STEVEN L. CROUCH

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Education

Ph.D. Mineral Engineering, University of Minnesota, 1970
M.S. Mineral Engineering, University of Minnesota, 1967
B.S. undesignated (with distinction), University of Minnesota, 1966

Professional Experience

2005–	Dean, College of Science and Engineering [formerly Institute of Technology], University of Minnesota
1997–2005	Associate Dean for Finance and Planning, College of Science and Engineering [formerly Institute of Technology], University of Minnesota
1997–2012	Theodore W. Bennett Professor of Mining Engineering and Rock Mechanics, Department of Civil Engineering, University of Minnesota
1987–97	Head, Department of Civil [and Mineral] Engineering, University of Minnesota
1981–	Professor, Department of Civil [and Mineral] Engineering, University of Minnesota
1976–77	Visiting Lecturer, Department of Applied Mathematics, University of the Witwatersrand, Johannesburg, South Africa
1970–81	Assistant (1970-75) and Associate (1975-81) Professor, Department of Civil and Mineral Engineering, University of Minnesota
1968–70	Research Officer, Mining Research Laboratory, Chamber of Mines of South Africa, Johannesburg, South Africa
1967	Research Engineer, Chevron Oil Company, Denver, Colorado

Professional Activities and Awards

2004	Charles W. Britzius Distinguished Engineer Award, Minnesota Federation of Engineering, Science, and Technology Societies
2004	Lead organizer for IABEM 2004 (conference for the International Association for Boundary Element Methods)
1992	U.S. National Committee for Rock Mechanics Applied Research Award (awarded to M. G. Mack and S. L. Crouch)

1991	AIME/SME 1991 Rock Mechanics Award
1990–96	Editorial Board, *Engineering Analysis with Boundary Elements*
1989	Quality Award, Minnesota Council on Quality
1989–96	Member, Sandia National Laboratories Yucca Mountain Site Characterization Project (YMP) Rock Mechanics Review Panel
1987	Member, U.S. National Academy of Sciences Task Group on Underground Engineering at the Basalt Waste Isolation Project (BWIP)
1983	Visiting Lecturer, various universities in Japan and the People's Republic of China (fellowship awarded by the Japan Society for the Promotion of Science)
1975–97	Editorial Board, *International Journal of Rock Mechanics and Mining Sciences & Geomechanics Abstracts*
1973	Member, U.S. National Academy of Sciences Committee on the Feasibility of Returning Coal Mine Waste Underground

Professional Society Memberships

American Rock Mechanics Association
Engineers Club of Minneapolis
International Association for Boundary Element Methods
International Society for Rock Mechanics
Minnesota Surveyors and Engineers Society

Publications

1. Crouch, S. L. 1967. Laboratory experiments and mine design. In *28th Annual Mining Symposium*, E. P. Pfleider and F. E. Berger (eds), 15-20. Minneapolis: University of Minnesota.
2. Crouch, S. L. and C. Fairhurst 1967. A four component borehole deformation gauge for determination of *in situ* stresses in rock masses. *Int. J. Rock Mech. Min. Sci.* **4**, 209–217.
3. Crouch, S. L. 1969. A note on the stress concentrations at the bottom of a flat-ended borehole. *J. S. Afr. Inst. Min. Metall.* **70**(5), 100–102.
4. Crouch, S. L. 1970. Experimental determination of volumetric strains in failed rock. *Int. J. Rock Mech. Min. Sci.* **7**, 589–603.
5. Crouch, S. L. 1972. The post-failure behavior of norite in triaxial compression. *Eng. Geol.* **6**(1), 19–30.
6. Crouch, S. L. 1972. A note on stress-strain path dependence in norite. *Int. J. Rock Mech. Min. Sci.* **9**, 197–204.
7. Hudson, J. A., S. L. Crouch and C. Fairhurst 1972. Soft, stiff and servo-controlled testing machines: a review with reference to rock failure. *Eng. Geol.* **6**(3), 155–189.
8. Crouch, S. L. 1973. Two-dimensional analysis of near-surface, single seam extraction. *Int. J. Rock Mech. Min. Sci.* **10**, 85–96.
9. Starfield, A. M. and S. L. Crouch 1973. Elastic analysis of single seam extraction. In *New Horizons in Rock Mechanics*, H. R. Hardy, Jr. and R. Stefanko (eds), 421–439. New York: Am. Soc. Civil Engrs.
10. Crouch, S. L. 1974. Analysis of rockbursts in cut-and-fill stopes. *Trans. Soc. Min. Engrs A.I.M.E.* **256**, 298–303.

