Curriculum Vitae

JOHN PETER WIKSWO, JR.

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PERSONAL HISTORY:	Born in Lynchburg, Virginia on October 6, 1949 Married, two children
DEGREES AWARDED:	B.A. - Physics, University of Virginia, 1970 M.S. - Physics, Stanford University, 1973 Ph.D. - Physics, Stanford University, 1975
FIELDS OF SPECIALIZATION:	Biological physics, biomedical engineering, cardiac electrophysiology, cellular instrumentation and control, electromagnetism, SQUID magnetometry, and systems biology
HONORS:	Echols Scholar, University of Virginia, 1966-1970 Phi Beta Kappa, 1968 Junior Fellow, University of Virginia Society of Fellows, 1969-1970 B.A. with Highest Distinction, 1970 Woodrow Wilson Fellow, 1970 Woodrow Wilson Independent Study Award, 1970 NSF Predoctoral Fellow 1971-1974 Bay Area Heart Research Committee Fellow, 1975-1977 Finalist, Deborah Heart and Lung Foundation Young Investigator Competition, 1980 Alfred P. Sloan Research Fellow, 1980-1982 IR-100 Award for Neuromagnetic Current Probe, 1984 Fellow, American Physical Society, 1990 John Simon Guggenheim Fellow, 1992-1993 Thomas Jefferson Award, Vanderbilt University, 1997 Fellow, American Institute for Medical and Biological Engineering, 1999 Fellow of the American Heart Association, Fellow of the Council on Basic Cardiovascular Sciences of the American Heart Association, 2001 Fellow, Biomedical Engineering Society (BMES), 2005 Senior Member, Institute for Electrical and Electronic Engineers, 2005-2007 Fellow, Heart Rhythm Society, 2006 The Nightingale Prize 2006 for the best paper published in Medical and Biological Engineering and Computing in 2005 Fellow, Institute for Electrical and Electronic Engineers, 2008
PROFESSIONAL SOCIETIES:	American Association for the Advancement of Science American Heart Association American Institute for Medical and Biological Engineering American Physical Society: Division of Biological Physics, Division of Material Physics; Instrument and Measurement Science Topical Group Biomedical Engineering Society (BMES) Biophysical Society Heart Rhythm Society

PROFESSIONAL SOCIETIES: (con't)	Institute for Electrical and Electronic Engineers: Engineering in Medicine and Biology Society; Magnetics Society Sigma Xi Tennessee Academy of Science Union of Concerned Scientists	
APPOINTMENTS:	Research Fellow in Cardiology, Stanford University School of Medicine	1975-1977
	Assistant Professor of Physics, Vanderbilt University	1977-1982
	Associate Professor of Physics, Vanderbilt University	1982-1988
	Professor of Physics, Vanderbilt University	1988-
	A.B. Learned Professor in Living State Physics, Vanderbilt University	1991-2001, 2005-
	Gordon A. Cain University Professor, Vanderbilt University	2001 -
	Professor of Biomedical Engineering, Vanderbilt University	2001-
	Professor of Molecular Physiology and Biophysics, Vanderbilt University	2001-
	Director, Vanderbilt Institute for Integrative Biosystems Research and Education	2001-
	Member, Vanderbilt Ingram Cancer Center	2006-

John P. Wikswo, Jr. -- Publications:

1. "Quantized Fluctuations in the Josephson Oscillations of a Shunted Superconducting Point Contact," R.D. Sandell, J.P. Wikswo, Jr., J.M. Pickler, and B.S. Deaver, Jr., J. Appl. Phys., 44: 3312-3318 (1973).
2. "Consistent System of Rectangular and Spherical Coordinates for Electrocardiography and Magnetocardiography," J.A.V. Malmivuo, J.P. Wikswo, Jr., W.H. Barry, D.C. Harrison, and W.M. Fairbank, Med. Biol. Eng. and Comput., 15: 413-415 (1977).
3. "A New Practical Lead System for Vector Magnetocardiography," J.A.V. Malmivuo and J.P. Wikswo, Jr., Proc. IEEE, 65: 809-811 (1977).
4. "Measurement of the Human Magnetic Heart Vector," W.H. Barry, D.C. Harrison, W.M. Fairbank, K. Lehrman, J.A.V. Malmivuo, and J.P. Wikswo, Jr., Science, 198: 1159-1162 (1977).
5. "The Calculation of the Magnetic Field from a Current Distribution: Application to Finite Element Techniques," J.P. Wikswo, Jr., IEEE Trans. Mag., MAG-14: 1076-1077 (1978).
6. "Non-Invasive Magnetic Detection of Cardiac Mechanical Activity: Theory," J.P. Wikswo, Jr., Medical Physics, 7: 297-306 (1980).
7. "Non-Invasive Magnetic Detection of Cardiac Mechanical Activity: Experiment," J.P. Wikswo, Jr., J.E. Opfer, and W.M. Fairbank, Medical Physics, 7: 307-314 (1980).
8. "Magnetic Field of a Nerve Impulse: First Measurements," J.P. Wikswo, Jr., J.P. Barach, and J.A. Freeman, Science, 208: 53-55 (1980).
9. "An Estimate of the Steady Magnetic Field Strength Required to Influence Nerve Conduction," J.P. Wikswo, Jr. and J.P. Barach, IEEE Trans. Biomed. Eng., BME-27: 722-723 (1980).
10. "Experiments on the Magnetic Field of Nerve Action Potentials," J.P. Barach, J.A. Freeman and J.P. Wikswo, Jr., J. Appl. Phys., 51: 4532-4538 (1980).
11. "A Calculation of the Magnetic Field of a Nerve Action Potential," K.R. Swinney and J.P. Wikswo, Jr., Biophys. J., 32: 719-732 (1980).
12. "Quark Chemistry," L.J. Schaad, B.A. Hess, J.P. Wikswo, Jr., and W.M. Fairbank, Phys. Rev. A, 23: 1600-1607 (1981).
13. "Sequential QRS Vector Subtractions in Acute Myocardial Infarction in Humans," J.P. Wikswo, Jr., S.C. Gundersen, W. Murphy,A.K. Dawson, and R.F. Smith, Circ. Res., 49: 1055-1062 (1981).
14. "Possible Sources of New Information in the Magnetocardiogram," J.P. Wikswo, Jr. and J.P. Barach, J. Theoretical Biol., 95: 721-729 (1982).
15. "Improved Instrumentation for Measuring the Magnetic Field of Cellular Action Currents," J.P. Wikswo, Jr., Rev. Sci. Instr., 53: 1846-1850 (1982).
16. "A Low-Noise, Low Input Impedance Amplifier for Magnetic Measurements of Nerve Action Currents," J.P. Wikswo, Jr., P.C. Samson, and R.P. Giffard, IEEE Trans. Biomed. Eng., BME-30: 215-221 (1983).
17. "Optimization of a SQUID Clip-On Current Probe," M.C. Leifer and J.P. Wikswo, Jr., Rev. Sci. Instr., 54: 1017-1022 (1983).
18. "A Comparison of Scalar Multipole Expansions," J.P. Wikswo, Jr. and K.R. Swinney, J. Appl. Phys., 56: 3039-3049 (1984).

19. "Magnetic Measurement of Action Currents in a Single Nerve Axon: A Core Conductor Model," J.P. Barach, B.J. Roth, and J.P. Wikswo, Jr., IEEE Trans. Biomed. Eng., BME-32: 136-140 (1985).

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21. "The QRS Complex During Transient Myocardial Ischemia: Studies in Patients with Variant Angina Pectoris and in a Canine Preparation," J.E. Barnhill, J.P. Wikswo, Jr., A.K. Dawson, S. Gundersen, R.M.S. Robertson, D. Robertson, R. Virmani, and R.F. Smith, Circulation, 71(5): 901-911 (1985).

22. "The Magnetic Field of a Single Axon: A Comparison of Theory and Experiment," B.J. Roth and J.P. Wikswo, Jr., Biophys. J., 48: 93-109 (1985).

23. "Optimisation of State Selection and Focusing of a Neutral Atomic Hydrogen Beam by a Hexapole Magnet," D.P. Russell and J.P. Wikswo, Jr., J. Physics E, 18: 933-940 (1985).

24. "The Magnetic Field of a Single Nerve Axon: A Volume Conductor Model," J.K. Woosley, B.J. Roth, and J.P. Wikswo, Jr., Mathematical Biosciences, 76: 1-36 (1985).

25. "The Electrical Potential and the Magnetic Field of an Axon in a Nerve Bundle," B.J. Roth and J.P. Wikswo, Jr., Mathematical Biosciences, 76: 37-57 (1985).

26. "The Effects of the Heart-Lung Boundary on the Magnetocardiogram," M.C. Leifer, J.P. Wikswo, Jr., J. Griffin, W.M. Barry, and D.C. Harrison, J. Electrocard., 19: 23-32 (1986).

27. "A Bi-Domain Model for the Extracellular Potential and Magnetic Field of Cardiac Tissue," B.J. Roth and J.P. Wikswo, Jr., IEEE Trans. Biomed. Eng., BME-33: 467-469 (1986).

28. "Capabilities of a Toroid-Amplifier System for Magnetic Measurement of Current in Biological Tissue," F.L.H. Gielen, B.J. Roth, and J.P. Wikswo, Jr., IEEE Trans. Biomed. Eng., BME-33: 910-921 (1986).

29. "Electrically-Silent Magnetic Fields," B.J. Roth and J.P. Wikswo, Jr., Biophys. J., 50: 739-745 (1986).

30. "Computer Simulation of Action Potential Propagation in Septated Nerve Fibers," J.P. Barach and J.P. Wikswo, Jr., Biophys. J., 51: 177-183 (1987).

31. "Electric and Magnetic Fields from Two-Dimensional Anisotropic Bisyncytia," N.G. Sepulveda and J.P. Wikswo, Jr., Biophys. J., 51: 557-568 (1987).

32. "Frequency- and Orientation-Dependent Effects of Mexiletine and Quinidine on Conduction in the Intact Dog Heart," A.K. Bajaj, H.A. Kopelman, J.P. Wikswo, Jr., F. Cassidy, R.L. Woosley, and D.M. Roden, Circulation, 75: 1065-1073 (1987).

33. "Magnetic Determination of the Spatial Extent of a Single Cortical Current Source: A Theoretical Analysis," J.P. Wikswo, Jr. and B.J. Roth, Electroenceph. and Clin. Neurophys., 69: 266-276 (1988).

34. "Spatial and Temporal Frequency-Dependent Conductivities in Volume Conduction Calculations of Skeletal Muscle," B.J. Roth, F.L.H. Gielen, and J.P. Wikswo, Jr., Mathematical Biosciences, 88: 159-189 (1988).

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36. "Magnetic Measurements of Cardiac Mechanical Activity," R. Maniewski, T. Katila, T. Poutanen, P. Siltanen, T. Varpula, and J.P. Wikswo, Jr., IEEE Trans. Biomed. Eng., 35: 662-670 (1988).

