

Proceedings of the
9th International Conference on
Auditory Display

July 6-9, 2003

Boston University, Boston, MA, USA

Financial support for ICAD 2003 was provided by



Editors: Eoin Brazil and Barbara Shinn-Cunningham

Cover Design: Virginia Johnson

Published by the Boston University Publications Production Department

ISBN: 0-87270-133-6

Copies may be ordered from:

Prof. Barbara Shinn-Cunningham
Department of Cognitive & Neural Systems and
Department of Biomedical Engineering
Boston University
677 Beacon St.
Boston, MA 02215
email: ICAD2003@cns.bu.edu
<http://www.cns.bu.edu/~ICAD2003/>
mail ICAD web site: www.icad.org

All rights reserved. Copyright remains with the individual authors. No part of this publication can be reproduced, stored in a retrieval system, or transmitted in any form by any means, electronic, mechanical, photocopying, recording, or otherwise without prior written permission of the individual authors.

COMMITTEES AND VOLUNTEERS

ICAD 2003 Organizing Committee

General Chair

Barbara Shinn-Cunningham, Boston University

Technical Program Chair

Abhijit Kulkarni, Bose Corporation

Treasurer

Barry Blesser, Blesser Associates

Committee Members

Nat Durlach, Boston University and MIT
Simon Carlile, University of Sydney
Matti Gröhn, Helsinki University of Technology
Greg Kramer, Metta Foundation
Eric Somers, SUNY Dutchess
Bruce Walker, Georgia Institute of Technology
Elizabeth Wenzel, NASA Ames

Workshop Organizing Committee

Ramani Duraiswami, University of Maryland

Nat Durlach, Boston University and MIT

Barbara Shinn-Cunningham, Boston University

Bruce Walker, Georgia Institute of Technology

Conference Support and Coordination

Conference Coordinator

Joan Brown, Boston University

Administrative Assistant

Nancy Maguire, Boston University

MIT Media Lab Reception Coordinators

Nyssim Lefford, Kristie Thompson
Lorin Wilde

Proceedings Editors

Eoin Brazil, University of Limerick
Barbara Shinn-Cunningham, Boston University

Web Masters

Jeffrey Lindsay, Georgia Institute of Technology (*main ICAD 2003 site*)
Yang Wang, University of Maryland (*submission, registration*)

Student Volunteers

Suzanne Carr, Sasha Devore, Antje Ihlefeld, Kosuke Kawakyu, Patricia Moy, Yusuke Naka, Gerald Ng, Becky Poon, Suraj Ram, Jake Scarpaci, Tim Streeter, Sanaz Zhalehdoust Sani

Paper Review Committee

Masato Akagi

Jim Alty

Stephen Barrass

Durand Begault

Barry Blesser

Terri Bonebright

Simon Carlile

Michael Cohen

Chris Darwin

Alistair Edwards

John Flowers

Elena Grassi

Matti Gröhn

Shirin Hassan

Thomas Hermann

Jyri Huopaniemi

Craig Jin

Matti Karjalainen

Abhijit Kulkarni

Greg Kramer

Tappio Lokki

William Martins

Joshua A. Miele

John Neuhoff

James Oliverio

Catherine Plaisant

Ville Pulkki

Lauri Savioja

Malcolm Slaney

Eric Somers

Vesa Valimaki

Bruce Walker

Elizabeth Wenzel

Beverly Wright

Nick Zacharov

Pavel Zahorik

Dmitry Zotkin



WELCOME

On behalf of the ICAD 2003 Organizing Committee, it is my honor to welcome you to Boston University for the 9th International Conference on Auditory Display.

This is the first time ICAD has been held in Boston and also marks ICAD's return to the United States after two years of being held in other countries (in Finland in 2001 and in Japan in 2002). It is almost surprising that it has taken nine conferences for ICAD and Boston to meet, for they make a near-perfect match: few places in the world boast as high a density of researchers investigating auditory perception, auditory neurophysiology, audio technology, and audio engineering as the Boston area.

