

Mark Evan Schafer

Current: President and Principal Scientist, Sonic Tech, Inc., Ambler, PA
Provide consulting expertise in management, product development, research, testing, manufacturing, and regulatory aspects of ultrasound systems and applications.

Prior Experience: Vice President, Ultrasound Technology Group, Perceptron, Inc., Plymouth Meeting, PA
Responsible for the research, design, development and sales of ultrasound systems applied to the Forest Products Industry. Managed R&D team bringing new product concepts to market, including extensive personal research, from computer simulation to field installation in sawmills (resulting in 6 patents). Coordinated with corporate office regarding sales, marketing, budgeting and manufacturing issues. Extensive technology transfer experience with government and university laboratories.

Founder, Sonic Technologies / Sonic Industries, Inc., Hatboro, PA.
Expert in the measurement of ultrasound, and in novel applications of ultrasonic technology. Formed company specializing in measurement of medical ultrasound devices (diagnostic, surgical, and lithotripsy) per FDA requirements. Designed and constructed the hardware and developed the software for transducer testing facility. Managed company's growth and technical capabilities: the company became one of the country's leading laboratories devoted to applied ultrasonic measurement. Supervised company's expansion into non-medical ultrasonic product development. Conceived, designed, and managed new product entries in the livestock and wood industries, from research, development to execution. Personally consulted on projects involving: transducer design, testing, and quality control; phacoemulsification probe testing and design; lithotripter design and measurement; ultrasonic catheter systems; ultrasonic nebulizer design; ultrasound applications in process control, food, forestry industries; regulatory requirements for ultrasound and lithotripsy systems.

Senior Research Engineer, Interspec, Inc, Conshohocken, PA.
Responsibilities: system design and project engineering of new medical ultrasound products, including annular array and flow mapping devices; design, specification, and testing of single and multi-element ultrasonic transducers; measurement of acoustic parameters; computer simulation of novel ultrasound imaging algorithms and transducer designs. Project Engineer on Annular and Curvilinear Array development, from concept definition to engineering pre-production.

Research Assistant, Biomedical Engineering, Drexel University, Philadelphia, PA.
Thesis work involved a novel approach to ultrasound transmission through tissue layers, with additional developments in ultrasonic transducer analysis techniques. Designed and built several systems for ultrasound research, including measurement of tissue back-scattering, effects of ultrasound exposure on fetal rat development, and transducer characterization in inhomogeneous media. Developed simulations of non-linear acoustic propagation, spatial averaging effects in acoustic measurements, and acoustic transmission through layered media.

Research Engineer, Applied Physics Lab, Seattle, WA.
Developed interactive computer graphics system for analysis and display of sonar echo returns from submerged and surface objects. SECRET Security Clearance.

Research Associate, Applied Research Lab, State College, PA.
Developed computer simulations of complex sonar echo returns. Designed measurement equipment and techniques for the electrical and acoustical characterization of sonar transducers and arrays. SECRET Security Clearance.

