

CHRIS A. WRIGHT

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Academic Qualification

Massachusetts Institute of Technology – BS, Mechanical Engineering 1982-1985

- Graduated in 3 Years
- Undergraduate Thesis: Distributed Piezoelectric Sensor and Actuator for Continuous Vibration Control

Massachusetts Institute of Technology/ University of California Berkeley –
Graduate work, Electrical Engineering September 1985- December 1987

- Focus on semi-conductor device physics and power electronics
- Thesis research published as: A 1 kW, 500 kHz Front-End Converter for a Distributed Power Supply System

Professional Qualification

Liberty Oilfield Services, Chief Executive Officer 2011- Present

- Executive leadership over technical innovation, operations, financial and strategic direction of company
- Oversight of 2500 employees

Liberty Resources, Chief Executive Officer 2010-2018

- Liberty Resources is a Bakken-based oil and gas production company

Stroud Energy, co-Founder & Chairman 2000-2006

- Pioneering shale gas producer in the Texas Barnett Shale

Pinnacle Technologies, Founder & Chief Executive Officer 1992-2006

- Pinnacle Technologies created the hydraulic fracture mapping industry by developing and commercializing tiltmeter, micro-seismic fracture, and fiber-optic technologies for mapping / monitoring underground fluid flow
- These technologies helped launch commercial shale gas production in the late 1990's

Resources Engineering Systems, Project Manager 1989-1992

- Led the development and the commercialization of FracPro, the world's most widely used hydraulic fracture modeling system
- Developed models of the simultaneous growth of underground fractures for applications in geothermal power and oil & gas

Hunter Geophysics, Design Engineer 1985-1989

- Designed charging circuits for solar panels to remotely and continuously power electronic monitoring equipment
- Designed next generation tiltmeter instrumentation
- Developed geophysical inversion software to map hydraulic fractures

Director Positions

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| Liberty Resources , <i>Chairman</i> | 2010-Present |
| Liberty Midstream Services , <i>Chairman</i> | 2015- Present |
| Urban Solutions Group , <i>Director</i> | 2018-Present |
| Kerogen Exploration , <i>Director</i> | 2013- 2017 |
| TAS , <i>Director</i> | 2007- 2017 |

Non-Profit Director Positions

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| ACE Scholarships Colorado , <i>Board of Trustees (Co-Chairman 2017-present)</i> | 2011-Present |
| Property and Environment Research Center (PERC) , <i>Director</i> | 2008-2014, 2018-Present |
| Pacific Research Institute (PRI) , <i>Director</i> | 2009-Present |
| ACE Scholarships Montana , <i>Director</i> | 2015-Present |
| Colorado Academy , <i>Director</i> | 2012-2014 |
| Yellowstone Club Community Foundation (YCCF) , <i>Director</i> | 2009-2017 |
| Foundation for Teaching Economics (FTE) , <i>Director</i> | 2006-2010 |

Notable Speaking Engagements

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|---|---------------|
| UK House of Lords | February 2015 |
| 1A Across America , <i>NPR</i> | March 2019 |
| State and Federal Judges , <i>George Mason University Law School</i> | 2014 |
| National Association of Attorney Generals , <i>Anchorage, Alaska</i> | 2013 |

Publications

L.H. Mweene, C.A. Wright, M.F. Schlecht: A 1 kW, 500 kHz Front-End Converter for a Distributed Power Supply System, Laboratory for Electromagnetic and Electronic Systems, Massachusetts Institute of Technology, Applied Power Electronics Conference and Exposition, 1989.

M.P. Cleary, C.A. Wright, T.B. Wright: Experimental and Modeling Evidence for Major Changes in Hydraulic Fracturing Design and Field Procedures, SPE Gas Technology Symposium, Houston, Texas, Jan 22-24, 1991.

L. Weijers, C.J. de Pater, K.A. Owens, H.H. Kogsbøll: Geometry of Hydraulic Fractures Induced from Horizontal Wellbores, European Petroleum Conference, Cannes, France, Nov 16-18, 1992.

D.E. Johnson, C.A. Wright, A. Satchel, H. Schmidt, M.P. Cleary: On-Site Real-Time Analysis Allows Optimal Propped Fracture Stimulation of a Complex Gas Reservoir, SPE Production Operations Symposium, Oklahoma City, Oklahoma, March 21-23, 1993.

