

Realistic Input for Realistic Images

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Course **1** **NOTES**

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Realistic Input for Realistic Images

Course Notes for SIGGRAPH '95

Course Organizer

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Course Speakers

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David L. DiLaura
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John Mardaljevic
Department of Zoology
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Holly E. Rushmeier
Computing and Applied Mathematics Laboratory
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Robert A. Shakespeare
Theatre Computer Visualization Center Studio Laboratory
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Kenneth E. Torrance
The Sibley School of Mechanical & Aerospace Engineering
Cornell University

Greg J. Ward
Lighting Systems Research Group
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ABSTRACT

Achieving realism in synthetic images requires realistic input data. This course: (a) examines the need for such data and the various models used to represent them, including physically realistic light sources, surface reflectance characteristics, and participating media; (b) reviews the measurement techniques used in light source photometry, daylighting studies, and surface reflectance characteristics; (c) discusses the models within a framework of practical implementation techniques for software developers; and (d) examines their potential for computer graphics users, professional lighting designers, illumination engineers, and architects, with examples from real-world applications.

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SCHEDULE

Topic	Speaker	Time
Introduction		
Why Do We Need Realistic Input Data? minutes	Shakespeare	30
Light Source Models		
IESNA Photometry minutes	DiLaura	60
<i>Morning Break</i>		
Near-Field Photometry minutes	Ashdown	30
Daylighting Models minutes	Mardaljevic	45
Applications and Examples I		
Theatrical Stage Design minutes	Shakespeare	30
<i>Lunch</i>		
Physics-Based Models		
Reflectance Models minutes	Torrance	60
Participating Media minutes	Rushmeier	45
<i>Afternoon Break</i>		
Implementation Issues		
Scene Geometry Description Formats minutes	Ward	60
Applications and Examples II		
Architectural Modelling minutes	Mardaljevic	30

Speaker Biographies

Ian Ashdown (chair)

Ian Ashdown is Research & Development Manager for Ledalite Architectural Products Inc. (Langley, BC), a manufacturer of linear fluorescent lighting systems. He received his B.App.Sc. (1973) in Electrical Engineering from the University of British Columbia, and worked as an electrical engineer specializing in lighting design for ten years, followed by five years as a software engineer with Glenayre Research & Development (Burnaby, BC). He has done research in nonimaging optics design, photometric methods, and image synthesis techniques at Ledalite since 1990, and has published 6 academic papers, one book (and co-authored another), and 28 articles on radiosity, illumination engineering, photometric techniques, genetic algorithms, compiler theory, numerical analysis, and other topics.

Ian holds a U.S. patent for a near-field goniophotometer, and is the author of *Radiosity: A Programmer's Perspective* (Wiley, 1994). His research interests include radiosity, realistic image synthesis, radiometry and photometry, nonimaging optics design, and genetic algorithms. His professional affiliations include the Illuminating Engineering Society of North America (IESNA), ACM SIGGRAPH, International Lighting Commission (CIE), Eurographics, and the IEEE Computer Society. He is a member of the IESNA Computer and Calculations Committees and the CIE Lighting Calculations Technical Committee, and maintains the RADBIB radiosity bibliography on <siggraph.org>.

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David L. DiLaura

David DiLaura is Senior Instructor in Illuminating Engineering and Interim Associate Dean for Undergraduate Programs at the Civil, Environmental and Architectural Engineering Department of the University of Colorado at Boulder. He received his B.S. (1970) in Physics from Wayne State University, and has taught illumination engineering at the University of Colorado since 1973. He founded Lighting Technologies (Boulder, CO) in 1981, where he developed *Lumen-Micro*, the first radiosity-based rendering program for architectural lighting design and visualization. His contributions to the field of illumination engineering include Technical Advising Editor for *Lighting Design* magazine and Illuminating Engineering Editor for *the IESNA Lighting Handbook of the Illuminating Engineering Society*, Eighth Edition, 1993. He has published 8 academic papers on radiant flux transfer (radiosity) theory.

