

Partnership in Physiological Measurements and Computing

A Proposal Prepared for the University of Rhode Island Partnerships Program - Part B

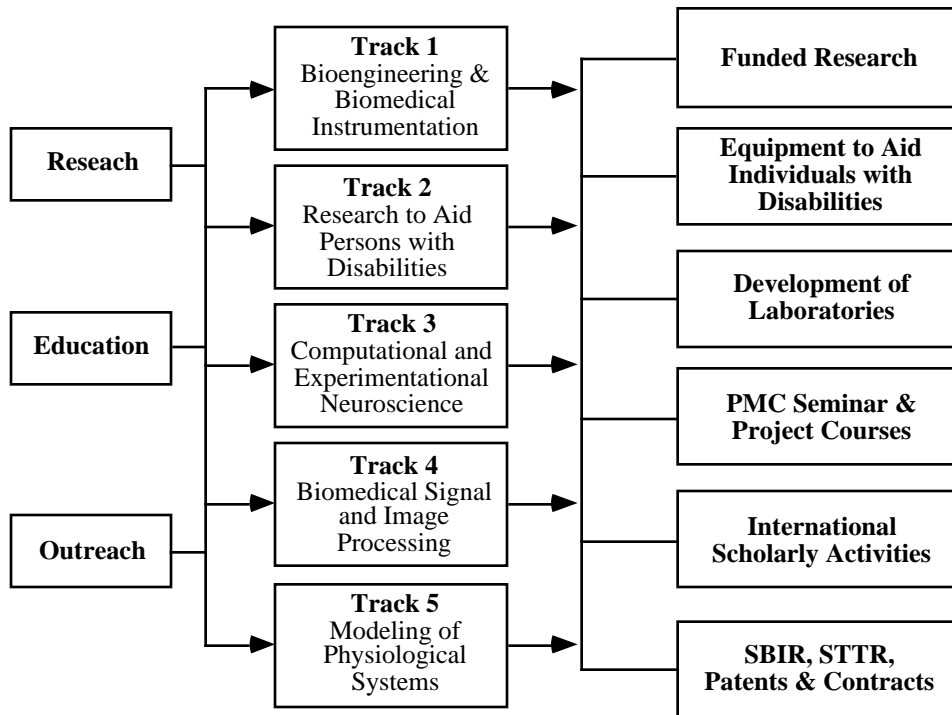
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APPENDIX

Table of Contents

Summary Chart of Partnership Objectives -----	B-1
Biographical Sketches of Faculty Participants -----	B-1
Summary of Experience and Expertise of External Institutes -----	B-7
Budget Summary -----	B-8
Budget Explanation -----	B-9

SUMMARY CHART OF PARTNERSHIP OBJECTIVES



BIOGRAPHICAL SKETCHES OF FACULTY PARTICIPANTS

College of Engineering

G. Faye Boudreaux-Bartels: BS University of Southwestern Louisiana; MS and PhD Rice University. She was a research assistant for Shell Development Company, Houston, TX from 1974-1977 and a Fulbright Scholar at Ecole National Supérieure des Telecommunications, Paris, France from 1981-1982. Since 1984, Dr. Boudreaux-Bartels has been teaching at URI where she is currently Professor of Electrical and Computer Engineering. Her research interests are in the area of time-frequency analysis of time-varying or dispersive signals and systems and in the area of

digital signal processing. She has published over 90 papers one of which won the "1988 Senior Paper Award" given by the IEEE Signal Processing Society (SPS). Dr. Boudreaux-Bartels was made a Fellow of the IEEE for her "contributions to time-frequency signal representations and their applications." Her research was funded by the US Navy.

Godi Fischer: Dipl.Ing. and PhD Swiss Federal Institute of Technology (ETH), Zurich; Research Associate, Institute for Signal and Information Processing, ETH 1981-85; Professor of Electrical Engineering at URI 1985-present. His research interests include: analog and digital filter design, high resolution data converters (sigma-delta modulators) and low power CMOS circuits. Past projects include: design of a direct digital frequency synthesizer (DDFS) with 12 bit amplitude and a 32 bit frequency resolution, realization of a monolithic wide-band sonar receiver with 90 dB dynamic range, design of an archival animal tag with integrated thermal sensor. Professor Fischer also coordinates the VLSI Design and Testing Laboratory.

