

William R. Mark

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EMPLOYMENT HISTORY

Google (December 2014 – present)

Technical lead of system software, for a project in the area of image processing and machine learning

Bebop, Inc. (August 2012 – December 2014)

Co-founder and software developer

Bebop is a software-as-a-service enterprise software startup building both applications and an underlying platform to support them. Worked with other co-founders and early employees to design the overall platform architecture and to build the company. Implemented several components of the server-side platform layer and the initial deployment infrastructure for running on Google Compute Engine. By the time I left, the platform was supporting the company's first application, which was in initial customer trials. Google acquired the company in December 2015 for \$380 million.

Intel Corporation (Jan. 2008 – August 2012)

Senior Research Scientist, Intel Labs

Led a 12-person team building prototype real-time 3D graphics systems. The team developed a prototype real-time ray-tracing game for a new hardware platform ("Larrabee"), using SW/HW co-design to deliver it months ahead of other applications. Initiated and managed the early development of the open source Embree high performance ray tracing kernels, which typically yielded at least 5x performance improvements for major ISVs compared to existing software and enabled Intel hardware to retain a strong position in ray tracing for professional graphics. Built stronger ties between Intel and academia in the areas of visual computing and parallel computing. In my last year, contributed to the design of the ispc language for high-performance SIMD programming on CPUs.

University of Texas at Austin (Jan. 2003 – Dec. 2007)

Assistant Professor, Department of Computer Sciences

Built and led a team of graduate students to investigate algorithms, hardware architectures, and programming environments for real-time 3D graphics systems and single-chip parallel computers. Results included major improvements in algorithms for ray tracing animated scenes that have been adopted by industry. Wrote high-performance rendering code and a DRAM performance simulator.

NVIDIA Corporation (Oct. 2001 – Oct. 2002)

Technical lead for the Cg system, which was the first product-quality programming language and compiler for modern graphics hardware. Worked with company management to define the product and development goals and to build a ten-person system development team. Wrote most of the Cg language specification and developed the first backend module of the Cg compiler.

Stanford University (May 1999 – Sept. 2001)

Postdoctoral Research Associate in Stanford Computer Graphics Lab (Pat Hanrahan's group).

Co-led a project to develop a high-level language for programming real-time graphics hardware, and co-advised students working on other graphics projects. Implemented an optimizing VLIW shading compiler backend for NVIDIA GeForce 3.

University of North Carolina, Chapel Hill (1992-1999)

Research Assistant and Ph.D. candidate in Computer Graphics Laboratory.

Developed an image-based technique to post-process rendered real-time 3D graphics, known as “post-rendering 3D image warping”. Co-developed a software system and API for high-fidelity haptics (force display).

Silicon Graphics Computer Systems (Summer 1995)

Software developer on the team designing the Nintendo-64 game console’s hardware and system software. Wrote software tools and code examples that were provided to game developers.

Rice University (Summer 1991 & 1992)

Research Assistant in Rice Quantum Institute (1992): Built a laser-based experiment for creating and measuring excited states of ozone.

Research Assistant in Bonner Nuclear Research Lab (1991): Wrote software to model part of a detector for a particle accelerator.

EDUCATION

University of North Carolina at Chapel Hill

Ph.D., Computer Science, May 1999.

Dissertation: *Post-Rendering 3D Image Warping: Visibility, Reconstruction, and Performance for Depth-Image Warping*.

Rice University

B.A. *cum laude*, Physics, May 1992.

Senior Thesis: *Lifetime measurement of an excited vibrational level of the 1B_2 excited state of ozone by a modification of the technique of stimulated emission pumping*.

REFEREED PUBLICATIONS

ispc: A SPMD Compiler for High-Performance CPU Programming

Matt Pharr and William R. Mark

Innovative Parallel Computing Conf. (InPar), May 2012. (Best paper award).

Combining Single and Packet Ray Tracing for Arbitrary Ray Distributions on the Intel MIC Architecture

Carsten Benthin, Ingo Wald, Sven Woop, Manfred Ernst, William R. Mark

IEEE Transactions on Visualization and Computer Graphics, Sept. 2012.

Razor: An Architecture for Dynamic Multiresolution Ray Tracing

Peter Djeu, Warren Hunt, Rui Wang, Ikrima Elhassan, Gordon Stoll, William R. Mark

ACM Transactions on Graphics, October 2011.

Consistent Normal Interpolation,

Alexander Reshetov, Alexei Soupikov, and William R. Mark.

SIGGRAPH ASIA 2010.

A Lazy Object-Space Shading Architecture with Decoupled Sampling,
Christopher A. Burns, Kayvon Fatahalian, William R. Mark
High Performance Graphics 2010

Reducing Shading on GPUs using Quad-Fragment Merging,
Kayvon Fatahalian, Solomon Boulos, James Hegarty, Kurt Akeley, William R. Mark, Henry Moreton,
Pat Hanrahan.
SIGGRAPH 2010.