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63. "Magnetic Fields From Simulated Cardiac Action Currents," J.P. Barach and J.P. Wikswo, Jr., IEEE Trans. Biomed. Eng., 41: 969-974 (1994).

64. "Diagnosing Intestinal Ischemia Using a Noncontact Superconducting Quantum Interference Device," J. Golzarian, D.J. Staton, J.P. Wikswo, Jr., R.N. Friedman, and W.O. Richards, Am. J. Surgery, 167: 586-592 (1994).

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68. "A New Finite-Element Approach to Reconstruct a Bounded and Discontinuous Two-Dimensional Current Image From a Magnetic Field Map," S. Tan, N.G. Sepulveda, and J.P. Wikswo, Jr., J. Comp. Phys., 122: 150-164 (1995).

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70. "Virtual Electrodes in Cardiac Tissue: A Common Mechanism for Anodal and Cathodal Stimulation," J.P. Wikswo, Jr., S.F. Lin, and R.A. Abbas, Biophys. J., 69: 2195-2210 (1995).

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74. "Application of Superconducting Magnetometry in the Study of Aircraft Aluminum Alloy Corrosion," D. Li, Y.P. Ma, W.F. Flanagan, B.D. Lichter, and J.P. Wikswo, Jr., Corrosion, 52(3): 219-231 (1996).

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95. "Panoramic Epifluorescent Visualization of Cardiac Action Potential Activity," M.-A. Bray, S.-F. Lin, and J.P. Wikswo, Jr., Proc. of SPIE - The International Society for Optical Engineering, Vol. 3658, pp. 99-107 (1999).

96. "Vector or Scalar Magnetometer Arrays?," L.A. Bradshaw and J.P. Wikswo, Jr., Proceedings of the First Joint BMES/EMBS Conference: Serving Humanity, Advancing Technology, p. 188 (1999).

97. "Magnetic Field Measurement of Rabbit Colonic Electrical Activity," L.A. Bradshaw, S.H. Allos, J.P. Wikswo, Jr., and W.O. Richards, Biomag 96: Proceedings of the 10th International Conference on Biomagnetism, C.J. Aine, Y. Okada, G. Stroink, S.J. Switenby, and C.C. Wood, Eds., Springer-Verlag,

New York, Vol. II, pp. 608-611 (2000).

98. "Noninvasive Measurement of the Vector Magnetic Field from Human Gastrointestinal Sources," D.J. Staton, S.H. Allos, V.K. Henry, L.A. Bradshaw, J.K. Ladipo, W.O. Richards, and J.P. Wikswo, Jr., Biomag 96: Proceedings of the 10th International Conference on Biomagnetism, C.J. Aine, Y. Okada, G. Stroink, S.J. Switenby, and C.C. Wood, Eds., Springer-Verlag, New York, Vol. II, pp. 635-637 (2000).

99. "Magnetic Susceptibility Tomography with Nonuniform Field," E. Parente Ribeiro, J.P. Wikswo, Jr., P. Costa Ribeiro, and J. Szczupak, Biomag 96: Proceedings of the 10th International Conference on Biomagnetism, C.J. Aine, Y. Okada, G. Stroink, S.J. Switenby, and C.C. Wood, Eds., Springer-Verlag, New York, Vol. II, pp. 671-674 (2000).

100. "Inverse Imaging of Distributed Oscillatory Activity," L.A. Bradshaw and J.P. Wikswo, Biomag 96: Proceedings of the 10th International Conference on Biomagnetism, C.J. Aine, Y. Okada, G. Stroink, S.J. Switenby, and C.C. Wood, Eds., Springer-Verlag, New York, Vol. II, pp. 923-926 (2000).

101. "SQUID Measurements for Thermal Aging of Stator Windings," Y.P. Ma, J.P. Wikswo, Jr., and G. Fitzpatrick, Review of Progress in Quantitative NDE, 20: 369-376 (2001).

102. "SQUID Measurements of Magnetization for a Magnetically Tagged Composite Material," Y.P. Ma, J.P. Wikswo, Jr., and G. Fitzpatrick, Review of Progress in Quantitative NDE, 20: 1831-1836 (2001).

103. "Magnetic Measurements of the Response of Corrosion Activity Within Aircraft Lap Joints," G. Skennerton, J.P. Wikswo, Jr., R.G. Kelly, and A. Abedi, 5th Joint NASA/FAA/DoD Conference on Aging Aircraft, September 10-13, 2001, Kissimmee, FL.

104. "The NanoPhysiometer: BioMEMS for High Bandwidth Detection of Cellular Activity in Subnanoliter Volumes," F. Baudenbacher, W.T. Monroe, A. Werdich, D. Cliffel, and J.P. Wikswo, Jr., Proceedings of the Second Joint EMBS/BMES Conference, pp. 1690-1691, 2002.

105. "Vector Analysis of Gastrointestinal Biomagnetic Fields," L.A. Bradshaw, J.A. Sims, P. Jordan, J.P. Wikswo, and W.O. Richards, Proc. 25th Annual International Conferene of the IEEE EMBS, pp. 3275-3278 (2003).

106. "NanoliterBioReactor: Monitoring of Long-Term Mammalian Cell Physiology at Nanofabricated Scale," A. Prokop, Z. Prokop, D. Schaffer, E. Kozlov, J. Wikswo, D. Cliffel, and F. Baudenbacher, Mat. Res. Soc. Symp. Proc., Vol. 820, pp. O5.5.1/W9.5.1-O5.5.12-W9.5.12, 2004 Materials Research Society.

107. "Identification of Magnetic Field Injury Currents in Ischemic Ischemic Small Intestine," L.A. Bradshaw, O.P. Roy, A.G. Myers, J.G. McDowell, J.P. Wikswo and W.O. Richards, BIOMAG 2004, Boston, MA.

108. "Remote Detection of Corrosion Activity by SQUID Magnetometry Across a Multiphase Medium Under Electrolyte Flow Conditions," Y.P. Ma, J.P. Wikswo, and E. Juzeliunas, Corrosion Science, 47: 621-633 (2005).

109. "Comparison of Chaotic Biomagnetic Field Patterns Recorded from the Arrhythmic Heart and Stomach," A. Irimia, M.R. Gallucci, and J.P. Wikswo, Jr., Proc. 6th International Conference on Complex Systems (ICCS '06), June 25-30, 2006, Quincy, MA.

110. "Actively-Controlled Electrokinetic Delivery of Single Fluorescent Biomolecules in Fluidic Nanochannels," L.M. Davis, B.K. Canfield, X. Li, W. Hofmeister, I. Lescano, B. Bomar, J. King, J. Germann, Z. Sikorski, W. Robinson, G. Shen, Y. White, D. Li, D. Markov, P. Samson, J. Wikswo, and C. Daniel, 7th International Weber Symposium on Innovative Fluorescence Methodologies in Biochemistry and Medicine, Kauai, HI, June 6-12, 2008.

John P. Wikswo, Jr. -- Conference Proceedings: (con't)

111. "Microfluidic Approach to Measure Bacterial Responses to Micro-Chemical Gradients," V. Allwardt, P. Samson, D. Markov, J.W. Dolan, J.P. Wikswo, and L.M. Shor, American Society for Microbiology (ASM) Regional Meeting, Hendersonville, TN, October 3-4, 2008.

John P. Wikswo, Jr. -- Invited Talks and Colloquia:

1. "Clinical Magnetocardiography," Non-Invasive Cardiovascular Measurements Conference, Stanford University, 1978.
2. "Magnetocardiography," Bio-Engineering Seminar, University of Minnesota, 1978.
3. "The Meaning of the Magnetocardiogram," Southeast Section of the American Physical Society, Blacksburg, 1978.
4. "The Measurement and Meaning of Biomagnetic Fields," Sigma Xi, United States Naval Academy, 1979.
5. "The Measurement of the Magnetic Field of Nerves," Dept. of Physics, University of Alabama, Birmingham, 1979.
6. "Measurement of the Magnetic Field of Isolated Nerves," Conference of the Engineering in Medicine and Biology Society, Washington, 1980.
7. "Recent Developments in the Measurement of Magnetic Fields From Isolated Nerves and Muscles," Magnetism and Magnetic Materials Conference, Dallas, 1980.
8. "The Magnetic Field of Nerves," AAPT Summer Meeting, Stevens Point, Wisconsin, 1981.
9. "Forward and Inverse Problems in Electrocardiography and Magnetocardiography," 34th Annual Conference for Engineering in Medicine and Biology, Houston, 1981 (Session Chair).
10. "The Magnetic Field of Nerves," Dept. of Physics, Illinois Institute of Technology, Chicago, 1981.
11. "An Advanced Undergraduate Laboratory in Living State Physics," Southeast Section of the American Physical Society, New Orleans, 1981.
12. "The Magnetic Field of Nerves," Dept. of Technical Physics, Helsinki University of Technology, Helsinki, Finland, August 1982.
13. Opponent, Doctoral Thesis Disputation by Timo Varpula, Dept. of Technical Physics, Helsinki University Technology, Helsinki, Finland, August 1982.
14. "Progress in Biomagnetism," Dept. of Electrical Engineering, Tampere University of Technology, Tampere, Finland, August 1982.
15. Three Lectures on "Cellular Action Currents," NATO Advanced Study Institute on Biomagnetism, Frascati, Italy, September 1982.
16. "The ECG-MCG Relationship," NATO Advanced Study Institute on Biomagnetism, Frascati, Italy, September 1982.
17. "The Measurement and Modeling of the Magnetic Field of an Isolated Nerve Axon," Spring Meeting of the Am. Phys. Soc., Baltimore, April 1983.
18. "Cellular Magnetism: Theory, Experiment and Applications," Symposium on Frontiers in Electrophysiology, 5th Annual Engineering in Medicine and Biology Society, Columbus, September 1983.
19. "Magnetic Field of Nerves and Cardiac Muscle," Department of Physics, Loyola University, New Orleans, November 1983.
20. "Neuromagnetism: A Possible Technique for Surgeons," Neurosurgical Grand Rounds, LSU Medical Center, New Orleans, November 1983.
21. "Magnetic Measurements of Peripheral Nerve Function," Dept. of Biomedical Engineering, Tulane University, New Orleans, November 1983.