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- Education:** Drexel University, Ph.D. in Biomedical Engineering, June 1988.
Thesis title: Transducer Characterization in Inhomogeneous Media Using the Angular Spectrum Method.
Pennsylvania State University, M.S. in Acoustics, May 1982.
Thesis title: The Prediction of Transducer Element Performance from In-air Measurements.
Massachusetts Institute of Technology, S.B. in Electrical Engineering, June 1979.
Thesis title: The Effect of Paradigm on Interaural Time Discrimination.
- Academic:** Visiting Adjunct Professor, Biomedical Engineering and Science Institute, Drexel University, 1993-1994, 1995-1996, 1997-1998.
- Fellowships:** Calhoun Foundation Research Fellowship, 1983-1985.
Physio-Control Corporation Teaching Fellowship, 1982.
- Research:** Principal Investigator (PI), "Miniature In-vivo Hydrophones for Lithotripter Use," Grant 1R43DK42747-01, Nat. Inst. Diab., Digestive Kidney Diseases, NIH, 4/90-10/90, \$48,595.
PI, "A Stone Phantom Device for Lithotripsy Quality Assurance," Grants 1R43/2R44-DK43166-01A1/-02, NIDDKD, NIH, 1/92 - 7/92, \$48,768; 9/93 - 2/95, \$290,857.
PI, "Advanced Ultrasonic Doppler System for Early Pregnancy Detection in Cattle," Grant 92-33610-7271, Dept. of Agriculture, 5/92 to 11/93, \$48,730.
PI, "Ultrasound/Collagen Treatment of Full Thickness Wounds," Grants 1R43/2R44-AG10650-01/-02, Nat. Inst. Aging, 9/92 - 9/93, \$50,000; 4/95 - 3/97, \$496,000.
PI, "A Self Monitoring, Disposable Shock Wave Hydrophone," Grants 1R43/2R44-FD01514-01/-02, FDA, 7/93 - 12/93, \$45,423; 7/95 - 8/97, \$391,000.
PI, "Fish Grading/Sorting for Aquaculture using Ultrasound Techniques," Grant 06-33610-2611, Dept. of Agriculture, 5/96 - 11/96, \$50,000; 9/97 - 8/99, \$215,000.
PI, "Ultrasonic Wetwood and Defect Detection System for Lumber Process Control," Grant 06-33610-4805, Dept of Ag., 5/97-11/97, \$55,000; 9/98-8/00, \$200,000.
PI, "Ultrasonic Wetwood and Defect Detection System for Lumber Process Control," Grant 001-035-907-7-7000-90717-651, U.S. DOE, 10/97-6/99, \$626,475
- Patents:** Phantom Kidney Stone System, # 5,014,686.
Shock Wave Hydrophone with Self-Monitoring Feature, # 5,072,426
Ultrasonic Apparatus and Method for Measuring Animal Backfat, # 5,613,493
Method and Device for Measuring Anisotropic Mechanical Properties of Tissue, #5,706,815
Ultrasound Image Freezing Apparatus and Method for Animal Backfat Measuring Instruments, # 5,717,142
Ultrasonic Apparatus and Method for Measuring Animal Backfat, #6,012,332
Ultrasonic Apparatus for Characterizing Wooden Members, #6,029,522
Method and Apparatus for Detecting and Characterizing Splits in Logs, #6,092,418
System and Method of Assessing the Structural Properties of Wooden Members Using Ultrasound, #6276209
Defect Parameter for Wooden Members, #6,367,330
Method and Apparatus for Detecting and Characterizing Splits in Logs, #6,457,363
Method and Apparatus for On-Line Monitoring of Log Sawing, #6,467,352
Roller mechanism using an array of elements to interrogate wood properties, #6,684,705
- Professional:** Fellow, American Institute of Ultrasound in Medicine (AIUM)
Vice President, President (1999-2001), Board Member, Ultrasonic Industry Association
Member, AIUM Standards Committee, 1993-96, 2002-05 (Chairman-elect, 2004)
Chairman of the Technical Committee of NEMA Ultrasound Section, 1990-93, 2003-05

Publications: Selected publications list follows.

Refereed Journals

- M.E. Schafer and P.A. Lewin, "The Influence of Front-End Hardware on Digital Ultrasonic Imaging," IEEE Trans. Sonics Ultrasonics **SU-31**, 295-306, 1984.
- P.A. Lewin and M.E. Schafer, "Ultrasonic Probes in Measurement Practice," Medical Device and Diagnostic Industry **8:5**, 40-45, 1986.
- P.A. Lewin, M.E. Schafer and R.C. Chivers, "Factors Affecting the Choice of Pre-amplification for Ultrasonic Hydrophone Probes," Ultrason. Med. Biology **13:5**, 141-145, 1987.
- M.E. Schafer and P.A. Lewin, "A Computerized System for Measuring the Acoustic Output from Diagnostic Ultrasound Equipment," IEEE Trans. Ultrason. Ferroelec. Freq. Control **UFFC-35**, 102-109, 1988.
- P.A. Lewin and M.E. Schafer, "Wideband Polymer Acoustic Sources," IEEE Trans. Ultrason. Ferroelec. Freq. Control **UFFC-35**, 175-184, 1988.
- M.E. Schafer and P.A. Lewin, "Transducer Characterization using the Angular Spectrum Method," J. Acoust. Soc. Am. **85:5**, 2202-2214, 1989.
- P.A. Lewin and M.E. Schafer, "Shock Wave Sensors: I. Requirements and Design," J. Lithotripsy and Stone Disease, **3(1)**, 3-17, 1991.
- P.A. Lewin and M.E. Schafer, "Wideband Characterization of Ultrasound Transducers and Materials using Time Delay Spectrometry," Arch. Acoust., **17(1)**, 103-115, 1992.
- M.E. Schafer, "Cost-Effective Shock Wave Hydrophones," J. Stone Disease, **5(2)**, 101-105, 1993.
- C.J. Vecchio, M.E. Schafer, and P.A. Lewin, "Prediction of Ultrasonic Field Propagation through Layered Media using the Extended Angular Spectrum Method," Ultrasound Med. Biology **20:7**, 661-622, 1994.
- M.F. Kabir, D.L. Schmoltdt, and M.E. Schafer, Time domain ultrasonic signal characterization for defects in thin unsurfaced hardwood lumber. Wood and Fiber Science, 34(1): 165-182, 2002.
- M.F. Kabir, D.L. Schmoltdt, P.A. Araman, M.E. Schafer, and S.M. Lee Classifying defects in pallet stringers by ultrasonic scanning. Wood and Fiber Science, 35(2): 203-223, 2003.

