

# Andrew T. Duchowski

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## Research & Teaching Interests

Visual perception and human-computer interaction.  
Eye tracking, computer vision and digital imaging.  
Computer graphics, and virtual environments.  
Wavelet and multi-resolution analysis.

## Education

**Ph. D. in Computer Science**, Texas A&M University 08/97  
Dissertation: *Gaze-Contingent Visual Communication*  
Thesis advisor: Professor Bruce H. McCormick  
**B. S. in Computer Science (Co-op)**, Simon Fraser University 05/90

## Academic Appointments

**Visiting Professor**, Institut für Kartografie and Geoinformation, ETH Zürich (01/16–04/16)  
**Professor**, School of Computing, Clemson University (08/09– )  
**Associate Professor**, Department of Computer Science, Clemson University (08/02–08/09)  
**Assistant Professor**, Department of Computer Science, Clemson University (01/98–08/02)  
**Postdoctoral Associate**, Department of Computer Science, Texas A&M University (09/97–12/97)

## Honors & Awards

Faculty Collaboration Award, Clemson University College of Eng. and Science (2008)  
Early Promotion (Associate Professor), Clemson University (2002)  
Award for Faculty Excellence, Clemson University Board of Trustees (2001)  
Recognition of Service Award, ACM (2000, 2002, 2004)  
Faculty Early Career Development (CAREER) Award, NSF (2000–2003)

## Professional Memberships

**Member**, EuroGraphics (2001– )  
**Member**, ACM SIGGRAPH (2000– )  
**Member**, Association for Computing Machinery, ACM (1990– )  
**Member**, Institute for Electronics and Electrical Engineers, IEEE (1990– )  
**Member**, Society of Photo-Optical Instrumentation Engineers, SPIE (1990–2000)

## Professional Service and Activities

Editorial Duties

**Co-Editor and Reviewer**, Journal of Eye Movement Research (JEMR), Special Issue on Eye Tracking and Visualization (2017)  
**Co-Editor and Reviewer**, Spatial Cognition and Computation, Special Issue on Eye Tracking for Spatial Research (2017)  
**Member of Editorial Board**, Journal of Eye Movement Research (JEMR) (2012–)  
**Co-Editor**, Computer Graphics Educational Material Source (CGEMS) (2017–2019)  
**Guest Editor and Reviewer**, Computer Vision and Image Understanding (CVIU), Special Issue on Eye Detection and Tracking (2004)

## Andrew T. Duchowski

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### Organizer or Program Committee Member

- Co-Founder, General Chair, Area Chair, and Reviewer**, Symposium on Eye Tracking Research & Applications (ETRA) (2000–2014, biennially)
- Co-Organizer**, An Eye on Perceptual Graphics: Eye-Tracking Methodology, *EuroGraphics 2013 Tutorial (Half-Day)* (2013)
- Co-Organizer**, Gaze Interaction in the Post-WIMP World, *CHI 2013 Workshop* (2013)
- Associate Chair**, ACM SIGCHI (2012, 2013)
- Co-Organizer**, PETMEI (2011)
- Member**, Program Committee, NGCA (2011)
- Associate Chair**, Program Committee, INTERACT (2011)
- Member**, Program Committee, Eye Gaze Workshop at IUI (2011)
- Member**, Program Committee, International Workshop on Gaze Sensing and Interactions (IWGSI), in conjunction with Asian Conference on Computer Vision (ACCV) (2010)
- Member**, Program Committee, ACM ASSETS (2008)
- Course Organizer** (with Ed Cutrell and Amy Alberts), ACM SIGCHI 2008, Course 14, *Augmenting Usability with Eye Movement Process Metrics: Hands-On Training* (2008)
- Co-Chair**, ACM SIGCHI alt.chi (2005)
- Course Organizer** (with Roel Vertegaal), ACM SIGGRAPH 2000, Course 05, *Eye-Based Interaction in Graphical Systems: Theory & Practice* (2000)

### External Reviewer/Opponent

- External Reviewer**, University of Eastern Finland, PhD Dissertation of Pavel Orlov, Joensuu, Finland (2016)
- External Reviewer**, Université de Toulouse, PhD Defense of Vsevolod Peysakhovich, Toulouse, France (2016)
- Opponent**, Aalto University, PhD Defense of Jarmo Kuisma, Helsinki, Finland (2015)
- External Reviewer**, Simon Fraser University, PhD Defense of Geoffrey Tien, Vancouver, BC, Canada (2015)
- External Reviewer**, University of Pretoria, MS Defense of Jhani Adré de Bruin, Pretoria, South Africa (2014)
- External Reviewer**, Florida Institute of Technology (FIT), PhD Defense of Alexandre Lucas Stephane, Melbourne, FL (2013)
- External Reviewer**, École Polytechnique Fédérale de Lausanne (EPFL), PhD Defense of Marc-Antoine Nüssli, Lausanne, Switzerland (2011)
- Opponent** (with Bjarne Kjær Ersbøll and Arne John Glenstrup), IT University, Denmark, Gaze Group, PhD Defense of Javier San Agustin Lopez, Copenhagen, Denmark (2010)
- External Examiner**, University of British Columbia, Electrical and Computer Engineering, PhD Dissertation of Craig Hennessey (2008)
- Opponent**, University of Joensuu, Department of Computer Science and Statistics, PhD Defense of Roman Bednarik, Joensuu, Finland (2007)
- PhD Defense Opponent**, Linköping Universitet, Image Coding Group, PhD Defense of Peter Bergström, Linköping, Sweden (2003)

### Proposal/Application Reviewer/Panelist

- Proposal Reviewer**, Polish National Science Center (NCN) (2015)
- Proposal Reviewer**, Swiss National Science Foundation (SNSF) (2014)
- Proposal Reviewer**, Eidgenössische Technische Hochschule Zürich (ETHZ; Swiss Federal Institute of Technology Zürich) Switzerland (2014)

