



Keenan Crane

Curriculum Vitæ

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Academic Positions and Education

Assistant Professor (2015–)

Computer Science Department and Robotics Institute
Carnegie Mellon University

NSF Mathematical Sciences Postdoctoral Fellow (2013–2015)

Columbia University

PhD, Computer Science

California Institute of Technology (2007–2013)

BS, Computer Science

University of Illinois at Urbana-Champaign (2002–2006)

Publications

JOURNAL ARTICLES

1. Nick Sharp, Yousuf Soliman, Keenan Crane
The Vector Heat Method
ACM Transactions on Graphics (conditionally accepted)
2. Nick Sharp, Keenan Crane
Variational Surface Cutting
ACM Transactions on Graphics 38 (4) 2018
3. Yousuf Soliman, Dejan Slepčev, Keenan Crane
Optimal Cone Singularities for Conformal Flattening
ACM Transactions on Graphics 38 (4) 2018
4. Oded Stein, Eitan Grinspun, Keenan Crane
Developability of Triangle Meshes
ACM Transactions on Graphics 38 (4) 2018
5. Mina Konakovic, Julian Panetta, Keenan Crane, Mark Pauly
Rapid Deployment of Curved Surfaces via Programmable Auxetics
ACM Transactions on Graphics 38 (4) 2018
6. Alex Baden, Keenan Crane, Misha Kazhdan
Möbius Registration
Computer Graphics Forum 37 (5), 2018
7. Rohan Sawhney, Keenan Crane
Boundary First Flattening
ACM Transactions on Graphics 37 (1) 2017
8. Chris Yu, Keenan Crane, Stelian Coros
Computational Design of Telescoping Structures
ACM Transactions on Graphics 37 (4), 2017

9. Derek Liu, Alec Jacobson, Keenan Crane
A Dirac Operator for Extrinsic Shape Analysis
Computer Graphics Forum 36 (5), 2017
10. Mina Konakovic, Keenan Crane, Bailin Deng, Sofien Bouaziz, Daniel Piker, Mark Pauly
Beyond Developable: Computational Design and Fabrication with Auxetic Materials
ACM Transactions on Graphics 35 (4), 2016
11. Felix Knöppel, Keenan Crane, Ulrich Pinkall, Peter Schröder
Stripe Patterns on Surfaces
ACM Transactions on Graphics 34 (4), 2015
12. Keenan Crane, Clarisse Weischedel, Max Wardetzky
Geodesics in Heat: A New Approach to Computing Distance Based on Heat Flow
ACM Transactions on Graphics 32 (5), 2013
13. Keenan Crane, Ulrich Pinkall, Peter Schröder
Robust Fairing via Conformal Curvature Flow
ACM Transactions on Graphics 32 (4), 2013
14. Felix Knöppel, Keenan Crane, Ulrich Pinkall, Peter Schröder
Globally Optimal Direction Fields
ACM Transactions on Graphics 32 (4), 2013
15. Keenan Crane, Ulrich Pinkall, Peter Schröder
Spin Transformations of Discrete Surfaces
ACM Transactions on Graphics 30 (4), 2011
16. Keenan Crane, Mathieu Desbrun, Peter Schröder
Trivial Connections on Discrete Surfaces
Computer Graphics Forum 29 (5), 2010 (Best Paper Award, Symposium on Geometry Processing)
17. Patrick Mullen, Keenan Crane, Dmitry Pavlov, Yiyong Tong, Mathieu Desbrun
Energy-Preserving Integrators for Fluid Animation
ACM Transactions on Graphics 28 (3), 2009
18. Marin Kobilarov, Keenan Crane, Mathieu Desbrun
Lie Group Integrators for Animation and Control of Vehicles
ACM Transactions on Graphics 28 (2), 2009
19. Ryan White, Keenan Crane, David Forsyth
Capturing and Animating Occluded Cloth
ACM Transactions on Graphics 26 (3), 2007
20. Eliot Young, Richard Binzel, Keenan Crane
A Two-color Map of Pluto's Sub-Charon Hemisphere
The Astronomical Journal 121 (1), 2001