22. "Magnetocardiography: Challenging Clinical Problems and Promising Analytic Techniques," Panel Moderator, Fifth World Conference on Biomagnetism, Vancouver, August 1984.
23. "Theoretical Models for Source Localization," Panelist, Fifth World Conference on Biomagnetism, Vancouver, August 1984.
24. "Modelling of Bioelectric Sources," "Neuroelectric Phenomena," and "Neuromagnetism," Three invited lectures at a preconference short-course at Tampere University of Technology, Tampere, Finland, XIV International Conference on Medical and Biological Engineering and VII International Conference on Medical Physics, August 1985.
25. "Magnetic Measurements on Single Nerve Axons and Nerve Bundles," Invited Tutorial, XIV International Conference on Medical and Biological Engineering and VII International Conference on Medical Physics, Espoo, Finland, August 1985.
26. "Measurements and Modeling of Neuromagnetic Fields," 38th Annual Conference on Engineering in Medicine and Biology, Chicago, September 1985.
27. "Cellular Biomagnetism: Nerves and Hearts, Measurements and Models," Department of Physics, New York University, October 1985.
28. "Magnetic Measurements of Single Axons and Nerve Bundles," FASEB Symposium on AThe Use of Neuromagnetism to Evaluate Normal and Abnormal Nerve Function, St. Louis," April 1986 (Session Chair).
29. "Magnetic Measurements of Cellular Action Currents," Department of Anatomy and Cellular Biology, Emory University, June 1986.
30. "Multicellular Systems: Action Currents and Magnetic Fields," 39th Annual Conference on Engineering in Medicine and Biology, Baltimore, September 1986.
31. "Magnetic Fields of Multicellular Systems: Ohm's Law Revisited," Department of Physics, Western Kentucky University, November 1986.
32. "High-Resolution Measurements of Biomagnetic Fields," 1987 Cryogenic Engineering Conference, St. Charles, Illinois, June 1987.
33. "The Biophysics of Neuromagnetism," The Beckman Institute, University of Illinois, Champaign-Urbana, July 1987.
34. "Finite Element Models for Cardiac Defibrillation," Fortieth Annual Conference on Engineering in Medicine and Biology, Niagara Falls, September 1987.
35. "Magnetic Fields From Action Currents: Instrumentation, Measurements, and Models," Department of Chemical, Bio, and Materials Engineering," Arizona State University, Tempe, September 1987.
36. "The Information Content of Biomagnetic Measurements," Department of Chemistry and Physics, Middle Tennessee State University, Murfreesboro, November 1987.
37. "High-Resolution SQUID Magnetometers for NDE: Sensitivity, Spatial Resolution, and Data Analysis," Office of Naval Research SQUID/Non-Destructive Evaluation Workshop, Harper's Ferry," April 1988.
38. "Applications of SQUIDS to Biomagnetism and Non-Destructive Testing," Hypres, Inc., Elmsford, NY, June 1988.
39. "High Resolution SQUID Magnetometry for Current Imaging: Applications to Biophysics and Non-Destructive Testing," Thomas J. Watson Research Ctr, IBM, Yorktown Heights, June 1988.
40. "Magnetic Measurements of Action Currents in Bundled Nerves," World Congress on Medical Physics

and Biomedical Engineering, San Antonio, August 1988.

41. "Current Distributions in Bisyncytial Tissue," World Congress on Medical Physics and Biomedical Engineering, San Antonio, August 1988.
42. "Virtual Cathode Effects and the Cardiac Bidomain," Basic Arrhythmia Laboratory, Duke University, September 1988.
43. "Magnetic Techniques for Evaluating Peripheral Nerve Function," Special Symposium on Maturing Technologies and Emerging Horizons in Biomedical Engineering, Tenth Annual International Conference of IEEE/EMBS, New Orleans, November 1988.
44. Tract Chair for the Biopotentials Tract; Session Chair for "Multicellular and Bidomain Systems," "Nerves and Electric Stimulation," and "Steady Currents," Tenth Annual International Conference of IEEE/EMBS, New Orleans, November 1988.
45. "Applications of SQUIDS to Biomagnetism and Non-Destructive Testing," Texas Instruments, Dallas, July 1989.
46. "Biomagnetic Sources and Their Models," Tutorial Lecture, 7th International Biomagnetism Conference, New York, August 1989.
47. "SQUIDS for NDE," Gordon Conference on Non-Destructive Testing, Ventura, March 1990.
48. "Bioelectricity and Biomagnetism in the Cardiovascular System," Workshop on Bioelectricity and Biomagnetism in Clinical Medicine, Little Company of Mary Hospital, Torrence, April 1990.
49. "Action Currents and Tissue Anisotropy," XVII International Congress on Electrocardiology and the 31st International Symposium on Vectorcardiography, Florence, Italy, September 1990.
50. "High-Resolution SQUIDS for Magnetic Imaging," 12th Annual International Conference of the IEEE Engineering in Medicine and Biology Society, Philadelphia, November 1990.
51. "The Vanderbilt University Living State Physics Group: A Case Study in Building a State-of-the-Art Research Program," Leadership Nashville, December 1990.
52. "Non-Destructive Evaluation with SQUIDS," and "High-Resolution Magnetic Imaging for Non-Destructive Testing," E.I. Dupont DeNemours, Wilmington, December 1990.
53. "High-Resolution SQUIDS for Non-Destructive Evaluation," Electric Power Research Institute, Palo Alto, January 1991.
54. "Teaching of Physics to Humanists: A Recent Experiment in Raising Students' Awareness About How They Think and Learn," University Series on Teaching, Vanderbilt, February, 1991.
55. "Magnetic Measurements of Cellular Action Currents," and "Magnetic Fields From Steady Bioelectric Currents," Ninth International Symposium on Man and His Environment in Health and Disease, Dallas, TX, March 1991.
56. "A Close View of Patterns of Electrical Current and Nerve in Cortex," American Physical Society, Cincinnati, OH, March 1991.
57. "The Virtual Cathode and Tissue Anisotropy: Current Flow in the Cardiac Bidomain," and "Capabilities and Limitations of Magnetic Measurements of Bioelectric Activity in Nerve and Muscle," Mayo Clinic, Rochester, MN, May 1991.
58. "Biomagnetic Fields: Information and Disinformation," A.B. Learned Professorship in Living State Physics Inaugural Lecture, Vanderbilt University, October 1991.
59. "Fundamental Factors That Affect the EEG and MEG: Introductory Talk on the Relationship of the

Electroencephalogram and the Magnetoencephalogram," EEG/MEG Workshop, Virginia Beach, VA, May 1992.

60. "Magnetic Susceptibility Imaging for Non-Destructive Evaluation," Applied Superconductivity Conference, Chicago, IL, August 1992.

61. "Electric and Magnetic Imaging of the Cardiac Bidomain: The New Information," Special Symposium on Cardiac Electrophysiology, Computers in Cardiology Conference, Durham, NC, October 1992.

62. "Magnetic Imaging of Current and Magnetization Distributions," North American BioMagnetism Action Group (NABMAG), Albuquerque, New Mexico, January 1993.

63. "SQUID Magnetometry for Non-Destructive Evaluation," Superconductivity Technical Action Group (STAG) and Contractors Meeting, Wright-Patterson Air Force Base, OH, March 1993.

64. "Superconducting Magnetometry: A Possible Technique for Aircraft NDE," Society of Photo-Optical Instrumentation Engineers Conference on Nondestructive Inspection of Aging Aircraft, San Diego, CA, July 1993.

65. "How Do Ventricular Arrhythmias Start: Triggers," Invited Panelist, Cardiac Electrophysiology: From Cell to Bedside -- A Symposium, Keystone Resort, CO, August 1993.

66. "The Cardiac Bidomain: A Macroscopic, Anisotropic Cable Model for Activation and Propagation," Duke-North Carolina National Science Foundation/Engineering Research Center for Emerging Cardiovascular Technologies Defibrillation Workshop, Durham, NC, April 1994.

67. "Advanced Instrumentation and Measurements for Early Nondestructive Evaluation of Damage and Defects in Aerostructures and Aging Aircraft," Second USAF Aging Aircraft Conference, Oklahoma City, OK, May 1994.

68. "Applications of Superconducting Magnetometry to Aircraft Corrosion," Tri-Service Conference on Corrosion, Orlando, FL, June 1994.

69. "SQUID Magnetometers for Biomagnetism and Non-Destructive Testing: Important Questions and Initial Answers," Plenary Lecture, Applied Superconductivity Conference, Boston, MA, October 1994.

70. "SQUID Magnetometers Applied to Aging Aircraft NDE," FAA/USAF/NASA Aging Aircraft Inspection Workshop on Enhanced Conventional Technologies, Ames, IA, November 1994.

71. "The Theoretical Basis of Biomagnetism," NIH Workshop on Developments in Magnetoencephalography as a Functional Imaging Tool, Washington, DC, February 1995.

72. "Magnetometry," North American BioMagnetism Action Group (NABMAG), Washington, DC, February 1995.

73. "Imaging of Electric and Magnetic Sources," NATO Advanced Study Institute on SQUID Sensors: Fundamentals, Fabrication and Applications, Villa del mare, Maretea, Italy, June 1995.

74. "Magnetic Imaging of Cellular Action Currents," NATO Advanced Study Institute on SQUID Sensors: Fundamentals, Fabrication and Applications, Villa del mare, Maretea, Italy, June 1995.

75. "The Two-Dimensional Magnetic Inverse Problem," NATO Advanced Study Institute on SQUID Sensors: Fundamentals, Fabrication and Applications, Villa del mare, Maretea, Italy, June 1995.

76. "Recent Developments in 5K Cryocoolers - An Outsider's View," Closing Summary, 5K Cryocooler Workshop, Hypres, Inc., Elmsford, NY, July 1995.

77. "Advanced Instrumentation and Measurements for Early Nondestructive Evaluation of Damage and Defects in Aerostructures and Aging Aircraft," Air Force 3rd Aging Aircraft Conference, Wright-Patterson AFB, OH, September 1995.

78. "NDE with SQUIDs," Alcoa Technical Center, Aflcoa Center, PA, October 1995.

79. "Experimental and Mathematical Linkages Between Microscopic and Macroscopic Descriptions of Cardiac Electrical Activity: Too Many Powers of Ten and the Need for Mesoscopic Models," Department of Physics and Astronomy, Vanderbilt University, November 1995.

80. "Biomagnetism and Non-Destructive Testing: Shared Problems and Solutions," Plenary Lecture, 1996 Biomagnetism Conference, Sante Fe, NM, February 1996.

81. "Tissue Anisotropy and Re-entry in the Heart," Cardiology Grand Rounds, Vanderbilt University Medical Center, Nashville, TN, December 1996.

82. "Magnetic Imaging with SQUIDs," Department of Physics and Astronomy, Vanderbilt University, January 1997.

83. "Cardiac Activation: From Uniform Double-Layers to the Bidomain," Ventritex, Sunnyvale, CA, February 1997.

84. "Imaging and Modeling Cardiac Electrical Activity -- The Need for Multiple Spatial Scales," 1997 International Conference on Mathematical Models in Medical and Health Sciences,Vanderbilt University, Nashville, TN, May 1997.

85. "SQUIDs for Biomagnetism -- Sources, Measurements, and Models," NATO Advanced Study Institute on SQUID Sensors: Fundamentals, Fabrication and Applications, Hotel Alexandra, Loen, Norway, June 1997.

86. "SQUIDs for NDE -- Methods and Applications," NATO Advanced Study Institute on SQUID Sensors: Fundamentals, Fabrication and Applications, Hotel Alexandra, Loen, Norway, June 1997.

