

## **NORMAN E. FARR**

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## **EDUCATION:**

University of Massachusetts, Lowell, MA

B.S.E.E, 1990

## **PROFESSIONAL EXPERIENCE:**

2015-present Principal Engineer, Advanced Engineering Laboratory, Woods Hole Oceanographic Institution, Woods Hole, MA

2003-2015 Senior Engineer, Advanced Engineering Laboratory, Woods Hole Oceanographic Institution, Woods Hole, MA

1993-2003 Principal Engineer and Manager, CardioFocus, Inc., Marlborough, MA

1990-1993 Senior Project Engineer, Fiberspar, Inc., New Bedford, MA

1987-1990 Project Engineer, USCI Division, C.R. Bard, Inc., Lowell, MA

## **PROFESSIONAL AFFILIATIONS:**

Member of the Institute of Electrical and Electronics Engineers (IEEE)

## **RESEARCH INTERESTS:**

Leads the optical communications group at WHOI, which develops high bandwidth undersea communication capabilities and wireless systems for vehicle control, data recovery from seafloor observatories, and data transfer.

Develops underwater imaging and lighting systems for use on low-power vehicles used for scientific research, Navy, and oil and gas applications.

Background is in electrical engineering with 16 years developing medical lasers and fiber optic medical devices; and 10 years in the underwater, free-space communications field. Inventor on numerous medical device and optical communications patents. Founder of a new WHOI spin-off company, Lumasys, which develops and commercializes underwater communication systems for the subsea industry.

## **PROFESSIONAL ACTIVITIES:**

Lab Manager, Advanced Engineering Laboratory, September 2009 – present.  
Supervises 12 engineers.

Member/advocate, Center for Marine Robotics, October 2011 – present.

### **Patents Granted**

US Patent #8540704 (Sept. 24, 2013) – “Guided cardiac ablation catheters.” Melsky, G., J.M. Arnold, E.L. Sinofsky, and **N.E. Farr**.

US Patent #8444639 (May 21, 2013), #8366705 (Feb. 5, 2013), and #8025661 (Sept. 27, 2011) – “Coaxial catheter instruments for ablation with radiant energy.” Arnold, J.M., E.L. Sinofsky, L.S. Baxter, and **N.E. Farr**.

- US Patent #8277444 (Oct. 2, 2012) – “Treatment of atrial fibrillation by overlapping curvilinear lesions.” Arnold, J.M., E.L. Sinofsky, L.S. Baxter, and **N.E. Farr**.
- US Patent #8241272 (Aug. 14, 2012) – “Methods for ablation with radiant energy.” Arnold, J.M., E.L. Sinofsky, L.S. Baxter, and **N.E. Farr**.
- US Patent #8152795 (Apr. 10, 2012) – “Method and device for cardiac tissue ablation.” **Farr, N.E.** and W.E. Wieler.
- US Patent #7953326 (May 31, 2011) – “Systems and methods for underwater optical communication.” **Farr, N.E.**, L. Freitag, J. Preisig, D.R. Yoerger, S.N. White, and A.D. Chave.
- US Patent #7357796 (Apr. 15, 2008), #6953457 (Oct. 11, 2005), and #6423055 (July 23, 2002) – “Phototherapeutic wave guide apparatus.” **Farr, N.E.** and W.E. Weiler.
- US Patent #7207984 (Apr. 24, 2007) – “Methods for projection of energy.” **Farr, N.E.** and W.E. Weiler.
- US Patent #6942657 (Sept. 13, 2005) and #6626900 (Sept. 30, 2003) – “Intraluminal contact sensor.” Sinofsky, E.L. and **N.E. Farr**.
- US Patent #6572609 (June 3, 2003) – “Phototherapeutic wave guide apparatus.” **Farr, N.E.**, W.E. Weiler, L.S. Baxter, J.T. McIntyre, and E.L. Sinofsky.
- US Patent #6558375 (May 6, 2003) – “Cardiac ablation instrument.” Sinofsky, E.L., **N.E. Farr**, and L.S. Baxter.
- US Patent #6102905 (Aug 15, 2000) – “Phototherapy device including housing for an optical element and method of making.” Baxter, L.S., E.L. Sinofsky, and **N. Farr**.
- US Patent #5997571 (Dec. 7, 1999) – “Non-occluding phototherapy probe stabilizers.” **Farr, N.**, L.W. Baxter, and E.L. Sinofsky.
- US Patent #5643253 (July 1, 1997) – “Phototherapy apparatus with integral stopper device.” Baxter, L.S., **N. Farr**, and E.L. Sinofsky.
- US Patent #5275594 (Jan. 4, 1994) – “Angioplasty system having means for identification of atherosclerotic plaque.” Baker, G.S., M.G. Dumong, M. Madden, and **N.E. Farr**.

