



Date	2010/07/30
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**Notification of Intent to Apply for a
Discovery Grant**

**Avis d'intention de présenter une demande de
subvention à la découverte**

APPLICANT / CANDIDAT				
Family name / Nom de famille		Given name / Prénom	Initial(s) of all given names / Initiale(s) de tous les prénoms	Personal identification no. (PIN) / N° d'identification personnel (NIP)
Booth		Kellogg	KS	Valid/Valide 10455
Department / Département			Institution / Établissement	
Computer Science			British Columbia	
E-mail address / Adresse de courriel				
ksbooth@cs.ubc.ca				
Degrees Diplômes	Discipline Discipline	Institution Établissement	Supervisor Directeur de travaux	Year Année
Master's / Maîtrise	Computer Science	University of California, Berkeley	Richard M. Karp	1970
Doctorate / Doctorat	Computer Science	University of California, Berkeley	Richard M. Karp	1975
Postdoctoral experience / Expérience postdoctorale				
Bachelor's	Mathematics	California Institute of Technology	Frederick B. Thompson	1964 - 1968
EVALUATION GROUP ASSIGNMENT / ASSIGNATION DU GROUPE D'ÉVALUATION				
Suggest the number of the evaluation group you feel should review your application. / Entrez le numéro du groupe d'évaluation qui selon vous devrait évaluer votre demande.				
<input type="text" value="1507"/> Computer Science				
APPLICATION INFORMATION / RENSEIGNEMENTS SUR LA DEMANDE			TYPE OF APPLICATION / TYPE DE DEMANDE	
Title of proposal / Titre de la proposition			Individual / Individuelle <input checked="" type="checkbox"/>	
Collaboration technology and multi-user interfaces			Team / Équipe <input type="checkbox"/>	
			Subatomic Physics / Physique subatomique <input type="checkbox"/>	
The application will be submitted in / La demande sera présentée en			<input checked="" type="checkbox"/> English / anglais <input type="checkbox"/> français / French	
Research topic(s) that describe the proposed research / Sujet(s) de recherche décrivant la recherche proposée				
CS17 - Human Computer Interaction CS19 - Computer Graphics and Visualization CS02 - User Adaptive Systems CS05 - Algorithms and Data Structures ENE07 - Video and Display technologies				
KEY WORDS that best describe the proposed research / MOTS CLÉS qui décrivent le mieux la recherche proposée				
augmented reality, collocated teamwork, computer-supported cooperative work, document authoring, instructional technology, interaction design, multi-touch, participatory design, shared displays, usable security				

SUMMARY OF PROPOSAL / RÉSUMÉ DE LA PROPOSITION

In the space provided below, state the objectives of the proposed research project and summarize the scientific approach, highlighting the novelty and expected significance of the work to a field or fields in the natural sciences and engineering. Note that NSERC supports research in the natural sciences and engineering (other than the health sciences).

Dans l'espace prévu ci-dessous, énoncez les objectifs du projet de recherche proposé et résumez la démarche scientifique, en soulignant l'originalité et l'importance prévue des travaux dans un ou plusieurs domaines des sciences naturelles ou du génie. Veuillez noter que le CRSNG appuie la recherche dans le domaine des sciences naturelles et du génie, à l'exception des sciences de la santé.

The proposed research focuses on several aspects of collaboration technology within the broader area of human-computer interaction. This continues an on-going research program with an additional five-year plan.

Interaction techniques for shared displays in collocated environments present a number of challenges. The proposed research will examine the affordances of tabletop, large wall-mounted, and hand-held displays to determine how each best fits with specific tasks during face-to-face collaboration, and how each can support the other. Included in this will be development of novel interaction techniques for use at a distance from the display, especially when used in collaborative environments where mutual awareness must be traded off against interference and distraction by one user's interaction with another's workflow. Two or more graduate students will be involved in these projects.

Classroom and meeting room presentation support using shared displays is a special case of the more general work that is of particular interest. As with the general topic, this continues recent work. Studies in actual classrooms using special-purpose software designed to support multiple projectors to extend standard PowerPoint presentations to a much larger screen area more like traditional multi-blackboard "chalk talk" lectures was the topic of a just-finished doctoral dissertation I supervised. Further work will assess specific pedagogical hypotheses and ways to engage students as active participants, rather than simply as passive receptors. One graduate student will work on this for a thesis project and two undergraduates and a postdoctoral fellow will also participate.