We have assembled what we think is an exciting mix of scientific and social events to make the inaugural Boston ICAD meeting memorable. The one-day workshop on auditory displays in assistive technology brings together academic researchers as well as consultants and practitioners who use auditory displays in real-world applications ranging from museum displays to everyday navigation. The main ICAD conference boasts over 60 technical presentations, selected (after careful peer review by an international panel of experts) from very high-quality submissions. In addition to talks, poster presentations, and what we hope will be a provocative panel discussion ("Science vs. Art in Auditory Displays"), we will visit the MIT Media Lab to see how technophiles use audio in displays. The social events (an informal pizza party, a "Duck Boat Tour" of Boston, the conference banquet, a reception at the Media Lab) are designed to nurture the already-strong camaraderie of the ICAD community and provide informal opportunities for ideas to be exchanged, discussed, and argued with a healthy give and take.

While we are here because of shared intellectual interests, we hope you take time to enjoy Boston during your stay. Walk the Freedom Trail; visit the Old North Church, Faneuil Hall, and Quincy Market. Between the laid-back nightlife of Harvard Square, live music clubs in and around Central Square, sports venues, museums, and other sights in and around Boston, there is something in our friendly city to appeal to everyone.

Generous financial support from the Boston University Hearing Research Center, the Air Force Office of Scientific Research, and Tucker-Davis Technologies allowed us to offer substantial subsidies to many student and post-doctoral participants and offset other ICAD 2003 meeting costs. Nancy Maguire and Joan Brown assisted mightily with administrative and logistical planning. The members of the ICAD 2003 Organizing Committee, particularly treasurer Barry Blesser, were extraordinarily generous with their time, ensuring the success of ICAD 2003. Many student volunteers will be helping in a variety of ways, down to guiding the ICAD community through the Boston subway system. However, more than anything else, the enthusiasm and dedication of the participants is responsible for the success of any conference. Thank you all for making this conference, and the ICAD community, as strong as it is. Because of you, it has been a pleasure to put together the program you are about to enjoy.

I look forward to seeing you all in Sydney for ICAD 2004!

Barbara Shinn-Cunningham
General Chair, ICAD 2003

Table of Contents

Committees and Volunteers	iii
Welcome	v
Table of Contents	vii
Biological Communication Sounds	
Vocal pedagogy and pedagogical voices (<i>invited talk</i>) <i>G. Wakefield</i>	1
Communicating with sound: An ethological perspective (<i>invited talk</i>) <i>T. Fitch</i>	12
Discriminating visible speech tokens using multi-modality <i>C.S. Campbell, S.K. Lodha, M.M. Shafae, and D.W. Massaro</i>	13
Spatial Auditory Perception	
Two-point discrimination in auditory displays <i>V. Best, A. van Schaik, and S. Carlile</i>	17
Identifying where you are in a room: Sensitivity to room acoustics <i>B. Shinn-Cunningham and S. Ram</i>	21
A study on sound source apparent shape and wideness <i>G. Potard, and I. Burnett, I</i>	25
Parameters for auditory display of height and size <i>D. Cabrera and S. Tilley</i>	29
Sound Design and Earcons	
Reality (sound)bites: Audio tricks from the film and TV studio (<i>invited talk</i>) <i>J. Rose</i>	33
Combining speech and earcons to assist menu navigation <i>M.L.M. Vargas and S. Anderson</i>	38
An investigation into the identification of concurrently presented earcons <i>D.K. McGookin and S.A. Brewster</i>	42
Perceptively based design of new car horn sounds <i>G. Lemaitre, P. Susini, S. Winsberg, and S. McAdams</i>	47

Perception in Auditory Display

- Increasing effectiveness of train horns without increasing intensity 51
F.A. Russo, M.E. Lantz, G. English, and L.L. Cuddy
- Auditory displays on the depth of hypertext 55
J.H. Lee, M.H. Jeon, and M.S. Kim
- Do location and content operate independently? 59
P.M.C. Lemmens, A. de Haan, and G.P. van Galen
- Focalisation on the temporal context of complex sequences 63
A. Guillaume and C. Drake
- Where's that sound? Exploring arbitrary user classifications of sounds for audio management 66
E. Brazil and M.Fernström