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**Application Reviewer**, National Research Foundation (NRF), South Africa (2010)  
**Proposal Reviewer**, Wiener Wissenschafts-, Forschungs- und Technologiefonds (WWTF; Vienna Science and Technology Fund) Austria (2010)  
**Reviewer**, R03, small research grants, National Institutes of Health (NIH) (2008)  
**Referee**, regular research proposals, Oak Ridge Affiliated Universities (ORAU) (1999)  
**Reviewer**, research proposals, Natural Sci. and Eng. Res. Council of Canada (NSERC) (2004)  
**Reviewer**, research grant proposals, Research Grants Council of Hong Kong (2002)  
**Reviewer**, research grant proposals, Civilian Research & Development Foundation (2003)  
**Panelist**, regular research proposals National Science Foundation (NSF) (2000, 2001, 2003, 2006, 2011)

### Paper/Course Reviewer

ACM Tran. on Multimedia Computing, Communications, and Applications (TOMM) (2015)  
InfoVis (2015)  
UbiComp (2014)  
Journal of Accounting Research (2014)  
IEEE VR (2011)  
Image, Video, and Multidimensional Signal Processing (IVMSP) (2011)  
ACM Tran. on Applied Perception (TAP) (2010)  
Vision Research (2009, 2010)  
Computer Graphics Forum (2009)  
Engineering Interactive Computing Systems (EICS) (2009)  
Tran. on Graphics (2009)  
Graphics Interface (2009)  
IEEE Tran. on Biomedical Engineering (2008)  
Presence (2008)  
ACM Tran. on Graphics (2007)  
IEEE Tran. on Systems, Man, and Cybernetics-Part B: Cybernetics (2007)  
Neurocomputing (2007)  
TOCHI (2005)  
ACM SIGCHI (2004, 2006, 2007, 2009–2016)  
ACM SIGGRAPH (2003, 2004, 2005, 2009–2016)  
International Journal of Human-Computer Studies (2003)  
Web3D Symposium (2002)  
Journal of Behavior Research Methods, Instruments, & Computers (BRMIC) (2002)  
International Journal of Industrial Ergonomics (2002)  
computer science textbook, Addison-Wesley (1999, 2001)  
IEEE Tran. on Circuits and Systems for Video Technology (1998)

### University and Public Service

**Director of Graduate Affairs**, School of Computing (CS & VC) (2012–2016)  
**Chair**, Graduate Affairs Cmte. (2012–)  
**Chair**, Visual Computing Faculty Search Cmte. (2011–)  
**Chair**, Visual Computing Faculty Tenure, Promotion, & Retention Cmte. (2011–)  
**Member**, Human Centered Computing Faculty Tenure, Promotion, & Retention Cmte. (2011–)  
**Member**, School of Computing Graduate Advisory Cmte. (2010–)  
**Elected Member**, Clemson University College of Engineering and Science Dean's Advisory Council (2002–2004)

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- Appointed Member**, Clemson University Computer Science Department Faculty Search Cmte. (2001– )
- Elected Member**, Clemson University Computer Science Department Advisory Cmte. (1999–2004)
- Faculty Advisor**, Dixie Skydivers (Clemson University sports club) (1999–2001)

### Consulting Experience

- Proposal Reviewer, Simons Foundation Autism Research Initiative (SFARI) (2015)
- Eye Movement Analysis, McNeil-PPC, Inc. (2013)
- Expert Reviewer, Enterprise Estonia, (2009–2011)
- SBIR conception, implementation, Luminit, Inc. (2007,2015)
- Reviewer, graphics-related artwork, PhotoAssist, Inc. (sub-contractor for US Postal Service) (1999)

### Research Support

- “CHS: Small: Looking Across the Uncanny Valley: Procedural and Data-Driven Methods for Gaze Modelling”, National Science Foundation (NSF), CISE Div. of Inf. and Intelligent Systems, Cyber-Human Systems Program, IIS-1423189, Co-PI, with S. Jörg (PI), \$494,347, (08/14-07/17).
- “HCC: Small: Eye Movement in Stereoscopic Displays, Implications for Visualization”, National Science Foundation (NSF), CISE Div. of Information and Intelligent Systems, Human-Centered Computing Program, IIS-0915085, PI, with D. House (Co-PI), \$498,563, (07/09-07/12).
- “Development of an Augmented Reality System for Military Training Applications–Phase I”, US Navy through Luminit, LLC, PI, with J. M. Westall (Co-PI), \$21,000, (10/09-02/11).
- “REU Site: Undergraduate Research in Human-Centered Computing”, National Science Foundation (NSF), CISE Div. of Computer and Network Systems, Research Experiences for Undergraduates (REU) Program, CNS-0850695, Co-PI, with L. Hodges (PI), \$272,616, (07/09-07/12).
- “CPATH EAE: TECHNI - Evaluation, Adoption and Extension”, National Science Foundation (NSF), CISE Pathways to Integrated Undergraduate Computing Education (CPATH) Program, Co-PI, with J. M. Westall (PI), J. Wang, T. A. Davis, and R. Geist, \$453,673, (07/07-07/10).
- “Virtual Simulated Inspection (ViSIns) Laboratory: Using Interactive 3D Knowledge Objects to Promote Learning for Non-Destructive Inspection in Aviation Maintenance Technology”, National Science Foundation (NSF) through Greenville Technical College, Div. of Undergraduate Education (DUE), Co-PI, with C. Washburn (PI), W. Kendall, M. Kurz, and A. K. Gramopadhye, \$269,962 (\$938,855 total), (06/07-06/10).
- “Patient Room for the Future Prototype Research Initiative”, Department of Defense through Spartanburg Regional Health System, Co-PI, with D. B. Battisto (PI), R. Pak, D. Allison, and T. A. Davis, and V. Blouin, \$363,678, (06/07-01/09).
- “Assessing Sailor-System Interfaces of the Common Systems Functions Employed Within FORCE-net Engagement Packs”, DoD/SPAWAR Charleston through Eagen, McAllister Associates, Inc., Subcontractor Award DO 0054-22 (Contract N65236-03-D-3830, Subcontract 00-3830-22), PI, \$20,000, (05/07-05/07).

