

# Curriculum Vitæ for David H. Eberly

Location: Redmond, Washington

Citizenship: U.S.

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## Strengths

- *Software Engineering.* Experience in the development of small-scale and large-scale commercial products and working with teams of people from multiple disciplines. Extensive experience with software development tools for both CPU and GPU including debuggers, profilers and concurrency visualizers.
- *High-Performance Computing.* Experience in computational mathematics including computational geometry, numerical analysis and nonlinear optimization, graphics, physics, computer vision and image analysis.
- *Cross-platform development.* Microsoft Windows (Microsoft Visual Studio), Linux/Unix (CMake, Visual Studio Code). C++ 11/14/17, SIMD and multithreading, GPGPU (DirectX 11 with HLSL, OpenGL with GLSL, CUDA). Experience with C#. Limited experience with Mathematica.
- *General skills.* Algorithm development, problem solving and analytical reasoning, quality assurance and control by paying attention to all the details, the ability to balance theory and practice, and technical writing (books, product documentation, publications).

## Professional History

- **Geometric Tools** (*Chief Technologist; Jan2000-present, noncontiguous*). The company provides freely downloadable source code and documentation for computational mathematics including numerical analysis, computational geometry, real-time graphics, real-time physics and related topics. We also provide contract programming services. Areas of focus include
  - CPU: C++ 11/14/17, multithreading, SIMD
  - GPU: DirectX 11 (HLSL), OpenGL (GLSL), CUDA
  - High-performance computing, robust geometric computing, optimization
  - C#, mainly writing managed code to support high-performance C++/GPU native code

Recent topics in contracting include

- Real-time performance for multiple cameras in surgical robotics (C#, C++, DX11)
  - Developing and implementing geometric algorithms for the airplane industry (C#)
  - Implementing algorithms for metrology (C#, C++, DX11)
  - Reverse engineering of 3D laser data for CAD/CAM (C++, DX11)
- **Omnivor Inc.** (*Senior Software Engineer; Jun2017-Apr2018*). The company develops algorithms and software for generation of live-action AR/VR content (surface reconstruction and meshing from multiple camera views for time-varying scenes, GPU-based mesh partitioning using bounding volume trees, GPU-based motion estimation). Areas of focus included GPGPU computing, numerical optimization, geometry, computer vision and Linux development. Also worked on 3D rendering in web browsers using WebGL and three.js.

- **Microsoft** (*Principal Software Engineer; Nov2010-May2017, noncontiguous*).  
 Jan2017-May2017: Worked on the Artificial Intelligence and Research Initiative, specifically on the [Custom Vision Service](#) associated with [Cognitive Services](#). Projects and tasks included
  - Improving performance of the machine-learning-based image tagging system
  - Algorithms for preprocessing images to reduce bandwidth to a cloud server
 Feb2016-Dec2016: Worked in Analog Science, the research and development branch for [Microsoft HoloLens](#). Projects and tasks included
  - General resource to help bridge the gap between research and engineering
  - GPU-based ray tracing
  - Modeling of camera sensors and optimization via bundle adjustment
  - Foveated rendering using DirectX 12 to minimize power consumption
  - Late latching for synchronization related to head pose and eye gaze
 Jun2015-Jan2016: Contractor through Aditi Private Technologies Ltd. Worked on the [Microsoft Surface Hub](#) project. Projects and tasks included
  - Working with camera systems for face detection via deep neural networks
  - Mapping algorithms from CPU to GPU and/or SIMD (SSE/AVX/AVX2)
  - Performance analysis and optimization (memory and speed)
 Nov2010-Dec2013: Worked in the Startup Business Group, a research branch of Microsoft. Projects and tasks included
  - Prototyping graphics and physics engines as an API for HoloLens developers
  - Helping develop a multisensor camera for computing depth from stereo
  - Prototyping large touch monitors with multisensor cameras and head trackers
  - Surface reconstruction from stereo camera data to produce manifold meshes
- **2XL Games, Inc.** (*PlayStation 3 Developer; Jan2007-Dec2008*). Projects and tasks included
  - A terrain tool for adaptive mesh refinement and embedding road meshes
  - Optimization of our real-time physics engine
  - Implementing broad-phase collision culling on the SPUs
  - Implementing ecosystem generation on the SPUs
  - 3DS Max exporter
  - FX metacompiler to bundle Cg files, shader constants and render state
  - Memory analysis tools and specialized memory managers
- **Numerical Design, Ltd.** (*Jan1997-Aug2000 and Oct2004-Apr2005, noncontiguous*). The company developed one of the first commercial game engines using GPU hardware, called NetImmerse and later known as Gamebryo.  
 Oct2004-Apr2005: Joint CTO. Projects and tasks included