OTHER REFEREED PUBLICATIONS

21. Keenan Crane
Conformal Geometry of Simplicial Surfaces
Proceedings of Symposia in Applied Mathematics (to appear)
22. Wode Ni, Katherine Ye, Joshua Sunshine, Jonathan Aldrich, Keenan Crane
SUBSTANCE and STYLE: Domain-Specific Languages for Mathematical Diagrams
DSLDI (Domain-Specific Language Design and Implementation) 2017
23. Katherine Ye, Keenan Crane, Jonathan Aldrich, and Joshua Sunshine
Designing Extensible, Domain-Specific Languages for Mathematical Diagrams
ACM SIGPLAN POPL - Off the Beaten Track 2017
24. Keenan Crane, Fernando de Goes, Mathieu Desbrun, Peter Schröder
Digital Geometry Processing with Discrete Exterior Calculus
ACM SIGGRAPH Course Notes, 2013

25. Michael Glueck, Keenan Crane, Sean Anderson, Andres Rutnik, Azam Khan
Multiscale 3D Reference Visualization
Proceedings of the Symposium on Interactive 3D Graphics, 2009
26. Keenan Crane, Ignacio Llamas, Sarah Tariq
Real Time Simulation and Rendering of 3D Fluids
GPU Gems 3 (Addison-Wesley), 2007
27. Ryan White, Keenan Crane, David Forsyth
Data Driven Cloth Animation
ACM SIGGRAPH Technical Sketches, 2007
28. Nathan Carr, Jared Hoberock, Keenan Crane, John Hart
Rectangular Multi-Chart Geometry Images
Proceedings of the Symposium on Geometry Processing, 2006
29. Nathan Carr, Jared Hoberock, Keenan Crane, John Hart
Fast GPU Ray Tracing of Dynamic Meshes
Proceedings of Graphics Interface, 2006

TECHNICAL REPORTS AND MANUSCRIPTS

30. Justin Solomon, Keenan Crane, Adrian Butscher, Chris Wojtan
A General Framework for Bilateral and Mean Shift Filtering
arXiv:1405.4734, 2014
31. Keenan Crane
Conformal Geometry Processing
Caltech PhD thesis, 2013
32. Keenan Crane
Discrete Connections for Geometry Processing
Caltech MS thesis, 2010

INVITED PAPERS

33. Keenan Crane, Max Wardetzky *A Glimpse into Discrete Differential Geometry*
Notices of the AMS, November 2017
34. Keenan Crane, Clarisse Weischedel, Max Wardetzky
The Heat Method for Distance Computation
Communications of the ACM (CACM) Research Highlights, November 2017

Press Coverage

- ZDNet, “*Telescoping Robots Can Shrink to Travel*” (August 2017)
- 90.5 WESA, “*CMU Researchers Put A Twist On Telescoping Structures*” (August 2017)
- ACM SIGGRAPH Press Release, “*Making Telescopes that Curve and Twist*” (July 2017)
- WIRED, “*A Freaky Anti-Rubber Is Still Weirding Scientists Out*” (August 2016)
- NSF Science Now, “*Computational Design Tool Transforms Flat Materials into 3-D Shapes*” (August 2016)
- 3DPrint.com, “*These 3D Printed Porcelain Coffee Mugs & Donuts are Clever Topology-Related Joke*” (August 2015)
- Scientific American Blog, “*In Love with Geometry*” (September 2013)
- National Public Radio, “*Digital Domain Grapples with Fur, Feathers*” (June 2012)
- Engineering & Science Magazine, “*Conquering Shapes*” (Spring 2012)

Awards & Honors

Packard Fellowship (2018–2023)

Awarded to 18 faculty/year across all areas of science and engineering; \$875,000 over 5 years.