### **Patent Applications**

- #14/166,650 (Jan. 28, 2014) – “N-wavelength interrogation scheme for low coherence interferometers.” **Farr, N.**, J. Kapit, and R. Schmitt
- #13/952013 (July 26, 2013) – “Guided cardiac ablation catheters.” Melsky, G., J.M. Arnold, E.L. Sinofsky, and **N.E. Farr**.
- #13/940814 (July 12, 2013) – “Marine environment antifouling system and methods.” **Farr, N.E.**, C.T. Pontbriand, and T.G. Peters.
- #13/344430 (Jan. 5, 2012) – “Systems and methods for establishing an underwater optical communication network.” Machado, C., L. Freitag, A. Bowen, and **N.E. Farr**.
- #13/117867 (May 27, 2011) – “Systems and methods for underwater optical communication.” Chave, A.D., **N.E. Farr**, L. Freitag, J. Preisig, D.R. Yoerger, and S.N. White.
- #12/423137 (Apr. 14, 2009) – “System and method for visualizing tissue during ablation procedures.” Sinofsky, E.L., G. Melsky, S.W. Sagon, and **N.E. Farr**.

## **PARTICIPATION IN EDUCATION PROGRAM:**

### **Guest/Summer Students**

Scott Curry, Lab Assistant I  
Nicholas Lineaweaver, Part-time Helper  
Ben Mann, Part-time Helper  
Leo-Paul Pelletier, Foreign Student  
Timothy Peters, Engineering Assistant I  
Miles Ochs, Engineering Assistant III

### **Thesis Committees**

Derya Akkaynak, MIT/WHOI Joint Program  
Anna Michel, MIT/WHOI Joint Program

## **CRUISE PARTICIPATION:**

July 2005: R/V *Thomas Thomson*, NOOTKA mooring recovery; Seattle, WA to Seattle, WA  
September 2005: R/V *Point Sur*, EOM mooring deployment; Moss Landing, CA to Moss Landing, CA  
August 2006: R/V *Tioga*; Optical modem test; Woods Hole, MA to Woods Hole, MA  
September 2006: R/V *Seward Johnson*, Methane Hydrates project, Gulfport, LA to Gulfport, LA  
November 2006: R/V *Point Sur*; EOM mooring recovery; Moss Landing, CA to Moss Landing, CA  
April 2008: R/V *Atlantic Explorer*, Optical modem clear water experiment, Bermuda to Bermuda  
March 2009: R/V *Pelican*, Methane hydrates deployment; Cocodrie, LA to Cocodrie, LA  
June 2009: R/V *Pelican*, Methane hydrates recovery; Cocodrie, LA to Cocodrie, LA  
May 2010: R/V *Connecticut*; CORK test cruise; Woods Hole, MA to Woods Hole, MA  
July 2010: R/V *Atlantis*; CORK installation; Astoria, OR to Astoria, OR  
Sept 2010: R/V *Pelican*, Methane hydrates deployment; Cocodrie, LA to Cocodrie, LA  
June 2011: R/V *Pelican*; Methane hydrates optical modem deployment cruise; Cocodrie, LA to Cocodrie, LA  
August 2011: R/V *Atlantis*; Optical modem and CORK deployment cruise; Astoria, OR to Astoria, OR  
August 2012: R/V *Marcus Langseth*; Optical modem and CORK deployment cruise; Astoria, OR to Astoria, OR  
September 2012: M/V *Alucia*; UTROV demonstration; Tamuning, Guam to Tamuning, Guam  
January 2013: M/V *Alucia*; Optical modem for Triton sub video transmission; Koror, Palau to Koror, Palau  
October 2013: M/V *Barents Ocean*, Optical modem demonstration; Hammerfest, Norway to Hammerfest, Norway  
July 2014: R/V *Atlantis*; Optical modem and CORK deployment cruise; Astoria, OR to Astoria, OR