87. "SQUID Magnetometers for Phase-Sensitive, Depth-Selective, Oriented Eddy Current Imaging," Quantitative NonDestructive Evaluation (QNDE 97), San Diego, July 27-August 1, 1997.

88. "SQUID Measurements of the Rate of Hidden Corrosion," Technical Interchange Meeting - Corrosion Fatigue and Corrosion Predictive Modeling, NCI/USAF, Tinker Air Force Base, Oklahoma City, OK, December 17-19, 1997.

89. "Bioelectric/Biomagnetic Phenomena: Ion Channels to Organ Function," NIH Bioengineering Consortium (BECON), National Institutes of Health, Bethesda, MD, February 28, 1998.

90. "High Speed Fluorescence Imaging of Cardiac Action Potentials: Confirmation of the Doubly Anisotropic Bidomain Model," Biomedical Engineering Seminar, University of Minnesota, Minneapolis, MN, April 7, 1998.

91. "Cardiac Electrodynamics: Just How Does Your Heart Work, and Why Not?" Physics Colloquium, University of Minnesota, Minneapolis, MN, April 8, 1998.

92. "Symmetry, Silent Sources, and Magnetic Imaging with SQUIDs," Condensed Matter Seminar, University of Minnesota, Minneapolis, MN, April 9, 1998.

93. "Biomedical Applications of SQUIDs," Hypres, Inc., Elmsford, NY, April 15, 1998.

94. "Novel Insights on the Virtual Electrode Response," Optical Mapping of Cardiac Excitation & Arrhythmias, Scottsdale, AZ, April 26, 1998.

95. "Tissue Anisotropy and Reentry in the Cardiac Bidomain," Clinical Tutorial on The Mathematics of Electrophysiology, 19th Annual Meeting of the North American Society of Pacing and Electrophysiology (NASPE), San Diego, CA, May 7, 1998.

96. "The Drug-Independent Roles of Cardiac Geometry and Tissue Anisotropy in Defibrillation and Reentry," 11th International Congress, Cardiostim 98, Nice, France, June 18, 1998.

97. "Magnetic Imaging of Cellular Action Currents: The Source-Field Relationships," *Electric and Magnetic Fields in Biology and Medicine: Sensory Perception, Self-Organization, and Therapeutic Applications*, Gordon Research Conference on Bioelectrochemistry, New England College, Henniker, NH, July 21, 1998.

98. "The Physics of the Heart," Plenary Lecture, 1998 Summer Meeting of the American Association of Physics Teachers, University of Nebraska, Lincoln, NB, August 6, 1998.

99. "Cardiac Electrodynamics - The Good, The Bad and The Non-Linear," Institute for Theoretical Physics, University of California, Santa Barbara, CA, April 28, 1999.

100. "The Role of Tissue Structure and the Extracellular Space in Propagation," North American Society for Pacing and Electrophysiology (NASPE) Clinical Tutorial on Fundamental Mechanisms of Impulse Propagation: From Gap Junctions to Anisotropy, Toronto, Canada, May 13, 1999.

101. "A Brief Introduction to DNA and Quantum Computers," Hypres, Inc., Elmsford, NY, May 27, 1999.

102. "Potential New Acoustical Techniques for Detecting Single-Leg Separation in the Björk-Shiley Heart Valve," Bowling-Pfizer Trust Supervisory Panel, Cincinnati, OH, June 3, 1999.

103. "An Introduction to DNA and Quantum Computers," Department of Physics and Astronomy, Vanderbilt University, Nashville, TN, September 2, 1999.

104. "SQUID Microscopes for Magnetic Imaging of Biological Systems," Tutorial on Magnetism and Living Systems, 44th Annual Conference on Magnetism and Magnetic Materials, San Jose, CA, November 15, 1999.

105. "Voltage, Calcium, and Magnetic Field Imaging: Fundamental Studies in Cardiac Excitation, Reentry, and Defibrillation," Vanderbilt Cardiology Group Meeting, January 10, 2000.

106. "Recent Results in Electromagnetic and Acoustic Techniques for Non-Invasive Detection and Catheter-Based Confirmation of Outlet Strut Fracture in the Björk-Shiley Heart Valve," Bowling Pfizer Supervisory Panel, Cincinnati, OH, January 19, 2000.

107. "The Physics of the Heart," focus session on Measuring and Controlling Cardiac Electrophysiology, March meeting of the American Physical Society Meeting in Minneapolis, MN, March 23, 2000; abstract in "The Physics of the Heart," J. Wikswo, Bull. Am. Phys. Soc., 45(1): 833 (2000) (Invited).

108. "Cardiac Planning Session," Vanderbilt University, June 26, 2000.

109. "Magnetic Imaging with SQUIDs: Biomagnetism, NDE, and Corrosion," Neocera, Beltsville, MD, June 28, 2000.

110. "Cardiac Fibrillation: An Challenging Example of Multi-Scale, Non-Linear, Biological Modeling," Panel on Computational Modeling & Simulation of the Dynamic Behavior of Complex Biological Systems and Bio-Engineered Systems, DARPA FOCUS 2000 Workshop, Chantilly, Virginia, June 28-30, 2000.

111. "The Challenges of Spatial Scales in Modeling and Understanding Cardiac Fibrillation," Chicago World Congress on Medical Physics and Biomedical Engineering, and the 22nd Annual International Conference of the IEEE Engineering in Medicine and Biology Society, Chicago, July 23-28, 2000.

112. "Review of Iowa/Vanderbilt Research on Detection of Outlet Strut Fracture in the Björk-Shiley Heart Valve," Bowling Pfizer Supervisory Panel, Pasadena, CA, October 27, 2000.

113. "Instrumenting and Controlling the Single Cell: Patch Clamp to Silicon and Talking to Cells with Light," DARPA Workshop on Nanotechnology for Biodetection/Bioassay and Delivery of Therapeutics to Individual Cells, Scottsdale, AZ, December 13-14, 2000.

114. "Discussion Group A: Biodetection/Bioassay of Individual Cells," (Co-Chair), DARPA Workshop on Nanotechnology for Biodetection/Bioassay and Delivery of Therapeutics to Individual Cells, Scottsdale, AZ, December 13-14, 2000.

115. "Phase and Wave Vector Dynamics During Cardiac Reentry," Dynamics Days 2001, Chapel Hill, NC, hosted by the Duke University Physics Department and the Center for Nonlinear and Complex Systems, January 3-6, 2001.

116. "Cardiac Physics: How Your Heart Works, or Doesn't," Nashville Rotary Club, Nashville, TN, February 26, 2001.

117. "Cardiac Phase Plane Dynamics During Stimulation and Reentry," American Physical Society, Seattle, March 15, 2001.

118. "A Multiscale View of Cardiac Electrodynamics," The A.C. Suhren Jr. Lecture Series, Tulane University, New Orleans, LA, March 29, 2001.

119. "The Physics of the Heart: Optical and Magnetic Imaging of Cardiac Activity," Theoretical Biophysics Seminar, Beckman Institute, University of Illinois,15-20 minute overview of the heart, then the bidomain, then reentry, April 30, 2001.

120. "The Magnetocardiogram, Tissue Anistropy, and the Cardiac Bidomain," co-authored with Franz Baudenbacher at "The Integrated Heart: Cardiac structure and function" a satellite meeting of the 34th World Congress of the International Union of Physiological Sciences in Queenstown, New Zealand, August 20, 2001.

121. "Multiphasic, Dynamic, High Throughput Measurements and Modeling for Postgenomic Cellular Biophysics," and panel discussion on Automating Physiological Data Collection: A Link to High-Throughput Modelling at the Scientific Scientific Advisory Board Meeting, Physiome, Inc., Princeton, NJ, November 10, 2001.

122. "SQUID Imaging of Exfoliation and Intergranular Corrosion," coauthored with Yu Pei Ma of Vanderbilt, Kevin Cooper of Luna Innovations, Inc., James Suzel of S&K Technologies, and Robert Kelly of the University of Virginia. Air Force Corrosion Program Office/S&K Technologies Working Group Meeting, Dayton, OH, November 14, 2001.

123. "High-Content Toxicology Screening Using Massively Parallel, Multi-Phasic Cellular Biological Activity Detectors," coauthored with Franz Baudenbacher, Robert Balcarcel, David Cliffel, Sven Eklund, Jonathan Gilligan, Owen McGuinness, Todd Monroe, Mark Stremler, Roy Thompson, Ales Prokop, and Andreas Werdich, DARPA PI Meeting, Miami, FL, February 21, 2002.

124. "Models and Measurements of the Anisotropic Cardiac Bidomain," Instituto de Matemática Pura e Aplicada, Rio de Janeiro, Brazil, May 6, 2002.

125. "The Physics of the Heart," XXV Encontro Nacional de Fisica de Matéria Condensada, Caxambu, Brazil, May 9, 2002. (Plenary)

126. "Virtual Electrodes," coauthored with Rubin Aliev, Mark-Anthony Bray, Franz Baudenbacher, Petra Baudenbacher, Veniamin Sidorov, Marcella Woods of Vanderbilt University, and Brad Roth of Oakland University, Cardiostim 2002, Nice, France, June 20, 2002.

127. "Imaging Hidden Corrosion with SQUID Magnetometers," Gordon Conference on Aqueous Corrosion, New London, NH, July 14-18, 2002.

128. "Vacuum Pair Production/Annihilation and Cardiac String Dynamics," Aspen Center for Physics," Aspen, CO, August 22, 2002.

129. "The Physics of the Heart," Heinz R. Pagels Memorial Lecture," Aspen Center for Physics, Aspen, CO,

August 28, 2002.

130. "Experimental and Computational Requirements for Post-Genomic Integrative Cellular Physiology," Intel Workshop on Early Detection, San Francisco, CA, September 24, 2002.

131. "VIIBRE: The Vanderbilt Institute for Integrative Biosystems Research and Engineering," Vanderbilt University Committee of Visitors Meeting, November 15, 2002.

132. "The Physics of the Heart," Department of Physics and Applied Physics Joint Colloquium, Stanford University, November 19, 2002.

133. "The Physics of the Heart," Vanderbilt Houston Alumni Club Fall Alumni Luncheon Series, December 4, 2002.

134. "Cardiac Phase, in the Spatial or Phase Domains, for Identifying Reentrant Behavior and Examining the Response of Cardiac Tissue to Electrical Stimulation," John Wikswo and Mark-Anthony Bray, Gordon Conference on Cardiac Arrhythmia Mechanisms, New London, NH, August 11, 2003.

135. "BioMEMS and the Measurements Needed to Drive Physiological Models," Biomedical Engineering Conference, Nashville, TN, October 2, 2003.

136. "An Overview of the Vanderbilt Institute for Integrative Biosystems Research and Education (VIIBRE)," Industrial/Practitioner Advisory Board for the Department of Biomedical Engineering, October 21, 2003.

137. "Correlations Between Single Cell Signaling Dynamics and Protein Expression Profiles," DARPA Meeting on Real Time Monitoring of Signaling Pathways in Biological Cells, Arlington, VA, April, 22, 2004.