A.D. Martinez, C.A. Wright, T.B. Wright: Field Application of Real-Time Hydraulic Fracturing Analysis, Low Permeability Reservoirs Symposium, Denver, Colorado, April 26-28, 1993.

C.A. Wright, D.W. Stewart, M.A. Emanuele, W.W. Wright: Reorientation of Propped Refracture Treatments in the Lost Hills Field, SPE Western Regional Meeting, Long Beach, California, March 23-25, 1994.

C.A. Wright, R.A. Conant, D.W. Stewart, P.M. Byerly: Reorientation of Propped Refracture Treatments, Rock Mechanics in Petroleum Engineering, Delft, Netherlands, Aug 29-31, 1994.

J.E. Schemeta, W.B. Minner, R.G. Hickman, P.A. Johnston, C.A. Wright, N. Watchi: Geophysical Monitoring During a Hydraulic Fracture in a Fractured Reservoir: Tiltmeter and Passive Seismic Results, Rock Mechanics in Petroleum Engineering, Delft, Netherlands, Aug 29-31, 1994.

C.A. Wright, R.A. Conant, G. M. Golich, P.L. Bonder, A.S. Murer, C.A. Dobie: Hydraulic Fracture Orientation and Production/Injection Induced Reservoir Stress Changes in Diatomite Waterfloods, SPE Western Regional Meeting, March 8-10, Bakersfield, California, 1995.

C.A. Wright, J.J. Tanigawa, M. Shixin, L. Zhigang: Enhanced Hydraulic Fracture Technology for a Coal Seam Reservoir in Central China, International Meeting on Petroleum Engineering, Beijing, China, Nov 14-17, 1995.

C.A. Wright, R.A. Conant: Hydraulic Fracture Reorientation in Primary and Secondary Recovery from Low-Permeability Reservoirs, SPE Annual Technical Conference and Exhibition, Dallas, Texas, Oct 22-25, 1995.

C.A. Wright, L. Weijers, W.A. Minner, D.M. Snow: Robust Technique for Real-Time Closure Stress Determination, SPE Production & Facilities, Aug, 1996.

W.A. Minner, C.A. Wright, C.A. Dobie: Treatment Diagnostics and Net Pressure Analysis Assist with Fracture Strategy Evaluation in the Belridge Diatomite, Western Regional Meeting, Anchorage, Alaska, May 22-24, 1996.

C.J. de Pater, M.D. Zoback, C.A. Wright, B. Engeser: Complications with Stress Tests - Insights from a Fracture Experiment in the Ultra-deep KTB Borehole, SPE Annual Technical Conference and Exhibition, Denver, Colorado, Oct 6-9, 1996.

C.A. Wright, L. Weijers, G.A. Germani, K.H. Maclvor, M.K. Wilson, B.A. Whitman: Fracture Treatment Design and Evaluation in the Pakenham Field: A Read-Data Approach, SPE Annual Technical Conference and Exhibition, Denver, Colorado, Oct 6-9, 1996.

N. Arihara, M. Abbaszadeh, C.A. Wright, M. Hyodo: Integration of Fracturing Dynamics and Pressure Transient Analysis for Hydraulic Fracture Evaluation, SPE Annual Technical Conference and Exhibition, Denver, Colorado, Oct 6-9, 1996.

C.A. Wright, E.J. Davis, L. Weijers, W.A. Minner, C.M. Hennigan, G.M. Golich: Horizontal Hydraulic Fractures: Oddball Occurrences or Practical Engineering Concern?, SPE Western Regional Meeting, Long Beach, California, June 23-27, 1997.

W.A. Minner, G.R. Molesworth, C.A. Wright, W.D. Wood: Real-Data Fracture Analysis Enables Successful Hydraulic Fracturing in the Point of Rocks Formation, Kern County, California, SPE Western Regional Meeting, Long Beach, California, June 23-27, 1997.

C.A. Wright, W.A. Minner, L. Weijers, E.J. Davis, G.M. Golich, H. Kikuchi: Wellbore-to-Fracture Communication Problems Pose Challenges in California Diatomite Horizontal Wells, SPE Annual Conference and Exhibition, San Antonio, Texas, Oct 5-8, 1997.