Steven Kay: BE Stevens Institute of Technology; MS Columbia University and PhD from Georgia Institute of Technology. At Bell Laboratories from 1972-75 he was involved with transmission planning for speech communications and simulation and subjective testing of speech processing algorithms. From 1977 to 1980, he was with the Raytheon Submarine Signal Division where he engaged in research on autoregressive spectral estimation and the design of sonar systems. He is presently Professor of Electrical Engineering at URI, and a consultant to industry and the Navy. He has written numerous papers and is a contributor to several edited books. He is the author of the textbooks Modern Spectral Estimation (Prentice-Hall, 1988), Fundamentals of Statistical Signal Processing, Vol. I: Estimation Theory (Prentice-Hall, 1993), and Fundamentals of Statistical Signal Processing, Vol. II: Detection Theory (Prentice-Hall, 1998). His current interests are spectrum analysis, detection and estimation theory, and statistical signal processing. Dr. Kay is a Fellow of the IEEE, and a member of Tau Beta Pi and Sigma Xi. He has served on the IEEE Acoustics, Speech, and Signal Processing Committee on Spectral Estimation and Modeling.

Ramdas Kumaresan: BS University of Madras, India; MS and PhD URI. Member of technical staff GTE Corporation 1982-83; University of Rhode Island 1983-present where he is currently Professor of Electrical Engineering. In 1989-90 he was an Humboldt fellow at Kaiserslautern, Germany. Professor Kumaresan is a Fellow of the IEEE recognized for his contributions to signal processing. He is widely published in the area of spectral/signal analysis and system identification. His current interest is in signal processing related to the auditory system. Particularly, his interest is in modeling the vibratory motions of the cells in the inner ear of mammals and in explaining how the auditory periphery represents the acoustic environment. He works with auditory scientists at Columbia and Brown University. The ultimate goal is speech analysis and recognition. Dr. Kumaresan is also Coordinator of the digital signal processing (DSP) laboratory in the Department of Electrical and Computer Engineering.

Allen G. Lindgren: BEE Clarkson University; MS and PhD University of Connecticut. Professor of Electrical Engineering, URI 1970-present; Visiting Professor Brown University 1971; Visiting Professor Swiss Institute of Technology (Institute for Signal and Information Processing) 1979, 1984, 1990 and 1997-98; Consultant to US Naval Underwater Systems Center and several industries. He has published over 50 papers in the area of signals and systems. His interests are signal and system theory including adaptive and nonlinear systems. Current research activities include adaptive echo cancellation using computational efficient frequency-domain techniques (with application to hearing aids with nonlinear compensation and hands-free telephony), system identification and modern methods for blind separation and deconvolution. Past projects include: control of multivariable systems, control and guidance of underwater vehicles, stability of multidimensional systems, modeling of physiological systems, computerized imaging

and the Radon Transform, locating and tracking sources of radiation, estimation and classification, system identification and echo cancellation.

Jien-Chung Lo: BS National Taipei Institute of Technology; MS and PhD University of Southwestern Louisiana; Associate Professor, URI 1988-present. His research interests include reliable distributed computing, concurrent error detection, error-control coding, high speed computations and VLSI testing. He is the Director of Distributed Computing Laboratory at URI. He is the General Chair of the IEEE North Atlantic Test Workshop (URI Alton Jones Campus, May 1999). In 1996 he was a visiting research professor at Tokyo Institute of Technology, Tokyo, Japan. His research in distributed computing for signal processing was supported by the Office of Naval Research. His research in semiconductor (VLSI) reliability and testing was funded by the National Science Foundation. He has published over 50 articles in professional conferences, IEEE transactions and journals. He is a senior member of IEEE and an executive committee member of Providence Section.