138. "From Physics to Medicine: Cardiac Complexity and the Challenges of Modeling Multiscale Causality," International Conference on Complex Systems (ICCS2004), Boston, MA, May 16, 2004.

139. "Measurements versus models in cardiac strong-shock response," John Wikswo and Marcella Woods, 2004 SIAM Conference on the Life Sciences, Portland, Oregon, July 12, 2004.

140. "BioMEMS for Instrumenting and Controlling the Single Cell," Workshop on Microanalytical Devices for Bioprocessing, 2004 IEEE EMBS Conference, San Francisco, CA, September 1, 2004.

141. "The Need for Cellular and Molecular Sensors and Actuators," Mini-Symposium: Biomolecular Processors through Micro- and Nanotechnology, 2004 EMBS IEEE Conference, San Francisco, CA, September 2, 2004.

142. "Correlations Between Single Cell Signaling Dynamics and Protein Expression Profiles," DARPA SIMBIOSIS Meeting, Vail, Colorado, October 14, 2004.

143. "Instrumentation Challenges for Systems Biology," Keynote Lecture, Third IEEE Sensors Conference, Vienna, Austria, October 26, 2004.

144. "The Need for Dynamic Sensing and Control of Cells to Specify and Validate Systems Biology Models," Systems Biology Lecture Series, University of Michigan, Ann Arbor, MI, November 16, 2004.

145. "Systems Biology - The Next New Biology?" Vanderbilt Alumni Club, Nashville, TN, December 2, 2004.

146. "Integrative Systems for Biotechnology and Bioinformatics A Workshop on Challenges and Opportunities in Integrative Macro- Micro- and Nano-Systems," Sponsored by the National Science Foundation, Arlington, VA., March 7-8, 2005.

147. "The Technical and Computation Challenges of Merging NanoScience and Systems Biology," UT

Dallas, May 4, 2005.

148. "Back to the Future: Systems Biology as the New Physiology," UCSD Center for Theoretical Biological Physics, San Diego, April 22, 2005.

149. "Cellular Metabolic and Signaling Dynamics for Toxin Classification, Therapy, and Prophylaxis," DARPA Cell Signaling Workshop, Arlington, September 27, 2005.

150. "Cellular and Synthetic Signaling Pathways for Detecting and Classifying Unknown Toxins and Emerging Pathogens," UES Kickoff Meeting, Dayton, October 13, 2005.

151. "An Update on the Vanderbilt Institute for Integrative Biosystems Research and Education (VIIBRE)," Industrial/Practioner Advisory Board for the Department of Biomedical Engineering, Vanderbilt University, October 25, 2005.

152. "Metabolic and Signaling Dynamics for Cell Biology, Toxin ID, and Drug Discovery," Systems Biology Department, Harvard University, Boston, October 26, 2005.

153. "Systems Biology - The Next New Biology?" Houston Vanderbilt Alumni Club, Houston, December 1, 2005.

154. "VIIBRE: Dynamic Cellular Instrumentation and Control for Quantitative, Experimental Systems Biology, Biodefense, and Toxicology," Oak Ridge Area Director Briefing, Vanderbilt University, December 12, 2005.

155. "The Systems Engineering Problems of Systems Biology,"Plenary Lecture, 38th IEEE Southeastern Symposium on Systems Theory, Cookville, TN, March 6, 2006.

156. "The Promise and Challenges of Multianalyte Metabolic Dynamics," John Wikswo, Franz Baudenbacher, David Cliffel, Ales Prokop, Momchil Velkovsky (Vanderbilt University); Bela Csukas (Kaposvar University, Hungary); Jerry Jenkins, Shankar Sundaram (CFD Research Corporation), BioLSI-2; Kavli Nanoscience Institute, CalTech, April 11, 2006.

157. "Dynamic Cellular Instrumentation and Control for Quantitative, Experimental Systems Biology, Biodefense, and Toxicology," Department of Biomedical Sciences, Meharry Medical College, April 17, 2006.

158. "The Five Dimensions of Systems Biology," Microscale Life Sciences Center at University of Washington, April 21, 2006.

159. "Where Should We Look for Our Keys?" Keck Roundtable Discussion on the Future of Sciences, Los Angeles, CA, May 5-6, 2006.

160. "Max Delbrück at Vanderbilt -- 1940-1947," The Max Delbrück Vanderbilt Centenary Celebration, Vanderbilt University, September 14, 2006.

161. "SyBBURE: Systems Biology and Bioengineering Undergraduate Research Experience," Vanderbilt Parents Leadership Council, Vanderbilt University, September 29, 2006.

162. "Between the Street Lamps: Looking for Missing Keys to Cancer Using a BioMEMS Flashlight," Cancer Biology Retreat, Lake Barkley, Cadiz, KY, November 17-18, 2006.

163. "BioMEMS Approaches to the Missing-Data Problem in Systems Biology," Program in Biomedical Engineering, University of Memphis, February 16, 2007.

164. "BioMEMS and Symbolic Regression for Automated Inference of Metabolic Network Dynamics," Institute for Advanced Study, May 9, 2007.

165. "Systematic Extraction of Minimal Network Models from Model Cellular Systems for the Design of Robust Abiotic Signaling Networks," CB Defense Conference, Timmonium, MD, November 13, 2007,

Coauthors: John P. Wikswo, Michael Schmidt, Jerry Jenkins, David Cliffel, Roy Thompson, and Hod Lipson.

166. "BioMEMS Instrumentation and Control for Autocrine, Paracrine, Juxtacrine and Mechanical Signaling," Mathematical Biosciences Institute, Columbus, Ohio, November 14, 2007.

167. "Microdevices and Models for Cellular Metabolic Dynamics," IBM Thomas Watson Research Center, Yorktown Heights, New York, May 21, 2008.

168. "The Possibility of Automated Experiments for Inference of Metabolic Models," CNLS q-bio Seminar, Center for Nonlinear Studies, Los Alamos National Laboratory, September 16, 2008.

John P. Wikswo, Jr. -- Graduate Degrees Supervised:

Kenneth R. Swinney, "Techniques for Multipole Expansion of the Electrical Potential of a Heart in a Conducting Sphere and Calculation of the Magnetic Field of a Nerve Axon," M.S., 1979.

James K. Woosley, "A Theoretical Study of the Magnetic Field due to the Action Potential of a Single Nerve Axon," M.S., 1983.

Mark E. Riecken, "Magnetic Stimulation of Nerves," M.S., 1983.

Mary E. Hartson, "The Effect of Thermotolerance on the Radiosensitivity and Thermosensitization of Mammalian Cells," Ph.D., 1984 (With George M. Hahn, Stanford).

Bradley J. Roth, Non-Thesis Master of Science, 1985, on "The Magnetic Field of a Single Axon: A Comparison of Theory and Experiment," B.J. Roth and J.P. Wikswo, Jr., Biophys. J., 48: 93-109 (1985).

Dwight P. Russell, Non-Thesis Master of Science, 1985, on "Optimization of State Selection and Focusing of a Neutral Atomic Hydrogen Beam by a Hexapole Magnet," D.P. Russell and J.P. Wikswo, Jr., J. Physics E, 18: 933-940 (1985).

Peng Zhang, "Electrodeless Impedance Measurement," M.S., 1986.

Ranjith S. Wijesinghe, Non-Thesis Master of Science, 1987.

Bradley J. Roth, "Longitudinal Resistance in Strands of Cardiac Muscle," Ph.D., 1987.

Wei-Qiang Guo, Non-Thesis Master of Science, 1987, on "The Effects of Spiral Anisotropy on the Electric Potential and the Magnetic Field Recorded at the Apex of the Heart," B.J. Roth, W.-Q. Guo, and J.P. Wikswo, Jr., Mathematical Biosciences, 88: 191-221 (1988).

Ranjith S. Wijesinghe, "Comparison of Electric and Magnetic Techniques for the Determination of Conduction Velocity Distributions of Nerve Bundles," Ph.D., 1988.

Julia S. Charles, "Bioelectric Measurements of Bone Using a Magnetic Current Probe," M.S., Electrical Engineering, 1988.

Renea G. Stasaski, "The Electrophysiological Effects and Biomagnetic Signature of a Crushed Nerve Axon: A Comparison of Theory and Experiment," M.S., Biomedical Engineering, 1989.

Jan M. van Egeraat, "Magnetic Aspects of Non-uniform Propagation of Action Signals in Biological Fibers," Ph.D., 1991.

Shaofen Tan, "Linear System Imaging and its Applications to Magnetic Measurements by SQUID Magnetometers," Ph.D., 1992.

Kevin Kit Parker, "Forward and Inverse Modeling of the Magnetic Fields from Single Motor Unit Compound Action Potentials in Skeletal Muscle," M.S., Mechanical Engineering, 1993.

Daniel J. Staton, "Magnetic Imaging of Applied and Propagating Action Current in Cardiac Tissue Slices: Determination of Anisotropic Electrical Conductivities in a Two Dimensional Bidomain," Ph.D., 1994.

Leonard Alan Bradshaw, "Measurement and Modeling of Gastrointestinal Bioelectric and Biomagnetic Fields," Ph.D., 1995.

Eduardo Parente Ribeiro, "Magnetic Susceptibility Tomography with Superconducting Magnetometer SQUID," Ph.D., Electrical Engineering, PUC-Rio, Rio de Janeiro, 1996 (Academic Advisor: Paulo Costa Ribeiro, Co-advisors: Jacquez Szczupak and John P. Wikswo).

John P. Wikswo, Jr. -- Graduate Degrees Supervised: (con't)

Anthony Ewing, "SQUID NDE and POD Using a BEM Measurement Model," Ph.D., Mechanical Engineering, 1997 (with Professor Thomas A. Cruse).

Matthew E. Kieron, Jr., "A Spherical Electrode Array for the Detection of Stretch Induced Arrhythmias," M.S., Biomedical Engineering, 1998 (with Professor Robert J. Roselli).

Kevin Kit Parker, "Cardiac Bioelectroelastics," Ph.D., Biological and Applied Physics, 1998.

Mark-Anthony P. Bray, "Three-Dimensional Visualization of Epifluorescent Cardiac Action Potential Activity," M.S., Biomedical Engineering, 1999.

Afshin Abedi, "Magnetic Imaging of Corrosion Activity," Ph.D., 2000.

Mark-Anthony Bray, "Visualization and Analysis of Electrodynamic Behavior During Cardiac Arrhythmias," Ph.D., Biomedical Engineering, 2003 (with Marc Lin).

Robert Palmer, "BME Signal Processing for Gastromagnetic Fields," Ph.D., Biomedical Engineering, 2005 (with Alan Bradshaw).

Marcella Woods, "The Response of the Cardiac Bidomain to Electrical Stimulation," Ph.D., Biomedical Engineering, 2005.

Davis Soans, "Biphasic Phased-Array Stimulator," M.S., Biomedical Engineering, 2005.