K. Sato, C.A. Wright, M. Ichikawa: Post-Frac Analyses Indicating Multiple Fractures Created in a Volcanic Formation, SPE India Oil and Gas Conference and Exhibition, New Delhi, India, Feb 17-19, 1998.

C.A. Wright, E.J. Davis, W.A. Minner, J.F. Ward, L. Weijers, E.J. Schell, S.P. Hunter: Surface Tiltmeter Fracture Mapping Reaches New Depths -- 10,000 Feet, and Beyond?, SPE Rocky Mountain Regional/Low-Permeability Reservoirs Symposium, Denver, Colorado, April 5-8, 1998.

C.A. Wright, E.J. Davis, G.M. Golich, J.F. Ward, S.L. Demetrius, W.A. Minner, L. Weijers: Downhole Tiltmeter Fracture Mapping: Finally Measuring Hydraulic Fracture Dimensions, SPE Western Regional Meeting, Bakersfield, California, May 10-13, 1998.

C.A. Wright, L. Weijers, W.A. Minner: On-Site Rate Stepdown Test Analysis Diagnoses Potential Hydraulic Fracturing Problems and Improves Fracture Treatment Success, SPE Western Regional Meeting, Bakersfield, California, May 10-13, 1998.

C.A. Wright, E.J. Davis, L. Weijers, G.M. Golich, J.F. Ward, S.L. Demetrius, W.A. Minner: Downhole Tiltmeter Fracture Mapping: A New Tool for Directly Measuring Hydraulic Fracture Dimensions, SPE Annual Technical Conference and Exhibition, New Orleans, Sept 27-30, 1998.

L. Weijers, C.A. Wright, S.L. Demetrius, G. Wang, E.J. Davis, M.A. Emanuele, J.B. Broussard, G.M. Golich: Fracture Growth and Reorientation in Steam Injection Wells, International Thermal Operations and Heavy Oil Symposium, Bakersfield, California, March 17-21, 1999.

C.A. Wright, L. Weijers, E.J. Davis, M. Mayerhofer: Understanding Hydraulic Fracture Growth: Tricky but not Hopeless, SPE Annual Technical Conference and Exhibition, Houston, Texas, Oct 3-6, 1999.

K. Sato, C.A. Wright, M. Ichikawa: Post-Frac Analyses Indicating Multiple Fractures Created in a Volcanic Formation, SPE Production & Facilities, Nov, 1999.

Z. Moschovidis, R. Steiger, R. Peterson, N. Warpinski, C.A. Wright, E. Chesney, A. Abou-Sayed, R. Keck, M. Frankl, C. Fleming, S. Wolhart, B. McDaniel, A. Sinor, S. Ottesen, L. Miller, R. Beecher, J. Dudley, D. Zinno, O. Akhmedov: The Mounds Drill-Cuttings Injection Field Experiment: Final Results and Conclusions, IADC/SPE Drilling Conference, New Orleans, Louisiana, Feb 23-25, 2000.

L.G. Griffin, C.A. Wright, S.L. Demetrius, B.D. Blackburn, D.G. Price: Identification and Implications of Induced Hydraulic Fractures in Waterfloods: Case History HGEU, SPE Permian Basin Oil and Gas Recovery Conference, Midland, Texas, March 21-23, 2000.

C.L. Cipolla, C.A. Wright: Diagnostic Techniquet to Understand Hydraulic Fracturing: What? Why? And How?, SPE/CERI Gas Technology Symposium, Calgary, Alberta, Canada, April 3-5, 2000.

L. Weijers, C.A. Wright, W.A. Minner, G. Molesworth, P. Huckabee, G. Roberts: The Rate Step-Down Test: A Simple Real-Time Procedure to Diagnose Potential Hydraulic Fracture Treatment Problems, SPE Western Regional Conference, Long Beach, California, 2000.

E. Davis, C.A. Wright, S. Demetrius, J. Choi, G. Craley: Precise Tiltmeter Subsidence Monitoring Enhances Reservoir Management, SPE/AAPG Western Regional Meeting, Long Beach, California, June 19-23, 2000.