Augmented, mixed, and hybrid reality each offer other avenues for extending research on shared displays. In this case the displays are super-imposed or embedded in physical objects, and interaction techniques that flow seamlessly back and forth between the real and virtual representations of the objects or the information underlying are being studied. Recent work has looked at a variety of multi-projector augmented reality techniques for architectural plans. This will be continued in a number of ways by two or more graduate students for their thesis research.

Document authoring and annotation tools are fundamental tools for collaboration. They are among the earliest examples of computer-based productivity applications, yet a number of problems still remain to be solved. Commercial desktop software, such as the Microsoft Office suite, offers many solutions, but does not yet provide adequate support for shared authoring of the type that is undertaken almost daily by academic researchers. Google provides an interesting counter-point with its documents, which are essentially collaboration tools first and document authoring tools second (though admittedly quite good at both). Nevertheless, neither these nor other commercial tools fully capture the workflow typical of collaborative writing, especially during the editing and annotation phase. The proposed research will build on previous research by the applicant and colleagues to examine how structured documents and annotations can naturally reflect the distributed nature of annotations and revisions in realistic settings. This will also examine other types of documents such as archives of webcasts, again building on recent work by the applicant and colleagues. One graduate student will be co-supervised on this.

1. Most Significant Contributions

Collaboration tools – Research begun in the mid-1990s on human-computer interaction studies of children in learning environments combined traditional HCI methodology and learning technology to analyze effectiveness of support for collaborative learning activities. This was followed by work on collaborative software to support art therapy followed by experimental studies of fundamental perceptual and cognitive aspects of shared viewing environments (LIU ET AL., 2005) and techniques for coordinating activity in co-present shared display environments (VOGT ET AL., 2004; SHOEMAKER ET AL., 2007).

Virtual and augmented reality - Since 1990 I have worked on problems in virtual and augmented reality involving human factors based on perceptual and motor performance. This work has been in collaboration with psychologists and kinesiologists. More recently I have been applying this to collaborative displays in a variety of settings, including architectural building models that is part of an NSERC strategic grant on construction technology. Recent studies include human performance in simulated 3-D environments (SPRAGUE ET AL., 2006) and work in progress on multi-modal augmented reality (MACKENZIE, BOOTH ET AL., 2009) and very large wall-sized “whale tank VR” (MAKSKOV ET AL., 2009 and 2010).

Document authoring and presentation tools – Prototype tools to support collaborative authoring, especially in the editing and revision cycle introduced structured annotations were developed and evaluated (ZHENG ET AL., 2006). An early prototype for ensuring privacy of information during public presentations (BERRY ET AL., 2005) is being extended for use in a general meeting support tool

(MacKenzie, Liu, et al., 2009) and a series of studies have been conducted on presentation software that employs multiple screens has been effectively demonstrated in classrooms by instructors in a variety of disciplines (LANIR, BOOTH & FINDLATER, 2008; LANIR, BOOTH & TANG, 2008; LANIR & BOOTH, 2009; LANIR, BOOTH & HAWKEY, 2010). This is ongoing work in the area of instructional technology.

Touch in the user interface – A series of collaborative studies on the role of touch (haptics) in the user interface (SWINDELLS ET AL., 2006; SWINDELLS ET AL., 2007; SWINDELLS ET AL., 2009) are being extended with new work involving multi-touch displays. This is work in collaboration with industry partner Smart Technologies (Calgary).

Knowledge and Technology Exchange and Exploitation - I recently served as the Vancouver director for the newly established Academic Research Centre Business Objects/SAP. My role was to establish joint research projects involving Business Objects and academic researchers, modeled loosely after the successful IBM CAS (Centre for Advanced Studies) model in which I was involved as a technical advisor (1990). I am the scientific director of a new Network of Centres of Excellence on New Media, Animation, and Games for which five-year funding was awarded in December 2009.

2. Research Contributions and Practical Applications

Student and postdoctoral co-authors are indicated in **BOLD FACE** in the following list of publications. Refereed publications include journal publications and major international conferences that are fully-reviewed, usually with an author-rebuttal

cycle. Partially reviewed and non-refereed publications are listed separately.