Shawn W. Forrest, "Pacing and the Dynamic Measurement of Potassium Concentration in Whole Rabbit Hearts", M.S., Biomedical Engineering, 2006.

Bryan R. Gorman, "Characterization of Transport in Microfluidic Gradient Generators," M.S., Biomedical Engineering, 2007.

Shannon L. Faley, "Development of a Novel Microfluidic Platform to Study T Cell Signaling," Ph.D., Biomedical Engineering, 2007.

Mark R. Holcomb, "Measurement and Analysis of Cardiac Tissue During Electrical Stimulation," Ph.D., Physics, 2007.

Ipshita Chakraborty, "Characterization of a Passive Diffusion Microdevice for Assays of Chemotaxis and Morphogenesis," M.S., Biomedical Engineering, 2007.

Junkai Xu, "Nanocalorimetric Sensor for Ultra-Low Volume Biological Measurement and Calibration by Chemical Method," Ph.D., Physics, 2007.

Andrei Irimia, "Multivariate Signal Analysis and Theoretical Modeling for the Study of Gastrointestinal Bioelectromagnetism," Ph.D., Physics, 2007 (with Alan Bradshaw).

David Mashburn, "Phased Array Stimulation of Cardiac Tissue," M.S., Physics, 2007.

Raghav Venkataraman, "A Hollow Fiber Embedded Microfluidic Bioreactor for Recreating *In-Vivo* Nutrient Delivery to Cells," M.S., Biomedical Engineering, 2008.

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John P. Wikswo, Jr. -- Abstracts:

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4. "Magnetic Measurement of Cardiac Mechanical Activity: Model Calculations," J.P. Wikswo, Jr., Proc. AAMI 12th Annual Meeting, p. 261 (1977).
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33. "Measurements and Modeling of Neuromagnetic Fields," J.P. Wikswo, Jr., Proc. 38th Annual Conference on Engineering in Medicine and Biology, p. 54 (1985) (invited).

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42. "Multicellular Systems: Action Currents and Magnetic Fields," J.P. Wikswo, Jr., Proc. 39th Annual Conference on Engineering in Medicine and Biology, p. 147 (1986) (invited).

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211. "Quantification of Cell Motion in a Microfluidic Device," E.G. Kim, J.P. Wikswo, and K.T. Seale, Proceedings of the 2007 Annual Meeting of the Biomedical Engineering Society: Engineering the Future of Biology and Medicine, Los Angeles, CA, September 26-29, 2007, Conference abstract.

212. "Modulation of Cardiac Myocyte Adhesion, Growth and Remodeling Using Microcantilever Arrays," K.A. Addae-Mensah, L. Pentassuglia, D.B. Sawyer, and J.P. Wikswo, Proceedings of the 2007 Annual Meeting of the Biomedical Engineering Society: Engineering the Future of Biology and Medicine, Los Angeles, CA, September 26-29, 2007, Conference abstract.

213. "Multiple Vantage Point Microscopy with Mirrored Pyramidal Wells," K.T. Seale, R.S. Reiserer, J.W. Chamberlain, C. Janetopoulos, and J.P. Wikswo, Proceedings of the 2007 Annual Meeting of the Biomedical Engineering Society: Engineering the Future of Biology and Medicine, Los Angeles, CA, September 26-29, 2007, Conference abstract.

214. "Quantification of the Motion of Non-Adherent Cells in a Microfluidic Device," E. Kim, K. Seale, and J. Wikswo, 74th Annual Meeting of the Southeastern Section of the American Physical Society, Session BB.00003, November 8-10, 2007, Nashville, TN.

215. "Activation Time of Cardiac Tissue in Response to a Linear Array of Spatial Alternating Bipolar Electrodes," D. Mashburn and J. Wikswo, 74th Annual Meeting of the Southeastern Section of the American Physical Society, Session CB.00005, November 8-10, 2007, Nashville, TN.

216. "Novel Micromirrors to Obtain Three-Dimensional Images of Cells," C. Wright, E. Boczko, J. Wikswo, and K. Seale, 74th Annual Meeting of the Southeastern Section of the American Physical Society, Session CB.00010, November 8-10, 2007, Nashville, TN.

217. "Simultaneous Multi-Perspective Three Dimensional Microscopy with Mirrored Pyramidal Wells," K.T. Seale, R. Reiserer, D. Markov, I. Ges, C. Janetopoulos, and J. Wikswo, Focus on Microscopy International Symposium, April 2007, Valencia, Spain, Platform Presentation.

218. "Novel Microfluidic Platform for the Analysis of T Cell Signaling Pathways," S. Faley, K.T. Seale, J. Hughey, D. Unutmaz, F. Baudenbacher, and J. Wikswo, SPIE Biophotonics West, San Jose, January 2007, Platform Presentation.

219. "BioMEMS Methods for Cell Biology," K.T. Seale and J. Wikswo, Vanderbilt Ingram Cancer Center Annual Fall Retreat, November 2007, Platform Presentation.

220. "Quantification of Cellular Motility for Application to Biological Assays," E. Kim, M. Harris, B. Weidow, V. Quaranta, J. Wikswo, and K. Seale, Proceedings of the 2008 Biomedical Engineering Society: Gateway to Innovation, Paper P1.105, St. Louis, MO, October 2-4, 2008.

221. "A Microfluidic Device for Galvanotaxis Measurements," A. Skandarajah, D. Henson, C. Janetopoulos, and J. Wikswo, Proceedings of the 2008 Biomedical Engineering Society: Gateway to Innovation, Paper P6.77, St. Louis, MO, October 2-4, 2008.

222. "Microfluidic Devices for Monitoring Cell-Receptor Interactions Under Flow Conditions," D. Markov, J. Lu, P. Samson, J. Wikswo, and L. McCawley, Proceedings of the 2008 Biomedical Engineering Society: Gateway to Innovation, Paper P6.131, St. Louis, MO, October 2-4, 2008.

223. "Thick-Tissue Bioreactor for Long-Term Organotypic Culture of Normal and Tumorigenic Mammary Epithelial Cell Lines," D. Markov, J. Lu, P. Samson, J. Wikswo, and L. McCawley, Proceedings of the 2008 Biomedical Engineering Society: Gateway to Innovation, Paper P6.136, St. Louis, MO, October 2-4, 2008.

224. "Microfluidic Approach to Measure Bacterial Responses to Micro-Chemical Gradients," V. Allwardt, P. Samson, D. Markov, J.W. Dolan, J.P. Wikswo, and L.M. Shor, American Society for Microbiology (ASM) Regional Meeting, Henderson, TN, Poster Presentation, October 3-4, 2008.

225. "A Platinum Screen-printed Electrode for Real-time Monitoring of Cellular Metabolism in a Microfluidic Device," J. Merritt, J. Wikswo, and D. Cliffel, PRIME2008, 214th Meeting of the Electrochemical Society, Abstract No. 2845, Honolulu, HI, October 16, 2008.

John P. Wikswo, Jr. -- Research Interests:

I joined Vanderbilt in 1977, fresh from graduate and postdoctoral work studying the cardiac magnetic field at Stanford University in the Division of Cardiology and the physics laboratory of William Fairbank. My goal was to build a program in the measurement of biological magnetic fields and make the first measurement of the magnetic field of an isolated nerve, which John Barach, John Freeman and I accomplished by 1980. More than a dozen years of support by the Office of Naval Research, the NIH, and the Veterans Administration led to the first measurements of the magnetic field of a single nerve axon and other studies that provided, for the first time, a firm biophysical foundation for the production and detection of the magnetoencephalogram and other biomagnetic signals.

By the late 1980s, I recognized that the holy grail of biomagnetic measurements, biological activity that was detectable magnetically but was electrically silent, would be hard to find in one-dimensional systems. I was the first to recognize that usually ignored differences in the electrical anisotropy between the intracellular and extracellular spaces of a sheet of cardiac tissue would lead to just such a situation. I had to devise a new class of Superconducting Quantum Interference Device (SQUID) magnetometers that had the spatial resolution and sensitivity required to detect these fields and raise the $300,000 to get the instrument built; by 1991 my group had found the desired field pattern and devised magnetic imaging algorithms that have become the gold standard in the field. We recognized that the same instrumentation, scanning stages, and analysis algorithms could detect flaws in metals and plastics, and we mounted a 10-year program that was funded by the Air Force Office of Scientific Research (AFOSR), private industry, and the German government. This work evolved into an AFOSR-sponsored initiative and produced the only technique yet known that can measure the instantaneous rate of corrosion occurring inside an aging aircraft lap joint. This work in turn attracted long-term support from the Air Force. As our understanding grew, we found that the mathematical models of electrically and magnetically silent fields applied not only to cardiac muscle but also riveted aluminum.

Meanwhile, with colleagues in the Medical Center, I began measuring cardiac conduction velocity during ischemia and infarct and in the presence of antiarrhythmic drugs. During one of these experiments, I recognized the existence of virtual cathodes in cardiac tissue, which happened to be related to the same anisotropy differences that produced the magic magnetic fields. The cardiac community paid little notice until my collaborators and I showed that these anisotropy differences and associated virtual cathodes and anodes could explain an old puzzle in cardiac electrophysiology, produce a previously unrecognized form of cardiac reentrant activation, and provide key mechanisms for understanding the success or failure of cardiac defibrillation. This work also led us into the non-linear dynamics of cardiac stimulation.

The continuing exploration of biomagnetic measurements picked up another first, the magnetic field of intestinal smooth muscle, which has spawned a large, well-funded and productive collaboration with Bill Richards and Alan Bradshaw that is developing SQUID measurements into the first non-invasive clinical tool for the diagnosis of acute mesenteric ischemia and other gastrointestinal disorders.

The quest for the higher spatial resolution SQUIDs led me to recruit Franz Baudenbacher to lead an NSF- and NIH-funded project that has produced the world's best SQUID microscope and used it in an experiment, in collaboration with a geobiology group at Caltech, to characterize the thermal history of a Martian meteorite from its magnetic signature and show that material could be transported from Mars to earth without sterilization. This NanoSQUID has the potential to revolutionize the magnetic measurement of geophysical samples, and it is now hard at work recording beautiful data of the electrically silent magnetic fields of currents propagating through cardiac tissue, made possible by productive excursions into geophysics and NDE!

In 2000, my colleagues and I designed and launched a major initiative to "Instrument and Control a Single Cell." A $5 million grant from Vanderbilt created the Vanderbilt Institute for Integrative Biosystems Research and Education (VIIBRE) as the springboard. We have already raised an additional $9 million in external funds, and we are working hard to build and equip new labs and begin experiments to determine how cells react to chemical and biological weapons, how best to specify dynamic metabolic and signaling pathways, why cancer cells crawl in response to chemical gradients and endothelial cells form capillaries,

how T cells are activated and their signaling pathways can be studied, and how to accelerate wound healing and contemplate why mammalian limbs don't regenerate. I have assembled a cadre of high school, undergraduate and graduate students, postdocs, faculty, and staff to explore the interface of physics, chemistry, engineering, biology and medicine. Over 200 people have collaborated on proposals and projects or been supported by VIIBRE. We have just begun to see the early returns on our long-term investment, in the form of research results, publications, and additional grants. I expect that the cell instrumentation project and the associated teaching will occupy me fully for the next decade.

