



Northeastern

CURRICULUM VITAE

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Professor of Biology

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PERSONAL: **Born:** Long Beach, California, November 14, 1947
Widowed: Nancy Jean Ayers, **Son:** Geoffrey Bert Ayers

EDUCATION:

BA	Biology	University of California, Riverside
1970		
Ph. D	Biology	University of California, Santa Cruz,
1975		
Postdoctoral	Neurophysiology	Centre National de la Recherche Scientifique, Marseilles, France
1975-1976		
Postdoctoral	Neurophysiology	University of California, San Diego,
1976-1978		

PROFESSIONAL EXPERIENCE:

Assistant, Associate and Full Professor of Biology, Department of Biology and Marine Science Center, Northeastern University, Boston and East Point, Nahant, Massachusetts, 1978 - present. Tenure July, 1984.

Visiting Scholar, Institute for Non-Linear Science, University of California, San Diego, La Jolla, CA, January –June, 2003

Director, Marine Science Center, Northeastern University, 1991 to 2001. In this capacity I oversaw the development, operations and programs of the Marine Science Center, the associated research vessels and the East/West Marine Biology Program.

Alfred E. Sloan Foundation Fellow. Department of Biology, Northeastern University, 1980-1982

NINCDS Postdoctoral Fellow in the laboratory of Prof. Allen I. Selverston, Department of Biology, University of California, San Diego, La Jolla, California, August, 1976 - July, 1978.

NSF-CNRS, U. S.-France Exchange of Scientists Postdoctoral Fellow in the laboratory of Dr. Francois Clarac, Institut de Neurophysiologie et Psychophysiologie, Centre National de la Recherche Scientifique, Marseilles, France, August, 1975 - July, 1976.

NIH Research Assistant in the laboratory of Prof. William J. Davis, The Thimann Laboratories, University of California, Santa Cruz, California. September, 1972 - July, 1975.

Teaching Assistant, Department of Biology, University of California, Santa Cruz, September, 1970 - Aug., 1972.

PROFESSIONAL ORGANIZATIONS:

Society for Neuroscience.

IEEE

International Union of Physiologists.

International Society for Neuroethology

American Association for the Advancement of Science.

Society for Counterordinance Technology

Scholarship

RESEARCH INTERESTS:

My research focuses on the neuroethology of motor systems in invertebrates and lower vertebrates and the application of this knowledge to the development of advanced robots and neuroprostheses. A developmental approach is directed toward establishing the adaptive mechanisms of simple action patterns and innate behavior. We have focused on the development of technology that allows recording from motor pattern generators and the behavior they control to directly address the mechanisms of behavior. We have performed these studies on the walking and feeding systems of lobster and the undulatory behavior of the lamprey. These studies have led to the biomimesis of ambulatory lobster-based and undulatory lamprey-based underwater robots. The robots are based on neurotechnology for myomorphic actuators, neuromorphic sensors and biomimetic controllers based on neuronal circuits. We are focusing on the achievement of reactive autonomy through the development of a process that allows the derivation of robotic behavioral libraries through reverse engineering the command sequences that underlie the behavior of the model species in the target environment. We are developing electronic nervous systems to control these robots based on analog VLSI and discrete-time map based instantiations of nonlinear dynamical models of neurons. An ongoing program of software development in digital neuronal signal processing biotelemetry, correlated motion and sensor based analysis from video and computational neuroethology supports all projects. We are establishing a collaboration with the Center for Engineering Education Outreach to implement our neuronal-based controllers on the Lego RoboLab system for K-12 outreach.

HONORS

US-France Exchange of Scientists Fellow

Alfred E Sloan Foundation Fellow

Time Magazine 2003 Invention of the Year Honoree

<http://www.time.com/time/2003/inventions/invlobster.html>

NEXTFest 2005 Invited Exhibitor

<http://www.wired.com/wired/archive/13.06/nextfest.html?pg=2>

Included in Design Life Now, National Design Triennial, 2006

RoboLobster Exhibited in the Cooper-Hewett Smithsonian National Design Museum

http://ndm.si.edu/EXHIBITIONS/triennial/design_life_now.asp 2006-2007

RoboLobster Exhibited in the Institute for Contemporary Art, Boston, MA 2007-2008

PATENT:

Process and Architecture of Robotic System to mimic animal behavior in the natural environment. Inventors: Joseph Ayers, Jan Witting, Stephane Ryder, Christopher Walcott. Docket No. NU-599xx Patent Awarded, 4/2010,

http://www.research.neu.edu/licensing_opportunities/biomimetics/documents/AyersRobot.pdf

EDITED BOOKS:

Ayers, J. and Davis, J., Rudolph, A. [ed] (2002) Neurotechnology for Biomimetic Robots, MIT Press, 636pp.