Refereed publications

HENDY, J.C., BOOTH, K. S., & MCGRENERE, J.L. (2010). Graphically enhanced keyboard accelerators for GUIs. *Proceedings of Graphics Interface 2010*. Ottawa, Ontario. May 31 – June 1, pp. 3-10.

MAKSAKOV, E., BOOTH, K. S., & HAWKEY, K. (2010). Whale tank virtual reality. *Proceedings of Graphics Interface 2010*. Ottawa, Ontario. May 31 – June 1, pp. 185-192.

LANIR, J., BOOTH, K.S., & HAWKEY, K. (2010). The benefits of more electronic screen space on students' retention of material in classroom lectures. *Computers and Education*, 55:892-903.

SWINDELLS, C., MACLEAN, K.E., & BOOTH, K.S. (2009). Designing for feel: Contrasts between human and automated parametric capture of knob physics. *IEEE Transactions on Haptics*, 2(4):200-211 (October-December).

SHOEMAKER, G., FINDLATER, L., DAWSON, J.Q., & BOOTH, K.S. (2009). Mid-air text input techniques for very large wall displays. *Proceedings of Graphics Interface 2009*, 231-238. Kelowna, British Columbia. May 25-27.

LANIR, J. & BOOTH, K.S. (2008). Presentation tools for high-resolution and multiple displays. In *Proceeding of the 3rd ACM International Workshop on Human-Centered Computing*, 61-68. Vancouver, British Columbia. October 31.

LANIR, J., BOOTH, K.S., & TANG, A. (2008). MultiPresenter: a presentation system for (very) large display surfaces. In *Proceeding of the 16th ACM international Conference on Multimedia*, 519-528.

Vancouver, British Columbia. October 26-31.

LANIR, J., BOOTH, K.S., & FINDLATER, L. (2008). Observing presenters' use of visual aids to inform the design of classroom presentation software. *CHI Letters* 10(1), 1247-1256. (*Proceedings of the ACM Conference on Human Factors in Computing (CHI 2008)*, Florence, Italy, April 5-10.)

SHOEMAKER, G., TANG, A.T., & BOOTH, K.S. (2007). Shadow Reaching: A new perspective on interaction for large wall displays. In *Proceedings of UIST 2007 – The 20th Annual ACM Symposium on User Interface Software and Technology*, October 7-10, Providence, RI, 4 pages.

MCGRENERE, J., BAECKER, R.M., & BOOTH, K.S. (2007). A field study of an adaptable two-interface design for feature-rich software. *ACM Transactions on Computer-Human Interaction*, 14(1), 43 pages (May).

SWINDELLS, C., MACLEAN, K.E., BOOTH, K.S., & MEITNER, M. (2007). Exploring affective design for physical controls. *CHI Letters* 9(1):933-942. (*Proceedings of the ACM Conference on Human Factors in Computing (CHI 2007)*, San Jose, CA, April 28 – May 3.)

SPRAGUE, D.W., PO, B.A., & BOOTH, K.S. (2006). The importance of accurate VR head registration on skilled motor performance. In *Proceedings of Graphics Interface 2006*. Quebec, Quebec. June 7-9, pp. 131-138.

SWINDELLS, C., MACLEAN, K.E., BOOTH, K.S., & MEITNER, M. (2006). A case-study of affect measurement tools for physical user interface design. In *Proceedings of Graphics interface 2006* (Quebec, Canada, June 07 - 09, 2006). ACM International Conference Proceeding