John P. Wikswo, Jr. -- Research Facilities:

Professor Wikswo has, over the past 29 years, created a series of laboratories and experimental capabilities ideally suited for biophysical, bioenginnering, and physiological studies on humans, whole animals, isolated tissue, and cells. The capstone of this effort is the Vanderbilt Institute for Integrative Biosystems Research and Education, VIIBRE, which was created in 2001 with a five-million dollar, five-year grant from the Vanderbilt Academic Venture Capital Fund to foster and enhance interdisciplinary research in the biophysical sciences and bioengineering at Vanderbilt integrated with a strong focus on undergraduate, graduate and post-doctoral education. Professors John Wikswo and Franz Baudenbacher are the VIIBRE Director and Co-Director, respectively.

Taking advantage of Vanderbilt's existing strengths in biology, physics, medicine, engineering, and education, VIIBRE has created on-campus collaborations in research areas such as cellular biosensors for cancer research, chemical and biological warfare defense and infectious disease detection, single- and multicellular instrumentation and control, biomedical imaging, biological applications of nanosystems, cellular/tissue bio-engineering and biotechnology, and bioengineering education technologies.

Professor David Cliffel is directing the MicroPhysiometry effort, Professor Baudenbacher is leading the NanoPhysiometry effort, and Professor David Wright is leading VIIBRE's NanoMedicine program. Professor Vito Quaranta is directing a major program in modeling of cancer in which several VIIBRE faculty are key participants. To date, VIIBRE has helped bring to Vanderbilt approximately twenty million dollars of new external funding.

Laboratories: The close physical proximity of Arts & Science, Medicine, and Engineering at Vanderbilt, which has given rise to a long tradition of interdisciplinary collaboration, has been a significant factor in VIIBRE's development. The ~9,000 ft^2 laboratories of the Vanderbilt Institute for Integrative Biosystems Research and Education (VIIBRE) are located on the first and eighth floors of Stevenson Center Building 6 for the Natural Sciences and Engineering (immediately adjoining the Department of Physics and Astronomy, which occupies the majority of Building 6, and the Department of Biomedical Engineering, which is located on the eighth and ninth floors of Building 5. The Department of Chemistry occupies floors 1, 2, and 5 of Building 5 and all of Building 7. The Stevenson Center was built next to the Vanderbilt University Medical Center to foster collaborative research, and hence the laboratories of collaborating Medical School investigators are within a two-minute walk of the VIIBRE, Biomedical Engineering, Chemistry and Physics Laboratories.

VIIBRE Microfabrication Laboratory: VIIBRE has three Class-100 clean rooms, totaling 550 sq.ft., that are equipped to perform standard micromachining techniques including thin-film deposition, photolithography, etching, and surface modification, with an emphasis on constructing hybrid soft-lithographic microfluidic devices with thin-film and optical sensors. The major equipment in this laboratory is discussed below. An additional room is devoted to wet sample processing, chemical etching, and chemical vapor coatings. A teaching laboratory has been created and equipped with laminar flow and chemical hoods for training students and research associates in microfabrication.

VIIBRE Cellular Instrumentation and Control Laboratory: Five VIIBRE worksta-tions are dedicated to high-bandwidth (i.e., rapid temporal response) studies of the dynamics of cellular signaling and metabolism. A particular focus is paid towards cell-based biosensors, and using soft-lithographic MEMS (microelectromechanical systems) fabrication techniques to create silicone-based elastomeric Micro- and NanoPhysiometers that measure simultaneously from a small population of cultured cells in microliter to sub-nanoliter cell-culture chambers oxygen consumption, extracellular pH, glucose consumption, lactate production, amino acid consumption and production, and release of specific small molecules, intracellular quantities such as oxidation/reduction potential, transmembrane potential, calcium concentration, and the expression of selected chemokines. Active pumps and feedback controls are being developed to maintain long-term cell health in the highly restricted nanoliter culture volumes. The small size of our nanobioreactor cell culture chambers (sub-nanoliter rather than milli- or microliter), the small number of cells being measured

(1 to 100 versus 10^4 to 10^6), and the small size and proximity of our electrochemical sensors to the cells (microns versus millimeters) provide an unprecedented 100 ms dynamical response (*i.e.*, wide bandwidth) to biochemical events that are at present studied with temporal resolution of many seconds or even minutes.

The combined use of our BioMEMS control systems and real-time numerical modeling of nonlinear cellular events allows us to explore the nature of cellular control mechanisms and discern the complexities of the role of specific proteins in cellular function in a manner not possible with conventional instrumentation. The VIIBRE cellular instruments are being created using state-of-the-art multichannel potentiostats, inverted microscopes, computer-controlled micropumps, and high-speed CCD and photodiode fluorescence imaging systems. Such devices are already being used by VIIBRE graduate and faculty fellows to study the chemotaxis and haptotaxis of cancer cells, pancreatic islet metabolism and the signaling dynamics that govern insulin release; physiological effects of bio-warfare agents; thermal changes associated with protein denaturation; the electrophysiology of single cardiac cells; and predator-prey relationships in bacterial-protozoan bioremediation.

SQUID Facility: Professors Wikswo and Baudenbacher have ten custom-built SQUID instruments, including two high resolution SQUID microscopes that define the state-of-the-art in sensitivity for room temperature samples, an imaging magnetic susceptometer for studies of biomagnetic susceptibility distributions in experimental animals, an axial-field SQUID eddy current system, a six-channel vector SQUID gradiometer, and a three-axis SQUID system dedicated to imaging corrosion currents in aluminum, and two low-noise, high resolution SQUID systems. The corrosion and MicroSQUID systems are equipped with magnetic shields and automated scanning systems that allow around-the-clock measurements. A 29-channel clinical SQUID system for magnetoenterography and a custom shielded room in the Vanderbilt University Medical Center are in regular clinical use by Professors Richards and Bradshaw.

In addition to a number of small magnetic shields, the facility has a Vacuumschmelze 15 ft $\times$ 12 ft $\times$ 9 ft magnetically shielded room that is used for the SQUID microscopes, for studies of biomagnetic signals from humans and for other measurements requiring a low field environment. The room has two mumetal layers and one of aluminum, and reduces the geomagnetic field within the shield to less than 0.15 μT. The 60 Hz magnetic field within the room is less than 0.5 nT. The room is equipped with DC lighting, and two overhead gantries for positioning SQUID magnetometers above a patient.

General VIIBRE Laboratories: In addition to the laboratories dedicated to micro-fabrication and cellular instrumentation, VIIBRE facilities on the eighth floor of Building 6 include a biochemistry laboratory; a conference room; a cold-room; a darkroom; an electronics shop; a laboratory-services room; and a machine shop. As a complement to its own shops, staffed by a full time technician, VIIBRE is a regular user of the Natural Science Division Machine Shop, also in Building 6, which is staffed by two full-time instrument makers.

Animal: VIIBRE has a Cardiac Imaging Laboratory for single camera, dual camera, and panoramic high-speed fluorescence imaging of the electrical response of isolated rabbit hearts to electrical stimulation. Other animal facilities are provided by the Division of Animal Care, immediately adjacent to Buildings 5 and 6 of the Stevenson Center.

Computer: All VIIBRE members and staff have individual Pentium-class computers, and the laboratories have numerous computers for data acquisition, control, and analysis.

Office: VIIBRE has offices for 32 project faculty, post-doctoral fellows, and students that are located on the first and eighth floors of Stevenson Center Building 6. There are internet connections in every office.

Other: Over the past three years VIIBRE has established various core technologies that are directly relevant to biodefense and infectious disease detection. These include Cytosensor Microphysiometers with added capabilities for simultaneous measurement of glucose, lactate, and oxygen; microfabrication facilities that have been constructed in the past two years; nanophysiometers for measurements on single cells; gradient migration chambers; beds-of-nails for traction force microscopy; high porosity nanofilters for cellular

perfusion and other applications; nanobioreactors for perfusing small populations of cells in multiple cell traps; devices to allow measurements of insulin and glucose signaling in a single pancreatic islet; and cell traps and filters to study the behavior of bacteria-protozoa colonies. Several of these are described under Major Equipment.

Major Equipment:

VIIBRE's cellular studies are conducted in two cellular biophysics laboratories with a total of five laminar-flow biosafety hoods, three electromagnetically shielded rooms equipped with Zeiss Axiovert inverted fluorescence microscopes, as well as in laboratories located in Biomedical Engineering, Chemistry, Chemical Engineering, Molecular Physiology & Biophysics, and Civil & Environmental Engineering. The Cellular Instrumentation and Control Laboratory also has extensive instrumentation for tissue- and cell-based electrophysiological measurements and test equipment such as digital oscilloscopes, low-noise amplifiers, computer I/O devices, power supplies, and a spinning-disk confocal microscope.

The VIIBRE MicroFabrication Laboratory is equipped with fume hoods, four Laurell technologies single-wafer spin processors, a Karl Suss MJB3 mask aligner, an Innotec electron-beam/ion-etch thermal evaporator system, a Novacure UV spot curing system, a plasma cleaner/bonder, binocular inspection microscopes, ovens, digitally programmable hot plates, and an electronically actuated precision micromanipulator for multi-layer device assembly. VIIBRE also has an ultrasonic wire bonder, a wire saw, a Buehler Isomet 4000 precision diamond saw, a wet diamond drill press, and other standard support instruments.

VIIBRE owns and operates five four-channel and one eight-channel Cytosensor™ (Microphysiometer) using microliter sensing volumes, both of which can use modified sensing heads for multianalyte recording. We adapted the Cytosensor™ Micro-physiometer enabling simultaneous measurement of changes in extracellular glucose, lactate, and oxygen concentrations in conjunction with extracellular acidification rate. Platinum electrodes are inserted into the standard Cytosensor™ plunger head and modified with enzymes and biocompatible polymeric. The lactate and glucose oxidase enzymes catalyze the reaction of lactate and glucose. Hydrogen peroxide, an end product of these catalyses, and extracellular oxygen are measured amperometrically while the acidification rate is measured potentiometrically by the Cytosensor™. Useful information is obtained during Cytosensor™ stop-flow cycles which produce increasing or decreasing peaks due to the production of lactic acid, carbonic acid, and consumption of glucose and oxygen by the cells. The result is a microphysiometer that can measure metabolic changes with respect to at least four analytes.

Electrophysiological Instrumentation: Professors Wikswo and Baudenbacher operate a laboratory suite that is well equipped for electric and magnetic recordings from isolated cardiac and neural tissue. The laboratory has an extensive collection microelectrode and patch clamp amplifiers, high-voltage stimulators, Faraday shields, electrophysiological, cryogenic, and general purpose test instruments, including a state-of-the-art system for panoramic laser-fluorescence imaging of cardiac action potentials in isolated hearts. The laboratory has many Labview-based data acquisition systems with extensive electronic instrumentation and digital oscilloscopes, including computerized scanning stages, and innumerable personal computers and workstations.