Kato, N., Ayers, J., Morikawa, H. [ed] (2004). Bio-mechanisms of Swimming and Flying. Tokyo, Springer-Verlag. 210pp

POPULAR BOOKS:

Ayers, J. and Risch, R. (2003) The Sea Around Nahant. Nahant Historical Society.

Ayers, J. (2006) Dr. Ayers Cooks with Cognac, 5th Ed. LuLu Press

REFEREED PUBLICATIONS:

Reish, D.J. and Ayers, J. (1968) Studies on the Mytilus edulis community in Alamitos Bay, California. III. The effects of reduced dissolved oxygen and chlorinity concentrations on survival and byssus thread formation. **Veliger 10**: 384-388

Davis, W.J. and Ayers, J. (1972) Locomotion: Control by positive feedback optokinetic responses. **Science 177**: 183-185

Ayers, J. and W.J. Davis (1977) Neuronal control of locomotion in the lobster. I. Motor programs for forward and backward walking. **J. Comp. Physiol. 115**: 1-24

Ayers, J. and W.J. Davis (1977) Neuronal control of locomotion in the lobster. II. Types of walking leg reflexes. **J. Comp. Physiol. 115**: 25-46

Ayers, J. and A. I. Selverston (1977) Synaptic control of an endogenous pacemaker network. **J. Physiol. (Paris) 73**: 453-461.

Clarac, F. and Ayers, J. (1977) La marche chez les crustaces: Activite motrice programme et regulation peripherique. **J. Physiol. (Paris) 73**: 523-544

Ayers, J. L. and W.J. Davis (1978) Neuronal control of locomotion in the lobster III. Dynamic organization of walking leg reflexes. **J. Comp. Physiol. 123**: 289-298

Ayers, J. and F. Clarac (1978) Neuromuscular strategies underlying different behavioral acts in a multi-functional crustacean leg joint. **J. Comp. Physiol., 128**: 81-94.

Ayers, J. and A.I. Selverston (1979) Monosynaptic entrainment of an endogenous pacemaker network: A cellular mechanism for von Holst's magnet effect. **J. Comp. Physiol. 129**: 5-17.

- Ayers, J. (1980) Do different behaviors require different central pattern generators? **The Behavioral and Brain Sciences**. **3**: 541.
- Ayers, J. Carpenter, G., Currie, S. and Kinch, J. (1983) Which behavior does the lamprey central motor program mediate?, **Science** **221**: 1312-1314.
- Currie, S., and Ayers, J. (1983) Regeneration of Locomotor Command Systems in the lamprey. **Brain Research** **279**: 238-240.
- Ayers, J. L. and A. I. Selverston (1984) Synaptic perturbation and entrainment of the gastric mill rhythm in the spiny lobster. **Journal of Neurophysiology** **51**: 129 - 141.
- Currie, S., and Ayers, J. (1987) Plasticity of fin command system function following spinal cord transection in larval sea lampreys, *Petromyzon marinus*, **Brain Research** **415**: 337-341.
- Bratton, B. and Ayers, J. (1988) Observations on the Electric Organ Discharge of two skate species and its relationship to behavior. **Environ. Biology. Fishes** **20**: 241-254.
- Davis, B. M, Ayers, J., L. Koran, J, Carlson, M. Anderson and S. B. Simpson (1990) Time course of regeneration of the salamander spinal cord and the recovery of swimming: HRP retrograde tracing and kinematic analysis. **Experimental Neurology** **108**: 1-16
- Ayers, J. and Crisman, J. (1992) Biologically-based Control of Omnidirectional Leg Coordination, **IEEE Proc. on Intelligent Robots and Systems** **1**: 574-581
- Ayers, J. and Crisman, J. and Massa, D. (1992) A Biologically-based Controller for a Shallow Water Walking Machine, **IEEE Proc. on Oceanic Systems** (1992) 837-842.
- Massa, D., Ayers, J. and Crisman, J. (1992) Acoustic Communication, Navigation and Sensing Systems for a Biologically-based Controller for a Shallow Water Walking Machine, **IEEE Proc. on Oceanic Systems**, (1992) 590-595.
- Swain, G.P., Snedeker, J.A., Ayers, J. & Selzer, M.E. (1993) The Cytoarchitecture of spinal-projecting neurons in the brain of the larval sea lamprey, **J. Comp. Neurol**, **336**: 194-210
- Ayers, J., Kashin, S., Blidberg, D. R. and Massa, D. (1994) Biologically-Based Underwater Robots. **Unmanned Systems** **12**: 30-36. .
- Swain, G.P., Ayers, J. & Selzer, M.E. (1995) Metamorphosis of spinal-projecting neurons in the brain of the sea lamprey during transformation of the larva to adult: Normal anatomy and response to axotomy, **J. Comp. Neurol**, **362**: 453-467
- Breithaupt, T., and Ayers, J.. 1998. Visualization and quantification of biological flow fields through video-based digital motion-analysis techniques. **Mar. Freshw. Behav. Physiol.** **31**:55-61.
- Lee, Y. J., J. Lee., Y.B. Kim, Ayers, J. , A. Volkovskii , A. Selverston , H. Abarbanel , M. Rabinovich (2004). "Low Power Real Time Electronic Neuron VLSI Design Using Subthreshold Techniques,," **IEEE Circuits and Systems** **4**: 744-747.
- Ayers, J. (2004) Underwater Walking. **Arthropod Structure and Development** **33**, 347-360.