- Mentor to the engineers and providing direction and insight for the product
- Automatic portalization tool to generate visibility graphs
- Animation compression tool to reduce keyframes but retain visual quality
- Screen-space polygon system for UI development

Jan1997-Aug2000: Director of Engineering. Projects and tasks included

- Managing the engineers and providing direction and insight for the product
- Joint architect of the engine subsystems, including implementing
  - \* Mathematics support
  - \* Scene graph management
  - \* Basic physics engine (collision detection/response, 3D picking)
  - \* Terrain management with continuous level of detail
  - \* Inverse kinematics
- [SAS Institute, Inc.](#) (Member of Applications Staff in Research and Development; Sep1995-Dec1996). Programmer on the SAS Insight project (statistical graphics). Worked on a team to convert SAS software to a client-server model with Windows NT clients and any architecture server.
- [Computer Science, University of North Carolina at Chapel Hill](#) (*Research Associate Professor; May1994-Aug1995*). Research Associate Professor with joint appointment in Neurosurgery. Research and development for visualizing 2D/3D medical image data with applications to brain surgery.
- Mathematics, Computer Science and Statistics, University of Texas at San Antonio (*Associate Professor; Sep1984-Aug1991*). Teaching and research in mathematics, computer science, and engineering. Published papers on modeling of solid fuel combustion, maximum likelihood estimation, signal processing and medical image analysis.

## Education

- Ph.D. (1994) and M.S. (1993) Computer Science, University of North Carolina
- Ph.D. (1984) and M.S. (1981) Mathematics, University of Colorado
- B.A. (1979) Mathematics, Bloomsburg University

## Books, Book Chapters, and Related

- D. Eberly, *Robust and Error-Free Geometric Computing*, CRC Press (Taylor & Francis), Boca Raton, May 2020.
- D. Eberly, *GPGPU Programming for Games and Science*, CRC Press (Taylor & Francis), Boca Raton, August 2014.
- D. Eberly, *Shape-Preserving Terrain Decimation and Associated Tools*, chapter in *Game Development Tools*, Marwan Ansari, ed., AK Peters/CRC Press, pp. 127-144, May 2011.
- D. Eberly, *Game Physics, 2nd Edition*, Elsevier, Inc., April 2010.
- D. Eberly, *3D Game Engine Design: A Practical Approach to Real-Time Computer Graphics, 2nd Edition*, Morgan Kaufmann Publishers, San Francisco, December 2005.
- D. Eberly, *3D Game Engine Architecture: Engineering Real-Time Applications with Wild Magic*, Morgan Kaufmann Publishers, San Francisco, December 2004.
- D. Eberly, *Game Physics*, Morgan Kaufmann Publishers, San Francisco, December 2003.
- P. Schneider and D. Eberly, *Geometric Tools for Computer Graphics*, Morgan Kaufmann Publishers, San Francisco, October 2002.
- D. Eberly, *3D Game Engine Design: A Practical Approach to Real-Time Computer Graphics*, Morgan Kaufmann Publishers, San Francisco, September 2000.
- *Series editor for the Morgan Kaufmann Series in Interactive 3D Technology (10/2000 to 9/2006)*
- D. Eberly, *Ridges in Image and Data Analysis*, Series on Computational Imaging and Vision, Kluwer Academic Publishers, September 1996.
- D. Eberly, *A differential geometric approach to anisotropic diffusion*, chapter in *Geometry-Driven Diffusion in Computer Vision*, Bart ter Haar Romeny, ed., Kluwer Academic Publishers, pp. 371-391, September 1994.
- J. Bebernes and D. Eberly, *Mathematical Problems from Combustion Theory*, Applied Mathematical Sciences Series 83, Springer-Verlag, New York, August 1989.

## Game Credits

- *Deathverse: Let It Die*, SuperTricks Games, Inc., GungHo Online Entertainment, Inc., September 2022 (PlayStation 5), (Geometric Tools, use of minimum-area rectangle code).
- *Immortals: Fenyx Rising*, Ubisoft Quebec City Studio, Ubisoft, Inc., December 2020 (PlayStation 5), (Geometric Tools).
- *Baja: Edge of Control HD*, 2XL Games Inc., THQ Nordic GmbH, September 2017 (Windows, PlayStation 4, Xbox One), port of the Xbox 360 and PS3 version to newer platforms).
- *Baja: Edge of Control*, 2XL Games Inc., THQ Inc., September 2008 (Xbox 360, PS3), programmer for the company.
- *Harrier Attack II*, Durell Games Ltd., August 2007 (Windows). 3rd party support (Geometric Tools)
- *Swat 4*, Irrational Games LLC, Sierra Entertainment Inc., April 2005 (Windows), special thanks (Geometric Tools)
- *Hot Wheels: Williams F1: Team Racer*, KnowWonder Inc., March 2002 (Windows), contract development (Magic Software)
- *Hot Wheels: Turbo Racing*, Stormfront Studios, Electronic Arts Inc., September 1999, (Nintendo 64, PlayStation), special thanks (Magic Software)

