

CHRISTOPHER J. LARSEN

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Education:

Ph.D., Mathematics, Carnegie Mellon University, 1996

M.S., Applied Mathematics, Carnegie Mellon University, 1994

J.D., University of Maryland School of Law, 1992

B.S., Physics, Carnegie Mellon University, 1989

Appointments:

- 2013-present: Professor, Department of Mathematical Sciences, Worcester Polytechnic Institute
- 2015-present: Associate Department Head, Department of Mathematical Sciences, Worcester Polytechnic Institute
- January-June 2006: Visiting Associate in Mechanical Engineering, California Institute of Technology
- 2004-2013 Associate Professor, Department of Mathematical Sciences, Worcester Polytechnic Institute
- March/May 2003: Invited Professor, University of Paris-Dauphine
- May 2002: Invited Professor, University of Paris-Nord
- Sept/Oct 2001: Invited Professor, University of Paris-Dauphine
- May 2001: Invited Professor, University of Paris-Nord
- 1999-2004: Assistant Professor, Department of Mathematical Sciences, Worcester Polytechnic Institute
- 1996-1999: Visiting Assistant Professor, Department of Mathematical Sciences, Worcester Polytechnic Institute

Research Funding:

PI:

- NSF: “New mathematical methods for fracture evolution.” 2016 - 2019. Total Expected Amount: \$345,339
- NSF: “New variational methods for quasi-static and dynamic material defect evolution.” 2013 - 2016. Awarded Amount: \$343,991
- NSF: “Variational methods for material defect evolution.” 2010 - 2013. Awarded Amount: \$167,534
- NSF: “Damage and fracture evolution.” 2008 - 2011. Awarded Amount: \$162,228
- NSF: “Variational methods for material damage: fracture, fatigue, and debonding.” 2005 - 2008. Awarded Amount: \$240,450

Additional support:

- ERC Advanced Grant: “Quasistatic and Dynamic Evolution Problems in Plasticity and Fracture” (Team Member; PI: G. Dal Maso). 2012 - 2017. Amount: €968,500

Honors:

Leverhulme Visiting Professor, University of Bristol

Graduate Students:

Ph.D.:

Casey L. Richardson, Ph.D. 2008. First position: CAM Assistant Professor, UCLA 2008-2011

Yiqing Li, Ph.D., 2016. Winner, Department Graduate Research Award

Masters:

David Evans, M.S. 2011

Publications:

1. G. DAL MASO, C. J. LARSEN, and R. TOADER, Existence for constrained dynamic Griffith fracture with a weak maximal dissipation condition, *J. Mech. Phys. Solids*, to appear.
2. I. CHENCHIAH and C. J. LARSEN, Quasi-static brittle damage evolution in elastic materials with multiple damaged states, *Arch. Ration. Mech. Anal.* **215** (2015), pp. 831-866.
3. C. J. LARSEN, A new variational principle for cohesive fracture and elastoplasticity, *Mech. Res. Commun.* **58** (2014), pp. 133-138.