- Lee, Y., Lee, J., Kim, Y.B., Ayers, J. (2005). Low power CMOS adaptive electronic central pattern generator design. **IEEE Circuits and Systems 2**: 1350-1353.
- Selverston, A. & Ayers, J. (2006) Oscillations and Oscillatory Behavior in Small Neural Circuits. *Biological Cybernetics* 95:537–554
- Ayers, J. and Witting, J. (2007) Biomimetic Approaches to the Control of Underwater Walking Machines. **Philosophical Transactions of the Royal Society, A**, 365, 273–295
- Lee, Y., Lee, J., Kim, K., Kim, Y., Ayers, J. (2007) Low Power CMOS Electronic Central Pattern Generator Design for a Biomimetic Underwater Robot. *Neurocomputing*, 71: 284-296.
- Ayers, J., N. F. Rulkov, et al. (2010). "Controlling Underwater Robots with Electronic Nervous Systems." *Applied Bionics and Biomechanics* 7: 57 - 67
- Blustein, D. and J. Ayers, (2010) A conserved network for control of arthropod exteroceptive optical flow reflexes during locomotion. *Lecture Notes in Artificial Intelligence*, 6226: 72-81
- Hu, J., YB. Kim, J. Ayers (2010) A Low Power 100M Ω CMOS Front-End Transimpedance Amplifier for Westphal, A., Rulkov, N., Ayers, J., Brady, D., & Hunt, M. 2011. Controlling a lamprey-based robot with an electronic nervous system. *Smart Structures and Systems*. 7(6): 471 - 484
- Ayers, J., Westphal, A., Blustein, D. (2011) A Conserved Neural Circuit-based Architecture for Ambulatory and Undulatory Biomimetic Robots. *J. Mar. Tech. Soc.*, 45(4): 1-6.
- INVITED/REFEREED CONFERENCE PROCEEDINGS:**
- Ayers, J., Crisman, J. D. and Massa, D. (1993) A Biologically-based Controller for an Underwater Ambulatory Robot. **Proc. Int. Symp. Unmanned Untethered Submersible Technology**. Autonomous Undersea Systems Institute, Portsmouth, N.H., Pp. 60-68
- Ayers, J. (1995) A Reactive Ambulatory Robot Architecture for Operation in Current and Surge. In: **Proc. of the Autonomous Vehicles in Mine Countermeasures Symposium**. Naval Postgraduate School. Pp. 15-31
- Jalbert, J. Kashin, S. Ayers, J. (1995) A Biologically-based Undulatory Lamprey-like AUV. In: Proc. of the Autonomous Vehicles in Mine Countermeasures Symposium. Naval Postgraduate School. Pp. 39-52
- Chappell, S and Ayers, J. (1995) Innate and Modulated Autonomous Underwater Vehicle Behavior. In: Proc. Int. Symp. **Unmanned Untethered Submersible Technology**. Autonomous Undersea Systems Institute, Portsmouth, N.H., Pp. 376-387.
- Jalbert, J. Kashin, S. Ayers, J. (1995) Design Considerations and Experiments on a Biologically-based Undulatory Lamprey-like AUV. In: Proc. Int. Symp. **Unmanned Untethered Submersible Technology**. Autonomous Undersea Systems Institute, Portsmouth, N.H., Pp. 124-138
- Ayers, J, Zavracky, P., McGruer, N., Massa, D., Vorus, W., Mukherjee, R. and Currie, S. (1998) A Modular Behavioral-Based Architecture for Biomimetic Autonomous Underwater Robots. In: **Proc. 3rd**

International Conference on Technology and the Mine Problem. Naval Postgraduate School. Pp 437-455.