Shmuel Mardix: MS and PhD, Hebrew University; Professor, Electrical and Computer Engineering, URI. Dr. Mardix has done funded research on photo electronic imaging devices for the United States Army Electronics Command, has worked on relief radiography for the National Science Foundation, and on new techniques for film evaluation for the National Science Foundation. In addition, he has published fifty articles in refereed journals such as Acta Crystallographica, the Journal of Applied Physics, the Review of Scientific Instruments, the Journal of Applied Crystals, and Philosophy Magazine. Some of these are: "Polytypism: A Controlled Thermodynamic Phenomenon,"; "A High Resolution Section Topograph Technique Applicable to Synchrotron Radiation Sources,"; "Radiographs in Relief," and "Improved Detection of Lattice Defects in X-Ray Topography." Dr. Mardix's research interests focus on: electronic materials and x-ray analysis.

William J. Ohley: BS and MS University of Massachusetts; PhD State University of New York at Stony Brook. He is Chair of Electrical and Computer Engineering, URI, and has been active in the area of Biomedical Engineering for more than twenty years. He has authored in excess of 75 papers, books and proceedings. Currently he works in the area of cardiac assist and in the use of fractals to analyze medical data. Dr. Ohley continues to serve on NSF review panels, and NIH study sections. During 1993, he took part in the United States NSF delegation to China to exchange research on biomedical engineering. In 1996 he spent a sabbatical as a visiting Professor at the ESPEO, University of Orleans, France.

Charles Polk: BS Washington University; MS and PhD University of Pennsylvania; Professor Emeritus, Electrical and Computer Engineering, URI. Former Chairman of the Department of Electrical Engineering and the Rhode Island Section of the IEEE, Fellow at the Institute of Electrical and Electronics Engineers, member of the United States National Committee of the International Scientific Radio Union, and recipient of the Superior Accomplishment Award from the National Science Foundation where he was Head of the Electrical Sciences and Analysis Section (75/76) and Acting Director of the Engineering Division (76/77). Dr. Polk is a Past President of the Bioelectromagnetics Society, Distinguished National Lecturer of the IEEE Engineering in Medicine and Biology Society and former chair of the Power Frequency subcommittee of the IEEE Committee on Man and Radiation. His current research on electromagnetic field effects on bone is carried on in collaboration with Brown University medical faculty at Rhode Island Hospital; he and his graduate students also collaborate with research staff of Roger Williams Hospital on field interaction with immune cells. Dr. Polk has in the past worked on antennas, radio propagation, and atmospheric electricity. He has received government and foundation grants, edited the Handbook of Biological Effects of Electromagnetic Fields, and published over fifty articles. He has recently been a consultant on field-biosystems interactions to the National Institutes of Health, Oak Ridge National Laboratories, and the Minnesota Public

Utilities Commission. His principal research interest is in: Interaction of Electric and Magnetic Fields with Living Organisms at the Cellular Level.

Mercedes A. Rivero-Hudec: BS University of Simons Bolivar; MS University of Pennsylvania; PhD University of Pennsylvania. Dr. Rivero-Hudec is Associate Professor at the Dept. of Chemical Engineering and the Director of Biochemical Engineering Laboratory, URI. Her research interests include microbial pathogenicity and effects of toxic salts on white blood cells.

Ying Sun: BS National Taiwan University; MS URI; PhD Worcester Polytechnic Institute. Dr. Sun is Associate Professor at the Department of Electrical & Computer Engineering and the coordinator of Biomedical Engineering at URI. During 1992-93 he was on sabbatical leave, visiting at Linköping University in Sweden and University of Vienna in Austria. His research in medical imaging, microprocessor-based instrumentation, and modeling of the cardiovascular system has been supported by industry and by the National Science Foundation. He has published about 100 articles to date in professional conferences and in a variety of journals such as IEEE Transactions (Biomedical Engineering, Medical Imaging, Pattern Analysis and Machine Intelligence, and Neural Networks), Optical Engineering, Journal of American Society of Echocardiography, and American Journal of Physiology. Dr. Sun holds a US patent and has served as a consultant to hospitals and the medical device industry.

Donald W. Tufts: SB, SM and ScD MIT; Research Fellow and Assistant Professor of Applied Mathematics at Harvard University 1960-67; Professor of Electrical Engineering URI 1967-present; Consultant to Bell Telephone Laboratories, Lockheed Sanders, and other companies and government laboratories. Dr. Tufts was elected Fellow of IEEE in 1982 for "Contributions to Signal Processing and Digital Communications". His current research interests are: the design of active sonar, radar, multispectral image processing and communications systems with special emphasis on detection, classification, localization, and hardware/software algorithms for efficient implementation of signal processing. He is also working on applications of advanced signal processing to performance and failure characterization in structures such as aircraft and bridges.