## PAPERS IN REFEREED JOURNALS AND BOOKS:

- Grosenbaugh, M.A., W. Paul, D. Frye, and **N. Farr**. (2006) Development of synthetic fiber-reinforced electro-optical-mechanical cables for use with moored buoy observatories. *IEEE J. Oceanic Eng.* 31(3): 574-584.
- Grosenbaugh, M., W. Paul, D. Frye and **N. Farr** (2005) Synthetic electro-optical-mechanical cables for ocean observatory moorings. In M.J. Briggs and M.E. McCormick (Eds.), *Civil Engineering in the Oceans VI* (pp. 192-202). Baltimore: American Society of Civil Engineers.
- Reddy, V.Y., C. Houghtaling, J. Fallon, G. Fischer, **N. Farr**, J. Clarke, J. McIntyre, E. Sinofsky, J.N. Ruskin, and D. Keane (2004) Use of a diode laser balloon ablation catheter to generate circumferential pulmonary venous lesions in an open-thoracotomy caprine model. *PACE* 27(1): 52-57.
- Lemery, R., J.P. Veinot, A.S.L. Tang, M. Green, **N. Farr**, L. Baxter, J. McIntyre, and E. Sinofsky (2002) Fiberoptic balloon catheter ablation of pulmonary vein ostia in pigs using photonic energy delivery with diode laser. *PACE* 25(1): 32-36.
- Lemery, R., J. Veinot, A. Tang, M. Green, **N. Farr**, L. Baxter, J. McIntyre, and E. Sinofsky (2001) Fiberoptic balloon catheter ablation of pulmonary vein ostia in pigs using photonic energy delivery with diode laser. *J. Am. Coll. Cardiol.* 37(2): 88A-89A.
- Lemery, R., J. Veinot, A. Tang, M. Green, **N. Farr**, L. Baxter, J. McIntyre, and E. Sinofsky (2001) Photonic energy delivery using diode laser to create circumferential and linear lesions to the coronary sinus in pigs. *J. Am. Coll. Cardiol.* 37(2): 89A.

## PUBLISHED ABSTRACTS:

- Bowen, A.D., M.V. Jakuba, **N.E. Farr**, J. Ware, C. Taylor, D. Gomez-Ibanez, C.R. Machado, and C. Pontbriand (2013) "An Un-Tethered ROV for Routine Access and Intervention in the Deep Sea." MTS/IEEE OCEANS 2013 Conference, San Diego, CA, 23-26 Sept.
- Farr, N.E.**, J.D. Ware, C.T. Pontbriand, and M.A. Tivey (2013) "Demonstration of Wireless Data Harvesting from a Subsea Node Using a 'Ship of Opportunity'." MTS/IEEE OCEANS 2013 Conference, San Diego, CA, 23-26 Sept.
- Camilli, R., **N. Farr**, C. Pontbriand, J. Kapit, J. Ware, O. Pizarro, and J. Whelan (2012) "Long-term Benthic Boundary Layer Monitoring at the Mississippi Canyon block 118 Hydrates Observatory." Abstract 12681 presented at 2012 Ocean Sciences Meeting, Salt Lake City, UT, 20-24 Feb.
- Kapit, J., R. Camilli, **N. Farr**, J. Ware, C. Pontbriand, B. Hamner, and S. Backus (2012) "Improving the Sustainability of Long-term Uncabled Hydrate Observatories: Technologies for Efficient Data Retrieval and Renewable Power." Abstract 12688 presented at 2012 Ocean Sciences Meeting, Salt Lake City, UT, 20-24 Feb.
- Farr, N.**, K. Sleeper, R. Camilli, C. Pontbriand, and J. Ware (2011) "Optical Telemetry Improves Persistence and Data Access at Woolsey Mound Observatory, Mississippi Canyon block 118, Gulf of Mexico." Abstract OS13D-1558 presented at 2011 Fall Meeting, AGU, San Francisco, CA, 5-9 Dec.
- Sleeper, K., R.M. Wilson, J. Chanton, L. Lapham, **N. Farr**, R. Camilli, C.S. Martens, and C. Pontbriand (2011) "Geochemical Arrays at Woolsey Mound Seafloor Observatory." Abstract OS13C-1545 presented at 2011 Fall Meeting, AGU, San Francisco, CA, 5-9 Dec.