E. Siebrits, J.L. Elbel, R.S. Hooper, I.R. Diyashev, L.G. Griffin, S.L. Demetrius, C.A. Wright, B.M. Davidson, N.P. Steinsberger, D.G. Hill: Refracture Reorientation Enhances Gas Production in Barnett Shale Tight Gas Wells, SPE Annual Conference and Exhibition, Dallas, Texas, Oct 1-4, 2000.

L.G. Griffin, C.A. Wright, E.J. Davis, S.L. Wolhart, Z.A. Moschovidis: Surface and Downhole Tiltmeter Mapping: An Effective Tool for Monitoring Downhole Drill Cuttings Disposal, SPE Annual Technical Conference and Exhibition, Dallas, Texas, Oct 1-4, 2000.

C.L. Cipolla, C.A. Wright: State-of-the-Art in Hydraulic Fracture Diagnostics, SPE Asia Pacific Oil and Gas Conference and Exhibition, Brisbane, Australia, Oct 16-18, 2000.

L. Weijers, C.A. Wright, H. Sugiyama, K. Sato, L. Zhigang: Simultaneous Propagation of Multiple Hydraulic Fractures-- Evidence, Impact and Modeling Implications, International Oil and Gas Conference and Exhibition, Beijing, China, Nov 7-10, 2000.

C.A. Wright, E.J. Davis, J.F. Ward, L.G. Griffin, M.K. Fisher, L.V. Lehman, D.D. Fulton, J. Podowski, W.V. Frieser, J.F. Special: Real-Time Fracture Mapping from the "Live" Treatment Well, SPE Annual Technical Conference and Exhibition, New Orleans, Louisiana, Sept 30-Oct 3, 2001.

N.R. Warpinski, S.L. Wolhart, C.A. Wright: Analysis and Prediction of Microseismicity Induced by Hydraulic Fracturing, SPE Annual Technical Conference and Exhibition, New Orleans, Louisiana, Sept 30-Oct 3, 2001.

C.L. Cipolla, C.A. Wright: Diagnostic Techniques to Understand Hydraulic FracturingL What? Why? And How?, SPE Production & Facilities, Feb, 2002.

M.K. Fisher, C.A. Wright, B.M. Davidson, A.K. Goodwin, E.O. Fielder, W.S. Buckler, N.P. Steinsberger: Integrating Fracture Mapping Technologies to Optimize Stimulations in the Barnett Shale, SPE Annual Technical Conference and Exhibition, San Antonio, Texas, Sept 29-Oct 2, 2002.

W.A. Minner, C.A. Wright, G.R. Stanley, C.J. de Pater, T.L. Gorham, L.D. Eckerfield, K.A. Hejl: Waterflood and Production-Induced Stress Changes Dramatically Affect Hydraulic Fracture Behavior in Lost Hills Infill Wells, SPE Annual Technical Conference and Exhibition, San Antonio, Texas, Sept 29-Oct 2, 2002.

L. Weijers, L.G. Griffin, H. Sugiyama, T. Shimamoto, S. Takada, K.K. Chong, J.M. Terracina, C.A. Wright: The First Successful Fracture Treatment Campaign Conducted in Japan: Stimulation Challenges in a Deep, Naturally Fractured Volcanic Rock, SPE Annual Technical Conference and Exhibition, San Antonio, Texas, Sept 29-Oct 2, 2002.

L. Weijers, L.G. Griffin, H. Sugiyama, T. Shimamoto, S. Takada, K.K. Chong, J.M. Terracina, B.W. McDaniel, C.A. Wright: Hydraulic Fracturing in a Deep, Naturally Fractured Volcanic Rock in Japan -- Design Considerations and Execution Results, Asia Pacific Oil & Gas Conference and Exhibition, Melbourne, Australia, Oct 8-10, 2002.

L.V. Lehman, L. Weijers, M. Mayerhofer, C.A. Wright, K. Fisher, E. Davis, D. Fulton: Calibrating Fracture Models with Direct Diagnostics: A Necessary but Humbling Experience, Asia Pacific Oil & Gas Conference and Exhibition, Melbourne, Australia, Oct 8-10, 2002.