NSF Mathematical Sciences Postdoctoral Fellowship (2013–2015; NSF Award #1304254)

Awarded to top 15% of applicants across all areas of pure & applied mathematics; \$150,000 over 2 years.

Google PhD Fellowship (2010–2013)

Awarded to ~15 students/year across all disciplines of computer science; 3-years tuition & stipend.

2013 Heidelberg Laureate Forum

2012 Oberwolfach Graduate Student Fellow

2012 Everhart Distinguished Speaker

2012 Symposium on Geometry Processing Best Paper Award

2011 NSF Junior Oberwolfach Fellow

Industry Experience

Autodesk Research, Toronto, Canada - *Research Intern* (Summer 2008)

NVIDIA Corporation, Santa Clara, CA - *Demo Team Intern* (Summer 2006)

NVIDIA Corporation, Santa Clara, CA - *Demo Team Intern* (Summer 2005)

NVIDIA Corporation, Santa Clara, CA - *Architecture Intern* (Summer 2004)

Invited Talks

September 2, 2019

Keynote Talk (TBD)

International Geometry Workshop
Strobl, Austria

April 1, 2019

TBD

IPAM Workshop on Geometric Processing
Los Angeles, CA

September 5, 2018

Discrete Differential Geometry

G. Milton Wing Lectures
University of Rochester

September 21, 2017

Boundary First Flattening

International Geometry Workshop
Obergurgl, Austria

July 10, 2017

Extrinsic Conformal Geometry

FoCM'17 Computational Topology & Geometry Workshop
Barcelona, Spain

November 16, 2016

Boundary First Flattening

IST Austria
Klosterneuburg, Austria

November 18, 2016

Differential Geometry and Developability [Keynote]

Symposium on Geometry & Computational Design
Vienna, Austria

July 1, 2016

Conformal Geometry and Auxetic Linkages

Brown University / ICERM
Providence, RI

June 17, 2016

Laplace-Beltrami: The Swiss Army Knife of Geometry Processing

EU Regional School
Aachen, Germany

January 28, 2016

Linear Conformal Parameterization with Boundary Control

Oberwolfach Mathematical Research Institute
Oberwolfach, Germany

October 14, 2015

Line Bundles in Geometry Processing

Oberwolfach Mathematical Research Institute
Oberwolfach, Germany

July 10, 2015

Developable Surface Flow

International Geometry Workshop
Seggau, Austria

April 27, 2015

Illustrating Geometry
Princeton University
Princeton, NJ

March 10, 2015

Spin Transformations and Geometry Processing
Technische Universität Berlin
Berlin, Germany

April 8, 2014

Optimizing Algorithms at the Level of Geometry
Carnegie Mellon School of Computer Science
Pittsburgh, PA

March 20, 2014

Optimizing Algorithms at the Level of Geometry
University of Toronto, Department of Computer Science
Toronto, Canada

February 27, 2014

Optimizing Algorithms at the Level of Geometry
Georgia Tech College of Computing
Atlanta, GA

December 12, 2013

Fast Algorithms for Geometry Processing
Blue Sky Studios
Greenwich, CT

August 31, 2013

Globally Optimal Direction Fields
International Geometry Workshop
Strobl, Austria

August 31, 2012

Optimal Algorithms for Vector Field Design and Editing
Rhythm and Hues Studios
El Segundo, California

June 18, 2012

Manipulating Geometry via Extrinsic Curvature
DDG Workshop @ SoCG
Chapel Hill, North Carolina

May 9, 2012

Helping Machines (and People) Think About Shape
Caltech Everhart Lecture Series
Pasadena, California

March 27, 2012

Robust Fairing using Conformal Surface Flows
Hausdorff Research Institute for Mathematics
Bonn, Germany

July 11, 2011

Spin Transformations of Discrete Surfaces
École Polytechnique Fédérale de Lausanne (EPFL)
Lausanne, Switzerland