11. Crouch, S. L. and C. Fairhurst 1974. Mechanics of coal mine bumps. *Trans. Soc. Min. Engrs A.I.M.E.* **256**, 317–323.
12. Hardy, M. P., S. L. Crouch, C. Fairhurst and K. P. Sinha 1974. A hybrid computer system for simulating inelastic seam behavior. *Proceedings Third Congress I.S.R.M.* (Denver, Colorado), **II-B**, 1015–1021.
13. Crouch, S. L. and C. Fairhurst 1974. Analysis of rock mass deformations due to excavations. In *Rock Mechanics Symposium*, D. L. Sikarskie (ed.), 25–40. New York: Am. Soc. Mech. Engrs.
14. Crouch, S. L. 1976. Solution of plane elasticity problems by the displacement discontinuity method, Part I: Infinite body solution. *Int. J. Num. Methods Engng* **10**, 301–318.
15. Crouch, S. L. 1976. Solution of plane elasticity problems by the displacement discontinuity method, Part II: Semi-infinite body solution. *Int. J. Num. Methods Engng* **10**, 319–343.
16. Board, M. P. and S. L. Crouch 1977. Mine planning to control rockbursts in cut and fill excavations. In *Design Methods in Rock Mechanics*, C. Fairhurst and S. L. Crouch (eds), 249–255. New York: Am. Soc. Civil Engrs.
17. Crouch, S. L. 1979. Computer simulation of mining in faulted ground. *J. S. Afr. Inst. Min. Metall.* **79**, 159–173.
18. Wang, Y.-J. and S. L. Crouch 1982. Boundary element methods for viscoelastic media. In *Issues in Rock Mechanics*, R. E. Goodman and F. Heuze (eds), 704–711. New York: Am. Inst. Min. Engrs.
19. Crouch, S. L. and A. M. Starfield 1983. *Boundary Element Methods in Solid Mechanics*. 322 pp. London: Unwin Hyman; Russian translation 1987; reprinted in paperback 1990.
20. Petersen, D. L. and S. L. Crouch 1986. A coupled boundary element-finite element method. *Byte* **11**(7), 219–230.
21. Sharp, S. and S. L. Crouch 1986. Boundary integral methods for thermoelasticity problems. *J. Appl. Mech.* **53**, 298–302.
22. Sharp, S. and S. L. Crouch 1987. Heat conduction, thermoelasticity and consolidation. In *Boundary Element Methods in Mechanics*, D. E. Beskos (ed.), 439–498. Amsterdam: Elsevier.
23. Crouch, S. L. and Y. Tian 1988. A two-dimensional direct boundary integral method for elastodynamics. *Int. J. Rock Mech. Min. Sci. & Geomech. Abstr.* **25**(3), 149–158.
24. Mack, M. G. and S. L. Crouch 1988. A dynamic boundary element method for modeling rockbursts. In *Rockbursts and Seismicity in Mines*, C. Fairhurst (ed.), 93–99. Rotterdam: Balkema.
25. Tian, Y., M. C. Loken and S. L. Crouch 1990. Elastodynamic simulation of mining. In *Static and Dynamic Considerations in Rock Engineering*, R. Brummer (ed.), 329–337. Rotterdam: Balkema.
26. Mack, M. G. and S. L. Crouch 1991. The three-dimensional dynamic displacement discontinuity method. In *Boundary Elements XIII*, C. A. Brebbia and G. S. Gipson (eds). Southampton: Computational Mechanics Publications.
27. Mack, M. G. and S. L. Crouch 1991. Mining applications of an elastodynamic boundary element method. In *Proceedings 32nd U.S. Rock Mechanics Symposium*, J.-C. Roegiers (ed.), 617–626. Rotterdam: Balkema.