- Series, vol. 137. Canadian Information Processing Society, Toronto, Ont., Canada, 243-250.
- ZHENG, Q., MCGRENERE, J.L., & BOOTH, K.S.** (2006). Co-authoring with structured annotations. In *Proceedings of the ACM Conference on Human Factors in Computing (CHI 2006)* Montreal, Quebec, April 22-27, pp. 131-141.
- BERRY, L., BARTRAM, L.R., & BOOTH, K.S.** (2005). Role-based policies to control shared application views. In *Proceedings of ACM User Interface Software & Technology 2005 (UIST)*, pp. 23-32.
- Po, B.A., FISHER, B.D., & BOOTH, K.S.** (2005). A two-visual systems approach to understanding voice and gesture interaction. *Virtual Reality*, 8:231-241.
- Po, B.A., FISHER, B.D., & BOOTH, K.S.** (2005). Comparing cursor orientations for mouse, pointer, and pen interaction. Submitted to *Proceedings of the ACM Conference on Human Factors in Computing (CHI 2005)*, Portland, OR, April 2-7, pp. 291-300.
- CUBRANIC, C., MURPHY, G.C., SINGER, J., BOOTH, K.S.** (2005). Hipikat: Project memory for software development. *IEEE Transactions on Software Engineering*, 31(6)-446-465. Special Issue on Mining Software Repositories.
- LIU, G., AUSTEN, E.L., BOOTH, K.S., FISHER, B.D., REMPEL, M.I., & ENNS, J.T.** (2005). Multiple object tracking is based on scene, not retinal, coordinates. *Journal of Experimental Psychology: Human Perception and Performance*, 31(2):235-247 (April).
- CUBRANIC, D., MURPHY, G.C., SINGER, J., & BOOTH, K.S.** (2004). Learning from project history: A case study for software development. *ACM CSCW 2004*, Chicago, IL, November 6-10, pp. 82-91.
- VOGT, F., WONG, J., PO, B.A., ARGUE, R., FELLS, S.S., & BOOTH, K.S.** (2004). Exploring collaboration with group pointer interaction. In *Proceedings of CGI 2004 (Computer Graphics International)*, Hersonissos, Crete, Greece, June 16-19, pp. 636-639.
- SWINDELLS, C., PO, B.A., HAJSHIRMOHAMMADI, I., CORRIE, B., DILL, J.C., FISHER, B.D., & BOOTH, K.S.** (2004). Comparing CAVE, wall, and desktop displays for navigation and wayfinding in complex 3D models. In *Proceedings of CGI 2004 (Computer Graphics International)*, Hersonissos, Crete, Greece, June 16-19, pp. 420-427.
- HANCOCK, M., & BOOTH, K.S.** (2004). Improving menu placement strategies for pen input. In *Proceedings of Graphics Interface 2004*. London, Ontario. May 17-19, pp. 221-230.
- Po, B.A., FISHER, B.D., & BOOTH, K.S.** (2004). Mouse and touchscreen selection in the upper and lower visual fields. In *Proceedings of the ACM Conference on Human Factors in Computing (CHI 2004)* Vienna, Austria, April 21-26, pp. 359-366.
- Invited talks**
- BOOTH, K.S.** (2008). 2⁵ years ago I couldn't even spell Canadian, now I are one: Momentos of collaborating on, with, and about technology. *Proceedings of Graphics Interface 2008*. Windsor, Ontario. May 28-30, pp. 107-114.

Conference Posters

- FERNQUIST, J., BOOTH, K.S., & MACKWORTH, A.K.** (2010). Using multi-touch tabletops to create and compare neighbourhood designs that satisfy constraints. *Second International Workshop on Constraint Reasoning and Optimization for Computational Sustainability*, Bologna, Italy. June 15.
- SHOEMAKER, G., TSUKITANI, T., KITAMURA, Y. BOOTH, K.S.** (2010). Whole body large wall display interfaces. Video and summary in *CHI Extended Abstracts*, pp. 4809-4812.
- RAJA, F., HAWKEY, K., BEZNOSOV, K., & BOOTH, K.S.** (2010). Investigating an appropriate design for personal firewalls. Work-in-progress in *CHI Extended Abstracts*, pp. 4123-4128
- HENDY, J.C., MCGRENERE, J.L., BOOTH, K.S.** (2009). Graphically-enhanced keyboard accelerators. Poster in *Extended Abstracts, Graphics Interface 2009*. Kelowna, British Columbia. May 25-27.
- MACKENZIE, R., BOOTH, K.S., HAWKEY, K., & STAUB-FRENCH, S.** (2009). Projected Fishtank Virtual Reality for Architectural Models. Poster in *Extended Abstracts, Graphics Interface 2009*. Kelowna, British Columbia. May 25-27.
- MACKENZIE, R., LIU, Z., PERSWAIN, P., HAWKEY, K., & BOOTH, K.S.** (2009). Lacome: The Large Collaborative Meeting Environment. Poster in *Extended Abstracts, Graphics Interface 2009*. Kelowna, British Columbia. May 25-27.
- MAKSAKOV, E., HAWKEY, K., & BOOTH, K.S.** (2009). Whale tank virtual reality: Collaboration in VR using a large screen. Poster in *Extended Abstracts, Graphics Interface 2009*. Kelowna, British Columbia. May 25-27.
- ARGUE, R., BOOTH, K.S., & INKPEN, K.M.** (2007). Reflect & satellite displays: advanced multi-display configuration. Poster in *Extended Abstracts, Graphics Interface 2007*.
- LANIR, J., & BOOTH, K.S.** (2007). Understanding instructors use of visual aids in a classroom setting. Poster in *Extended Abstracts, Graphics Interface 2007*.
- LANIR, J., BERRY, L., & BOOTH, K.S.** (2006). WinClone: Role-based control of distributed application views. Interactive demo at *ACM CSCW 2006*, Banff, AB, November 4-8.
- TANG, A.T., PARKER, K.J., LANIR, J., BOOTH, K.S., FELS, S.S.** (2006). Studying collaborative surface use to guide large display interaction design. Poster at *ACM CSCW 2006*, Banff, AB, November 4-8.
- ZHENG, Q., BOOTH, K.S., & MCGRENERE, J.** (2005). Designing structured annotations to support collaborative writing workflow. Poster in *Extended Abstracts, Graphics Interface 2005*.
- BERRY, L., BARTRAM, L.R., & BOOTH, K.S.** (2005). Visual manipulations for improved generalized presentations. Poster in *Extended Abstracts, Graphics Interface 2005*.