DiagSplit: Parallel, Crack-Free, Adaptive Tessellation for Micropolygon Rendering,
Matthew Fisher, Kayvon Fatahalian, Solomon Boulos, Kurt Akeley, William R. Mark, Pat Hanrahan.
SIGGRAPH ASIA 2009.

Data Parallel Rasterization of Micropolygons with Defocus and Motion Blur,
Kayvon Fatahalian, Edward Luong, Solomon Boulos, Kurt Akeley, William R. Mark, Pat Hanrahan.
High Performance Graphics 2009, August 2009.

Soft Irregular Shadow Mapping: Fast, High-Quality, and Robust Soft Shadows
Gregory Johnson, Allen Hux, Chris Burns, Warren Hunt, Stephen Junkins, William R. Mark
2009 Symposium on Interactive 3D Graphics, Feb, 2009.

Venkatraman Govindaraju, Karthikeyan Sankaralingam, Mary Vernon, Peter Djeu, William R.
Mark. "A Multi-core Architecture for Real-time Ray-tracing," 41st Annual IEEE/ACM Intl.
Symp. on Microarchitecture (MICRO 2008), Nov. 2008.

Warren Hunt and William R. Mark. "Ray-specialized acceleration structures for Ray Tracing,"
2008 IEEE/EG Symposium on Interactive Ray Tracing, August 2008.

Warren Hunt and William R. Mark. "Adaptive acceleration structures in perspective space,"
2008 IEEE/EG Symposium on Interactive Ray Tracing, August 2008.

Ryan Overbeck, Ravi Ramamoorthi, and William R. Mark. "Large Packets for Real-time
Whitted Ray Tracing," 2008 IEEE/EG Symposium on Interactive Ray Tracing 2008.

William R. Mark. "Future Graphics Architectures," ACM Queue, March/April 2008. (Invited
paper for special issue on graphics architectures)

Warren Hunt, William R. Mark, and Donald Fussell. "Fast and Lazy Build of Acceleration
Structures from Scene Hierarchies", 2007 IEEE Symposium on Interactive Ray Tracing, Sept
2007.

Paul Navratil, Donald Fussell, Calvin Lin, and William R. Mark. "Dynamic Ray Scheduling for
Improved System Performance," 2007 IEEE Symposium on Interactive Ray Tracing, Sept 2007.

Ryan Overbeck, Ravi Ramamoorthi, and William R. Mark. "A Real-time Beam Tracer with
Application to Exact Soft Shadows," 2007 Eurographics Symposium on Rendering, June 2007.

Ingo Wald, William R. Mark, Johannes Gunther, Solomon Boulos, Thiago Ize, Warren Hunt,
Steven G. Parker, and Peter Shirley. "State of the Art in Ray Tracing Animated Scenes,"

Eurographics 2007 State of the Art Report.

Warren Hunt, William R. Mark, Gordon Stoll. “Fast kd-tree Construction with an Adaptive Error-Bounded Heuristic,” 2006 IEEE Symposium on Interactive Ray Tracing, Sept 2006.

Gregory S. Johnson, Juhyun Lee, Christopher A. Burns, William R. Mark. “The Irregular Z-Buffer: Hardware Acceleration for Irregular Data Structures,” ACM Transactions on Graphics, Oct. 2005.

Karthikeyan Sankaralingam, Stephen W. Keckler, William R. Mark, Doug Burger. “Universal Mechanisms for Data Parallel Architectures,” 36th Annual International Symposium on Microarchitecture (MICRO-36), December, 2003.

William R. Mark, R. Steven Glanville, Kurt Akeley, Mark J. Kilgard. “Cg: A System for Programming Graphics Hardware in a C-like Language,” ACM Transactions on Graphics, Vol 22, #3, July 2003 (SIGGRAPH 2003).

Tim Purcell, Ian Buck, William R. Mark, and Pat Hanrahan, “Ray Tracing on Programmable Graphics Hardware.” SIGGRAPH 2002.

Kekoa Proudfoot, William R. Mark, Svetoslav Tzvetkov and Pat Hanrahan, “A Real-Time Procedural Shading System for Programmable Graphics Hardware.” SIGGRAPH 2001.

William R. Mark and Kekoa Proudfoot, “Compiling to a VLIW Fragment Pipeline.” SIGGRAPH/Eurographics Workshop on Graphics Hardware 2001.

William R. Mark and Kekoa Proudfoot, “The F-Buffer: A Rasterization-Order FIFO Buffer for Multi-Pass Rendering.” SIGGRAPH/Eurographics Workshop on Graphics Hardware 2001.

William R. Mark and Gary Bishop, “Memory Access Patterns of Occlusion-Compatible 3D Image Warping.” SIGGRAPH/Eurographics Workshop on Graphics Hardware 1997.

William R. Mark, Leonard McMillan, and Gary Bishop, “Post-Rendering 3D Warping.” 1997 Symposium on Interactive 3D Graphics.

William R. Mark, Scott Randolph, Mark Finch, James Van Verth, and Russell M. Taylor II, “Adding Force Feedback to Graphics Systems: Issues and Solutions.” SIGGRAPH 1996.