28. Crouch, S. L. and S. Selcuk 1992. A two-dimensional direct boundary integral method for multilayered elastic media. *Int. J. Rock Mech. Min. Sci. & Geomech. Abstr.* **29**(5), 491–501.
29. Selcuk, S. and S. L. Crouch 1992. A direct boundary integral method for multilayered rock with fractures. In *Proceedings 33rd U.S. Rock Mechanics Symposium*, J. R. Tillerson and W. R. Wawersik (eds) , 629–638. Rotterdam: Balkema.
30. E. Siebrits, Y. Tian and S. L. Crouch 1992. Two-dimensional elastodynamic boundary element methods with mining applications. In *Boundary Elements XIV*, C. A. Brebbia, J. Dominguez, and F. Paris (eds), 90–104. Southampton: Computational Mechanics Publications.
31. Siebrits, E. and S. L. Crouch 1993. Geotechnical applications of a two-dimensional elastodynamic displacement discontinuity method. *Int. J. Rock Mech. Min. Sci. & Geomech Abstr.* **30**(7), 1387–1393.
32. Selcuk, S., D. S. Hurd, S. L. Crouch and W.W. Gerberich 1994. Prediction of interfacial crack path: a direct boundary integral approach and experimental study. *Int. J. Fracture* **67**, 1–20.
33. Siebrits, E. and S. L. Crouch 1994. A two-dimensional elastodynamic displacement discontinuity method. *Int. J. Num. Methods Engng* **37**, 3229–3250.
34. Shou, K.-J. and S. L. Crouch 1995. A higher order displacement discontinuity method for analysis of crack problems. *Int. J. Rock Mech. Min. Sci. & Geomech. Abstr.* **32**(1), 49–55.
35. Shou, K.-J., E. Siebrits and S. L. Crouch 1997. A higher order displacement discontinuity method for three-dimensional elastostatics problems. *Int. J. Rock Mech. Min. Sci. & Geomech. Abstr.* **34**(2), 317–322.
36. Siebrits, E., B. Birgisson, A. P. Peirce and S. L. Crouch 1997. On the numerical stability of time domain boundary element methods. *Quarterly Journal of Fragmentation and Blasting*, **1**(3), 305–316.
37. Birgisson, B. and S. L. Crouch 1998. An elastodynamic boundary element method for piecewise homogeneous media. *Int. J. Num. Methods Engng*. **42**, 1042–1069.
38. Mogilevskaya, S. G. and S. L. Crouch 2001. A Galerkin boundary integral method for multiple circular elastic inclusions. *Int. J. Num. Methods Engng*. **52**, 1069–1106.
39. Wang, J., S. G. Mogilevskaya and S. L. Crouch 2001. A Galerkin boundary integral method for nonhomogeneous materials with cracks. In *Proceedings 38th Rock Mechanics Symposium*, D. Elsworth, J. P. Tinucci and K. A. Heasley (eds), 1453–1460. Rotterdam: Balkema.
40. Mogilevskaya, S. G., S. L. Crouch and J. Wang 2001. A Galerkin boundary integral method for an elastic plane with multiple inclusions, holes and cracks. In *Advances in Boundary Element Techniques II*, M. Denda, M. H. Aliabadi and A. Charafi (eds), 509–518. Geneva: Hoggar.
41. Wang, J., S. G. Mogilevskaya and S. L. Crouch 2001. Numerical implementation of a Galerkin boundary integral method for elastic materials with inclusions and holes. In *Advances in Boundary Element Techniques II*, M. Denda, M. H. Aliabadi and A. Charafi (eds), 519–526. Geneva: Hoggar.
42. Mogilevskaya, S. G. and S. L. Crouch 2002. A Galerkin boundary integral method for multiple circular elastic inclusions with homogeneously imperfect interfaces. *International Journal of Solids and Structures* **39**, 4723–4746.