Richard J. Vaccaro: BSEE and MSEE Drexel University; PhD Princeton University. Joined URI in 1983 where he is currently a Professor of Electrical Engineering. His research interests include the design of digital control systems, sensor-array processing, and underwater acoustic signal processing including multipath time-delay estimation and passive source localization. He has written numerous journal articles and conference papers. He is the author of the book, Digital Control: A State-space Approach (McGraw-Hill, 1995), and the accompanying Digital Control Matlab Toolbox. He served as the Chair of the Underwater Acoustic Signal Processing Technical Committee of the IEEE Signal Processing Society from 1995-1998.

Zongqin Zhang: BS Huazhong University of Science and Technology, China; MS and PhD Duke University; Associate Professor, Mechanical Engineering, URI. Professor Zhang has broad research interests in the areas of fluid mechanics, heat transfer and optimum thermal system design. He has performed funded research of the NSF Thermal System Program, the NSF Bioengineering Program, the Whitaker Foundation Bioengineering Program and the US Environmental Protection Agency. His current research involves studying the aerosol regional deposition patterns within the human respiratory tract which is very important in assessing potential toxicological hazards from industrial airborne contaminants, and in the application of aerosol medicine therapy. His other research interests include: heat transfer and flows phenomena with moving boundaries, melting and solidification heat transfer, flow within or near deformable boundaries in biology, medicine and biotechnology and the optimum design of HVAC system. Professor Zhang has authored and co-authored about 70 journal and conference papers. He has eight years industrial experience in the design and manufacture of refrigeration and air conditioning equipment.

College of Arts and Sciences

Emily C. Bell: BA Cornell University; PhD Stanford University; Assistant Professor, Biological Sciences, URI. Professor Bell's general interest in biology is in the biomechanics and functional morphology of marine organisms. Specifically, she evaluates the interactions of organisms with their physical environment and the extent to which such interactions can affect an organism's ecological function. Her research focuses on organisms living in one of the most physically stressful habitats known: the wave-swept rocky intertidal zone. In this habitat, large breaking waves can challenge an organism's strength of attachment to the substrate, while warm, sunny days can heat and desiccate an organism beyond its physiological limit. Her research interests include both animals and plants and span many levels of biological organization, from the mechanics of biological materials, to the physiology of whole organisms, to the persistence of populations and communities, to the characterization of the physical environment.

Robert B. Hill: SB Tufts University; PhD Harvard University; Professor, Biological Sciences, URI. Dr. Hill conducts research in collaboration with students and with colleagues at research institutions and marine biological stations. A common theme is to approach physiological processes vital in the life of an animal at several levels. For instance, he has been studying control of isolated gastropod buccal muscles at the tissue level, where he is best able to investigate the role of neurotransmitters, neuromodulators, and circulating peptides in control of contractility and rhythmicity. This approach is perhaps less direct than research on isolated cells, but more applicable to the study of neural control of complex fixed action patterns in gastropod feeding. Another line of investigation is the study of cardiac muscle as a tissue alongside study of isolated entire working gastropod or bivalve hearts, with valve action preserved. Cellular control mechanisms are studied with intact cardiac muscle in the sucrose gap or with innervated myocardial cells by microelectrode methods. However, the response of the heart to physiological demands of the whole organism are best studied with the whole heart model. In studies with gastropod heart or buccal muscle emphasis has been placed on control by neurotransmitters, neuromodulators, or circulating peptides. A continuing concern has been control by mechanical stretch and with muscle mechanics. This has been the main theme in Dr. Hill's research with holothurian longitudinal muscle where electron microscope studies show that the cells are extensively interconnected by fused plasma membranes. This has been a classical tissue for ergometer studies of active state and muscle mechanics, but a great deal more remains to be learned by the application of modern computer controlled ergometer methods. Dr. Hill is conducting parallel studies on viscosity changes in the holothurian body wall.