Witting J., Ayers, J., K. Safak. (2000) Development of a biomimetic underwater ambulatory robot: advantages of matching biomimetic control architecture with biomimetic actuators. in *Sensor Fusion and Decentralized Control in Robotic Systems III*, Gerard T. McKee, Paul S. Schenker, Editors, **Proceedings of SPIE** Vol. 4196. pp. 54-61.

Ayers, J., J. Witting, C. Wilbur P. Zavracky, N. McGruer and D. Massa (2000) Biomimetic Robots for Shallow Water Mine Countermeasures. In **Proc. 4th International Conference on Technology and the Mine Problem.** Pp 457-472.

Ayers, J. , A. Volkovski, N. Rukov, A. Selverston, & H.D.I. Abarbanel, M. R. 2003 Building a Brain for the Lobster Robot Using Electronic Neurons. In *International Conference on Non-Linear Wave Physics*, 3 pp. Nizhny-Novgorod, Russia.

Selverston, A. I., Rabinovich, M. I., Huerta, R., Novotny, T., Levi, R., Arshavsky, Y., Volkovskii, A., Ayers, J. & Pinto, R. (2005) Biomimetic Central Pattern Generators for Robotics and Prosthetics. In *IEEE International Conference on Robotics and Biomimetics*, 1: 885 - 888. Shenyang, China.

Ayers, J. Rulkov, N., Taub, E. Kim, Y., Knudsen, Selverston, A. & Uswatte, G. (2006) Electronic Neurons: From Biomimetic Robots to Blast Neurorehabilitation. **Proc. 7th International Conference on Technology and the Mine Problem**, Naval Postgraduate School, Monterey, CA. 10 pp., On CD

Ayers, J., Rulkov (2006) Controlling Biomimetic Underwater Robots with Electronic Nervous Systems, In: **Proc. International Symposium on Aquabiomechanisms 2006**, Springer-Verlag. Pp 295-306.

Hu, J., YB. Kim, J. Ayers (2010) A Low Power 100MΩ CMOS Front-End Transimpedance Amplifier for Biosensing Applications. *IEEE Circuits and Systems*. 53: 541 – 544

Hu, J., Y.-B. Kim and J. Ayers (2010). A CMOS Low-Power Low-Offset and A 65nm CMOS Ultra Low Power and Low Noise 131M Ohm Front-End Transimpedance Amplifier. *IEEE International SOC Conference*. Las Vegas, NV. **45**: 281-284.

Lu, J., Y. B. Kim and J. Ayers (2011). A low power 65nm CMOS electronic neuron and synapse design for a biomimetic micro-robot. *IEEE International Midwest Symposium on Circuits and Systems (MWSCAS)*. **54**: 1-4.

Lu, J., J. Yang, Y. B. Kim and J. Ayers (2012). Low Power, High PVT Variation Tolerant Central Pattern Generator Design for a Bio-hybrid Micro Robot. *IEEE International Midwest Symposium on Circuits and Systems (MWSCAS)*. **55**: 782-785.

BOOK CHAPTERS:

Clairborne, B. and Ayers, J. (1987) Functional Anatomy and Behavior. In: **The Crustacean Stomatogastric System**. A. Selverston and M. Moulins [eds.]. Springer-Verlag, Pp. 9-29.

Ayers, J. and Kushner, P. (1987) Contingent effects of synaptic input to the lobster stomatogastric pyloric system In: **The Crustacean Stomatogastric System**. A. Selverston and M. Moulins [eds.]. Springer-Verlag, Pp. 257-261