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- “Usability Engineering in FORCEnet”, DoD/SPAWAR Charleston through Eagan, McAllister Associates, Inc., Subcontractor Award DO 0054-22 (Contract N65236-03-D-3830, Subcontract 00-3830-22), PI, \$8,319, (09/06-09/06).
- “Human Systems Integration Usability Lab Support”, DoD/SPAWAR Charleston through Eagan, McAllister Associates, Inc., Subcontractor Award DO 0054-22 (Contract N65236-03-D-3830, Subcontract 00-3830-22), PI, with L. Gugerty, E. Muth, and R. Tyrrell, \$115,528, (08/04-07/05).
- “ATE: Integrating Asynchronous Technology and Virtual Reality to Support Education in Aircraft Maintenance Technology Education”, National Science Foundation (NSF) through Greenville Technical College, Advanced Technology Education (ATE) Program, Co-PI, with C. Castle (PI), A. K. Gramopadhye, M. S. Leonard, and C. Washburn, \$389,655, (10/03-09/06).
- “EI: TECHNI: A New Approach to the B. A. Degree in Computer Science”, National Science Foundation (NSF), Educational Initiative (EI) Program, Co-PI, with T. A. Davis (PI), J. M. Westall, J. Kundert-Gibbs, and R. Geist, \$330,000, (06/03-05/06).
- “REU Supplement-ITR: Visual Deictic Reference in a Collaborative Virtual Environment for Visual Search Training”, National Science Foundation (NSF), Information Technology Research (ITR) Program (Small), Grant IIS-0217600 (REU Supplement), PI, with A. K. Gramopadhye, and J. Greenstein, \$12,000, (10/02-09/03).
- “ITR: Visual Deictic Reference in a Collaborative Virtual Environment for Visual Search Training”, National Science Foundation (NSF), Information Technology Research (ITR) Program (Small), Grant IIS-0217600, PI, with A. K. Gramopadhye, and J. Greenstein, \$313,361, (10/02-09/04).
- “Using Advanced Displays to Support Training & Job-Aiding: Improving Aircraft Inspection Performance”, NASA Ames, Human Factors Research and Technology Division, Co-PI, with A. K. Gramopadhye, and B. J. Melloy, \$153,000, (01/02-12/02).
- “An Upgrade to Clemson’s Graphics-Supercomputer”, Clemson University Provost’s Office, Co-PI, with R. Geist (PI), D. Dawson, L. Dooley, D. Edie, R. Latour, and J. M. Westall, \$115,000 (\$55,444 matching funds), (03/00-08/00).
- “CAREER: Development of an Eye Tracking Education and Research Program at Clemson University”, National Science Foundation (NSF), Directorate for Computer Information Science and Engineering, Human Computer Interaction Program, Grant IIS-9984278, PI, \$212,022, (04/00-04/03).
- “Virtual Reality Technology for Aircraft Visual Inspection: Training and Job-Aiding”, NASA Ames, Human Factors Research and Technology Division, Task #NCC 2-1114, Co-PI, with A. K. Gramopadhye, and B. J. Melloy, \$267,742, (02/99-01/01).
- “Development of an Eye Tracking Methodology Course at Clemson”, Clemson University Innovation Fund, Project #1-20-1906-51-4087, PI, with G. Galluscio, C. Pury, J. Mittelstaedt, L. Carlson, B. J. Melloy, and A. K. Gramopadhye, \$39,860 (\$20,000 matching funds), (08/98-08/99).

“Exploring the Brain Forest”, Texas Advanced Technology Program, Project #999903-124, assisted in preparation, B. H. McCormick (PI), \$126,947 (\$39,710 matching funds), (01/96–12/97).

“Telecommunications in Virtual and Real Environments”, National Science Foundation, Directorate for Computer Information Science and Engineering (CISE), Research Instrumentation Grant CDA-9422123, assisted in preparation, with R. A. Volz, R. Furuta, B. H. McCormick, K. L. Watson, \$101,232 (\$33,315 matching funds), (01/95–12/97).

### Publications

#### Books and Monographs

- [1] A. T. Duchowski, *Eye Tracking Methodology: Theory & Practice*, Springer-Verlag, London, UK, 3rd ed., 2017.
- [2] A. T. Duchowski, *Eye Tracking Methodology: Theory & Practice*, Springer-Verlag, London, UK, 2nd ed., 2007.
- [3] A. T. Duchowski, *Eye Tracking Methodology: Theory & Practice*, Springer-Verlag, London, UK, 2003.

#### Book Chapters

- [4] A. T. Duchowski and K. Krejtz, “Visualizing Dynamic Ambient/Focal Attention with Coefficient K”, in *Eye Tracking and Visualization*, M. Burch et al. (Eds.), Springer International, 2016, DOI 10.1007/978-3-319-47024-5\_13.
- [5] A. T. Duchowski and S. Jörg, “Eye Animation”, in *Handbook of Human Motion*, B. Müller, S. I. Wolf, G-P. Brueggemann, Z. Deng, A. McIntosh, F. Miller, W. S. Selbie, Eds., Springer Link, 2016.
- [6] A. Szarkowska, I. Krejtz, K. Krejtz, and A. T. Duchowski, “Harnessing the Potential of Eye-Tracking for Media Accessibility”, in *Translation Studies and Eye-Tracking Analysis*, S. Grucza, M. Płużyczka, and J. Zajac, Eds., Peter Lang, GmbH, 2013. ISBN: 978-3-631-63448-6.
- [7] M. Baladi, H. Vitali, G. Fadel, J. Summers, and A. T. Duchowski, “A Taxonomy for the Design and Evaluation of Networked Virtual Environments-Its Application to Collaborative Design”, in *Research in Interactive Design*, Vol. 2, X. Fischer and D. Coutellier, Eds., Springer-Verlag, 2007. ISBN-10: 2287483632.
- [8] A. T. Duchowski, Eye Tracking, in *Encyclopedia of Human-Computer Interaction*, William Sims Bainbridge, Ed., Berkshire Publishing Group, Great Barrington, MA, 2004, pp.251-254.