4. C. J. LARSEN and V. SLASTIKOV, Dynamic cohesive fracture: models and analysis, *Math. Models Methods Appl. Sci.* **24** (2014), pp. 1857-1875.
5. C. J. LARSEN, Local minimality and crack prediction in quasi-static Griffith fracture evolution, *Discrete Contin. Dyn. Syst. Series S* **6** (2013), pp. 121-129.
6. G. DAL MASO and C. J. LARSEN, Existence for wave equations on domains with arbitrary growing cracks, *Rend. Lincei Mat. Appl.* **22** (2011), pp. 387-408.
7. B. BOURDIN, C. J. LARSEN, and C. L. RICHARDSON, A time-discrete model for dynamic fracture based on crack regularization, *Int. J. Fracture* **168** (2011), pp. 133-143.
8. A. BRAIDES and C. J. LARSEN, Γ -convergence for stable states and local minimizers, *Ann. Scuola Norm. Sup. Pisa Cl. Sci. (5)* **X** (2011), pp. 193-206.
9. H. JIANG, C. J. LARSEN, and L. SILVESTRE, Full regularity of a free boundary problem with two phases, *Calc. Var. Partial Differential Equations* **42** (2011), pp. 301-321.
10. C. J. LARSEN, Epsilon-stable quasi-static brittle fracture evolution, *Comm. Pure Appl. Math.* **63** (2010), pp. 630-654.
11. C. J. LARSEN, C. ORTNER, and E. SÜLI, Existence of solutions to a regularized model of dynamic fracture, *Math. Models Methods Appl. Sci.* **20** (2010), pp. 1021-1048.
12. C. J. LARSEN, *Models for dynamic fracture based on Griffith's criterion*, in IUTAM Symposium on Variational Concepts with Applications to the Mechanics of Materials (Klaus Hackl, ed.), Springer, 2010, pp. 131-140.
13. A. GARRONI and C. J. LARSEN, Threshold-based quasi-static brittle damage evolution, *Arch. Ration. Mech. Anal.* **194** (2009), pp. 585-609.
14. C. J. LARSEN, M. ORTIZ, and C. L. RICHARDSON, Fracture paths from front kinetics: relaxation and rate-independence, *Arch. Ration. Mech. Anal.* **193** (2009), pp. 539-583.
15. C. J. LARSEN, C. L. RICHARDSON, and M. SARKIS, A level set method for the Mumford-Shah functional and fracture, *Technical Report Serie A 581* (2008), Instituto de Matematica Pura e Aplicada, Brazil.
16. H. JIANG and C. J. LARSEN, Analyticity for a two dimensional free boundary problem with volume constraint (2006) (preprint)
17. G. A. FRANCFORT and C. J. LARSEN, Existence and convergence for quasi-static evolution in brittle fracture, *Comm. Pure Appl. Math.* **56** (2003), pp. 1465-1500.
18. A. CHAMBOLLE and C. J. LARSEN, C^∞ regularity of the free boundary for a two-dimensional optimal compliance problem, *Calc. Var. Partial Differential Equations* **18** (2003), pp. 77-94.
19. C. J. LARSEN, Regularity of components in optimal design problems with perimeter penalization, *Calc. Var. Partial Differential Equations* **16** (2003), pp. 17-29.
20. C. J. LARSEN, Regularity in two-dimensional variational problems with perimeter penalties, *C. R. Acad. Sci. Paris Sér. I Math.* **333** (2001), pp. 261-266.

21. C. J. LARSEN and R. LUI, Uniqueness of steady-states and asymptotic behavior of solutions of a liquid junction model with insulation, *Nonlinear Anal. Real World Appl.* **3** (2002), pp. 227-241.
22. C. J. LARSEN, On the representation of effective energy densities, *ESAIM Control Optim. Calc. Var.* **5** (2000), pp. 529-538.
23. C. J. LARSEN, Distance between components in optimal design problems with perimeter penalization, *Ann. Scuola Norm. Sup. Pisa Cl. Sci.* **28** (1999), pp. 641-649.
24. C. J. LARSEN, A new proof of regularity for two-shaded image segmentations, *Manuscripta Math.* **96** (1998), pp. 247-262.
25. C. J. LARSEN, Quasiconvexification in $W^{1,1}$ and optimal jump microstructure in BV relaxation, *SIAM J. Math. Anal.* **29** (1998), pp. 823-848.

Invited Short Courses:

- Three week course on “Variational methods in materials science,” Park City Mathematics Institute - Institute for Advanced Study, June-July 2014
- One week mini-course on “Mathematical issues in globally minimizing, locally minimizing, and dynamic fracture evolutions” in *Evolution Problems in Fracture Mechanics*, SISSA, Italy, March 2013
- “A Guide to SBV and applications,” University of Oxford, May 2009
- “A Guide to SBV and applications,” Caltech, January-March 2006

Invited Conference Presentations as a Primary Speaker:

1. Conference on “Calculus of Variations and PDE,” Berkeley, May 2017
2. CIRM Conference on “Shape Optimization, Isoperimetric and Functional Inequalities,” Luminy, France, November 2016
3. (“Selected Lecture”) International Workshop on “Multiscale Innovative Materials and Structures,” Salerno, Italy, October 2016
4. Workshop on “Quasistatic and Dynamic Evolution Problems in Plasticity and Fracture,” Trieste, Italy, June 2016
5. Lorentz Center workshop “Microstructure evolution in materials: defects, cracks & interfaces,” Leiden, Netherlands, April 2016
6. IUTAM Symposium “Innovative numerical approaches for materials and structures in multi-field and multi-scale problems” (dedicated to the 60th birthday of Michael Ortiz), Attendorn, Germany, September 2014
7. PIRE Workshop on Evolution Problems for Material Defects: Dislocations, Plasticity, and Fracture, Trieste, Italy, September-October 2013

8. (“Selected Lecture”) Workshop on Multi-scale Modeling and Characterization of Innovative Materials and Structures, Salerno, Italy, May 2013
9. Computational Methods for Multiscale Modeling of Materials Defects, IPAM, UCLA, December 2012
10. International Conference on Variational Problems with Multiple Scales, Otranto, Italy, June 2012
11. Oberwolfach workshop on Variational Methods for Evolution, December 2011
12. (Keynote) International Workshop on Phase Separation, Damage and Fracture, WIAS Berlin, September 2011
13. Banff workshop on Rate-independent systems: Modeling, Analysis, and Computations, August 2010 (video)
14. Oberwolfach workshop on Microstructures in Solids: From Quantum Models to Continua, March 2010
15. IUTAM Symposium “Variational Concepts with Applications to the Mechanics of Materials,” Bochum, Germany, September 2008
16. Oxford Workshop on Fracture, Oxford, England, March 2008
17. (Plenary) ICM2006 Satellite Conference “New Trends and Challenges in the Calculus of Variations and its Applications,” Toledo, Spain, August 2006
18. Workshop on Rate-Independent Processes, Paris, France, August 2004
19. Workshop on Calculus of Variations, Savoie, France, June 2003

Conferences Organized:

1. Workshop on New Challenges for the Calculus of Variations Stemming From Problems in the Materials Sciences and Image Processing In Honour of the 60th Birthday of Irene Fonseca, May 2016 (organized with R. Choksi, N. Fusco, and G. Leoni)
2. Banff Workshop on Variational Models of Fracture, May 2016 (organized with B. Bourdin, G. Francfort, and C. Maurini)
3. 48th Annual Technical Meeting of Society of Engineering Sciences, Symposium on Defect Evolution in Materials, Evanston, IL, October 2011
4. Oberwolfach mini-workshop on Mathematical Models, Analysis, and Numerical Methods for Dynamic Fracture (organized with G. Dal Maso and C. Ortner), April 2011
5. AMS Sectional Meeting, Special Session on Quasi-static and Dynamic Evolution in Fracture Mechanics, Worcester, MA, April 2009
6. SIAM Conference on Mathematical Aspects of Materials Science, four Special Sessions on Damage and Fracture Evolution (invited, organized with G. Dal Maso, G. Francfort, and A. Garroni), Philadelphia, PA, May 2008

7. Workshop on Free Discontinuity Problems: From Image Processing to Materials Science (organized with B. Bourdin), Baton Rouge, LA, January 2007
8. Joint Mathematics Meetings, AMS Special Session on Free Discontinuity Problems: From Image Processing to Materials Science (organized with B. Bourdin), New Orleans, LA, January 2007
9. First SIAM Meeting on Analysis of Partial Differential Equations, Special Session on Free Boundary Problems and Optimal Transportation (organized with R. Jerrard), Houston, TX, December 2004

Invited Conferences:

1. International Congress of Theoretical and Applied Mechanics, thematic session on Fracture Mechanics, Montreal, August 2016
2. International Congress on Industrial and Applied Mathematics, minisymposium on New Developments in Fracture Mechanics, Beijing, August 2015
3. Fourth International Conference on Computational Modeling of Fracture and Failure of Materials and Structures, mini-symposium on Theory of Fracture, Crack Propagation Criteria, and Crack Tracking Algorithms, Paris, June 2015 (Keynote)
4. SIAM Conference on Mathematical Aspects of Materials Science, Special Session on Aspects of Homogenization: Analysis and Applications in Materials Science and Biophysics, Philadelphia, PA, June 2013
5. Joint Mathematics Meetings, AMS Special Session on Recent Advances and New Challenges in Applied Analysis, San Diego, CA, January 2013
6. International Congress on Industrial and Applied Mathematics, minisymposium on Modern Methods and Applications of the Calculus of Variations: Fracture Mechanics and Plasticity, Vancouver, July 2011
7. International Congress on Industrial and Applied Mathematics, minisymposium on Multiscale Phenomena in Calculus of Variations and Inverse Problems, Vancouver, July 2011
8. SIAM Conference on Mathematical Aspects of Materials Science, Special Session on New Frontiers in Calculus of Variations and Applications to Materials Science, Philadelphia, PA, May 2010
9. SIAM Conference on Analysis of Partial Differential Equations, Special Session on Variational Methods in Materials Science, Miami, Florida, December 2009
10. SIAM Conference on Mathematical Aspects of Materials Science, Special Session on Variational Models for Advanced Materials, Philadelphia, PA, May 2008
11. SIAM Conference on Analysis of Partial Differential Equations, Special Session on Free Boundary Problems And Beyond, Mesa, Arizona, December 2007
12. SIAM Conference on Analysis of Partial Differential Equations, Special Session on Gradient Fields, Stresses, and Free Surfaces in Heterogeneous Materials, Mesa, Arizona, December 2007

13. Society of Engineering Science Annual Meeting, Special Session on Transport Properties of Micro-structured Media and Composite Materials, College Station, Texas, October 2007
14. International Congress on Industrial and Applied Mathematics, minisymposium on Mathematical Modeling and Numerical Analysis of Fracture Phenomena, Zurich, July 2007
15. International Congress on Industrial and Applied Mathematics, minisymposium on Mathematical Aspects of Materials Science: Plasticity and Fracture, Zurich, July 2007
16. Oberwolfach workshop on Analysis and Numerics for Rate-Independent Processes, February 2007 (declined due to conflict)
17. Joint Mathematics Meetings, AMS Special Session on Calculus of Variations and Nonlinear PDE: Theory and Applications, New Orleans, LA, January 2007
18. AMS Sectional Meeting, Special Session on Nonconvex Variational Problems: Recent Advances and Applications, University of Utah, October 2006
19. SIAM Meeting on Analysis of Partial Differential Equations, Special Session on Contemporary Developments in Calculus of Variations and PDE, Boston, MA, July 2006
20. IX Conference on Partial Differential Equations, IMPA, Brazil, July 2005
21. First SIAM Meeting on Analysis of Partial Differential Equations, Special Session on Calculus of Variations, PDE and Mass Transport, Houston, TX, December 2004
22. First Joint Meeting of the AMS-UMI, Special Session on Contemporary Developments in Partial Differential Equations and in the Calculus of Variations, Pisa, Italy, June 2002
23. Nonlinear Analysis 2000→, Courant Institute, May 2000
24. SIAM conference on Mathematical Aspects of Materials Science, Special Session on Optimal Design of Structures and Microstructures, Philadelphia, May 2000
25. Workshop on Structured Deformations, Carnegie Mellon University, January 1999
26. Canadian Applied Mathematics Society meeting, Simon Fraser University, May 1998
27. AMS Sectional Meeting, Special Session on Recent Developments in PDE's, Calculus of Variations, and Applications to Problems in Materials Science, Georgia Tech, October 1997

Invited Seminars:

1. Mathematics Colloquium, University of Pittsburgh, November 2015
2. PDE/Applied Math Seminar, Drexel University, February 2015
3. PDE/Differential Geometry Seminar, University of Connecticut, October 2013
4. Applied Analysis & Computation Seminar, University of Massachusetts-Amherst, September 2013
5. Analysis Seminar, Temple University, September 2013