April 19, 2015

Line Bundles in Geometry Processing
Columbia University
New York, NY

June 27, 2014

Optimizing Algorithms at the Level of Geometry
Google
Mountainview, CA

April 1, 2014

Optimizing Algorithms at the Level of Geometry
Stanford University, Department of Computer Science
Stanford, CA

March 19, 2014

Optimizing Algorithms at the Level of Geometry
Autodesk Research
Toronto, Canada

February 24, 2014

Optimizing Algorithms at the Level of Geometry
UCSD Department of Computer Science and Engineering
San Diego, CA

September 3, 2013

Geodesics in Heat
Institute of Science and Technology Austria
Klosterneuburg, Austria

November 18, 2012

Manipulating Geometry via Extrinsic Curvature
Johns Hopkins University
Baltimore, Maryland

July 11, 2012

The Heat Method
Oberwolfach Mathematical Research Institute
Oberwolfach, Germany

May 19, 2012

Helping Machines (and People) Think About Shape
Caltech Alumni Association Seminar Day
Pasadena, California

April 19, 2012

Optimal Algorithms for Vector Field Design and Editing
Digital Domain
Venice, California

December 13, 2011

Helping Machines Think About Shape
Johns Hopkins Center for Imaging Science
Baltimore, Maryland

June 28, 2011

Spin Transformations of Discrete Surfaces
Institute of Science and Technology Austria
Klosterneuburg, Austria

June 21, 2011

Conformal Surface Flows
International Geometry Workshop
Oberurgl, Austria

June 17, 2011

Recent Developments in Discrete Differential Geometry
Institute of Science and Technology Austria
Klosterneuburg, Austria

May 24, 2011

Recent Developments in Discrete Differential Geometry
California Institute of Technology
Pasadena, CA

April 13, 2011

Spin Transformations of Discrete Surfaces
Stanford University
Stanford, CA

February 2, 2011

Spin Transformations of Discrete Surfaces
Oberwolfach Mathematical Research Institute
Oberwolfach, Germany

September 30, 2010

Trivial Connections on Discrete Surfaces
Freie Universität Berlin
Berlin, Germany

May 20, 2010

Trivial Connections on Discrete Surfaces
Barrett Memorial Lectures
Knoxville, TN

July 7, 2009

Lie Group Integrators for Animation and Control of Vehicles
Technische Universität Berlin
Berlin, Germany

External Professional Activities

Associate Editor - ACM Transactions on Graphics (2017–)

Inaugural Committee Member - ACM SIGGRAPH Doctoral Consortium (2018)

Committee Member - AMS Short Course Subcommittee (2019–2022)

Co-Organizer - ICERM Workshop on Illustrating Geometry & Topology (2019)

Organizer - AMS Short Course on Discrete Differential Geometry, Joint Mathematics Meeting (2018)

Technical Papers Committee - SIGGRAPH (2015, 2016), SIGGRAPH Asia (2014)

Program Committee - Symposium on Geometry Processing (SGP 2013, 2014, 2015, 2018)

Program Committee - Conference on Computer Vision & Pattern Recognition (CVPR 2013)

Program Committee - Tiny Transactions on Computer Science (TinyToCS 2013)

Program Committee - Midwest Conference on Computer Graphics (MIDGRAPH 2005)

Chair - ACM SIGGRAPH Student Chapter at UIUC (2005)

Reviewer: SIGGRAPH 2006–2017; SIGGRAPH Asia 2008, 2010, 2013; ACM Transactions on Graphics 2007, 2008, 2012, 2014–2017; Eurographics 2006, 2007, 2011, 2013, 2016, 2017; Pacific Graphics 2013, 2014; IEEE TVCG 2009, 2011, 2012, 2014, 2015; Computers & Graphics 2011, 2012; ECCV 2012; CVPR 2013; GMOD 2013; Graphics Interface 2006; MIDGRAPH 2005; SIAM SIIMS 2011, 2012; Computer Aided Design 2013; Computer Graphics Forum 2013; Origami6 2015.