Gabrielle Kass-Simon: BA University of Michigan; MA Columbia University; D.Phil. University of Zurich; Professor, Biological Sciences, URI. Research in Professor Kass-Simon's laboratory is focused on the cellular and behavioral neurobiology of invertebrates – "crunchies" (lobsters) and "squishies" (hydra). Intracellular and extra-cellular electrophysiological and behavioral studies in ultrastructural, and biochemical studies in other laboratories at URI and elsewhere. The aim of the work is to define the cellular-membranal and chemical (transmitters and hormones) mechanisms that determine certain behaviors. In lobsters, her group have been focusing on the physiology of agonistic behavior over the molt-cycle and the physiology of agonistic behavior in gravid females; in hydra her group have concentrated on the physiology of nematocyst discharge and feeding behavior, and on the chemical neurotransmission of hydra's pacemaker systems.

James G. Kowalski: PhD University of Notre Dame; Associate Professor, Computer Science and Statistics, URI. Professor Kowalski's work can be generally described as the application of artificial intelligence algorithms and techniques to practical and/or analytically ill-defined problems. It includes the investigation and application of neural networks, genetic

algorithms, machine learning, and knowledge-based and fuzzy-inferencing techniques to simulation, classification and optimization problems, and to problems of interpretation and analysis of remotely sensed data.

Biyue (Betty) Liu: PhD University of Maryland; Assistant Professor, Mathematics, URI. Professor Liu's Primary research area is numerical solutions of partial differential equations. Her research interests include numerical analysis, partial differential equations, scientific computation, mathematical modeling, computational fluid dynamics, and singular perturbation. She has been working on the numerical solutions of Navier Stokes equations for many years by developing numerical methods, analyzing the uniqueness and existence of the solution, and proving a priori error estimates of the numerical solutions. Her research addresses some important problems in biomedical sciences and the application of numerical and computer techniques to medical problems. Her recent work is concerned with mathematical modeling and numerical simulation of incompressible flows with moving boundaries, which has many applications in blood flow in arteries and air flow in human airways.

College of Human Science and Services

James Agostinucci: ScD, OT; Associate Professor, Physical Therapy, URI. Dr. Agostinucci's teaching focus is in anatomy, physiology, and neuroscience. His research is in peripheral nervous system physiology and its role in the regulation of motoneuron excitability and muscle tone. Emphasis is on pathophysiological mechanisms that cause movement disorders resulting from nervous system diseases. He will be focusing studies on the analysis of single motor unit activity through electromyographic studies.

Peter R. Blanpied: PhD, PT; Associate Professor, Physical Therapy, URI. Dr. Blanpied's teaching focus is in musculoskeletal therapeutics, specifically biomechanics and orthopaedics. His research interests include aging and therapeutic effects on the mechanical properties of muscles and tendons, specifically stiffness, and maximizing functional use of muscle through the stretch-shorten cycle. Current research projects performed with students in the program include analysis of open vs. closed kinetic chain rehabilitative exercise, and exercises used in rehabilitation following anterior cruciate ligament reconstruction.

Linda S. Lamont: PhD; Associate Professor, Exercise Science, URI. Dr. Lamont has published several articles and conducted research relating to cardiac rehabilitation and exercise as well as the effects of exercise and diet on substrate usage in normal and heart diseased patients. She is the director of URI's Cardiac Rehabilitation and Maintenance programs and is the PI of an NIH Bridge to the future grant (approximately \$800,000) in which URI minority graduate students in exercise science are trained in the physiology field. These students receive their MS degree at URI, which acts as a bridge toward a doctorate in exercise science.

Thomas G. Manfredi: PhD; Professor, Exercise Science, URI. Dr. Manfredi is the coordinator of the Human Performance Laboratories which include light and electron microscopy and image analysis. His research focal area relates to the effects of diet and exercise on the aging process. His collaborative efforts with several research physicians in hospital settings in Rhode Island and with Tufts University and UCONN provide research projects for several URI students at the graduate and undergraduate levels. Dr. Manfredi also coordinates research efforts relating to fall prevention in the elderly. His labs depend on image analysis software and computerization of images captured from the light and electron microscopes.

Thomas D. Romeo, ME, PT. Mr. Romeo's primary responsibilities include developing educational, research, and service opportunities for students and faculty in pharmacy, nursing, and physical therapy. His teaching focus is on organizational management. His research interest is in public policy formation and implementation is based on extensive experience managing public institutions.