## Publications

- COMPUTER GRAPHICS

- D. Eberly, *A fast and accurate algorithm for computing SLERP*, The Journal of Graphics, GPU, and Game Tools, vol. 15, no. 3, pp. 161-176, October 21, 2011.
- D. Eberly, J. Bebernes, *GPU-based methods for exploring parabolic partial differential equations*, Rocky Mountain Journal of Mathematics, vol. 41, no. 2, pp. 457-470, 2011.
- D. Eberly, *Metrics for Level of Detail*, GDC 2000 Conference Proceedings, pp. 173-190, San Jose, March 8-12, 2000.
- L. Bishop, D. Eberly, M. Finch, M. Shantz, T. Whitted, *Designing a PC Game Engine*, IEEE Computer Graphics and Application, pp. 46-53, January/February 1998.

- IMAGE PROCESSING

- S.M. Pizer, D. Eberly, D. Fritsch, B. Morse, *Zoom-invariant vision of figural shape: The mathematics of cores*, Computer Vision and Image Understanding, vol. 69, no. 1, pp. 55-71, 1998.
- J.D. Furst, S.M. Pizer, D. Eberly, *Marching cores: a method for extracting cores from 3D medical images*, Proceedings of IEEE Workshop on Mathematical Methods in Biomedical Image Analysis, San Francisco, June 21-22, 1996.
- S. Aylward, S.M. Pizer, E. Bullitt, D. Eberly, *Intensity ridges and widths for tubular object segmentation and description*, Proceedings of IEEE Workshop on Mathematical Methods in Biomedical Image Analysis, San Francisco, June 21-22, 1996.
- M.J. McAuliffe, D. Eberly, D.S. Fritsch, E.L. Chaney, S.M. Pizer, *Scale-space boundary evolution initialized by cores*, Proceedings of Visualization in Biomedical Computing, Hamburg, Germany, September 22-25, 1996.
- D. Wenzel, D. Eberly, *Group algebras in signal and image processing*, invited paper in Advances in Imaging and Electron Physics, vol. 95, pp. 2-79, October 1995.
- D. Eberly, *Fast algorithms for ridge construction*, Proceedings SPIE Photonics East 1994: Vision Geometry III, vol. 2356, pp. 231-242, 1994.
- A. Liu, S. Pizer, D. Eberly, B. Morse, J. Rosenman, E. Chaney, E. Bullitt, V. Carrasco, *Volume registration using the 3D core*, Visualization in Biomedical Computing 1994, SPIE Proceedings, vol. 2359, pp. 217-226.
- D. Eberly, R. Gardner, B. Morse, S. Pizer, C. Scharlach, *Ridges for image analysis*, Journal of Mathematical Imaging and Vision, vol. 4, pp. 351-371, 1994.
- D. Eberly, S. Pizer, *Ridge flow models for image segmentation*, Proc. SPIE Medical Imaging VIII, vol. 2167, pp. 54-64, 1994.
- D. Puff, D. Eberly, S. Pizer, *Object-based interpolation via the multiscale medial axis*, Proc. SPIE Medical Imaging VIII, vol. 2167, pp. 143-150, 1994.
- D.V. Beard, D. Eberly, B. Hemminger, S. Pizer, R. Faith, C. Kurak, M. Livingston, *Interacting with image hierarchies for fast and accurate object segmentation*, Proc. SPIE Medical Imaging VIII, vol. 2167, pp. 10-17, 1994.
- D. Fritsch, S. Pizer, B. Morse, D. Eberly, A. Liu, *The multiscale medial axis and its applications in image registration*, Pattern Recognition Letters, vol. 15, pp. 445-452, 1994.

