

**SIGGRAPH 1990**

**17th International Conference  
On Computer Graphics and  
Interactive Techniques**

**Dallas Convention Center  
August 6th—10th**

# COURSE NOTES

# 12

**SOLID MODELING:  
ARCHITECTURES,  
MATHEMATICS, AND  
ALGORITHMS**

***Chair***

**James R. Miller  
The University of Kansas**

***Lecturers***

**George Allen  
McDonnell Douglas  
James R. Miller  
The University of Kansas  
Kevin J. Weiler  
Student Computer  
Peter R. Wilson  
Rensselaer Polytechnic Institute**

# Solid Modeling: Architectures, Mathematics, and Algorithms

## Course Abstract

In this course we will study issues involved in the design and construction of contemporary solid modeling systems. It is impossible in one day to provide sufficient material so that one could go out and design such a system from scratch, so our goal is to present a framework in which to understand the basic design and architectural considerations. We begin with a brief review of pertinent background concepts and an overview of the assumed overall modeling environment. We then present relevant high-level architectural considerations with an emphasis on dual representation (CSG-BRep) solid modeling systems. The importance of a boundary evaluation algorithm in such environments will be introduced, and an approach to such an algorithm described. This will lead to the need for robust curve and surface representations and intersection algorithms, descriptions of which will follow. The importance of efficient and comprehensive representation schemes for Boundary Representations will also be apparent, so contemporary approaches will be presented next. Finally we examine the important topic of Features in modeling systems. Applications of features, feature recognition, and designing with features will be considered.

## Speaker Biographies

**George Allen** is a staff scientist with McDonnell Douglas Manufacturing and Engineering Systems Company, where he has been involved in the development of commercial CAD/CAM systems since 1977. He also teaches a graduate course in computational geometry at the University of California at Irvine. Allen holds B.Sc. and M.A. degrees in mathematics and has authored a variety of talks and articles on geometric modeling and other aspects of CAD/CAM. He has been teaching SIGGRAPH courses since 1982.

**James R. Miller** is an Associate Professor of Computer Science at The University of Kansas in Lawrence where he is involved in teaching and research in computer graphics and geometric modeling. He has been involved in research and prototype development activities in the general area of graphics for design since 1976, and specifically in solid modeling for mechanical CAD/CAM since 1980. Prior to joining the faculty at the University of Kansas, Dr. Miller spent eight years with Control Data Corporation where his duties included research, development, and planning for various commercial CAD/CAM products. He is the author of several papers and talks on solid modeling, and has been involved in the SIGGRAPH solid modeling courses since 1984.

**Kevin J. Weiler** is Director of Advanced Graphics at Ardent Computer. His fields of interest are computer graphics, where his best known work has been in hidden surface removal, polygon clipping, and algorithms; and geometric modeling, where he has worked in topological representations, topological sufficiency, nonmanifold geometric modeling representations, and algorithms. Prior to joining Ardent Computer, Dr. Weiler was a graphics scientist at General Electric Corporate R&D, and previously he was Senior Scientist and Director of the CAD-Graphics Laboratory at Carnegie-Mellon University. He has been an adjunct faculty member at Carnegie-Mellon and Rensselaer Universities. Dr. Weiler earned a B.Arch. from the University of Maryland in 1975, an M.S. from Cornell University in 1977, and a Ph.D. from Rensselaer University in 1986.

**Peter R. Wilson** is Visiting Research Professor in the Electrical and Computer Systems Engineering Department at Rensselaer Polytechnic Institute on leave of absence from the GE Corporate Research & Development Center. His research interests have been primarily in the field of solid modeling with an emphasis on feature based systems and applications of solid modeling. More recently this has led to an interest in information modeling technology and applications. In an earlier incarnation, Dr. Wilson was a semiconductor device physicist. He has had many papers published on the mathematics of semiconductors and CAD systems. He is an active participant in the development of the ISO Standard for the Exchange of Product Model Data (PDES/STEP).

### Course Schedule

<b>Time</b>	<b>Speaker</b>	<b>Topic</b>	<b>Pages</b>
8:30 - 9:30	Miller	Architectural Issues in Solid Modelers	I-1 to I-23
9:30 - 10:30	Miller	A Boundary Evaluation Algorithm	III-1 to III-22
10:30 - 10:45		BREAK	
10:45 - 12:00	Allen	Geometric Representations & Computations	IV-1 to IV-20
12:00 - 1:30		LUNCH	
1:30 - 3:00	Weiler	Topological Structures for Solid Modeling	VII to X
3:00 - 3:15		BREAK	
3:15 - 4:45	Wilson	Feature Modeling and Feature Recognition	XI to XII
4:45 - 5:00	All	Open Question Forum	

# Solid Modeling: Architectures, Mathematics, and Algorithms

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<b>Section I:</b>	<b>Architectural Issues in Solid Modelers (slides)</b>	<b>Miller</b>	<b>I-1 to I-23</b>
<b>Section II:</b>	<b>Architectural Issues in Solid Modelers (paper)</b>	<b>Miller</b>	<b>II-1 to II-8</b>
<b>Section III:</b>	<b>A Boundary Evaluation Algorithm</b>	<b>Miller</b>	<b>III-1 to III-22</b>
<b>Section IV:</b>	<b>Geometric Representations and Computations (slides)</b>	<b>Allen</b>	<b>IV-1 to IV-20</b>
<b>Section V:</b>	<b>Geometric Representations &amp; Computations (paper)</b>	<b>Allen</b>	<b>V-1 to V-56</b>
<b>Section VI:</b>	<b>Geometric Approaches to Nonplanar Quadric Surface Intersection Curves (paper)</b>	<b>Miller</b>	<b>VI-1 to VI-17</b>
<b>Section VII:</b>	<b>Several Non-Manifold Topology Geometric Modeling Algorithms</b>	<b>Weiler</b>	<b>VII-1 to VII-10</b>
<b>Section VIII:</b>	<b>Two Taxonomies for Geometric Modeling Representations</b>	<b>Weiler</b>	<b>VIII-1 to VIII-7</b>
<b>Section IX:</b>	<b>Edge-Based Data Structures for Solid Modeling in Curved-Surface Environments</b>	<b>Weiler</b>	<b>IX-1 to IX-10</b>
<b>Section X:</b>	<b>Non-Manifold Geometric Boundary Modeling</b>	<b>Weiler</b>	<b>X-1 to X-43</b>
<b>Section XI:</b>	<b>Feature Modeling Overview</b>	<b>Wilson</b>	<b>XI-1 to XI-56</b>
<b>Section XII:</b>	<b>Feature-based Design using Constructive Solid Geometry</b>	<b>Ostrowski</b>	<b>XII-1 to XII-39</b>