43. Wang, J., S. L. Crouch, and S. G. Mogilevskaya 2003. A numerical procedure for multiple circular holes and elastic inclusions in a finite domain with a circular boundary. *Computational Mechanics* **32**, 250–258.
44. Crouch, S. L. and S. G. Mogilevskaya 2003. On the use of Somigliana's formula and Fourier series for elasticity problems with circular boundaries. *Int. J. Num. Methods Engng*. **58**(4), 537–578.
45. Wang, J., S. L. Crouch, and S. G. Mogilevskaya 2003. A complex boundary integral method for multiple circular holes in an elastic plane. *Engineering Analysis with Boundary Elements* **27**(8), 789–802.
46. Wang, J., S. L. Crouch, and S. G. Mogilevskaya 2003. Benchmark results for the problem of interaction between a crack and a circular inclusion. *J. Appl. Mech*. **70**(4), 619–621.
47. Bunger, A. P. and S. L. Crouch 2003. Investigation of two-dimensional crack growth in compression using moiré interferometry. In *Soil Rock America 2003*, P. J. Culligan, H. H. Einstein, and A. J. Whittle (eds), 945–951. Essen: Verlag Gluckauf.
48. Mogilevskaya, S. G. and S. L. Crouch 2004. A Galerkin boundary integral method for multiple circular elastic inclusions with uniform interphase layers. *Int. J. Solids Struct*. **41**, 1285–1311.
49. Legros, B., S. G. Mogilevskaya, and S. L. Crouch 2004. A boundary integral method for multiple circular inclusions in an elastic half-plane. *Engineering Analysis with Boundary Elements* **28**(9), 1083–1098.
50. Crouch, S. L. and S. G. Mogilevskaya 2004. Loosening of elastic inclusions. *International Journal of Solids and Structures* **43**, 1638–1668.
51. Wang, J., S. L. Crouch, and S. G. Mogilevskaya 2005. An embedding method for circular inhomogeneities in a finite convex domain. *International Journal of Solids and Structures* **42**, 4588–4612.
52. Huang, Y., S. L. Crouch, and S. G. Mogilevskaya 2005. A time domain direct boundary integral method for a viscoelastic plane with circular holes and elastic inclusions. *Engineering Analysis with Boundary Elements* **29**, 725–737.
53. Huang, Y., S. L. Crouch, and S. G. Mogilevskaya 2005. Direct boundary integral procedure for a Boltzmann viscoelastic plane with circular holes and elastic inclusions. *Computational Mechanics* **37**, 110–118.
54. Sadraie, H. R. and S. L. Crouch 2005. A spectral alternating method for elastostatic problems with multiple spherical cavities. *Computational Mechanics* **37**, 60–69.
55. Wang, J., S. L. Crouch, and S. G. Mogilevskaya 2005. A fast and accurate algorithm for a Galerkin boundary integral method. *Computational Mechanics* **37**, 96–109.
56. Dejoie A., S. G. Mogilevskaya, and S. L. Crouch 2006. A boundary integral method for multiple circular holes in an elastic half-plane. *Engineering Analysis with Boundary Elements* **30**, 450–464.
57. Huang, Y., S. G. Mogilevskaya, and S. L. Crouch 2006. Semi-analytical solution for a viscoelastic plane containing multiple circular holes. *Journal of Mechanics of Materials and Structures* **1**, 471–501.
58. Wang, J., S. L. Crouch, and S. G. Mogilevskaya 2006. Numerical modeling of the elastic behavior of fiber-reinforced composites with radially graded interphases. *Composite Sciences and Technology* **66**, 1–18.