6. Analysis Seminar, SISSA, Trieste Italy, June 2012
7. Analysis Seminar, University of Rome “La Sapienza”, October 2011
8. Analysis and Applied Math Seminar, University of Toronto, February 2011
9. Applied and Computational Mathematics Seminar, Georgia Tech, October 2010
10. Centre for Nonlinear Mechanics Seminar, University of Bath, May 2009
11. PDE Seminar, Brown University, April 2009
12. Analysis Seminar, University of Bristol, November 2008
13. OxPDE Seminar, University of Oxford, November 2008
14. Analysis Seminar, SISSA, Trieste Italy, October 2008
15. Applied Math Seminar, University of Glasgow, March 2008
16. CMAP Seminar, Ecole Polytechnique, Paris, February 2008
17. Applied Math Seminar, Temple University, February 2007
18. Mathematical Physics Seminar, Caltech, May 2006
19. Analysis Seminar, SISSA, Trieste Italy, May 2006
20. Applied Math Seminar, UC Irvine, March 2006
21. Mathematics Colloquium, Louisiana State University, March 2006
22. Differential Equations Seminar, University of Rome “La Sapienza”, November 2005
23. Numerical Analysis Seminar, Ecole Polytechnique, Paris, November 2005
24. Applied Analysis Seminar, Weierstrass Institute, Berlin, November 2005
25. Analysis Seminar, University of Warwick, October 2005
26. Center for Nonlinear Analysis Seminar, Carnegie Mellon University, March 2005
27. Partial Differential Equations Seminar, IMPA, Brazil, May 2004
28. Calculus of Variations Seminar, University of Paris-Dauphine, March 2003
29. Computer Science Research Institute Seminar, Sandia National Laboratories, October 2002
30. Harmonic Analysis Seminar, University of Paris-Sud, June 2002
31. Partial Differential Equations Seminar, University of Savoie, May 2002
32. Homogenization and Multiple Scales Seminar, University of Paris VI, May 2002
33. Calculus of Variations Seminar, University of Paris-Dauphine, March 2002
34. Applied and Computational Mathematics Seminar, Caltech, February 2002

35. Center for Nonlinear Analysis Seminar, Carnegie Mellon University, January 2002
36. Applied Mechanics Seminar, Caltech, October 2001
37. Computer Science Research Institute Seminar, Sandia National Laboratories, September 2001
38. Seminar of the Laboratoire Jacques-Louis Lions, University of Paris VI, May 2001
39. Applied Analysis and Computation Seminar, University of Massachusetts-Amherst, March 2001
40. Center for Nonlinear Analysis Seminar, Carnegie Mellon University, April 2000
41. Applied and Computational Mathematics Seminar, Penn State University, April 2000
42. Image Science Seminar, Computer Science Department, WPI, November 1999
43. Harmonic Analysis Seminar, University of Paris-Sud, March 1999
44. Differential Equations Seminar, North Carolina State University, December 1998
45. Stochastic and Nonlinear Analysis Seminar, University of Illinois at Urbana-Champaign, September 1998
46. Differential Equations Seminar, University of Connecticut, September 1997
47. Mathematics Colloquium, WPI, September 1996
48. Mathematics Colloquium, University of Missouri-Rolla, February 1996

Invitations:

1. SISSA, Trieste, Italy, March 2013, one week
2. IPAM (UCLA) program on “Materials Defects: Mathematics, Computation, and Engineering,” invited “long term core participant,” fall 2012
3. SISSA, Trieste, Italy, June 2012, one week
4. Carnegie Mellon University, May 2012, one week
5. University of Rome, November 2011, one week
6. Caltech, January 2011, one week
7. University of Bonn, Germany, March 2010, three days
8. University of Oxford, May 2009, one week
9. Louisiana State University, LA, January 2009, four days
10. University of Oxford, November 2008, one month
11. University of Rome, October 2008, one week
12. SISSA, Trieste, Italy, October 2008, one week

