

*SIGGRAPH 1991
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On Computer Graphics and
Interactive Techniques*

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COURSE NOTES

C16

**X3D-PEX (PEX): THREE-
DIMENSIONAL GRAPHICS
IN A DISTRIBUTED
WINDOW SYSTEM**

Chair
Marty Hess
Sun Microsystems, Inc.

Lecturers
Jeff Friedberg
Kubota Pacific
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Table of Contents

Course Information

Table of Contents	I-1
Course Abstract	I-2
Introduction to the Course Notes	I-2
Speaker Biographies	I-3
Course Outline	I-4

Course Slide Set

Introduction	S-2
X Window System Concepts	S-17
PEX Concepts	S-41
PHIGS Concepts	S-48
Client-Side View of PEX	S-57
Server-Side View of PEX	S-72
PEX Implementation Considerations	S-126
Application Programmer's Considerations	S-135
PEX Sample Implementation	S-141

Course Notes and Additional Material

"Flexing PEX", Marty Hess	N-1
"PHIGS Input Support in the X/PEX Environment", David J. Plunkett	N-13
"Understanding the PEX Rendering Pipeline", Randi J. Rost	N-23
"PEX-SI Architecture Specification", Sun PEX-SI Team	N-53
"Some Useful PEX Extensions", Jeffrey Friedberg	N-93
Reprinted Articles About PEX	

PEX Documentation

"PEX v5.0P Protocol Specification", PEX Design Team	
"PEX v5.0P Encoding Document", PEX Design Team	

Course Abstract

X3D-PEX (PEX) is a network protocol extension to the X11 Window System. PEX, the PHIGS (PLUS) Extension, adds three dimensional (3D) capability to X11. PHIGS, the Programmers Hierarchical Interactive Graphics System, is an international standard for 3D graphics. PHIGS PLUS is an extension to PHIGS being proposed in the international community to support additional features for lighting, shading, depth cueing, and advanced curve and surface primitives. The PEX effort marks a major milestone in marrying important industry standards, making it possible to use standard programming interfaces to transmit 3D graphics efficiently across a network to an X Window System display.

This course is for technical professionals who are either applications or graphics-system designers or developers. It is recommended that attendees be comfortable with the concepts of the X Window System and be very familiar with the fundamentals of the existing PHIGS graphics standard, and the proposed PHIGS standard extensions, PHIGS-PLUS (or their equivalent.)

Attendees should be versed in a programming language and be familiar with PHIGS programming. (Simple C language and PHIGS program examples will be used.)

With the exception of PHIGS, the material is of moderate difficulty due to the volume and complexity of information, not due to depth of the technical content.

Introduction to the Course Notes

This course will examine advanced graphics concepts such as those of PHIGS and PHIGS PLUS in light of the additional capabilities of a heterogeneous, distributed window system environment.

Most of the speakers for this course have been involved with the design of the PEX protocol since its early stages, and all are involved with implementations of PEX in one form or another.

We hope that the information presented through the notes and talks will not only serve to inform you about PEX, but that it will encourage thinking in the directions of the future of effective distribution of complex operations such as high-end graphics.

Speaker Biographies

Course Organizer / Speaker

Name: Marty Hess

Affiliation: Sun Microsystems, Inc.

Biography:

Marty Hess has been a member of Sun's Graphics Standards Department since early 1987. He is a member of the original multi-vendor architecture team that designed PEX — the PHIGS (PLUS) Extension to X. Marty was the manager responsible for the design and development of the PEX Sample Implementation (PEX-SI) written at Sun to be distributed to the public through the X Consortium at the Massachusetts Institute of Technology. He is now managing development of Sun's PEX-related products.

Marty has been involved in computer graphics since 1978 in the areas of MCAD, ECAD, business graphics, and graphics standards. He holds a BSE in Computer Engineering from the University of Michigan.

Speakers

Name: Jeff Friedberg

Affiliation: Digital Equipment Corp.

Biography:

Jeffrey Friedberg is a Principal Engineer at Digital Equipment Corporation in the Workstations Advanced Technology Development Group. He is one of the principal architects of PEX and an active member of the PEX multi-vendor Architecture Team. He is also the chief architect and document editor for the X multi-buffering extension. He joined Digital in 1986 and is the Project Leader for PEX software on Digital RISC-based workstations.

Friedberg received his BS in Computer Science from Cornell University in 1980. He spent two years as a research and teaching assistant in Cornell Program of Computer Graphics. He is a member of ACM and ACM SIGGRAPH.

Name: Cheryl Huntington

Affiliation: Sun Microsystems, Inc.

Biography:

Cheryl Huntington has been doing PEX programming since 1988. She first worked on the prototype implementation developed at The University of Michigan Center for Information Technology Integration. This prototype was demonstrated at SIGGRAPH '88 as the first example of a PEX implementation. Cheryl then became a member of the PEX-SI team at Sun Microsystems, where she has contributed to the design and implementation of PEX-SI.

Cheryl has an MS in Computer Engineering from The University of Michigan and a BA from The Indiana University.

Course Outline

- 8:30 – Introduction/Hess (0.75 hour)
 - Day's Logistics and Introductions
 - History and Goals of PEX
 - Basic X and PEX Terminology and Concepts
- 9:15 – Technical Concepts and Overview (1.00 hour)
 - The X Window System Concepts and Architecture/Friedberg
 - PEX Overview/Friedberg,Hess
 - Ramifications of Diverse Goals (X versus PHIGS)
 - Relationship to Core X and PHIGS/PHIGS PLUS
- 10:15 – *Break (0.25 hour)*
- 10:30 – Concepts and Overview (Continued)/Huntington (0.25 hour)
 - Review of PHIGS Concepts Relating to PEX
- Architectural Examination of PEX
 - 10:45 – “Client's/Application's View”/Huntington (1.25 hour)
 - Standard PHIGS API (Application Programming Interface)
 - PHIGS as a PEX Client API <Examples>
 - Impact of the a Windowing Environment <Examples>
- 12:00 – *Lunch (1.5 hours)*
- 1:30 – “Server's-Eye View”/Friedberg,Hess (1.25 hour)
 - Design Criteria
 - Protocol Architecture
 - PEX Requests and Output Commands
 - PEX Resources
- 2:45 – PEX Client and Server Implementator's Considerations/Hess (0.5 hour)
 - Device Range of Implementations
 - Choices and Trade-offs
- 3:15 – *Break (0.25 hour)*
- 3:30 – Application Programmer's Considerations/Huntington (0.5 hour)
 - “Standard PHIGS” Applications
 - “Window Saavy” Applications <Examples>
 - Additional Considerations <Examples>
 - PEX Benefits for Application Developers
- 4:00 – PEX-SI Overview and Status/Hess (0.50 hour)
- 4:30 – <Wrap-up>/All (0.50 hour)
 - Live PEX Demonstrations
 - Q & A