#### Refereed Journal Publications

- [9] P. Kiefer, I. Giannopoulos, M. Raubal, and A. T. Duchowski, “Eye tracking for spatial research: Cognition, computation, challenges”, *Spatial Cognition and Computation*, Special Issue on Eye Tracking for Spatial Research, P. Kiefer, I. Giannopoulos, M. Raubal, and A. T. Duchowski (Eds.), 17(1), 2017. <http://dx.doi.org/10.1080/13875868.2016.1254634>
- [10] L. Dupont, A. T. Duchowski, K. Ooms, M. Antrop, and V. Van Eetvelde, “Investigating the Visual Exploration of the Rural-Urban Gradient using Eye-Tracking”, *Spatial Cognition*

- and Computation*, Special Issue on Eye Tracking for Spatial Research, P. Kiefer, I. Gianopoulos, M. Raubal, and A. T. Duchowski (Eds.), 17(1), 2017. <http://dx.doi.org/10.1080/13875868.2016.1226837>
- [11] K. Krejtz, A. T. Duchowski, H. Zhou, S. Jörg, and A. Niedzielska, “Perceptual Evaluation of Synthetic Gaze Jitter”, *Computer Animation and Virtual Worlds*, 2016(e1745). DOI 10.1002/cav.1745.
- [12] K. Krejtz, A. T. Duchowski, I. Krejtz, A. Kopacz, P. Chrzastowski-Wachtel, “Gaze Transitions in Multimedia Learning”, *Journal of Eye Movement Research*, 9(1):5, 2016, pp. 1-17.
- [13] K. Krejtz, A. T. Duchowski, I. Krejtz, A. Szarkowska, and A. Kopacz, “Discerning Ambient/Focal Attention with Coefficient K”, *Tran. on Applied Perception*, 13(3), 2016.
- [14] K. Krejtz, A. T. Duchowski, T. Szmidt, I. Krejtz, F. G. Perilli, A. Pires, A. Vilaro, and N. Villalobos, “Gaze Transition Entropy”, *Tran. on Applied Perception*, 13(1), 2015.
- [15] R. I. Wang, B. Pelfrey, A. T. Duchowski, and D. H. House, “Online 3D Gaze Localization on Stereoscopic Displays”, *Tran. on Applied Perception*, 11(1), 2014.
- [16] A. T. Duchowski, “τέχνη Photons: Evolution of a Course in Data Structures”, *Computer Graphics Forum*, 33(1), 2014, pp. 294-304.
- [17] D. J. Rajendran, A. T. Duchowski, P. Orero, J. Martinez, and P. Romero-Fresco, “Effects of Text Chunking on Subtitling: A Quantitative and Qualitative Examination”, *Perspectives: Studies in Translatology*, Special Issue: When Modalities Merge, M. Arumi, A. Matamala, and P. Orero, Eds., 21(1), 2013, pp. 5-21.
- [18] S. McIntyre, L. Gugerty, and A. T. Duchowski, “Brake lamp detection in complex and dynamic environments: Recognizing limitations of visual attention and perception”, *Accident Analysis and Prevention*, 45, 2012, pp. 588-599.
- [19] A. Vilaró, A. T. Duchowski, P. Orero, T. J. Grindinger, S. Tetreault, and E. Di Giovanni, “How Sound is The Pear Tree Story? Testing the Effect of Varying Audio Stimuli on Visual Attention Distribution”, *Perspectives: Studies in Translatology*, Special Issue on The Pear Stories, J. L. Kruger and I. Mazur, Eds., 2011.
- [20] A. T. Duchowski, D. Bate, P. F. Stringfellow, K. Thakur, B. J. Melloy, and A. K. Gramopadhye, “On Spatiochromatic Visual Sensitivity and Peripheral Color LOD Management”, *ACM Tran. on Applied Perception*, 6(2), Feb. 2009. <http://doi.acm.org/10.1145/1498700.1498703>
- [21] H. A. Murphy, A. T. Duchowski, and R. A. Tyrrell, “Hybrid Image/Model-Based Gaze-Contingent Rendering”, *ACM Tran. on Applied Perception*, 5(4), Jan. 2009. <http://doi.acm.org/10.1145/1462048.1462053>
- [22] M. Baladi, H. Vitali, G. Fadel, J. Summers, and A. T. Duchowski, “A taxonomy for the design and evaluation of networked virtual environments: its application to collaborative design”, *International Journal of Interactive Design and Manufacturing*, 2, 2008, pp. 17-32.
- [23] A. T. Duchowski and A. Çöltekin, “Foveated Gaze-Contingent Displays for Peripheral LOD Management, 3D Visualization, and Stereo Imaging”, *ACM Tran. on Multimedia Computing, Communications, and Applications*, 3(4), Dec. 2007.
- [24] B. J. Melloy, S. Das, A. K. Gramopadhye, A. T. Duchowski, “A Model of Extended, Semi-Systematic Visual Search”, *Human Factors*, 48(3), Dec. 2006, pp.540-554.

- [25] A. T. Duchowski, “A Breadth-First Survey of Eye Tracking Applications”, *Behavior Research Methods, Instruments, & Computers (BRMIC)*, 34(4), November 2002, pp.455-470.
- [26] A. T. Duchowski, E. Medlin, N. Cournia, H. Murphy, A. K. Gramopadhye, S. Nair, J. Vora, B. J. Melloy, “3D Eye Movement Analysis”, *Behavior Research Methods, Instruments, & Computers (BRMIC)*, 34(4), November 2002, pp.573-591
- [27] J. Vora, S. Nair, A. K. Gramopadhye, A. T. Duchowski, B. J. Melloy, B. Kanki, “Using Virtual Reality Technology for Aircraft Visual Inspection Training: Presence and Comparison Studies”, *Applied Ergonomics*, 33(6), November, 2002, pp. 559-570.
- [28] A. K. Gramopadhye, A. T. Duchowski, B. J. Melloy, B. Kanki, J. Vora, S. Nair, S. Orhan, S. Shivashankaraiah, and T. Rawls, “Using Virtual Reality Technology for Aircraft Inspection Training”, *International Journal of Industrial Engineering: Theory, Applications and Practice*, 2001, UTEP.
- [29] A. T. Duchowski, “Acuity-Matching Resolution Degradation Through Wavelet Coefficient Scaling”, *Tran. on Image Processing*, August 2000, IEEE, Piscataway, NJ.
- [30] B. P. Burton, T. S. Chow, A. T. Duchowski, W. Koh, and B. H. McCormick, “Exploring the Brain Forest”, *Neurocomputing*, 26-27, 1999, Elsevier, pp. 971-980.
- [31] B. L. Deuermeier, G. L. Curry, A. T. Duchowski, and S. Venkatesh, “An Automatic Approach to Deadlock Detection and Resolution in Discrete Simulation Systems”, *Journal on Computing*, 9(2), Spring 1997, Institute for Operations Research and the Management Sciences (INFORMS), Linthicum, MD, pp. 195-205.

