible for this upper-level undergraduate course. I also developed new lecture materials and assignments for this class.
  - CS 4390 (Computer Graphics, Summer 1998): As a graduate student at Georgia Tech, I was solely responsible for teaching, administering, and grading this upper-level undergraduate course.
- Teaching Assistant, College of Computing, Georgia Institute of Technology, Fall 1997 and 1998. I served as a TA for Computer Graphics, Virtual Environments, and User Interface Software classes.
- Guest Lecturer, College of Computing, Georgia Institute of Technology, 1996-1998.
- Recitation instructor, Department of Mathematics and Computer Science, Emory University. I taught recitation sections to freshman and sophomore non-majors in CS 150 (Introduction to Computers and Programming, 1994).

SELECTED SERVICE ACTIVITIES

Selected Professional Service:

- Member, IEEE ISMAR Best Paper Award committee, 2023.
- Member, IEEE ISMAR Career Impact Award committee, 2023.
- Co-organizer, IEEE Virtual Reality satellite event, Blacksburg, Virginia, March 2023.
- External Reviewer, University of Central Florida School of Modeling, Simulation, and Training, 2023
- Associate Editor-in-Chief, *IEEE Transactions on Visualization and Computer Graphics*, 2019-2022
- Associate Editor, *Frontiers in Virtual Reality*, 2019-present
- External Reviewer, Worcester Polytechnic Institute Dept. of Computer Science, 2021
- Chair, IEEE VGTC Virtual Reality Best Dissertation Award Committee, 2018-2022
- Member, Board on Army Research and Development, National Academies of Science, 2018-2019
- Associate Editor, *Frontiers in Robotics and AI, Section on Virtual Environments*, 2014-2019
- Associate Editor, *IEEE Transactions on Visualization and Computer Graphics*, 2012-2016
- Associate Editor, *International Journal of Human-Computer Studies*, 2005-2014
- Editorial Board Member, *Virtual Reality*, 2014-present
- Associate Editor, *International Journal of Virtual Reality*, 2006-2013
- Chair, Steering Committee, IEEE Virtual Reality Conference, 2011-2014
- Steering Committee member, IEEE Virtual Reality Conference, 2009-2018

- Steering Committee member, IEEE Symposium on 3D User Interfaces, 2006-2017
- General Chair, IEEE Virtual Reality Conference, 2007 and 2008
- Program Chair, IEEE Virtual Reality Conference, 2006
- Founding Co-Chair, IEEE Symposium on 3D User Interfaces, 2006
- Co-Organizer, Workshop on New Directions in 3D User Interfaces, IEEE Virtual Reality Conference, 2005
- Co-Organizer, Workshop on Beyond Wand and Glove Based Interaction, IEEE Virtual Reality Conference, 2004
- Co-Organizer, Workshop on The Future of VR and AR Interfaces, IEEE Virtual Reality Conference, 2001
- Co-Organizer, Workshop on Perceptual and Multi-Modal Interfaces, IEEE Virtual Reality Conference, 2000
- Panels Chair, IEEE Virtual Reality Conference, 2004
- Program Chair, Conference on Construction Applications of Virtual Reality, 2003
- Video Chair, IEEE Virtual Reality Conference, 2002 and 2003
- Exhibits Chair, IEEE Virtual Reality Conference, 2000 and 2001
- Member, ACM SIGGRAPH and SIGCHI
- Member, IEEE Computer Society
- Co-founder, 3D User Interface Mailing List (www.3dui.org)
- Numerous program committees
- Numerous reviewing assignments

Selected University Service:

- Director, Center for Human-Computer Interaction, Virginia Tech, 2011-present
- Director, 3D Interaction Research Group, Virginia Tech, 1999-present
- Lead, Proposed master's degree in Human-Centered Technology Design, 2019-present
- Chair, Department of Computer Science Human-Computer Interaction faculty search committee, 2023-2024
- Co-Chair, Department of Computer Science Innovation Campus Intelligent Interfaces faculty search committee, 2023-2024
- Member, Department of Computer Science Department Head search committee, 2023-2024
- Member, College of Architecture, Arts, and Design Dean search committee, 2022-2023
- HCI Lead, Department of Computer Science joint faculty search committee, 2022-2023
- HCI Lead, Department of Computer Science joint faculty search committee, 2021-2022
- Member, Department of Computer Science joint faculty search committee, 2020-2021
- Member, College of Engineering Task Force on Identifying Research Thrusts for Investment, 2020-2021
- Member, Innovation Campus Faculty Planning committee, 2020-2021
- Member, Department of Computer Science joint faculty search committee, 2019-2020

- Member, Program review committee for Industrial and Systems Engineering department, 2020
- Member, University Cluster Operations and Hiring Committee, 2017-2018
- Member, Creativity & Innovation strategic growth area stakeholder committee, 2016-2018
- Chair, Department of Computer Science Human-Centered Computing faculty search committee, 2017-18
- Member, Institute for Creativity, Arts, and Technology research faculty search committee, 2017
- Member, Institute for Creativity, Arts, and Technology web developer search committee, 2017
- Member, School of Visual Arts faculty search committee, 2016-2017
- Member, Dean of Engineering search committee, 2016-17
- Member, Department of Computer Science executive committee, 2016-2018
- Member, Department of Computer Science Department Head search committee, 2015
- Member, Artificial intelligence faculty search committee, 2014-2015
- Chair, HCI faculty search committee, 2013-2014
- Chair, Machine learning faculty search committee, 2012-2013
- Member, Virginia Tech Center for Human-Computer Interaction, 2000-present
- Member, Virginia Tech University Visualization and Animation Group
- Member, Machine learning faculty search committee, 2011-2012
- Member, Artificial Intelligence faculty search committee, 2014-2015
- Appointed chair, CS Dept. Admissions Committee, 2009-2011
- Member, CS Department Head search committee, 2007-2008
- Elected member, CS Dept. Personnel Committee, 2005-2008, 2014-present
- Elected member, CS Dept. Computing Resources Committee, 2000-2004
- Member, Animation/Graphics faculty search committee, 2005-2006
- Chair, CS Department ad-hoc committee on assessment, 2005
- Co-founder, Virginia Tech Virtual Environments Research Group
- Georgia Institute of Technology delegate to the Human-Computer Interaction Consortium (HCIC) conference, 1998

PERSONAL INFORMATION

- Married to Dawn Bowman, five children
- Born 1971
- Active in the ministries of Grace Covenant Presbyterian Church, Blacksburg