Joonkoo Yun: BPE Sung Kyun Kwan University; MS University of Wisconsin; PhD Indiana University; Assistant Professor, Physical Education & Exercise Science, URI. Dr. Yun's expertise includes adapted physical activity, motor development (motor behavior), and measurement.

SUMMARY OF ACTIVITIES AND EXPERTISE OF EXTERNAL INSTITUTES

NIH NCRR BioCurrents Research Center: As part of NCRR, Biomedical Research Technology Program, the BioCurrents Research Center has pioneered methods in the study of steady transmembrane currents and, over the years since its establishment as the National Vibrating Probe Facility, has hosted diverse scientific endeavors and repeatedly broken new ground. The Center researches and develops techniques for the noninvasive measurement of biologically important molecular flux across cell membranes. All instruments rely on the unifying principle of drift and noise reduction by creating self-referencing systems. The ion-selective systems can measure relatively steady-state calcium, potassium, and proton fluxes. The polarographic system, designed and successfully developed for measuring single cell oxygen consumption, is being diversified to measure nitric oxide and ascorbic acid flux. The BioKelvin probe operates in an aerial environment measuring voltage fields generated by subsurface ionic currents or surface charges. (Dr. Peter J. S. Smith, Director)

US Cerebral Palsy Athletic Association: The United States Cerebral Palsy Athletic Association (USCPAA) is the National Governing Body for competitive sports for individuals with cerebral palsy, traumatic brain injuries and survivors of strokes. USCPAA is responsible for conduct and administration of approved sports in the United States, formulates the rules, implements policies and procedures, conducts national championships in twelve sports, disseminates safety and sports medicine information, and selects the athletes to represent the United States in international competition (Jerry McCole, Executive Director).

Our Lady of Mercy Medical Center: Cardiology, cardiovascular dynamics, modeling of circulatory system, echocardiography, and cardiac radionuclide imaging (Dr. Salvatore A. Chiaramida, Chief of Cardiology; Dr. Richard J. Lucariello, Director of Nuclear Cardiac Imaging).

Eleanor Slater Hospital: Adaptive equipment, rehabilitation, physical therapy, and exercise science (James P. Benedict, Chief Operating Officer).

Miriam Hospital: Research in aging, skeletal muscle, tissue engineering, and gene therapy (Dr. Daniel E. Forman; Dr. Herman Vandenburg).

Roger Williams Hospital: Effects of magnetic fields on immune system and studies on apoptosis of normal and transformed immune cells (Dr. S. Mehta, Director of Surgical Research).

Rhode Island Hospital: Orthopaedics – Research on bone and cartilage development, including effects of magnetic fields; methods for early identification of osteoporosis (Dr. Roy K. Aaron; Dr. Deborah McK. Ciombor).

Lancaster University and University of Central Lancashire in UK: Neuromuscular physiology (Dr. Henry Huddart; Dr. Darrell Brooks).

Biomedical Engineering of Linköping University in Sweden: Physiological measurements and biofluid dynamics (Prof. Per Ask; Prof. Dan Loyd)

Linköping University Hospital in Sweden: Clinical physiology, echocardiography, and Laser Doppler flowmetry (Bengt Wranne; Birgitta Janerot-Sjöberg; Folke Sjöberg).

BUDGET EXPLANATION

A. Senior Personnel

We request summer support for 14 faculty to lead the development of grant proposals, laboratories, and courses. The effort of these faculty during the academic year and other collaborating faculty is not included here and considered as part of the matching (see below).

		Yr. 1	Yr. 2	Yr. 3	3 Yrs.	Subtotal
Faculty Summer	Agostinucci J		5,000		5,000	
Support for	Bell EC	5,000			5,000	
Proposal	Blanpied PR			5,000	5,000	
Development	Hill RB	5,000	5,000		10,000	
	Kowalski JG			5,000	5,000	
	Lamont LS		5,000		5,000	
	Liu B	5,000			5,000	
	Manfredi TG	5,000		5,000	10,000	
	Rivero-Hudec MA		5,000		5,000	
	Romeo TD		5,000		5,000	
	Sun Y	5,000	5,000	5,000	15,000	
	Vaccaro RJ		5,000		5,000	
	Yun J	5,000			5,000	
	Zhang Z			5,000	5,000	90,000

B. Graduate and Undergraduate Students

We request support for 2 graduate assistants and 4 undergraduate students. The students will be involved in research, projects, and development of laboratories related to the PMC Partnership. The support for graduate students is based on the rate for out-of-state level-II Graduate Assistant. The undergraduate students will be supported on the hourly-rate basis for a total of 800 person-hours per year.

