



# Keenan Crane

## Curriculum Vitæ

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### *Academic Positions and Education*

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*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*

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#### JOURNAL ARTICLES

1. Rohan Sawhney, Keenan Crane  
*Boundary First Flattening*  
**ACM Transactions on Graphics** (to appear)
2. Chris Yu, Keenan Crane, Stelian Coros  
*Computational Design of Telescoping Structures*  
**ACM Transactions on Graphics** 35 (4), 2017
3. Derek Liu, Alec Jacobson, Keenan Crane  
*A Dirac Operator for Extrinsic Shape Analysis*  
**Computer Graphics Forum** 36 (5), 2017
4. 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
5. Felix Knöppel, Keenan Crane, Ulrich Pinkall, Peter Schröder  
*Stripe Patterns on Surfaces*  
**ACM Transactions on Graphics** 34 (4), 2015
6. 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 (to appear in CACM Research Highlights)
7. Keenan Crane, Ulrich Pinkall, Peter Schröder  
*Robust Fairing via Conformal Curvature Flow*  
**ACM Transactions on Graphics** 32 (4), 2013
8. Felix Knöppel, Keenan Crane, Ulrich Pinkall, Peter Schröder  
*Globally Optimal Direction Fields*  
**ACM Transactions on Graphics** 32 (4), 2013

9. Keenan Crane, Ulrich Pinkall, Peter Schröder  
*Spin Transformations of Discrete Surfaces*  
**ACM Transactions on Graphics 30 (4), 2011**
10. Keenan Crane, Mathieu Desbrun, Peter Schröder  
*Trivial Connections on Discrete Surfaces*  
**Computer Graphics Forum 29 (5), 2010 (Best Paper Award, Symposium on Geometry Processing)**
11. Patrick Mullen, Keenan Crane, Dmitry Pavlov, Yiying Tong, Mathieu Desbrun  
*Energy-Preserving Integrators for Fluid Animation*  
**ACM Transactions on Graphics 28 (3), 2009**
12. Marin Kobilarov, Keenan Crane, Mathieu Desbrun  
*Lie Group Integrators for Animation and Control of Vehicles*  
**ACM Transactions on Graphics 28 (2), 2009**
13. Ryan White, Keenan Crane, David Forsyth  
*Capturing and Animating Occluded Cloth*  
**ACM Transactions on Graphics 26 (3), 2007**
14. 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

15. 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**
16. Keenan Crane, Fernando de Goes, Mathieu Desbrun, Peter Schröder  
*Digital Geometry Processing with Discrete Exterior Calculus*  
**ACM SIGGRAPH Course Notes, 2013**
17. Michael Glueck, Keenan Crane, Sean Anderson, Andres Rutnik, Azam Khan  
*Multiscale 3D Reference Visualization*  
**Proceedings of the Symposium on Interactive 3D Graphics, 2009**
18. Keenan Crane, Ignacio Llamas, Sarah Tariq  
*Real Time Simulation and Rendering of 3D Fluids*  
**GPU Gems 3 (Addison-Wesley), 2007**
19. Ryan White, Keenan Crane, David Forsyth  
*Data Driven Cloth Animation*  
**ACM SIGGRAPH Technical Sketches, 2007**
20. Nathan Carr, Jared Hoberock, Keenan Crane, John Hart  
*Rectangular Multi-Chart Geometry Images*  
**Proceedings of the Symposium on Geometry Processing, 2006**
21. Nathan Carr, Jared Hoberock, Keenan Crane, John Hart  
*Fast GPU Ray Tracing of Dynamic Meshes*  
**Proceedings of Graphics Interface, 2006**

## TECHNICAL REPORTS AND MANUSCRIPTS

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

## INVITED PAPERS

25. Keenan Crane, Max Wardetzky *A Glimpse into Discrete Differential Geometry*  
Notices of the AMS (in submission)
26. Keenan Crane, Clarisse Weischedel, Max Wardetzky  
*The Heat Method for Distance Computation*  
Communications of the ACM (CACM) Research Highlights, 2017 (to appear)

## Press Coverage

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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

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### NSF Mathematical Sciences Postdoctoral Fellowship

Awarded to top 15% of applicants across all areas of pure & applied mathematics.

PI: Crane (NSF Award #1304254, \$150,000)

### Google PhD Fellowship

Awarded to ~15 students/year across all disciplines of computer science; 3-year full fellowship.

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

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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

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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

**June 17, 2016**

*Laplace-Beltrami: The Swiss Army Knife of Geometry Processing*  
EU Regional School  
Aachen, Germany

**October 14, 2015**

*Line Bundles in Geometry Processing*  
Oberwolfach Mathematical Research Institute  
Oberwolfach, Germany

**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

**July 1, 2016**

*Conformal Geometry and Auxetic Linkages*  
Brown University / ICERM  
Providence, RI

**January 28, 2016**

*Linear Conformal Parameterization with Boundary Control*  
Oberwolfach Mathematical Research Institute  
Oberwolfach, Germany

**July 10, 2015**

*Developable Surface Flow*  
International Geometry Workshop  
Seggau, Austria

**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

**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

**June 21, 2011**

*Conformal Surface Flows*  
International Geometry Workshop  
Obergurgl, Austria

**May 24, 2011**

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

**February 2, 2011**

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

**May 20, 2010**

*Trivial Connections on Discrete Surfaces*  
Barrett Memorial Lectures  
Knoxville, TN

**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 17, 2011**

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

**April 13, 2011**

*Spin Transformations of Discrete Surfaces*  
Stanford University  
Stanford, CA

**September 30, 2010**

*Trivial Connections on Discrete Surfaces*  
Freie Universität Berlin  
Berlin, Germany

**July 7, 2009**

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

## *External Professional Activities*

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**Associate Editor** - ACM Transactions on Graphics (2017–)

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

**Organizer** - 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)

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

**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, 2015, 2016, 2017; Eurographics 2006, 2007, 2011, 2013, 2016; 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

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### 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	15-86J	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		
Fall 2017	Computer Graphics	15-462/662		

### 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 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

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### CURRENT

**Postdoc:** Etienne Corman. **PhD:** Nick Sharp (*CMU CSD 2015-*), Chris Yu (*CMU CSD 2015-*), Rohan Sawhney (*CMU CSD 2016-*), Katherine Ye (*CMU CSD 2016-*). **MS:** Derek Liu (*CMU MechE*) **Undergrad:** Chris Kaffine (*CMU ECE*), Joshua Brakensiek (*CMU Math*), Yousuf Soliman (*CMU CS & Math*)

### PAST

**Undergrad:** Pooja Mathur (*UIUC Intel/Lockheed Martin URSP, 2005-2006*), Isaac Kim (*Caltech SURF, 2011*), Joaquín Ruales (*Columbia REU, 2014*), Rohan Sawhney (*Columbia independent study, 2014*), Henrique Maia (*Columbia independent study, 2014*), Kevin Li (*Columbia REU 2015*), Lucas Schuermann (*Columbia REU 2015*), Bryce Summers (*CMU Senior Thesis, 2015*), Kai Kang (*CMU independent study, 2015*), Surbhi Inani (*CMU SURF, 2016*). **PhD Committee:** Péter Borosán (PhD, Rutgers University, 2013).