Book Chapters

- P.A. Lewin and M.E. Schafer, "Piezoelectric Polymer Transducers in Biomedical Ultrasonics," in *Medical Applications of Piezoelectric Polymers*, R. Galletti, ed., (Gordon and Breach, New York, 1988), 215-232, 1988.
- P.A. Lewin and M.E. Schafer, "Ultrasound: Measurements and Instrumentation", in *Non-Ionizing Radiation*, M. Wayne Greene, ed (Univ. British Columbia Press), 189-208, 1992.
- M.E. Schafer, "Techniques of Hydrophone Calibration," in *Ultrasonic Exposimetry*, M. Ziskin and P. Lewin, eds., (CRC Press), 217-256, 1993.
- M.E. Schafer, "The Angular Spectrum Method of Transducer Characterization," in *Ultrasonic Exposimetry*, M. Ziskin and P. Lewin, eds., (CRC Press), 257-282, 1993.

Conference Proceedings

- P.A. Lewin, P.C. Pedersen, and M.E. Schafer, "A Spectral Analysis Technique in Ultrasound Transducer Characterization," Proc. 1984 IEEE Ultras. Symp., 731-734.
- P.A. Lewin, M.E. Schafer and R.C. Chivers, "Integrated Pre-amplifiers for Ultrasound Transducers," Proc. 1985 IEEE Ultras. Symp., 503-506, 1985.
- P.A. Lewin, M.E. Schafer and M.E. Haran, "Nonlinear Propagation Models in Ultrasound Hyperthermia," Proc. Institute of Acoustics, **8:2**, 85-93, 1986.
- P.A. Lewin and M.E. Schafer, "Piezoelectric Polymer Hydrophones for Ultrasound Dosimetry Applications," Proc. 1986 International Society for the Application of Ferroelectrics (ISAF) Conference, 515-518, 1986.
- P.A. Lewin and M.E. Schafer, "A Novel Instrument for Measurement of Relevant Ultrasound Parameters in Clinical Practice," Proc. 8th Ann. Conf. IEEE Eng. in Med. Biol. Soc., 1029-1032, 1986.
- M.T. Poczobutt, P.A. Lewin, and M.E. Schafer, "A Computerized Acoustic Output Acquisition System," Proc. 13th Northeast Bioengineering Conf., 477-479, 1987.
- M.E. Schafer, P.A. Lewin, and J.M. Reid, "A New Technique for Characterizing Transducers in Inhomogeneous Media," in *Acoustical Imaging, Vol. 15* H. Jones, ed, (Plenum Press, New York), 135-146, 1987.