Perception in Spatial Auditory Displays

- Augmented intelligibility in simultaneous multi-talker environments 71
N. Mesgarani, K. Grant, S. Shamma, and R. Duraiswami
- Perceptual consequences of including reverberation in spatial auditory displays 75
S. Devore and B. Shinn-Cunningham
- A physics-based approach to the presentation of acoustic depth 79
F. Fontana and D. Rocchesso
- A spatial auditory display for the prevention of pedestrian-motor vehicle collisions 83
J.G. Neuhoff and J. Preston
- A three-dimensional virtual simulator for aircraft flyover presentation 87
S.A. Rizzi, B.M. Sullivan, and C.A. Sandridge
- Design considerations for a background auditory display to aid pilot situation awareness 91
M.L.N. Kazem, J.M. Noyes, and N.J. Lieven

Spatial Auditory Display Technology

- Extending SMIL with 3D audio 95
K. Pihkala and T. Lokki
- An independent declarative 3D audio format on the basis of XML 99
H. Hoffmann, R. Dachsel, and K. Meissner
- The spatial sound lab at Fraunhofer IMK.VE 103
J. Goffmann and F. Dombois

A 3D real time rendering engine for binaural sound reproduction <i>M. Noisternig, T. Musil, A. Sontacchi, and R. Höldrich</i>	107
Latency measurement of a real-time virtual acoustic environment rendering system <i>J.D. Miller, M.R. Anderson, E.M. Wenzel, and B.U. McClain</i>	111
Extracting significant features from the HRTF <i>V.C. Raykar, R. Duraiswami, L. Davis, and B. Yegnanarayana</i>	115
Measurement of head-related transfer functions based on the empirical transfer function estimate <i>E. Grassi, J. Tulsi, and S. Shamma</i>	119
 Display Systems and Technology	
D'groove: A haptic turntable for digital audio control <i>T. Beamish, K. van den Doel, K. MacLean, and S. Fels</i>	123
The IEM cube: A periphonic re-/production-system <i>J.M. Zmöltnig, W. Ritsch, and A. Sontacchi</i>	127
Instrument timbre models with noisy partial inclusion <i>C. O'Sullivan and M. Fernström</i>	131
Narrowcasting operations for mobile phone CVE chatspace avatars <i>M. Cohen and M. Kawaguchi</i>	136
 Auditory Display Examples	
Auditory icon support for navigation in speech-only interfaces for room-based design metaphors <i>D. Skantze and N. Dahlbäck</i>	140
The use of walking sounds in supporting awareness <i>K. Mäkelä, J. Hakulinen, M. Turunen</i>	144
Evaluating soundscapes as a means of creating a sense of place <i>P. Turner, I. McGregor, S. Turner, and F. Carrol</i>	148
 Sonification Approaches	
Drawing by ear: Interpreting sonified line graphs <i>L.M. Brown and S.A. Brewster</i>	152
Sonification of statistical graphs <i>S.C. Peres and D.M. Lane</i>	157
Sonification sandbox: A graphical toolkit for auditory graphs <i>B.N. Walker and J.T. Cothran</i>	161

Algorithmic Composition

- Ocean buoy spectral data sonification: Research update 164
B.L. Sturm
- For those who died 166
M. Quinn, W. Quinn, and B. Hatcher

Designing Effect Displays

- Sonification design patterns (*invited talk*) 170
S. Barrass
- Design process for auditory interfaces 176
S. Daudé and L. Nigay
- Audiocentric interface design: A building blocks approach 180
C. Thornton, A. Kolb, F. Gemperle, and T. Hirsch
- Acqua alta a Venezia: Design of an urban scale auditory warning system 184
F. Avanzini, D. Rocchesso, A. Dal Palù, A. Belussi, and A. Dovier

Spatial Auditory Displays

- Optimizing the spatial configuration of a seven-talker speech display 188
D.S. Brungart and B.D. Simpson
- Using multi-channel spatialization in sonification: A case study with meteorological data 192
E. Childs and V. Pulkki
- Spatially-modulated auditory alerts 196
D.R. Begault, M.R. Anderson, and B.U. McClain
- Comparison of auditory, visual, and audio-visual navigation in a 3D space 200
M. Gröhn, T. Lokki, and T. Takala
- Effect of beacon sounds on navigation performance in a virtual reality environment 204
B.N. Walker and J. Lindsay

Sonification

- Broadcasting auditory weather reports: A pilot project 208
T. Hermann, J.M. Drees, and H. Ritter
- Educational testing of auditory display regarding seasonal variation of Martian polar ice caps 212
J. Keller, E.E. Prather, W.V. Boynton, H.L. Enos, L.V. Jones, S.M. Pompea, T.F. Slater, and M. Quinn

Auditory Display Examples

- Audio games: Fun for all? All for fun? 216
S. Targett and M. Fernström
- "LISTENIN" to domestic environments from remote locations 220
C. Schmandt and G. Vallejo
- Household appliances control device for the elderly 224
F.J. Sainz Salces, D. England, and P. Vickers

Auditory Display Dimensions

- Sound-discrimination learning and auditory displays (*invited talk*) 228
B.A. Wright and M.B. Fitzgerald
- Dynamic auditory cues for event importance level 233
J. Häkkinen and S. Ronkainen
- A new experimental technique for gathering similarity ratings for sounds 238
E. Brazil, L. Ottaviani, and M. Fernström
- Sonification of absolute values with single and multiple dimensions 243
A. Sandor and D.M. Lane

Auditory Display System Architecture

- Interactive visualization and sonification for monitoring complex processes 247
T. Hermann, C. Niehus, and H. Ritter
- NeMoS: Network monitoring with sound 251
D. Malandrino, D. Mea, A. Negro, G. Palmieri, and V. Scarano

Spatial Auditory Synthesis

- Perceptual spatial-audio coding 255
C. Jin, A. van Schaik, V. Best, and S. Carlile
- Subjective selection of non-individual head-related transfer functions 259
B.U. Seeber and H. Fastl
- Individualized and generalized earphone correction filters for spatial sound reproduction 263
W.L. Martens
- A spatial audio user interface for generating music playlists 267
J. Hiipakka and G. Lorho

Auditory Displays In Assistive Technologies (Papers)

Auditory assistive devices for the blind (<i>invited talk</i>) <i>R.W. Massof</i>	271
Maximum listening speeds for the blind <i>C. Asakawa, H. Takagi, S. Ino, and T. Ifukube</i>	276
3d audio interfaces for the blind <i>C. Frauenberger and M. Noisternig</i>	280
Design guidelines for audio presentation of graphs and tables <i>L.M. Brown, S.A. Brewster, R. Ramloll, M. Burton, and B. Riedel</i>	284
Smith-Kettlewell display tool: A sonification toolkit for Matlab (<i>invited talk</i>) <i>J.A. Miele</i>	288
Perceptive study and recommendation for sonification categories <i>P. Susini, P. Gaudibert, E. Deruty, and L. Dandrel</i>	292
Boardtalker: Initial experiences and open problems in prototyping a talking digital whiteboard to assist visually impaired students <i>D. Berque</i>	296
Basic and applied research relating to auditory displays for visually impaired people (<i>invited talk</i>) <i>J.M. Loomis</i>	300
Soundview: Sensing color images by kinesthetic audio <i>K. van den Doel</i>	303

Auditory Displays In Assistive Technologies (Abstracts)

A case study in the design of software that uses auditory cues to help low vision students view notes on a blackboard <i>D. Berque, T. Bonebright, S. Kinnett, N. Nichols, and A. Peters</i>	307
Sonification of dynamic choropleth maps: Geo-referenced data exploration for the vision-impaired <i>H. Zhao, C. Plaisant, B. Shneiderman, D.N. Zotkin, and R. Duraiswami</i>	307
Sonification of SQL constructs in multi-modal database interaction <i>T. Stockman</i>	308
WYSIWIH- What you see is what I hear: Giving blind users access to visual collaboration <i>F. Winberg</i>	308
A game for visually impaired children with a 3-d virtual auditory display <i>M. Ohuchi, Y. Iwaya, Y. Suzuki, and T. Munekata</i>	309
Author Index	311

