



# 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. Nick Sharp, Keenan Crane  
*Variational Surface Cutting*  
**ACM Transactions on Graphics 38 (4) 2018**
2. Yousuf Soliman, Dejan Slepčev, Keenan Crane  
*Optimal Cone Singularities for Conformal Flattening*  
**ACM Transactions on Graphics 38 (4) 2018**
3. Oded Stein, Eitan Grinspun, Keenan Crane  
*Developable Surface Flow*  
**ACM Transactions on Graphics 38 (4) 2018**
4. Mina Konakovic, Julian Panetta, Keenan Crane, Mark Pauly  
*Rapid Deployment of Curved Surfaces via Programmable Auxetics*  
**ACM Transactions on Graphics 38 (4) 2018**
5. Alex Baden, Keenan Crane, Misha Kazhdan  
*Möbius Registration*  
**Computer Graphics Forum 37 (5), 2018** (conditionally accepted)
6. Rohan Sawhney, Keenan Crane  
*Boundary First Flattening*  
**ACM Transactions on Graphics 37 (1) 2017**
7. Chris Yu, Keenan Crane, Stelian Coros  
*Computational Design of Telescoping Structures*  
**ACM Transactions on Graphics 37 (4), 2017**
8. Derek Liu, Alec Jacobson, Keenan Crane  
*A Dirac Operator for Extrinsic Shape Analysis*  
**Computer Graphics Forum 36 (5), 2017**

9. 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**
10. Felix Knöppel, Keenan Crane, Ulrich Pinkall, Peter Schröder  
*Stripe Patterns on Surfaces*  
**ACM Transactions on Graphics 34 (4), 2015**
11. 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**
12. Keenan Crane, Ulrich Pinkall, Peter Schröder  
*Robust Fairing via Conformal Curvature Flow*  
**ACM Transactions on Graphics 32 (4), 2013**
13. Felix Knöppel, Keenan Crane, Ulrich Pinkall, Peter Schröder  
*Globally Optimal Direction Fields*  
**ACM Transactions on Graphics 32 (4), 2013**
14. Keenan Crane, Ulrich Pinkall, Peter Schröder  
*Spin Transformations of Discrete Surfaces*  
**ACM Transactions on Graphics 30 (4), 2011**
15. Keenan Crane, Mathieu Desbrun, Peter Schröder  
*Trivial Connections on Discrete Surfaces*  
**Computer Graphics Forum 29 (5), 2010 (Best Paper Award, Symposium on Geometry Processing)**
16. Patrick Mullen, Keenan Crane, Dmitry Pavlov, Yiyong Tong, Mathieu Desbrun  
*Energy-Preserving Integrators for Fluid Animation*  
**ACM Transactions on Graphics 28 (3), 2009**
17. Marin Kobilarov, Keenan Crane, Mathieu Desbrun  
*Lie Group Integrators for Animation and Control of Vehicles*  
**ACM Transactions on Graphics 28 (2), 2009**
18. Ryan White, Keenan Crane, David Forsyth  
*Capturing and Animating Occluded Cloth*  
**ACM Transactions on Graphics 26 (3), 2007**
19. 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

20. 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**
21. 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**
22. Keenan Crane, Fernando de Goes, Mathieu Desbrun, Peter Schröder  
*Digital Geometry Processing with Discrete Exterior Calculus*  
**ACM SIGGRAPH Course Notes, 2013**
23. Michael Glueck, Keenan Crane, Sean Anderson, Andres Rutnik, Azam Khan  
*Multiscale 3D Reference Visualization*  
**Proceedings of the Symposium on Interactive 3D Graphics, 2009**
24. Keenan Crane, Ignacio Llamas, Sarah Tariq  
*Real Time Simulation and Rendering of 3D Fluids*  
**GPU Gems 3 (Addison-Wesley), 2007**

25. Ryan White, Keenan Crane, David Forsyth  
*Data Driven Cloth Animation*  
ACM SIGGRAPH Technical Sketches, 2007
26. Nathan Carr, Jared Hoberock, Keenan Crane, John Hart  
*Rectangular Multi-Chart Geometry Images*  
Proceedings of the Symposium on Geometry Processing, 2006
27. Nathan Carr, Jared Hoberock, Keenan Crane, John Hart  
*Fast GPU Ray Tracing of Dynamic Meshes*  
Proceedings of Graphics Interface, 2006

## TECHNICAL REPORTS AND MANUSCRIPTS

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

## INVITED PAPERS

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

## Press Coverage

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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

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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 5, 2018**

*Discrete Differential Geometry*  
G. Milton Wing Lectures  
University of Rochester

**July 10, 2017**

*Extrinsic Conformal Geometry*  
FoCM'17 Computational Topology & Geometry Workshop  
Barcelona, Spain

**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

**September 21, 2017**

*Boundary First Flattening*  
International Geometry Workshop  
Obergurgl, Austria

**November 16, 2016**

*Boundary First Flattening*  
IST Austria  
Klosterneuburg, Austria

**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 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

**June 21, 2011**

*Conformal Surface Flows*  
International Geometry Workshop  
Oberurgl, 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

**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 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-)

Inaugural Committee Member - ACM SIGGRAPH Doctoral Consortium (2018)

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

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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	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:

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

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## CURRENT

**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:** 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).