### Conference Proceedings (Reviewed)

- [32] P. Kiefer, I. Giannopoulos, A. Duchowski, and M. Raubal, “Measuring Cognitive Load for Map Tasks through Pupil Diameter”, in *Proceedings of GI Science*, September 27-30, 2016, Montreal, Canada.
- [33] D. S. Best, and A. T. Duchowski, “A Rotary Dial for Gaze-based PIN Entry”, in *Proceedings of Eye Tracking Research & Applications (ETRA)*, March 14-17, 2016, Charleston, SC, USA.
- [34] A. T. Duchowski, S. Jörg, T. N. Allen, I. Giannopoulos, and K. Krejtz, “Eye Movement Synthesis”, in *Proceedings of Eye Tracking Research & Applications (ETRA)*, March 14-17, 2016, Charleston, SC, USA.
- [35] A. T. Duchowski, S. Jörg, A. Lawson, T. Bolte, L. Świrski, and K. Krejtz, “Eye Movement Synthesis with 1/f Pink Noise”, in *Proceedings of Motion In Games (MIG)*, November 16-18, 2015, Paris, France.
- [36] A. T. Duchowski and K. Krejtz, “Visualizing Dynamic Ambient/Focal Attention with Coefficient K”, in *Proceedings of the First Workshop on Eye Tracking and Visualization (ETVIS)*, October 25, 2015, Chicago, IL.
- [37] A. T. Duchowski and S. Jörg, “Modeling Physiologically Plausible Eye Rotations: Adhering to Donders’ and Listing’s Laws”, in *Proceedings of Computer Graphics International (Short Papers)* June 24-26, 2015, Strasbourg, France.
- [38] A. T. Duchowski, T. Bolte, and K. Krejtz, “Massive-Scale Gaze Analytics: Exploiting High Performance Computing”, in *Proceedings of Intelligent Decision Technologies: Special Session on Intelligent Methods for Eye Movement Data Processing and Analysis*, June 17-19, 2015, Sorrento, Italy.



- [39] K. Bektaş, A. Çöltekin, J. Krüger, and A. T. Duchowski, “Combined Human Visual Perception Models for Geographic Gaze Contingent Displays (Short Paper)”, in *Proceedings of EuroVis*, May 25-29, 2015, Cagliari, Italy.
- [40] K. Bektaş, A. Çöltekin, J. Krüger, and A. T. Duchowski, “Combining Human Visual System Models for Geographic Gaze Contingent Displays (Poster)”, in *Proceedings of EuroGraphics (EG)*, May 4-8, 2015, Zürich, Switzerland.
- [41] G. Rakoczi, A. T. Duchowski, M. Pohl, “Deisgning Online Tests for a Virtual Learning Environment—Evaluation of Visual Behaviour Between Tasks”, in *International Conference on Human Behavior in Design (HBiD)*, October 14-17, 2014, Ascona, Switzerland.
- [42] A. T. Duchowski, D. H. House, J. Gestring, R. I. Wang, K. Krejtz, I. Krejtz, R. Mantiuk, and B. Bazyluk, “Reducing Visual Discomfort of 3D Stereoscopic Displays with Gaze-Contingent Depth-Of-Field”, in *Symposium on Applied Perception (SAP)*, August 8-9, 2014, Vancouver, BC.
- [43] K. Krejtz, T. Szmidt, A. T. Duchowski, I. Krejtz, “Entropy-based Statistical Analysis of Eye Movement Transitions”, in *Proceedings of Eye Tracking Research & Applications (ETRA)*, March 26-28, 2014, Safety Harbor, FL.
- [44] A. T. Duchowski, D. H. House, J. Gestring, R. Congdon, L. Świrski, N. A. Dodgson, K. Krejtz, I. Krejtz, “Comparing Estimated Gaze Depth in Virtual and Physical Environments”, in *Proceedings of Eye Tracking Research & Applications (ETRA)*, March 26-28, 2014, Safety Harbor, FL.
- [45] J. Bertrand, E. Ebrahimi, A. Wachter, J. Luo, S. V. Babu, A. T. Duchowski, N. Meehan, and A. K. Gramopadhye, “Visual Attention to Wayfinding Aids in Virtual Environments”, in *Proceedings of the Joint Virtual Reality Conference (JVRC)*, December 11-13, 2013, Paris, France.
- [46] A. D. Ouzts, N. E. Snell, P. Maini, and A. T. Duchowski, “Determining Optimal Caption Placement Using Eye Tracking (Poster)”, in *Proceedings of the Special Interest Group on the Design of Communication (SIGDOC)*, September 30-1 October, 2013, Greenville, NC.
- [47] G. Rakoczi, A. T. Duchowski, H. Casas-Tost, and M. Pohl, “Visual Perception of International Traffic Signs: Influence of e-Learning and Culture on Eye Movements”, in *Proceedings of the Eye Tracking South Africa (ETSA '13) Conference*, August 29-31, 2013, Cape Town, South Africa.
- [48] R. I. Wang, B. Pelfrey, A. T. Duchowski, and D. H. House, “Online Gaze Disparity via Binocular Eye Tracking on Stereoscopic Displays”, in *Proceedings of the Second Joint 3DIM/3DPVT Conference: 3D Imaging, Modeling, Processing, Visualization & Transmission (3DimPVT 2012)*, October 13-15, 2012, Zürich, Switzerland, IEEE.
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- [112] A. T. Duchowski, J. Martinez, and P. Romero-Fresco, “Live Subtitling with Punctuation-Based Segmentation: Effects on Eye Movements”, in *Proceedings of the European Conference on Eye Movements (ECEM) 2013 (Abstract)*, Lund, Sweden, August 11-16, 2013.
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- [115] D. Vembar, S. Sadasivan, P. F. Stringfellow, A. T. Duchowski, “Gamepad vs. Keyboard: An Evaluation of Interaction Devices for NDI Training in VR”, in *Proceedings of the*