- Tivey, M., **N. Farr**, J. Ware, and C. Pontbriand (2011) "Results from an Integrated Optical/Acoustic Communication System Installed at CORK 857D: Implications for Future Seafloor Observatories." Abstract OS11A-1464 presented at 2011 Fall Meeting, AGU, San Francisco, CA, 5-9 Dec.
- Wilson, R.M., L. Lapham, **N. Farr**, C. Lutken, I.R. MacDonald, L. Macelloni, M. Riedel, K. Sleeper, and J. Chanton (2011) "Does the 'Sleeping Dragon' Really Sleep? The Case for Continuous Long-term Monitoring at a Gulf of Mexico Cold Seep Site." Abstract OS13D-1566 presented at 2011 Fall Meeting, AGU, San Francisco, CA, 5-9 Dec.
- Farr, N.**, A. Bowen, M. Tivey, J. Ware, and C. Pontbriand (2010) "An Integrated, Underwater Optical/Acoustic Communications System." IEEE Oceans Conference, Sydney, Australia, 24-27 May.
- Farr, N.**, M. Tivey, J. Ware, and C. Pontbriand (2010) "Optical Communication System Expands CORK Seafloor Observatory's Bandwidth." MTS/IEEE OCEANS 2010 Conference, Seattle, WA, 20-23 Sept.
- Farr, N.**, M. Tivey, J. Ware, C.T. Pontbriand, and D.E. Frye (2010) Integrated optical/acoustic communications system for deep sea data transfer and vehicle control. Eos Trans. AGU 91(26), Ocean Sci. Meet. Suppl., Abstract MT23A-05.
- Farr, N.**, J. Ware, C.T. Pontbriand, D.E. Frye, and M. Tivey (2010) "An Integrated Optical/Acoustic Communications System." MTS/IEEE OCEANS 2010 Conference, Seattle, WA, 20-23 Sept.
- Tivey, M., **N. Farr**, J. Ware, and C.T. Pontbriand (2010) An integrated optical/acoustic communication system for seafloor observatories. Eos Trans. AGU 91(52), Fall Meet. Suppl., Abstract U43A-05.
- Tivey, M., **N. Farr**, J. Ware, C. Pontbriand (2010) "An Integrated Optical/Acoustic Communication System for Seafloor Observatories: A Field Test of High Data Rate Communications at CORK 857D." Abstract U43A-0005 presented at 2010 Fall Meeting, AGU, San Francisco, CA, 13-17 Dec.
- Pontbriand, C., **N. Farr**, J. Ware, J. Preisig, and H. Popenoe (2008) "Diffuse, High Bandwidth Optical Communications." MTS/IEEE OCEANS 2008 Conference, Quebec City, Canada, 15-18 Sept.
- Farr, N.**, A.D. Chave, L. Freitag, J. Preisig, S.N. White, D. Yoerger, and F. Sonnichsen (2006) "Optical Modem Technology for Seafloor Observatories." MTS/IEEE OCEANS 2006 Conference, Boston, MA, 18-21 Sept.
- Farr, N.**, A.D. Chave, L. Freitag, J. Preisig, S.N. White, D. Yoerger, F. Sonnichsen, P. Titterton, J. Bolstad, and D. Leonard (2006) "Optical Modem Technology for Seafloor Observatories." IEEE/OES 4th International Workshop on Scientific Use of Submarine Cables and Related Technologies, Dublin, Ireland, 8-10 Feb.
- Farr, N.**, D. Frye, M. Grosenbaugh, W. Paul, D. Peters, and M. Chaffey (2006) "Development of a Nylon EOM Mooring Cable for Moored Ocean Observatories." IEEE/OES 4th International Workshop on Scientific Use of Submarine Cables and Related Technologies, Dublin, Ireland, 8-10 Feb.
- Farr, N.**, D. Frye, M. Grosenbaugh, W. Paul, D. Peters, J. Kemp, W. Ostrom, M. Chaffey, and D. Bentley, "Development of a Nylon EOM Mooring Cable for Moored Ocean Observatories", Presented at the ONR/MTS Buoy Workshop, March 14-16, 2006, College Station, TX (abstract published in conference record), p. , vol. , (2006). Published,