W.A. Minner, J. Du, B.L. Gangong, C.B. Lackey, S.L. Demetrius, C.A. Wright: Rose Field: Surface Tilt Mapping Shows Complex Fracture Growth in 2500' Laterals Completed with Uncemented Liners, SPE Western Regional/AAPG Pacific Section Joint Meeting, Long Beach, California, May 19-24, 2003.

L.G. Griffin, R.B. Sullivan, S.L. Wolhart, C.K. Waltman, C.A. Wright, L. Weijers, N.R. Warpinski: Hydraulic Fracture Mapping of the High-Temperature, High-Pressure Bossier Sands in East Texas, SPE Annual Technical Conference and Exhibition, Denver, Colorado, Oct 5-8, 2003.

M.K. Fisher, J.R. Heinze, C.D. Harris, B.M. Davidson, C.A. Wright, K.P. Dunn: Optimizing Horizontal Completion Techniques in the Barnett Shale Using Microseismic Fracture Mapping, SPE Annual Technical Conference and Exhibition, Houston, Texas, Sept 26-29, 2004.

L. Weijers, C.A. Wright, M.J. Mayerhofer, C.L. Cipolla: Developing Calibrated Fracture Growth Models for Various Formations and Regions Across the United States, SPE Annual Technical Conference and Exhibition, Dallas, Texas, Oct 9-12, 2005.

J. Du, S.J. Brissenden, P. McGillivray, S. Bourne, P. Hofstra, E.J. Davis, W.H. Roadarmel, S.L. Wolhart, C.A. Wright: Mapping Fluid Flow in a Reservoir Using Tiltmeter-Based Surface-Deformation Measurements, SPE Annual Technical Conference and Exhibition, Dallas, Texas, Oct 9-12, 2005.

J. Du, S.J. Brissenden, P. McGillivray, S. Bourne, P. Hofstra, E.J. Davis, W.H. Roadarmel, S.L. Wolhart, S. Marsic, R. Gusek, C.A. Wright: Mapping Reservoir Volume Changes During Cyclic Steam Stimulation Using Tiltmeter-Based Surface-Deformation Measurements, SPE International Thermal Operations and Heavy Oil Symposium, Calgary, Alberta, Canada, Nov 1-3, 2005.

J. Du, S.J. Brissenden, P. McGillivray, S. Bourne, P. Hofstra, E.J. Davis, W.H. Roadarmel, S.L. Wolhart, S. Marsic, R. Gusek, C.A. Wright: Mapping Reservoir Volume Changes During Cyclic Steam Stimulation Using Tiltmeter-Based Surface-Deformation Measurements, SPE Reservoir Evaluation & Engineering, Feb, 2008.

C.A. Wright, L. Weijers: Hydraulic Fracture Reorientation: Does it Occur? Does it Matter?, The Leading Edge, Oct, 2001.

C.M. Pearson, L. Griffin, C.A. Wright, L. Weijers: Breaking Up is Hard to Do: Creating Hydraulic Fracture Complexity in the Bakken Central Basin, SPE Hydraulic Fracturing Technology Conference and Exhibition, The Woodlands, Texas, Feb 4-6, 2013.

C.A. Wright, M. Pearson, L.G. Griffin, L. Weijers, B. Weaver: Two Cs Drive Bakken Well Performance, The American Oil & Gas Reporter, Jan, 2013.

Larry Griffin, C. Mark Pearson, Stacy Strickland, Jeromy McChesney, Chris Wright, Jerrold Mayer, William Coleman, Michael Roth, and Leen Weijers: The Value Proposition for Applying Advanced Completion and Stimulation Designs to the Bakken Central Basin, SPE Annual Technical Conference and Exhibition held in New Orleans, Louisiana, USA, 30 September–2 October 2013, .

Leen Weijers, Chris Wright, Tom Riebel, Jon Wright and Marc Barella: Some Fracs Are More Equal Than Others: Expanding the Use of a Complexity & Conductivity Focused Frac Design in the Williston Basin, SPE Annual Technical Conference and Exhibition held in Amsterdam, The Netherlands, 27–29 October 2014.

Leen Weijers, Chris Wright, Mike Mayerhofer, Mark Pearson, Larry Griffin and Paul Weddle: Trends in the North American Frac Industry: Invention through the Shale Revolution, SPE Hydraulic Fracturing Technology Conference held in The Woodlands, Texas, USA, 5–7 February 2019.