John P. Wikswo, Jr. -- Biographical Sketch:

John P. Wikswo, Ph.D. received a B.A. degree in Physics from the University of Virginia and his M.S. and Ph.D. degrees in Physics from Stanford University. He was a Research Fellow in Cardiology at the Stanford University School of Medicine from 1975 to 1977. He joined the faculty in the Department of Physics and Astronomy at Vanderbilt University as an Assistant Professor of Physics in 1977. He is now the Gordon A. Cain University Professor, A.B. Learned Professor of Living State Physics, Director of the Vanderbilt Institute for Integrative Biosystems Research and Education (VIIBRE), and Professor of Biomedical Engineering, Molecular Physiology & Biophysics, and Physics. He has been a Woodrow Wilson Fellow, an NSF Predoctoral Fellow, a Bay Area Heart Research Committee Fellow, an Alfred P. Sloan Research Fellow, and a John Simon Guggenheim Fellow. He is a fellow of the American Physical Society, the American Institute for Medical and Biological Engineering, the American Heart Association, the Council on Basic Cardiovascular Sciences of the American Heart Association, the Biomedical Engineering Society, Heart Rhythm Society, and the Institute for Electrical and Electronic Engineers. In 1997, he received the Thomas Jefferson Award from Vanderbilt University for service to the university.

At Vanderbilt, John Wikswo's research has been directed primarily towards using novel instrumentation, electric and magnetic measurements, and electromagnetic theory and numerical models for studying the propagation of bioelectric activity, non-destructive testing, and biological microelectromechanical systems (BioMEMS). He made the first successful measurements of the magnetic field of an isolated nerve axon and a single muscle fiber, and was the first to visualize virtual electrodes in cardiac tissue during strong electrical shocks. He has taken an active role in arguing that judicial electrocution constitutes cruel and unusual punishment. His current research includes studies of the role of tissue anisotropy on the initiation and propagation of cardiac action potentials, and the application of cellular instrumentation and control to experimental systems biology. In particular, he and his collaborators are developing advanced techniques to study metabolic and signaling dynamics; cell migration in cancer, angiogenesis, and wound healing; and predator-prey relationships in bacterial/protozoal bioremediation. He has guided the research of 31 graduate students, 19 research associates, and 9 research assistant professors. He has published over 150 research articles and book chapters, and more than 360 conference papers, abstracts and reports. He holds eleven patents.

John P. Wikswo, Jr. -- University Service:

Ever since I arrived at Vanderbilt in 1977, I have served on a wide range of departmental, college, and university committees; this contribution was recognized in 1997, when I received the Thomas Jefferson Award for university service. Of all of my service and administrative activities, several have had a lasting University-wide impact. In 1984-1985, I served on the Ad Hoc Committee on a Special Program for Outstanding Students, which recommended the creation of the College Scholars Program. From 1990-1993, I took an active role, through the University Patent Review Committee, in the development of the University's intellectual property policy. From 1995 through 1998, I chaired the Committee on Appointment, Promotion, and Tenure, which conducted an in-depth review and revision of the criteria, policies, and procedures for appointment, promotion, and tenure within University Central. These last two committees have defined an appreciable fraction of the Faculty Manual for Vanderbilt University. At present, I am serving on the Provost's Strategic Academic Planning Group, which is developing a strategic plan for University Central.

John P. Wikswo, Jr. -- Teaching:

My teaching philosophy can be embodied in three quotations: "The mind is not a vessel to be filled but a fire to be kindled" (Plutarch); "You cannot teach a man anything; you can only help him to find it within himself" (Galileo); and "Education is what survives when what you have learned is forgotten" (B.F. Skinner). My teaching also reflects my upbringing and interests. I am an experimental physicist, engineer, and physiologist. I love to build and play with gadgets, help people learn to build things, and figure out and explain how things work – vocations I trace to my childhood. My father, an industrial research chemist and master equally of all trades and the Socratic method, started building a 16-inch telescope when I was five. During my 15-year apprenticeship to this and other projects, I learned the how and wherefore of everything from mirror grinding to plumbing. (Our telescope and observatory were featured in Scientific American in April, 1970). My mother, a college mathematics professor, shared with me her love for teaching. When I was in third grade, I explained to one of her classes a binary adding machine I had assembled. In high school I explained things the teachers didn't understand to my algebra and physics classmates. As an undergraduate at the University of Virginia, I had another remarkable mentor in Professor Bascom Deaver, who hired me as a technician to equip his new low temperature physics laboratory, guided me as I taught myself experimental physics, and encouraged me to work with his mentor at Stanford, William Fairbank. My belief in learning by doing and by teaching was deepened when my wife and I taught our children at home for a few years. I observed not only the various ways that humanists and scientists approach the world, but also how different people think and learn. Watching our children explain things to each other and their friends convinced me that students learn by explaining. I can even cite professional pedagogical influences, such as Richard Light's *The Harvard Assessment Seminars* (which I require my students to read) and Sheila Tobias' *They're not Dumb, They're Different*.

Teaching at Vanderbilt is marvelously rewarding. My undergraduate repertoire includes Advanced Laboratory in Mechanics and Heat, Medical Physics, Electricity and Magnetic Fields, General Physics, Bioelectricty, Elementary Physics, Biophysical Electrodynamics, Principles of Physics, Practical Physics, Introduction to Applied Physics, and Electricity, Magnetism, and Electrodynamics. I have developed new demonstrations for premed introductory courses, taught medical physics to biomedical engineers (including Kevin Kit Parker, who is contributing a letter) and electricity and magnetism to upperclass physics undergraduates and incoming graduate students. I showed my medical physics class how to build an X-ray machine from physics demonstration apparatus and took an X-ray of a frozen frog. I regularly recruit undergraduates to work in my lab. In revising old teaching laboratories or devising new ones, I have enlisted undergraduates to develop many of the course materials. The largest such project was an Advanced Undergraduate Laboratory in Living State Physics, supported by NSF and Vanderbilt, and for which Barbara Vickrey, an undergraduate major in biomedical engineering, created a 265-page lab manual in 1980 that I used for many years. I have participated in the Honors Seminars Program since it was begun 20 years ago. When discussing thermodynamics in my honors seminar on Revolutions in Physics, I realized that no one had a deeper understanding of how a refrigerator works than "Well, you open the door and you take out the Diet Coke" and immediately designed and began teaching a seminar on Physics of Technology that used Lego and David Macaulay's The Way Things Work, which happens to contain, beneath the wooly mammoths, a complete introductory physics text.. When Vanderbilt installed its first Mac classroom, I enlisted Chuck Black, then a junior physics major and now a staff physicist at IBM's Watson lab, to use Hypercard to create a complete courseware authoring system that we used for interactive learning and student presentations. This project evolved to an introductory physics class that I taught to the general non-science student body. I enlisted two students to help me add a lab to the course, which began with each student disassembling, studying, explaining, and reassembling a lawnmower engine, and ended with mastering the use of oscilloscopes to see how springs damp automobile vibrations.

As my interdisciplinary research has expanded into new areas, so has my teaching. I received a Whitaker Special Opportunity Award ("Instrumenting and Controlling the Single Cell: An Education Program in Biomedical Engineering") that supported two new faculty members and created new courses.

Over the past few years, a wonderful mix of science, humanities, and engineering students has been

taking my honors seminar *What is Life?* that spans the interface between physics, engineering, and biology. We begin with a critical reading of Erwin Schrödinger's famously flawed book of the same name, and go on to Gunter Stent's annotated edition of *The Double Helix* (and viewing of the documentary *The Secret of Photo 51*), Dyson's *The Origins of Life* (which provides a fertile ground for discussion of the frontiers of knowledge), and student-led presentations and a rational analysis of intelligent design versus evolution.

Most recently, a generous gift from an alumnus created SyBBURE, the Systems Biology and Bioengineering Undergraduate Research Experince. Through SyBBURE, a select group of Vanderbilt undergraduates are being offered a distinctive opportunity to explore science at one of its most promising and exciting frontiers – the intersection of systems biology and bioengineering – where the traditional lines of disciplines and fields blur and the work of transinstitutional, interdisciplinary collaboration and discovery takes place. The gift was made with the aim of providing undergraduate students with mentored experiences in advanced scientific investigation with some of the University's leading research and teaching faculty. The program's major aim is to enable science and engineering students to participate actively in ongoing research projects. However, a limited number of non-science majors also may design a research experience by combining independent study projects with the directed readings and seminars offered by the program. The donor's objective of increasing the number of undergraduates involved in scientific research dovetails with the educational mission of VIIBRE, which seeks to enhance the role of the biophysical and biochemical sciences and bioengineering in educational programs in biology and medicine at the undergraduate, graduate, and postgraduate levels.

SyBBURE, in its broadest sense, will give students a larger view of the needs and consequences of the emergence of interdisciplinary science. The program will focus on systems biology and bioengineering – highly quantitative, analytical fields that together are enabled by tools, techniques, and theories from across the biological, medical, mathematical, engineering, and physical science disciplines. The goals of the program are to provide to undergraduate students, as early as possible in their academic careers, training in specific research tools and participation in scientific research. The program exposes students to interdisciplinary research, gives them the experience of working in teams and mentoring each other, and involves them in the immediacy and relevance of interdisciplinary science. They are learning to formulate problem-driven questions and are participating in the development of new technology, much of which will be based upon Biological MicroElectroMechanical Systems (BioMEMS) and nanodevices.

Components of the program include

- Workshops in research tools (BioMEMS microfabrication, electronic instrumentation, machining, and microscopy) and analytical and computational software programs, including LabVIEW, MATLAB, AutoCAD, Metamorph, ImageJ, and Slidebook. Upon completion of the appropriate workshops, undergraduates will be prepared to contribute to and function as self-motivated partners in research on real problems. In subsequent years, they will also be able to teach the workshops themselves and mentor more junior participants in the program. The workshops and seminars are utilizing the challenge-based learning approaches developed by the Vanderbilt Texas Northwestern Harvard/MIT (VaNTH) Engineering Research Center for Biomedical Engineering Education.
- Four research teams of five undergraduates are working with graduate students, postdoctoral fellows, research staff, and faculty in Arts and Science, Engineering, and Medicine. Each team will focus on a project involving quantitative measurements on living cells.
- Topical seminars in journal club format, led by faculty and postdoctoral fellows, summer and academic research stipends, travel to conferences, and on-campus informal gatherings and other activities.

Eighteen students participated in the summer 2006 program, and additional sophomores and juniors will be recruited for the fall of 2006. The first workshop modules on BioMEMS were implemented in the summer of 2006 and are being offered again in fall 2006. As the workshops are perfected, students not associated with SyBBURE can use these workshops to gain skills useful in their research with other Vanderbilt faculty.