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- [120] A. T. Duchowski, "Eye Tracking Techniques for Perceptually Adaptive Graphics", in *SIGGRAPH 2001 Perceptually Adaptive Graphics Campfire*, Snowbird, UT, May 2001, ACM SIGGRAPH and EuroGraphics, New York, NY.
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- [123] A. T. Duchowski, "3D Wavelet Analysis of Eye Movements", in *Wavelet Applications IV*, April 1998, SPIE, Bellingham, WA.
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- [125] A. T. Duchowski and B. H. McCormick, "Gaze-Contingent Video Resolution Degradation", in *Human Vision and Electronic Imaging II*, January 1998, SPIE, Bellingham, WA.
- [126] A. T. Duchowski, "Incorporating the Viewer's Point-Of-Regard (POR) in Gaze-Contingent Virtual Environments", in *The Engineering Reality of Virtual Reality*, January 1998, SPIE, Bellingham, WA.
- [127] B. H. McCormick, D. A. Batte, and A. T. Duchowski, "A Virtual Environment: Exploring the Brain Forest", in *CENAC Conference*, October 1996, Mexico City, Mexico.
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### Research Reports

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### Other Scholarly Publications

- [133] Q. Ji, H. Wechsler, A. Duchowski, and M. Flickner, Editorial, Special Issue on Eye Detection and Tracking, *Computer Vision and Image Understanding*, 98(1), April, 2005.
- [134] P. Baudisch, D. DeCarlo, A. T. Duchowski, and W. S. Geisler, “Focusing on the Essential: Considering Attention in Display Design”, *Communications of the ACM*, 46(3), March, 2003.

### Keynote and Invited Presentations

- [135] A. T. Duchowski, Okulograficzny Pomiar Obciążenia Poznawczego (Eye Tracking Measurement of Cognitive Load), Polska Konferencja Eyetrackingowa, Lublin, Polska, April 21-23, 2017 (keynote address).
- [136] A. T. Duchowski, Modele i Modelowanie Ruchów Oka w Czytaniu (Models and Modeling of Reading Eye Movements), Laboratorium Eksperymentalnej Lingwistyki Okulograficznej (LELO), Uniwersytet Warszawski, Warszawa, Polska, April 19, 2017 (invited seminar).
- [137] A. T. Duchowski, Symulacja Ruchu Oka (Eye Movement Simulation), Centrum Studiów Zaawansowanych, Politechnika Warszawska, Warszawa, Polska, March 7, 2016 (invited seminar).
- [138] A. T. Duchowski, Eye Tracking: Data Synchronization, Capture, Visualization, and Analysis, User eXperience and Interaction Research Center, Faculty of Informatics and Information Technologies, Slovak University of Technology in Bratislava, Bratislava, Slovakia, February 27, 2016 (invited workshop).
- [139] A. T. Duchowski, Eye Tracking: Experimental Design, Implementation, and Analysis, Politechnika Warszawska, Warszawa, Polska, March 7, 2016 (invited talk).
- [140] A. T. Duchowski, Zaawansowana Analityka Eyetrackingowa (Advanced Eye Tracking Analytics), Polska Konferencja Eyetrackingowa, Warsaw, Poland, March 5-6, 2015 (keynote address).
- [141] A. T. Duchowski, Okulografia w Interakcji Człowieka z Komputerem: Przebieg Pracy od Pomysłu do Papieru (Eye Tracking in Human-Computer Interaction: Research Pipeline from Idea to Publication), *SWPS*, Warsaw, Poland, December 16, 2014 (invited workshop).
- [142] A. T. Duchowski, Analiza Badań Okulograficznych i Symulacja Ruchu Oka (Massive-Scale Gaze Analytics and Eye Movement Simulation), *SWPS*, Warsaw, Poland, December 16, 2014 (invited talk).



- [143] A. T. Duchowski, Current Eye Tracking Research at Clemson, *ETH Zürich*, Zürich, Switzerland, October 20, 2014 (invited talk at the ETIZ Seminar).
- [144] A. T. Duchowski, Eye Tracking in Design, *HBiD 2014*, Ascona, Switzerland, October 14-17, 2014 (keynote address).
- [145] A. T. Duchowski, Eye Tracking in Geographic Contexts: Intent and Interaction, *ET4S 2014*, Vienna, Austria, September 23, 2014 (keynote address).
- [146] A. T. Duchowski, Eye Tracking in the Comfort Zone, *ETSA 2013*, Cape Town, South Africa, August 29-31, 2013 (keynote address).
- [147] A. T. Duchowski, Quantitative and Qualitative Eye Movement Metrics: An Eye Tracking Analytics Pipeline, *Researching Reading, Visual Marketing and Usability with Eye Tracking Methodology*, Aalto University, Helsinki, Finland, May 6-17, 2013 (invited talk).
- [148] A. T. Duchowski, Medical training and machine interaction: haptics, stereo, and gaze-based applications, *Ergonomics and Human-Robot Interaction Workshop, The Hamlyn Symposium on Medical Robotics*, London, UK, July 1-2, 2012 (invited talk).
- [149] A. T. Duchowski, Gaze Over Video: Capture, Analysis, Visualization, *CRAFT, École Polytechnique Fédérale de Lausanne (EPFL)*, Lausanne, Switzerland, November 4, 2011 (invited talk).
- [150] A. T. Duchowski, Audio Description: Who's Watching? Quantifying the Viewing Experience, *Advanced Research Seminar on Audio Description (ARSAD)*, Barcelona, Spain, March 24-25, 2011 (keynote address).
- [151] A. T. Duchowski, Eye Camera Settings and Calibration, Universitat Autònoma de Barcelona, *Winter School on Eye-Tracking Methodology (WSETM 2009)*, Centre de Visió per Computador, Barcelona, Spain, November 25, 2009 (invited talk).
- [152] A. T. Duchowski, Research Experience for Undergraduates: Re-instrumenting a UI for Eye Movement Recording and Analysis (in Eight Weeks), Queens University, Kingston, ON, Canada, August 6, 2009 (invited talk).
- [153] A. T. Duchowski, Eye Tracking Technology and its Application Toward Image Analysis & Synthesis, Universitat Autònoma de Barcelona, Centre de Visió per Computador, Barcelona, Spain, March 27, 2009 (invited talk).
- [154] A. T. Duchowski, Modes and Transitions: Charting a Course for Creative Interaction, *COGAIN 2007*, Leicester, UK, September 3-4, 2007 (keynote address).
- [155] A. T. Duchowski, Eye Tracking Methods and Applications @ Clemson: With Slight Emphasis on Interaction, University of Zürich - Irchel, Department of Geography, Geographic Information Visualization & Analysis (GIVA) Division, Zürich, Switzerland, July 23, 2007 (invited talk).
- [156] A. T. Duchowski, Usability: Mainstream Eye Tracking? Recent Developments, Outstanding Issues, and Future Directions, Tobii User Meeting, Frankfurt, Germany, April 18-19, 2007 (keynote address).
- [157] A. T. Duchowski, Gaze-Contingent Displays: Review and Current Trends, *Adaptive Displays Conference*, Los Angeles, CA, August 7, 2004 (invited talk). Material for this presentation was published as the following journal paper: A. T. Duchowski, N. Cournia, and H. Murphy, "Gaze-Contingent Displays: A Review", *CyberPsychology and Behavior*, 7(6), 2004, Mary Ann Lieber, Inc.