BOOK CHAPTER

“Real-time programmable shading” in “Texturing and Modeling: A Procedural Approach,” David S. Ebert *et al.*, third edition, Morgan-Kaufmann, 2003.

SELECTED PRESENTATIONS

Panelist, From Publication to Product: How Recent Graphics Research has (and has not) Shaped the Industry, in SIGGRAPH 2012 Course “Beyond Programmable Shading”, August 7, 2012.

Panelist, The Future of Graphics, Hot3D panel, High Performance Graphics, August 7, 2011.

Panelist, Jon Peddie Research's Press Luncheon at SIGGRAPH 2010, July 28, 2010.

Panelist, Jon Peddie Research panel on "Ray Tracing and Rasterization", August 13, 2008.

Invited panel presentation for "GPUs vs. Multicore CPUs: On a converging course or fundamentally different?", Graphics Hardware 2008, June 20, 2008.

Invited panel presentation on the future of graphics hardware and the graphics hardware conference (panel title "Wither graphics hardware, and Graphics Hardware"), Graphics Hardware 2007, August 4, 2007.

"State of the art in interactive ray tracing", SIGGRAPH 2006 course, July 30, 2006, course presenter.

"Introduction to Real-Time Ray Tracing" SIGGRAPH 2005 Course, August 3, 2005, course presenter.

"3D Graphics Hardware: Evolution Now, Revolution Later," William R. Mark, invited panel presentation for Graphics Hardware 2005 panel "3D Graphics Hardware: Revolution or Evolution?", July 31, 2005.

"Real-time graphics architecture," William R. Mark and Henry Moreton, MICRO 2004 Tutorial, Dec. 4, 2004.

"Future Visualization Platform", Invited panel presentation at Visualization 2004 conference, Oct. 14, 2004.

SIGGRAPH 2000, 2001, 2002, and 2003: Course presentations on programming languages and compilers for graphics hardware.

Invited keynote speaker, Graphics Hardware 2002 conference, Sept 1, 2002.

"Programmable graphics hardware: Beyond real-time movie rendering"

Game Developer's Conference, "Shading Languages for Graphics Hardware", March 23, 2001.

Workshop on Image Synthesis and Interactive 3D Graphics, Dagstuhl, Germany, "Real-Time Programmable Shading", June 19, 2000.

CONFERENCE LEADERSHIP

Program co-chair, 2011 High Performance Graphics Conference, August 5-7, 2011.

General co-chair, 2008 IEEE Symposium on Interactive Ray Tracing, August 9-10, 2008.

Papers co-chair, 2006 IEEE Symposium on Interactive Ray Tracing, Sept 18-20, 2006.

Papers co-chair, SIGGRAPH/Eurographics Graphics Hardware conference, 2003.

PROGRAM COMMITTEES

Papers committee, SIGGRAPH 2011.

Program committee, ACM/Eurographics High Performance Graphics, 2009-2014.

Program committee, Eurographics Symposium on Rendering, 2008-2010.

Program committee, Symposium on Interactive 3D Graphics and Games, 2008, 2012.

Program committee, SIGGRAPH/Eurographics Graphics Hardware conference, 2001-2008.

Program committee, IEEE Symposium on Interactive Ray Tracing, 2007.

COURSES TAUGHT

Computer Architecture (undergraduate), Spring 2007 (UT), Spring 2005 (UT) , Spring 2004 (UT) , Spring 1994 (UNC).

Computer Graphics (graduate and honors undergraduate), Fall 2004, Fall 2005 , Fall 2007 (UT).

Fine-grained parallelism, Spring 2006, Graduate Seminar, UT Austin

High-Performance Ray Tracing for Dynamic Scenes (w/ Don Fussell), Fall 2003, Grad. Seminar (UT)

Economics of Technology (with Don Fussell), Fall 2003, Graduate Seminar, UT Austin

Real-Time Graphics Architectures, Algorithms, and Programming Systems, Spring 2003, UT Austin.
Graduate seminar covering topics relevant to future real-time 3D graphics systems and algorithms.

Real-time programmable shading (with Marc Olano), Spring 2000, Stanford University.
A research-topics course for graduate students and advanced undergraduates.

VISITING RESEARCH and CONSULTING

Neoptica (startup later acquired by Intel), consultant, 2006 and 2007.

Intel Corporation, Visiting Researcher, mid-May to mid-June 2005, and May to Nov, 2006.

NVIDIA, consultant, Spring and Summer 2001.

RESEARCH FUNDING

While at UT Austin (January 2003-December 2007)

NSF CAREER award, \$400,000, February 2006,

“CAREER: A systems approach to real-time graphics on single-chip highly-programmable hardware”

Lead PI on over \$570,000 in industry gift funds and graduate student fellowship funding from Microsoft, Intel, NVIDIA, and ATI/AMD.

Lead PI on over \$100,000 in equipment donations from Intel, NVIDIA, and ATI.

REVIEW PANELS

NSF proposal review panelist, Nov 2006.

External reviewer for DOE / LANL internally funded project on using GPUs and FPGAs for high performance computing, July 27, 2005.