Teaching and Education

At CMU:

| TERM | COURSE | NUMBER | FCE OVERALL TEACHING | DEPT. AVG. |
|-------------|--------------------------------|------------|----------------------|------------|
| Fall 2015 | Computer Graphics Seminar | 15-869J | | |
| Fall 2015 | Computer Graphics | 15-462/662 | 4.8/4.9 | 4.3 |
| Spring 2016 | Discrete Differential Geometry | 15-869J | 4.8 | 4.3 |
| Fall 2016 | Computer Graphics | 15-462/662 | 4.7/4.9 | 4.3 |
| Fall 2017 | Discrete Differential Geometry | 15-458/858 | 4.1/4.7 | 4.2 |
| Fall 2017 | Computer Graphics | 15-462/662 | 4.7/4.6 | 4.2 |

At previous institutions:

Teaching Assistant — Caltech CS 177 (Discrete Differential Geometry), 2011, 2012

Teaching Assistant — Caltech CS 101.4 (Algorithms in Geometry and Topology), 2009

External Teaching Activities:

July 7, 2018

Conformal Geometry Processing

Symposium on Geometry Processing Grad School
Paris, France

January 5–6, 2018

Discrete Differential Geometry

Joint Mathematics Meeting
San Diego, CA

July 1, 2017

Conformal Geometry Processing

Symposium on Geometry Processing Grad School
London, UK

July 6, 2017

Conformal Geometry Processing

AICES EU Regional School
Aachen, Germany

July 11, 2014

Geometry Processing with Laplace-Beltrami

Symposium on Geometry Processing Grad School
Cardiff, Wales

July 22, 2013

Geometry Processing with Discrete Exterior Calculus

SIGGRAPH Courses
Anaheim, CA

July 8, 2013

Geometry Processing with Discrete Exterior Calculus

Symposium on Geometry Processing Grad School
Genova, Italy

July 14, 2012

Differential Geometry and Discrete Curvature Flows

Symposium on Geometry Processing Grad School
Tallinn, Estonia

Advising

CURRENT

PhD: Nick Sharp (*CMU CSD 2015–*), Chris Yu (*CMU CSD 2015–*), Rohan Sawhney (*CMU CSD 2016–*), Katherine Ye (*CMU CSD 2016–*), Mark Gillespie (*CMU CSD 2018–*). **MS:** Derek Liu (*CMU MechE*) **Undergrad:** Joshua Brakensiek (*CMU Math*), Yousuf Soliman (*CMU CS & Math*), Sophia Deng (*CMU CS & Math*), Connor Lin (*CMU CS*)

PAST

Undergrad: Pooja Mathur (*UIUC Intel/Lockheed Martin URSP, 2005–2006*), Isaac Kim (*Caltech SURF, 2011*), Joaquín Ruales (*Columbia REU, 2014*) → Microsoft Software Engineer, Rohan Sawhney (*Columbia independent study, 2014*) → CMU CS PhD, Henrique Maia (*Columbia independent study, 2014*) → Columbia University CS PhD, Kevin Li (*Columbia REU 2015*) → Stanford CS PhD, Lucas Schuermann (*Columbia REU 2015*), Bryce Summers (*CMU Senior Thesis, 2015*) → NYU IDM MS, Kai Kang (*CMU independent study, 2015*), Surbhi Inani (*CMU SURF, 2016*), Chris Kaffine (*CMU independent study 2017*), Wode Ni (*CMU REUSE*). **MS:** Derek Liu (*CMU MechE MS 2017*) → CS PhD at UToronto. **Postdoc:** Etienne Corman (2017–2018) → UToronto **Thesis Committee:** Péter Borosán (PhD, Rutgers University CS, 2013), Wumengjian Zhu (MS, CMU Computational Design 2018).