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- [158] A. T. Duchowski, Eye Movement in VR: Applications, Concerns, and Pitfalls, *European Conference on Eye Movements (ECEM) 12*, Dundee, Scotland, August 20-24, 2003 (invited talk).
- [159] A. T. Duchowski, Attentive User Interfaces: Considering Attention in Display Design, Image Coding Group, Electrical Engineering Dept., Linköping Universitet, Linköping, Sweden, June 4, 2003 (invited talk).
- [160] A. T. Duchowski, Eye Movement Measurement in Virtual Reality: Diagnostic and Interactive Applications, *Southern Society for Philosophy and Psychology (SSPP) Annual Meeting*, Atlanta, GA, April 17-19, 2003 (invited talk).
- [161] A. T. Duchowski, *Eye Tracking Techniques in Virtual Reality* Naval Research Lab, Washington, D.C., June 2001 (invited talk).

### Courses, Symposia, Schools, and Workshops

- [162] A. T. Duchowski, K. Krejtz, and I. Krejtz, Microsaccades: Modeling, Analysis, and Synthesis, Symposium at the European Conference on Eye Movements (ECEM), Wuppertal, Germany, August 20-24, 2017 (symposium).
- [163] A. T. Duchowski, J. Bertrand, and M. Volonte, Eye Tracking in Desktop VR: Data Synchronization, Capture, Visualization, and Analysis, IEEE VR 2016, Greenville, SC, March 19-23, 2016 (half-day tutorial).
- [164] A. T. Duchowski, I. Krejtz, K. Krejtz, and I. S. MacKenzie, Eye Tracking Experimental Design, Implementation, and Analysis, ETH Zürich Winter School, Ascona, Switzerland, January 17-22, 2016, P. Kiefer, M. Raubal, C. Hölscher, and M. Meboldt, organizers.
- [165] A. T. Duchowski, K. Krejtz, I. Krejtz, R. Mantiuk, and B. Bazyluk, An Eye on Perceptual Graphics: Eye-Tracking Methodology, *EuroGraphics 2013 Tutorial (Half-Day)*, Girona, Spain, May 6-10, 2013.
- [166] A. Bulling, R. Dachselt, A. T. Duchowski, R. J. K. Jacob, S. Stellmach, and V. Sundstedt, Gaze Interaction in the Post-WIMP World, *CHI 2013 Workshop*, Paris, France, Apr 27-2 May, 2013.
- [167] A. T. Duchowski, Eye-Tracking Research Methodology, PhD Summer School, *Universitat Autònoma de Barcelona*, Barcelona, Spain, June 4-8, 2012.
- [168] A. T. Duchowski, Eye-Tracking Research Methodology, *Universitat Autònoma de Barcelona*, PhD Summer School, Barcelona, Spain, June 4-8, 2012.
- [169] A. T. Duchowski, Hands-on Eye Tracking: Working with Images and Video, GaCIT Summer School on Gaze, Communication, and Interaction Technology, Tampere, Finland, August 18-22 2008.
- [170] A. Alberts, E. Cutrell, and A. T. Duchowski, Augmenting Usability with Eye Movement Process Metrics: Hands-On Training, SIGCHI 2008 Course 14, Florence, Italy, April 2008, ACM.
- [171] A. T. Duchowski and R. Vertegaal, *Eye-Based Interaction in Graphical Systems: Theory & Practice* SIGGRAPH 2000 Course 05, New Orleans, LA, July 2000, ACM.

### Other Presentations

- [172] E. F. Anderson, A. T. Duchowski, F. Liarokapis, and A. Redford, The New CGEMS—Preparing the Computer Graphics Educational Materials Source to Meet the Needs of Educators, *EuroGraphics*, Lyon, France, April 24-28, 2017 (panel).

- [173] S. V. Babu, A. T. Duchowski, A. K. Gramopadhye, D. H. House, and R. Wang, *Gaze Interaction in the Near-Field: Accommodating Vergence at Arm's Length* in Proceedings of the CHI 2013 Workshop on Gaze Interaction in the Post-WIMP World, Paris, France, Apr 27-2 May, 2013 (position paper).
- [174] A. T. Duchowski, K. Holmqvist, and K.-J. R  ih  , Gaze Over Subtitles: Avoiding Analysis Pitfalls, *Points of View in Language and Culture: AudioVisual Translation*, Krakow, Poland, October 14-15, 2011 (panel).
- [175] A. T. Duchowski, Eye-tracking Technology and its Potential Application to Tracing and Validation of Microscopy Data, *CNS\*2010 Workshop on high-throughput 3D microscopy and high-performance computing for multi-scale modeling and simulation of large-scale neuronal circuits*, San Antonio, TX, July 29-30, 2010.
- [176] H. Murphy and A. T. Duchowski, Perceptual Gaze Extent & Level Of Detail in VR: Looking Outside the Box, in *SIGGRAPH 2002 Conference Abstracts & Applications*, San Antonio, TX, July 2002, ACM.