- S.M. Pizer, D.S. Fritsch, B.S. Morse, D.H. Eberly, A. Liu, *Multiscale medial axis approaches for object definition and registration in medical images*, Proc. International Conference on Volume Image Processing, Dept. of Radiology, Univ. of Utrecht, the Netherlands, pp. 1-4, 1993.
  - D.V. Beard, R.E. Faith, D. Eberly, S.M. Pizer, C. Kurak, R.E. Johnston, *The Magic Crayon: An object definition and volume calculation testbed*, SPIE Medical Imaging VII, vol. 1898, pp. 789-796, 1993.
  - J. Lancaster, D. Eberly, A. Alyassin, J.H. Downs III, P.T. Fox, *A geometric model for measurement of surface distance, surface area, and volume from tomographic images*, Medical Physics, vol. 19, no. 2, March/April, pp. 419-431, 1992.
  - D. Eberly, D. Fritsch, C. Kurak, *Filtering with a normalized Laplacian of a Gaussian filter*, Proc. SPIE Mathematical Methods in Medical Imaging, vol. 1768, pp. 50-57, 1992.
  - D. Eberly, J. Lancaster, *On gray scale image measurements: I. Arc length and area*, CVGIP: Graphical Models and Image Processing, vol. 53, no. 6, pp. 538-549, 1991.
  - D. Eberly, J. Lancaster, A. Alyassin, *On gray scale image measurements: II. Surface area and volume*, CVGIP: Graphical Models and Image Processing, vol. 53, no. 6, pp. 550-562, 1991.
  - D. Eberly, D. Wenzel, *Adaptation of group algebras to signal and image processing*, CVGIP: Graphical Models and Image Processing, vol. 53, no. 4, pp. 340-348, 1991.
  - D. Eberly, D. Wenzel, H. Longbotham, *Hexagonal tessellations in image algebra*, Proc. SPIE Image Algebra and Morphological Image Processing, vol. 1350, pp. 25-30, 1990.
  - D. Eberly, P. Hartung, *Group convolutions and matrix transforms*, SIAM Journal on Algebraic and Discrete Methods, vol. 8, pp. 263-276, 1987.
- SIGNAL PROCESSING
    - H. Longbotham, D. Eberly, *The WMMR filters: A class of robust edge enhancers*, IEEE Transactions on Signal Processing, vol. 41, no. 4, pp. 1680-1685, 1993.
    - H. Longbotham, D. Eberly, *Statistical properties, fixed points, and decomposition with the WMMR filters*, Journal on Mathematical Imaging and Vision, vol. 2, pp. 99-116, 1992.
    - H. Longbotham, D. Eberly, *Fixed points of some ordering based filters*, Proc. SPIE Nonlinear Image Processing III, vol. 1658, pp. 37-45, 1992.
    - D. Eberly, H. Longbotham, J. Aragon, *Complete classification of the fixed points to 1-dimensional median filtering*, IEEE Trans. on Signal Processing, vol. 39, pp. 197-200, 1991.
  - COMBUSTION MODELS
    - D. Eberly, *Analysis of a model in solar magnetohydrostatics*, International Journal of Mathematics and Mathematical Science, vol. 13, pp. 755-762, 1990.
    - J. Bebernes, D. Eberly, *Characterization of blowup for a reaction-diffusion equation with a convection term*, Q. Jour. Mech. appl. Math., vol. 42, pp. 448-456, 1989.
    - J. Bebernes, D. Eberly, *A description of self-similar blowup for dimensions  $n \geq 3$* , Analyse Non Lineaire, Ann. Inst. Henri Poincare, vol. 5, pp. 1-21, 1988.
    - D. Eberly, *Nonexistence for the Kasoy problem in dimensions 1 and 2*, Journal of Mathematical Analysis with Applications, vol. 129, pp. 401-408, 1988.
    - J. Bebernes, A. Bressan, D. Eberly, *A description of blowup for the solid fuel ignition model*, Indiana University Mathematics Journal, vol. 36, pp. 295-305, 1987.

- D. Eberly, W. Troy, *Existence of logarithmic-type solutions to the Kapila-Kassoy problem in dimensions  $2 < n < 10$* , Journal of Differential Equations, vol. 70, pp. 309-324, 1987.
- D. Eberly, *Continuous dependence of boundary values for some semi-infinite interval ordinary differential equations*, International Journal of Mathematics and Mathematical Sciences, vol. 9, pp. 525-530, 1986.
- J. Bebernes, D. Eberly, W. Fulks, *Solution profiles for some simple combustion models*, Nonlinear Analysis: Theory, Methods, and Applications, vol. 10, pp. 165-177, 1986.

- MAXIMUM LIKELIHOOD ESTIMATION

- J. Aragon, D. Eberly, *On convergence of convex minorant algorithms for distribution estimation with interval-censored data*, Journal of Computational and Graphical Statistics, vol. 1, no. 2, pp. 129-140, 1992.
- J. Aragon, D. Eberly, S. Eberly, *Existence and uniqueness of the maximum likelihood estimator for the two-parameter negative binomial distribution*, Statistics and Probability Letters, vol. 17, no. 4, pp. 375-379, 1992.
- D. Eberly, J. Aragon, *Existence and uniqueness of maximum likelihood estimators for certain size-biased discrete distributions of order  $\beta$* , Sankhya: The Indian Journal of Statistics, 53, Series B, Pt. 2, pp. 213-228, 1991.