59. Huang, Y., S. G. Mogilevskaya, and S. L. Crouch 2006. Complex variable boundary integral method for linear viscoelasticity. Part I-basic formulations. *Engineering Analysis with Boundary Elements* **30**, 1049–1056.
60. Huang, Y., S. G. Mogilevskaya and S. L. Crouch 2006. Complex variable boundary integral method for linear viscoelasticity. Part II-application to problems involving circular boundaries. *Engineering Analysis with Boundary Elements* **30**, 1057–1068.
61. Mogilevskaya, S. G., J. Wang, and S. L. Crouch 2007. Numerical evaluation of the effective elastic moduli of rocks. *International Journal of Rock Mechanics and Mining Sciences* **44**, 425–436.
62. Sadraie, H. R., S. L. Crouch, and S. G. Mogilevskaya 2007. A boundary spectral method for elastostatics problems with multiple spherical cavities and inclusions. *Engineering Analysis with Boundary Elements* **31**, 425–442.
63. Mogilevskaya, S. G. and S. L. Crouch 2007. On the use of Somigliana's formula and series of surface spherical harmonics for elasticity problems with spherical boundaries. *Engineering Analysis with Boundary Elements* **31**, 116–132.
64. Huang, Y., S. G. Mogilevskaya, and S.L. Crouch 2008. Numerical modeling of micro- and macro-behavior of viscoelastic porous materials. *Computational Mechanics* **41**, 797–816.
65. Gordeliy, E., S. L. Crouch, and S. G. Mogilevskaya 2008. Transient heat conduction in a medium with two circular cavities: Semi-analytical solution. *International Journal of Heat and Mass Transfer* **51**, 3556–3570.
66. Wang, J. and S. L. Crouch 2008. An iterative algorithm for modeling crack closure and sliding. *Engineering Fracture Mechanics* **75**, 128–135.
67. Mogilevskaya, S. G., S. L. Crouch, and H. K. Stolarski. Multiple interacting circular nano-inhomogeneities with surface/interface effects. *Journal of the Mechanics and Physics of Solids* **56**, 2928–2327.
68. Gordeliy, E., S. L. Crouch, and S. G. Mogilevskaya 2009. Transient heat conduction in a medium with multiple spherical cavities. *International Journal for Numerical Methods in Engineering* **77**(6), 751–775.
69. Gordeliy, E., S. L. Crouch, and S. G. Mogilevskaya 2009. Transient heat conduction in a medium with multiple circular cavities and inhomogeneities. *International Journal for Numerical Methods in Engineering* **80**, 1437–1462.
70. Gordeliy, E., S. G. Mogilevskaya, and S. L. Crouch 2009. Transient thermal stresses in a medium with a circular cavity with surface effects. *International Journal of Solids and Structures* **46**, 1834–1848.
71. Brusselaars, N., S. G. Mogilevskaya, and S. L. Crouch 2009. A Semi-analytical solution for multiple circular inhomogeneities in one of two joined isotropic elastic half-planes. *Engineering Analysis with Boundary Elements* **33**, 233–248.
72. Mogilevskaya, S. G., S. L. Crouch, R. Ballarini, and H. K. Stolarski 2009. Interaction between a crack and a circular inhomogeneity with surface stiffness and tension. *International Journal of Fracture* **159**, 191–207.
73. Jammes, M., S. G. Mogilevskaya, and S. L. Crouch 2009. Multiple circular nano-inhomogeneities and/or nano-pores in one of two joined isotropic elastic half-planes. *Engineering Analysis with Boundary Elements* **33**, 233-248.

74. Mogilevskaya, S. G., S. L. Crouch, A. La Grotta, and H. K. Stolarski 2010. The effects of surface elasticity and surface tension on the transverse overall behavior of uni-directional nano-composites. *Composites Science and Technology* **70**, 427–434.
75. Mogilevskaya, S. G., S. L. Crouch, H. K. Stolarski, and A. Benusiglio 2010. Equivalent inhomogeneity method for evaluating the effective properties of multi-phase composites. *International Journal of Solids and Structures* **47**, 407–418.
76. Koroteeva, O., S. G. Mogilevskaya, S. L. Crouch, and E. Gordeliy 2010. A computational technique for evaluating the effective thermal conductivity of isotropic porous materials. *Engineering Analysis with Boundary Elements* **34**,793-801.
77. Mogilevskaya, S. G., A. V. Pyatigorets, and S. L. Crouch 2011. Green function for the problem of a plane containing a circular hole with surface effects. *Journal of Applied Mechanics* **78**, 021008-1-9.
78. Mogilevskaya, S. G., V. I. Kushch, O. Koroteeva, and S. L. Crouch 2011. Equivalent inhomogeneity method for evaluating the effective conductivities of isotropic particulate composites. *Journal of Mechanics of Materials and Structures*. Accepted.
79. Kushch, V. I., S. G. Mogilevskaya, H. K. Stolarski, and S. L. Crouch 2011. Elastic interaction of spherical nanoinhomogeneities with Gurtin-Murdoch type interfaces. *Journal of the Mechanics and Physics of Solids*. Submitted.
80. Mogilevskaya, S. G., H. K. Stolarski, and S. L. Crouch 2011. On Maxwell's concept of equivalent inhomogeneity: when do interactions matter? *Journal of the Mechanics and Physics of Solids*. Accepted.
81. Mogilevskaya, S.G., and S. L. Crouch 2011. Extension of Maxwell's methodology for evaluating the effective properties of composite and micro-cracked materials. *Computational Mechanics*. Submitted.