### Student Advising

#### Doctoral Graduates

- Tonkin, Chip (PhD), *CUshop: A Simulated Shopping Environment Fostering Consumer-Centric Packaging Design & Testing*, August 2011.
- Grinding, Thomas J. (PhD), *Event-Driven Similarity and Classification of Scanpaths*, August 2010.
- Vembar, Deepak S. (PhD), *Visuohaptic Simulation of a Borescope for Aircraft Engine Inspection*, December 2009.
- Murphy, Hunter A. (PhD), *Hybrid Image/Model Based Gaze-Contingent Rendering*, December 2007.
- Cournia, Nathan A. (PhD), *Penumbra Volumes For Real-Time Generation of Perceptually Correct Soft Shadows on Modern Graphics Hardware*, December 2006.

#### Masters Graduates

- Daugherty, Brian C. (MS), *Ocular Vergence Response Over Anaglyphic Stereoscopic Video*, May 2009.
- Smalls, Rondey (MS; paper option), *Developing an Eye Tracking Application to Maintain Reading Pace for Dyslexics*, May 2009.
- Eaddy, Tiras (MS; course option), December 2008.
- Ryan, Wayne J. (MS), *LimbusTrack: Stable Eye-Tracking in Imperfect Light Conditions*, May 2007.
- Grinding, Thomas (MS), *Eye Movement Analysis & Prediction with the Kalman Filter*, August 2006.
- Heminghouse, John (MS), *iComp: A Scanpath Comparison Tool*, May 2006.
- Cumming, Brian (MS), *Facilitating the Development of Maya File Translator Plug-ins Through Middleware*, December 2004.
- Vembar, Deepak (MS), *Towards Improved Behavioral Realism in Avatars*, December 2004.
- Marmitt, Gerd (MS), *Modeling Visual Attention in VR: Measuring the Accuracy of Predicted Scanpaths*, May 2003.
- Medlin, Eric (MS), *Vergence Eye Movements in Virtual Reality*, May 2003.
- Hunter, Murphy (MS), *Nonisotropic Gaze-Contingent Geometric Level Of Detail Rendering*, August 2001.

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Shivashankaraiah, Vinay (MS), Multi-Threading a Binocular Eye Tracking Virtual Reality Environment for Aircraft Inspection, August 2000.

### Current Graduate Advising

Bolte, Takumi (PhD), Large-Scale Scanpath Comparison (expected graduation: August 2018).

### Undergraduate Honors Advisees

Valdez, Jeffrey, Eye Movements and Attentional Bias in Anxiety, (May 2000).

Borland, David, Hyperview: A Viewer/Reader/Writer for Alias|Wavefront OBJ, VDF, and VRML Files, (December 2000).

### Personal Development

Completion of 4-day course on the use of Apple Shake, a digital special effects compositing tool, September 2002.

Attendance at 2-day workshop for DoD proposal writers, July 2002.

Completion of 4-day course on the use of Maya Composer, a digital special effects programming tool, August 2000.

## References

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1. Karol Myszkowski is a senior researcher at the Max-Planck Institute for Computer Science, Saarbrücken, Germany, and is actively involved in research concerning realistic image synthesis, computer animation, and perception in computer graphics applications. He received his Ph.D. in Computer Science from Warsaw University of Technology (Poland) in 1991. His current research is investigating the role of human perception for improving performance of photo-realistic rendering and animation techniques.

Dr. Myszkowski has published numerous papers on global illumination methods, animation sequence rendering, and visual attention modeling in interactive environments. He is well qualified to comment on my computer graphics-related eye tracking work.

2. Kari-Jouko Rähä is interested in Human-Computer Interaction, in particular in new interaction techniques and usability evaluation methods. He is head of the graduate school on User-Centered Information Technology at the University of Tampere, Finland and heads the Tampere Unit for Computer-Human Interaction.

Professor Rähä served with me as general co-chair of ETRA 2004 and 2006, ACM's premier symposium on Eye Tracking Research & Applications. He can provide comments on my leadership and service contributions to this research field.

3. Jeff Pelz is a Professor in the Center for Imaging Science at the Rochester Institute of Technology. He teaches courses on imaging science, vision, and psychophysics. He has also taught courses in optics and computer programming in the Microelectronic Engineering and Imaging and Photographic Technology programs. Dr. Pelz completed his doctoral work in Brain and Cognitive Sciences (BCS) at the University of Rochester's Center for Visual Science (CVS).

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Dr. Pelz's expertise in visual perception and eye tracking qualify him to comment on my own work in these fields. His teaching record also suggests that Dr. Pelz may be able to comment on my eye tracking course.

4. Carol O'Sullivan is a Professor of Visual Computing at Trinity College Dublin. She is currently working as Senior Research Scientist at Disney Research in Los Angeles. She has published numerous works on graphics and perception including a number of papers involving eye tracking.

Dr. O'Sullivan is well qualified to evaluate my contributions on graphics-related eye tracking work, e.g., gaze-contingent displays.

5. Carl Gutwin is Professor of Computer Science at the University of Saskatchewan. His main research areas are Computer-Supported Cooperative Work, Information Visualization, and Information Retrieval. He is director of the Human-Computer Interaction (HCI) lab at the University of Saskatchewan.

Professor Gutwin is one of several Canadian HCI researchers known to me. He can readily comment on my contributions to SIGCHI, including our 2005 award-nominated paper as well as my 2008 full day course, both centered on eye tracking.

6. Professor Alan Chalmers is expert in high fidelity computer graphics, visual perception, parallel processing and archaeological site reconstructions. He and his research team use computing power and techniques to produce computer simulations that run at high speeds yet still have the ability to make detailed calculations that can display the real physical laws of how changing light effects what you see. His techniques have been applied to everything from industrial and commercial virtual reality to the creation of 3D imagery to assist the study of Byzantine Art in Cyprus, and Bosnian archaeology.

Professor Chalmers has also been active in SIGGRAPH organization for many years, serving as its vice president from 1999-2002. I have known Professor Chalmers since my attendance of a SIGGRAPH Campfire for perception and graphics in 2001, which lay the foundations for assembly of a Perception in Graphics Birds-Of-a-Feather SIGGRAPH community as well as the formulation of the Applied Perception in Graphics and Visualization (APGV) annual symposium and the Transaction on Applied Perception journal. Professor Chalmers can comment on my contributions to these latter two venues.