13. University of Oxford, March 2008, one week
14. University of Rome, February 2008, two weeks
15. Ecole Polytechnique, Paris, February 2008, two weeks
16. Louisiana State University, LA, January 2008, one week
17. SISSA, Trieste, Italy, July 2007, one week
18. University of Rome, March 2007, one week
19. Caltech Department of Aerospace Engineering, January 2007, one week
20. SISSA, Trieste, Italy, May 2006, one week
21. University of Rome, February 2006, two weeks
22. University of Rome, November 2005, one week
23. Ecole Polytechnique, Paris, December 2005, three days
24. Weierstrass Institute, Berlin, November 2005, one week
25. University of Paris-Nord, October 2005, one week
26. University of Warwick, England, August 2005, three months
27. IMPA, Brazil, July 2005, one month
28. IMA, University of Minnesota, June 2005, one week
29. Carnegie Mellon University, PA, March 2005, one week
30. IMA, University of Minnesota, October-November 2004, two weeks
31. IMPA, Brazil, May 2004, one week
32. University of Bonn, Germany, June 2003, one week
33. Sandia National Laboratories, NM, October 2002, one week
34. University of Savoie, France, May 2002, three days
35. Carnegie Mellon University, PA, January 2002, two weeks
36. Caltech Department of Applied Mechanics, CA, October 2001, two weeks
37. University of Paris-Dauphine, France, September-October 2001, two weeks
38. Sandia National Laboratories, NM, September 2001, one week
39. University of Bonn, Germany, June 2001, one week
40. Caltech Department of Applied Mechanics, CA, April 2001, two days
41. Carnegie Mellon University, PA, April 2000, one week

42. Penn State University, PA, April 2000, one week
43. Carnegie Mellon University, PA, May 1999, one week
44. University of Paris-Sud, France, March 1999, one week
45. Carnegie Mellon University, PA, January 1999, one week
46. North Carolina State University, NC, December 1998, four days
47. Simon Fraser University, Canada, May 1998, one week

Refereeing:

Communications on Pure and Applied Mathematics
Archive for Rational Mechanics and Analysis
Calculus of Variations and Partial Differential Equations
SIAM Journal on Mathematical Analysis
SIAM Journal on Numerical Analysis
SIAM Journal on Applied Mathematics
Annali della Scuola Normale Superiore di Pisa Classe di Scienze
International Journal of Fracture
Journal of Differential Equations
Journal of Elasticity
Proceedings of the Royal Society A
Journal of Nonlinear Science
The Royal Society of Edinburgh Proceedings A (Mathematics)
Mathematical Models and Methods in Applied Sciences
Mathematical Modelling and Numerical Analysis
ESAIM: Control, Optimisation and Calculus of Variations
Interfaces and Free Boundaries
Applied Mathematics Research Express
Applied Mathematics and Optimization
Journal of Mathematical Analysis and Applications
Computer Methods in Applied Mechanics and Engineering
Optimization

Ph.D. Thesis Referee, Functional Analysis and Applications Sector, SISSA

Reviewer for Austrian Science Fund

Reviewer for Swiss National Science Foundation

NSF panelist, Division of Mathematical Sciences, Materials and Continuum Mechanics Panel

NSF reviewer, Division of Materials Research

Assessor for the Italian National Research Assessment 2011-2014

Courses Developed:

- Introduction to Analysis I - IV, a Freshman sequence as an alternative to the Calculus sequence, for motivated Freshmen (with B. Vernescu)
- Graduate Topics course on Partial Differential Equations
- Undergraduate Topics course on Mathematics of Quantum Mechanics
- Undergraduate Topics course on Topology

Undergraduate Projects:

- Construction of Stable States for Cohesive Fracture and Elastoplasticity
- Crack Derivatives
- Stable Convergence of the Ambrosio-Tortorelli Functionals
- Continuity of Crack Sets in Dynamic Fracture
- SBV Compactness
- Weak Topologies and Metrizability (runner-up, Provost's award)
- Interdisciplinary Project: Coalitions in the U.S. Supreme Court
- Interaction of Gravity and Electromagnetic Waves
- Heat Flow in Porous Media, co-advised with B. Vernescu (runner-up, Provost's award)
- Interdisciplinary Project: Civil Standards and Justice
- Notions of Size for Infinite Sets and Applications (winner, Provost's award)
- Two Projects for WPI's Industrial Math REU program