- Howland, J., **N. Farr**, and H. Singh (2006) “Field Tests of a New Camera/LED Strobe System.” MTS/IEEE OCEANS 2006 Conference, Boston, MA, 18-21 Sept.
- Michel, A.P.M., **N.E. Farr**, and A.D. Chave (2006) “Evaluation of laser-induced breakdown spectroscopy (LIBS) as a new in situ chemical sensing technique for the deep ocean.” MTS/IEEE OCEANS 2006 Conference, Boston, MA, 18-21 Sept., 5 pp.
- Pizarro, O., **N. Farr**, R. Camilli, J. Whelan, and C. Martens (2006) In-situ optical characterization of methane seeps and bubble plumes. Eos Trans. AGU 87(52), Fall Meet. Suppl., Abstract OS31B-1643.
- Rowland, J., **N. Farr**, and H. Singh (2006) “Field tests of a new camera/LED strobe system.” MTS/IEEE OCEANS 2006 Conference, Boston, MA, 18-21 Sept., 4 pp.
- Whelan, J., R. Camilli, C. Martens, O. Pizarro, and **N. Farr** (2006) Coordinated mapping and characterization of ocean floor methane sources with manned submersibles, AUVs and modular observatory arrays.” Eos Trans. AGU 87(52), Fall Meet. Suppl., Abstract OS33A-1682.
- White, S.N., E. Sholkovitz, and **N. Farr** (2006) “Visual Reflectance Spectroscopy on a Buoy-Mounted Aerosol Sampler: Development of a Sensor for Quantifying the Deposition of Mineral Dust to the Oceans.” MTS/IEEE OCEANS 2006 Conference, Boston, MA, 18-21 Sept., 6 pp.
- Farr, N.**, L. Freitag, J. Preisig, S. White, D. Yoerger, and P. Titterton (2005) “Optical Modem Technology for Seafloor Observatories.” MTS/IEEE OCEANS 2005 Conference, Washington, DC, 19-23 Sept.
- Pizarro, O., **N. Farr**, R. Camilli, J. Whelan, C. Martens, J. Goudreau, H. Mendlovitz, L. Camilli (2005) “Advances in Optical Characterization of Methane Seeps and Bubble Plumes.” Eos Trans. AGU 86(52), Fall Meet. Suppl., Abstract OS43A-0617.
- Grosenbaugh, M.A., W. Paul, D. Frye, and **N. Farr** (2004) “Design and Modeling of Synthetic Fiber Reinforced Electro-Optical-Mechanical Cables for Use with Moored-Buoy Observatories.” Proc. 14th Int. Offsh. Polar Eng. Conf. 1: 332-337, Toulon, France, 23-28 May.

#### **PAPERS PRESENTED AT MEETINGS AND INVITED LECTURES:**

- November 2005: UMISS GoM Gas Hydrates Consortium meeting; presented project status report
- February 2008: UMISS GoM Gas Hydrates Consortium meeting; presented “Engineering Advances for Long-Term BBLA Deployment”
- November 2009: UMISS GoM Gas Hydrates Consortium meeting; presented project status report
- October 2010: Gulf of Mexico Hydrates Research Consortium Annual Meeting; Oxford, MS; Presentation “The Benthic Boundary Layer Array: A Modular, Reconfigurable Seafloor Observatory Mode”
- November 2011: Gulf of Mexico Hydrates Research Consortium Annual Meeting; Jackson, MS
- May 2012: ONR’s Communications Technology Program Review, Planning, and Assessment Meeting; Alexandria, VA; presented “WHOI Optical Communications Overview”
- March 2013: ONR Workshop on Blue-Green Optical Communications Technologies, Architecture, and UUV Payload Design Consideration; Arlington, VA

June 2013: Incorporated Research Institutions for Seismology Seismic Instrumentation Technology Symposium; Albuquerque, NM; presented “High Bandwidth Wireless Communication for Seafloor Data Recovery and Vehicle Control”

January 2014: ONR Program Review Meeting; Panama City, FL; presented “High Bandwidth Wireless Communication for Data Transfer and Vehicle Control”

March 2014: Oceanology International 2014 Meeting; London, UK; presented “Optical communication system expands CORK seafloor observatory's bandwidth”