Technical Reports

- Mackenzie, R., Hawkey, K., Perswain, P. & Booth, K.S.** (2010). Evaluating two window manipulation techniques on a large screen display. TR 2010-03. UBC CS.
- LANIR, J., BOOTH, K.S., & WOLFMAN, S.** (2009). Promoting collaborative learning in lecture halls using multiple projected screens with persistent and dynamic content. TR 2009-10. UBC CS.

SHOEMAKER, G., TSUKITANI, T., KITAMURA, Y., & BOOTH, K.S. (2009). Body-centric interactions with very large wall displays. TR 2009-12. UBC CS.

Patents

SHOEMAKER, G., & BOOTH, K.S. (2009). Method and Device to Interact with Large Scale Displays. U.S. provisional patent. Filed August 29, 2008.

3. Other Evidence of Impact and Contributions

I directed the Media and Graphics Interdisciplinary Centre (MAGIC) at UBC for its first twelve years. MAGIC's mandate is multidisciplinary research and educational activities involving emerging media-based and computer graphics technologies. I was responsible for identifying potential new media applications and initiating and leading research projects that integrate technology into the research and educational infrastructure at UBC.

I was an adjunct scientist at the New Media Innovation Centre (NewMIC), a partnership between the federal government, the Province of British Columbia, and universities in British Columbia. My role as a senior academic researcher was liaison with the academic community, and consultant in defining projects with industry in the area of advanced multimedia and in establishing the Immersion Laboratory (an Advanced Collaborative Environment jointly funded by NRC) and the User Centred Design Laboratory (a usability lab available to industrial and academic partners). Included were activities with Sony, Electronic Arts, and General Motors.

I have served on numerous program committees, including: ACM CHI 2002, 2004, 2006 & 2008; ACM I3D 2001; ACM SIGGRAPH '98 & '99; ACM UIST '99, 2001, 2003, 2006 & 2008; and Graphics Interface

'98. These are the top international conferences in HCI and interactive computer graphics, the two fields in which most of my research has been conducted. I have been a referee or reviewer for many journals, conferences, granting agencies, and tenure and promotion cases. From 2002-2008 I was the president of the Canadian Human-Computer Communications Society. I was a fellow of the B.C. Advanced Systems Institute from 1992-2004.

I was the associate director for NECTAR (Network for Effective Collaboration Technology through Advanced Research), a five-year NSERC Research Network and for six months in 2006 the acting director. As a member of the Executive Committee and the Board of Directors for NECTAR, I was heavily involved in developing the relationship between the six university research sites and the two major sponsors (Smart Technology and Microsoft Research / Microsoft Canada) as well as other companies involved in the network.

4. Delays in Research Activity

(none)

5. Contributions to the Training of Highly Qualified Personnel (HQP)

I have been very involved in the training of HQP and have supervised many students at all levels who are now working in industry or who hold academic positions. For the past 30 years many of my students have been involved in one or more projects funded under NSERC's strategic grant program. In many cases students subsequently accepted jobs with partners on those projects, a direct result of the training they received under my supervision and the involvement they had with the partners during the research.