Ph.D. Theses Supervised or Co-supervised

1. Van Eeckhout, E. 1974. The Effect of Moisture on the Mechanical Properties of Coal Mine Shales.
2. Sinha, K. P. 1979. Displacement Discontinuity Technique for Analyzing Stresses and Displacements due to Mining in Seam Deposits.
3. Callahan, G. 1982. A Plasticity Approach for Rock Containing Planes of Weakness.
4. Sharp, S. 1982. Boundary Element Methods in Quasi-Static Thermoelasticity with Applications in Rock Mechanics.
5. Wang, Y.-J. 1983. Numerical Model for Computing Time-Dependent Displacements and Stresses in Rock Mechanics.
6. Lindner, E. 1983. A Constitutive and Experimental Investigation of Load-history Influences on the Creep Behavior of Salt.
7. Tian, Y. 1990. Boundary Element Methods in Elastodynamics.
8. Mack, M. G. 1991. A Three-Dimensional Boundary Element Method for Elastodynamics.
9. Petersen, D. L. 1991. A Hybrid Numerical Model for Seam and Vein Mining Problems.
10. Loken, M. C. 1992. A Three-Dimensional Boundary Element Method for Linear Elastodynamics.
11. Siebrits, E. 1992. Two-Dimensional Time Domain Elastodynamic Displacement Discontinuity Method with Mining Applications.

12. Selcuk, S. 1992. A Higher-Order Direct Boundary Integral-Displacement Discontinuity Method for Fracture Propagation in Layered Elastic Media.
13. Shou, K.-J. 1993. A Higher Order Three-Dimensional Displacement Discontinuity Method with Application to Bonded Half-Space Problems.
14. Board, M. P. 1994. Numerical Examination of Mining-Induced Seismicity. [Awarded the 1996 Rocha Medal for outstanding Ph.D. research by the International Society for Rock Mechanics.]
15. Birgisson, B. 1996. A Two-Dimensional Dynamic Direct Boundary Element Method for Piecewise Homogeneous Elastic Media.
16. Cheng, L. 1996. Numerical Modeling of Indentation and Scratch Problems.
17. Carvalho, F. C. S. 1999. Characterizing Brittle Failure Through Quantitative Acoustic Emission (co-adviser with J. F. Labuz).
18. Savitski, A. A. 2000. Propagation of a Penny-Shaped Hydraulic Fracture in an Impermeable Rock (co-adviser with E. Detournay).
19. Wang, J. 2004. Numerical Modeling of Elastic Materials with Inclusions, Holes, and Cracks (co-adviser with S. G. Mogilevskaya).
20. Bunger, A. 2005. Near-Surface Hydraulic Fracture (co-adviser with E. Detournay).
21. Huang, Y. 2006. Computational Modeling of Viscoelastic Composite and Porous Materials (co-adviser with S. G. Mogilevskaya).
22. Sadraie, H. 2006. A Boundary Spectral Method for Elasticity Problems with Spherical Inhomogeneities (co-adviser with S. G. Mogilevskaya).
23. Gordeliy, E. 2008. Numerical Modeling of Transient Heat Conduction and Transient Thermoelasticity in Heterogeneous Media (co-adviser with S. G. Mogilevskaya).