- M.E. Schafer, P.A. Lewin, and J.M. Reid, "Propagation through Inhomogeneous Media using the Angular Spectrum Method," Proc. 1987 IEEE Ultras. Symp., 943-946, 1987.
- P.A. Lewin and M.E. Schafer, "Design of Piezoelectric Polymer Transducers for Time Delay Spectrometry Applications," Proc. 1987 IEEE Ultras. Symp., 721-724, 1987.
- M.T. Poczobutt, P.A. Lewin, and M.E. Schafer, "Calibration of Medical Ultrasound Equipment: An Analog vs. A Digital Approach," Ultrasonics International 87 Conf. Proc. 686-691, 1987.
- M.E. Schafer and P.A. Lewin, "Transducer Surface Velocity Reconstruction using the Angular Spectrum Method," Proc. 1988 IEEE Ultras. Symp., 669-672, 1988.
- P.A. Lewin, M.E. Schafer, and J.M. Gilmore, "Ultrasonic Probes for Shock Wave Measurements," Proc. 1988 IEEE Ultras. Symp., 955-958, 1988.
- M.E. Schafer and P.A. Lewin, "Use of Time Delay Spectrometry in Fluid Attenuation Measurement," Proc. 1989 IEEE Ultras. Symp., 973-976, 1989.
- M.E. Schafer and P.A. Lewin, "Ultrasound Transducer Characterization using the Angular Spectrum Backpropagation," *Acoustical Imaging, Vol. 18*, H.Lee and G. Wade, eds., (Plenum Press, New York), 1990.
- M.E. Schafer, "Alternative Approaches to *In-situ* Intensity Estimation," Proc. 1990 IEEE Ultras. Symp., 1381-1384, 1990.
- M.E. Schafer, T.L. Kraynak, and P.A. Lewin, "Design Of A Miniature *In-vivo* Shock Wave Hydrophone," Proc. 1990 IEEE Ultras. Symp., 1623-1626, 1990.
- C. J. Vecchio, P.A. Lewin, and M.E. Schafer, "Characterization of the Surface Vibration Patterns of Acoustically Radiating Structures using the Angular Spectrum Method," Ultrasonics International 91 Conf. Proc., 327-330, 1991.
- M. Schafer, S. Dubin, A. Geshury, R. Mark, and F. Ko, "Ultrasound/Collagen Treatment of Full Thickness Wounds," Proc. 13th Southern Biomed. Engrg. Conf., 891-894, 1994.
- M. Schafer, T. Kraynak, and V. Krakhman, "Development of a Cost-effective Shock Wave Hydrophone," Proc. 1994 IEEE Ultras. Symp., 1805-1808, 1994.
- M. Schafer, S. Dubin, A. Geshury, and F. Ko, "Experimental Methods for Ultrasonically Enhanced Wound Healing," Proc. 1994 IEEE Ultras. Symp., 1853-1856, 1994.
- M. Schafer, and A. Broadwin, "Acoustical Characterization of Ultrasonic Surgical Devices," Proc. 1994 IEEE Ultras. Symp., 1903-1906, 1994.
- M. Schafer, R. Ross, B. Brashaw, and R. Adams, "Ultrasonic Inspection and Analysis Techniques in Green and Dried Lumber," *Proceedings of the 11th International Symposium on Nondestructive Testing of Wood*, Editor: D.G. Pollock. 1999 Forest Products Society
- M.F. Kabir, D.L. Schmoldt, M.E. Schafer, and P.A. Araman, Ultrasonic scanning for pallet parts grading. Proceedings of the 28th Annual Hardwood Symposium, May 11-13, 2000, Cannon Valley Resort & Conference Center, West Virginia, May 11-13, 2000: 151-159, 2000.
- M.F. Kabir, D.L. Schmoldt, and M.E. Schafer, Ultrasonic detection of knots, cross grain and bark pockets in wooden pallet parts. Proceeding of the World Conference on Timber Engineering, Vancouver, British Columbia, Canada, July 31-August 3, 2000, 7pp, 2000.
- M.F. Kabir, D.L. Schmoldt, and M.E. Schafer, Detection of defects in red oak deckboards by ultrasonic scanning. Proceedings of the Forth International Conference on Image Processing and Scanning of Wood, Mountain lake Resort, Mountain Lake, Virginia, August 21-23, 2000: 89-96, 2000.
- M. Schafer, "Ultrasound for defect detection and grading in wood and lumber", Proc. 2000 IEEE Ultras. Symp. P340-348, 2000.
- M. Kabir, D. Schmoldt, and M.Schafer, "Roller transducer scanning of wooden pallet parts for defect detection," *Review of Progress in Quantitative Nondestructive Evaluation*, D. O. Thompson and D. E. Chimenti (eds.) Vol. 20B. American Institute of Physics, 1218-1225, 2001.
- M.F. Kabir, D.L. Schmoldt, and M.E. Schafer, Roller-transducer scanning of wooden pallet parts for defect detection. Review of Progress in Quantitative Nondestructive Evaluation, 20: 1218-1225, 2001.

Special Presentations

Short Course Presentation at 1997 and 1998 IEEE Ultrasonics Symposia "Ultrasound Measurements in the Laboratory: Practice and Pitfalls".