David holds a U.S. patent for a visual task luminance and contrast meter and has received numerous awards, including the Illuminating Engineering Society Gold Medal for "outstanding technical contributions to the field of lighting engineering." He is a Senior Member of the International Association of Lighting Designers, a Fellow of the Illuminating Engineering Society of North America, United States Delegate to the International Lighting Commission (CIE), and Director of the National Council on Qualifications for the Lighting Professions. His

research interests include radiative transfer theory, architectural lighting design, luminaire design and daylighting models.

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John Mardaljevic

John Mardaljevic is a research assistant with the Department of Zoology of Aberdeen University. He received his B.Sc. (1982) in Physics and an M.Phil. (1988) in Astronomy from Leicester University, and is currently a Ph.D. candidate in daylighting research at Leicester University. His research interests include validation of daylighting model illuminance predictions under real sky conditions, comparison of daylighting models for lighting simulation, and applications of lighting design and analysis programs to complex architectural designs for lighting and visualization studies.

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Holly E. Rushmeier

Dr. Holly Rushmeier is on the staff of the Computing and Applied Mathematics Laboratory at the National Institute of Standards and Technology. She received her B.S. (1977), M.S. (1986) and Ph.D. (1988) degrees in Mechanical Engineering from Cornell University. Following receipt of her B.S. degree, she worked as an engineer at the Boeing Commercial Airplane Company (Seattle, WA), and at the Washington Natural Gas Company (Seattle, WA). Upon completion of her Ph.D., she served on the Mechanical Engineering faculty at the Georgia Institute of Technology, where she was the recipient of an NSF Presidential Young Investigator Award. She is the author of articles in the fields of computer graphics and radiative heat transfer. Her research interests include computer graphics image synthesis, scientific visualization, and radiant heat transfer.

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Robert A. Shakespeare

Robert Shakespeare is a professional lighting designer, Associate Professor at the Department of Theatre and Drama of Indiana University, and Director of the Indiana University Theatre Computer Visualization Center. He has lighted over 150 stage productions, with recent work including the Utah Shakespearean Festival and Carmen at the Lyric Theatre in Hong Kong. His architectural lighting projects have included Times Square, the Jin Jaing Hotel in Shanghai, and the Hong Kong Marriot atrium, Harbour-Gateway buildings, and Tsing Ma Bridge in Hong Kong.

Robert uses *RADIANCE* and other lighting simulation software as part of his design process, and is developing interface systems to advance the use of these tools. Current projects include linking databases derived from lighting/computer visualization interactions directly to the technology of complex lighting control environments, such as theaters and theme parks. His professional affiliations include the Illuminating Engineering Society of North America, the International Association of Lighting Designers, and the United States Institute for Theatre Technology. He is a member of the IESNA Computer Committee.

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Dr. Kenneth E. Torrance

Dr. Kenneth Torrance received his Bachelor's (1961), Master's (1962) and doctoral (1966) degrees in Mechanical Engineering from the University of Minnesota. He is Professor of Mechanical and Aerospace Engineering at Cornell University, where he also served as Associate Dean of the College of Engineering.

A Fellow of the American Association of Mechanical Engineers and recipient of the 1994 ACM SIGGRAPH Computer Graphics Achievement Award, he has nearly 90 publications in the fields of combustion, heat transfer, experimental and computational methods, and photorealistic image synthesis. Working with Dr. Donald Greenberg at Cornell University, he also guided and encouraged the early development of radiosity for image synthesis.

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Greg J. Ward

Greg Ward is a staff scientist at the Lighting Systems Research Group at the Lawrence Berkeley Laboratory. He graduated with a B.S. in Physics in 1983 from the University of California at Berkeley, and earned his Master's (1985) in Computer Science from San Francisco State University. His professional interests include physically-based rendering, global and local illumination, luminaire simulation, electronic data standards, and lighting-related energy and environmental conservation issues.

Greg has published numerous papers in computer graphics (including four SIGGRAPH papers) and illumination engineering. He is the chief architect of the widely used *RADIANCE* software system for the analysis and visualization of lighting in architectural design. He also has a U.S. patent pending on an imaging gonioreflectometer for the measurement of reflectance in architectural materials.

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