		Yr. 1	Yr. 2	Yr. 3	3 Yrs.	Subtotal
Graduate	Stipend	36,994	38,474	40,012	115,480	
Assistants (2)	FICA (7.65% of Summer)	1,332	1,386	1,440	4,158	
	Tuition	19,778	21,388	22,244	63,410	183,048
Undergraduates (4)	800 person-hrs/year	10,000	10,300	10,800	31,100	31,100

D. Equipment

We request support for upgrading the equipment in 14 laboratories associated with the PMC Partnership.

		Yr. 1	Yr. 2	Yr. 3	3 Yrs.	Subtotal
<i>1. Adaptive Equipment Lab (ELE)</i>						
	Electronics & microcontrollers	3,000	1,000		4,000	
	Adaptive equipment		2,000	2,000	4,000	
<i>2. Behavioral Neurobiology Lab (BIO)</i>						
	Computer-based imaging system		4,500		4,500	
<i>3. Biochemical Lab (MCE)</i>						
	Computer-based imaging system			4,500	4,500	

(Equipment continued.)

	Yr. 1	Yr. 2	Yr. 3	3 Yrs.	Subtotal
<i>4. Biofluid Dynamics Lab (MCE)</i>					
Aerosol generator	8,500			8,500	
<i>5. Biomedical Instrumentation Lab (ELE)</i>					
Power Mac G3 with C++ Compiler	3,000	2,500	2,500	8,000	
Dell Pentium II GX1p computer	2,000	2,000	2,000	6,000	
InstruTech 4-channel A/D & D/A	3,000			3,000	
Texas Instrument TMS320 DSP board		2,500		2,500	
Laser Doppler flowmeter	8,500			8,500	
Pressure transducers & amplifiers	7,800			7,800	
Perfusion pump			2,000	2,000	
Flow meter			4,000	4,000	
Pulse Oximeter		2,500		2,500	
ECG recorder			5,000	5,000	
EEG recorder			7,000	7,000	
<i>6. Cardiac Rehabilitation Lab (PEX)</i>					
Pentium based computer & printer	3,000			3,000	
<i>7. Computational Biofluid Dynamics Lab (MTH)</i>					
Power Mac G3		3,000		3,000	
<i>8. Human Biomechanics Lab (PEX)</i>					
Computerized data acquisition			4,500	4,500	
<i>9. Human Neuromuscular Lab (PEX)</i>					
Pentium based computer	2,000			2,000	
A/D & Stimulus analysis software		4,400		4,400	
Torque motor/amp/controller card			2,000	2,000	
<i>10. Human Performance Lab (PEX)</i>					
Power Mac based imaging system		4,500		4,500	
CCD camera for digital microscopy		10,000			
<i>11. Marine Biomechanics Lab (BIO)</i>					
Microscope	5,000			5,000	
Computer-based imaging system		4,500		4,500	
<i>12. Motor Behavior Lab (PEX)</i>					
Computerized imaging system			4,500	4,500	
<i>13. Neuromuscular Physiology Lab (BIO)</i>					
Power Mac G3 & data acquisition	6,000			6,000	
HSE voltage clamp amplifier			8,500	8,500	
<i>14. VLSI Design & Testing Lab (ELE)</i>					
Prototype IC chips			2,000	2,000	145,700
	Yr. 1	Yr. 2	Yr. 3	3 Yrs.	
Total Direct Costs	149,904	149,948	149,996	\$449,848	

Matching Funds

In this proposal we do not request funds for travel, materials, supplies, publication costs, and academic-year release time for the collaborating faculty. The funding for these items will come from other supports of our participating faculty. The level of these matching funds is estimated at 20% of the Total Direct Costs requested.