- Evoy, W. H. and Ayers, J. (1981) Locomotion and Control of Limb Movements. Chapter 16, In: **The Biology of Crustacea** (D. E. Bliss, ed.). Pp. 61-105.
- Pinsker, H. M. and Ayers, J. (1983) Neuronal Oscillators. Chapter 9 in: **The Clinical Neurosciences**. Section Five. Neurobiology. W. D. Willis [ed]. Churchill Livingstone Publishers. Pp. 203-266.
- Prosser, C. L., Ayers, J., Green, E. and Nelson, D. (1985) Evolution of temperature regulation and constancy of function (Homeokinesis) at different temperatures. In: **Evolutionary Biology of Primitive Fishes**. R. E. Forman, A. Gorbman, J.M. Dodd and R. Olsson [eds.] Plenum Press.
- Ayers, J. (1989) Recovery of oscillator function following spinal regeneration in the sea lamprey. In: **Cellular and Neuronal Oscillators**. J. Jacklet, [ed]. Marcel Dekker, New York, Pp. 349-383.
- Maney, E.J., Ayers, J., Sebens, K.P, and Witman, J. (1990) Quantitative Techniques for Underwater Video Photography. In: **Diving For Science**. Am. Acad. Underwater Sci., St. Petersburg. Pp. 255-265
- Ayers, J. and Crisman. J. (1992) The Lobster as a Model for an Omnidirectional Robotic Ambulation Control Architecture. In: **Biological Neural Networks in Invertebrate Neuroethology and Robots.**, R. Beer., R. Ritzmann and T. McKenna [eds], 287-316.
- Breithaupt, T. and Ayers, J. (1996) Visualization and quantitative analysis of underwater biological flow fields using suspended particles. In: **Zooplankton: Sensory Ecology and Physiology** . P. H. Lenz, D. K. Hartline, J. E. Purcell and D. L. MacMillan [eds]. Basel: Gordon and Breach Science Publishers., Pp. 117-129
- Ayers, J. (1999) A Behavior-Based Controller Architecture for Biomimetic Underwater Robots. In: **Prerational Intelligence: Adaptive Behavior and Intelligent Systems without symbols and logic**. Vol. I. H. Cruse, H. Ritter and J. Dean [eds] Kluwer Acad. Pub. Dordrecht. Pp. 357-370.
- Ayers, J., Witting, J., McGruer, N., Olcott, C., Massa, D. (2000) Lobster Robots. In: **Proceedings of the International Symposium on Aqua Biomechanisms**. T. Wu and N, Kato, [eds]. Tokai University.
- Ayers, J., Wilbur, C., Olcott, C. (2000) Lamprey Robots. In: **Proceedings of the International Symposium on Aqua Biomechanisms**. T. Wu and N, Kato, [eds]. Tokai University.
- Ayers, J. (2001) Building a Robotic Lobster. In **Artificial Ethology**, D. MacFarland and O. Holland [eds]. Pp. 139-155
- Ayers, J. (2002) A Conservative Biomimetic Control Architecture for Autonomous Underwater Robots. In: **Neurotechnology for Biomimetic Robots.**, Ayers, J., J. Davis and A. Rudolph [eds]. MIT Press, Pp. 241-259
- Ayers, J. (2004). Architectures for Adaptive Behavior in Biomimetic Underwater Robots. **Bio-mechanisms of Swimming and Flying**. N. Kato, Ayers, J., Morikawa, H. Tokyo, Springer-Verlag: 171-187.

NON-REFEREED ARTICLES:

- Ayers, J and Fletcher, G. (1990) Color Segmentation and Motion Analysis of Biological Image Data on the Macintosh II. ***Advanced Imaging 5***: 39-42

Ayers, J. (1992) Desktop Motion Video for Scientific Image Analysis. *Advanced Imaging 7*: 52-55.

Rudolph, A., Ayers, J., J. Davis, M. V. Srinivasan, M. Willis, R. Cartledge, R. Potember, R. Triendl, V. Payne, (1999) Multidisciplinary Bioscience & Technology In Japan. **DARPA/DSO Technical Report**.

Ayers, J. and Davis, J. (2005) Biomimetic Robots. Weapon Systems Technology Information Analysis Center Newsletter 5(4): 1-4.

PUBLISHED ABSTRACTS

Ayers, J. (1976) Programmes locomoteurs et organization reflexe chez le homard. **J. Physiol. (Paris) 72**: 18a

Ayers, J. and A. I. Selverston (1977) Monosynaptic control of inter- and intra-oscillator coordination of an endogenous pacemaker network. **Soc. Neurosci. Abstr. 4**: 267

Ayers, J. (1978) Synaptic perturbation and entrainment of the gastric mill rhythm of the spiny lobster. **Soc. Neurosci. Abstr. 5**: 379.

Ayers, J. (1979) Locomotion in Homarus americanus. **Grass Instrument Co. Bulletin** No. X817K79.

Ayers, J., Carpenter, G., Currie, S. and Kinch, J. (1980) Quantitative Analysis of Normal and Regenerating Behaviors in the Sea Lamprey. **Soc. Neurosci. Abstr. 6**: 431

Ayers, J., Carpenter, G., Currie, S. and Kinch, J. (1981) Behavioral analysis of spinal cord regeneration in the Sea Lamprey. **Soc. Neurosci. