

VISUAL LANGUAGES'92 TUTORIAL DESCRIPTION

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TUTORIAL 4: VIRTUAL REALITY AND EXPERIENTIAL COMPUTATION

Virtual reality is a computer generated, multi-dimensional, inclusive environment which can be accepted by a participant as cognitively valid. VR provides the opportunity for experiential computation, for direct participation in formal systems. We'll discuss participatory systems with natural semantics (architectural databases, terrain models, physical simulation) and systems with abstract structure (logic, algebra).

The tutorial will cover the essential characteristics of VR: the philosophy and mathematics of inclusion, natural interaction as opposed to symbolic mediation, multisensory display, multi-dimensional environments, and the sense of presence. The focus will be on the software infrastructure and tools for maintaining virtual environments, including: the Virtual Environment Operating System (VEOS), entity management, objects, spaces, and abstractions, the Wand, the Virtual Body, multiple participants and inconsistency maintenance, editing and interaction techniques, and design of virtual worlds.

Applications to be discussed include world building by high school students, design and maintenance of aircraft, teleconferencing and cooperative work, and experiential mathematics. The tutorial will close with consideration of the issues and implications of VR for participants and for social institutions.

ACTIVITIES

We need to select approximately 8 to 16 topics (depending upon detail) from the following list of possible topics. This comes to about 10 minutes per topic quickly, 20 minutes per topic in depth. Marked modules are recommended.

- Historical overview
- Overview of i/o hardware
- Overview of computation
- * Terms and definitions
- * System Architecture
- Varieties of VR
- VR paradigm shift
- * Inclusion
- * Semantics
- VEOS
- Linda
- * Entities (external)
- Entities (internal)
- * Space
- * Abstract cube
- * Wand
- * Virtual Body
- * Multiple participants
- Media Tool
- Editing entities
- Research directions
- Boundary models
- Boundary mathematics
- * Visual logics
- * Experiential logic
- Experiential algebra
- * Psychological issues
- * Social issues
- Open discussion
- Other topics
- * Virtual world: Virtual Seattle
- * Virtual worlds: Octopus Garden and Green Valley
- * Virtual world: VSX, the Virtual Osprey
- * Virtual worlds: Constructed by high school students

ANNOTATED CONTENTS

SECTION I: VIRTUAL REALITY

The papers in this section provide a technical look at VR software systems, at the theory of inclusion, and at design principles for virtual worlds.

W. Bricken: *Virtual Interface Technology*, Two sections of the SIGGRAPH Course Slides, 7/90

VR Software covers the VEOS architecture, entities, interaction tools and editors. **Implications of VR** covers definitions, the theory of inclusion, and social issues.

W. Bricken: *Virtual Reality: Directions of Growth*, Proceedings, Imagina'92, Centre National de la Cinematographie, Monaco, 1/92

The VR paradigm shift as exemplified by the scope of evolving VR research, tools and applications, and by likely trends, risks and philosophical perspectives of VR technology.

W. Bricken: *VEOS: Preliminary Functional Architecture*, HITL Technical Report M-90-2, 1990

A short description of the functional components of the Virtual Environment Operating System, the architecture of entities and the software tools for the construction and interaction with models. Introduces the Wand and the Virtual Body.

W. Bricken: *Mathematical Foundations of Cyberspace* and *Extended Abstract: A Formal Foundation for Cyberspace*, Proceedings, Virtual Reality '91, San Francisco, Meckler, 9/91

Boundary mathematics interpreted as a calculus of inclusion, with the void, the universe and the participant as primitives.

M. Bricken: *Virtual Worlds: No Interface to Design*, Cyberspace: The First Steps, M. Benedikt (ed), MIT Press, 1991

Aspects of the VR paradigm shift applied to the design and construction of virtual worlds. Models of cyberspace from the perspective of the engineer, the participant, and the designer.

SECTION II: VIRTUAL REALITY APPLICATIONS

In contrast to the theoretical perspective of Section I, the papers in this section describe projects which apply VR technology. These applications include teleconferencing, aircraft design, education, and gender specific science.

M. Bricken: *The Virtual Conference Room: A Shared Environment for Remote Collaboration*, HITL Technical Report M-90-8, 1990

A short description of the features and advantages of VR teleconferencing.

C. Esposito, M. Bricken, and K. Butler: *Building the VSX Demonstration: Operations with Virtual Aircraft in Virtual Space*, Proceedings, CHI'91, New Orleans, 5/91

The system architecture and software challenges of the virtual Osprey built for Boeing as a demonstration of the capabilities of VR.

M. Bricken: *Virtual Reality Learning Environments: Potentials and Challenges*, Computer Graphics Magazine, ACM, 6/91

The unique potential of virtual worlds as learning environments. How attributes of VR relate to educational theory and practice, and the challenges of integrating VR into educational settings.

M. Bricken and C. Byrne: *Summer Students in Virtual Reality: A Pilot Study on Educational Applications of Virtual Reality Technology*, Softwhere, A. Wexelblat (ed), Academic Press, 1992 (to appear)

Fifty-nine high school students build seven new virtual worlds. The theoretical approach, student activities, data analysis and discussion of a pioneering project in which students construct their own realities.

M. Bricken: *Gender Issues in Virtual Reality*, HITL Technical Report P-91-6, 1991

The relation of gender to computer science and to the inclusive metaphor of VR.

SECTION III: EXPERIENTIAL MATHEMATICS

Experiential mathematics is the application of VR visualization and interaction techniques to formal mathematical systems. The papers describe a way of thinking about representation in mathematics that is non-linear and spatial, and provide examples of logic and elementary algebra.

W. Bricken: *A Simple Space*, Proceedings, Second Conference on Sign and Space, Santa Cruz, 1986

A spatial representation which does not impose the linearity of text is examined from its foundations. Propositional calculus provides an application for non-linear representational concepts.

W. Bricken, E. Gullichsen and M. Brzustowicz: *A Boundary Logic Tutorial with the Losp Parallel Deduction Engine*, HITL Technical Report R-87-1

Boundary logic is introduced as a diagrammatic formal system. The tutorial discusses boundary mathematics and its notations, the interpretation for elementary logic, and the animated, interactive implementation which performs logical deduction in parallel.

W. Bricken: *Spatial Representation of Elementary Algebra*, Proceedings, Visual Languages '92, ACM, Seattle, 9/92

Boundary mathematics techniques applied to high school algebra, resulting in an interactive, manipulable representation with some nice properties.

J. James and W. Bricken: *A Boundary Notation for Visual Mathematics*, Proceedings, Visual Languages '92, ACM, Seattle, 9/92

The general techniques of boundary mathematics are demonstrated in several formal systems. The computational infrastructure of each representation is abstracted from its appearance.

Bio

William Bricken is the Principal Scientist at the Human Interface Technology Lab at the University of Washington, where he is designing and implementing the Virtual Environment Operating System and the interactive tools of the VR environment. His prior positions include Director of the Autodesk Research Lab, which developed the Cyberspace CAD application of virtual reality, and Principal Scientist at ADS, where he pioneered high-performance inference engines, visual programming systems, and instructable interfaces. Dr. Bricken holds a multidisciplinary PhD in Research Methodology, Education, Computer Science, and Psychology from Stanford, and degrees in Statistics (MS Stanford), Education (DipEd, Monash Australia), and Social Psychology (BA, UCLA). He is the developer of Boundary Mathematics, a reworking of the foundations of mathematics using spatial representations, which provides experiential interaction with formal systems, spatial parallelism, void-based computation, and a family of visual languages.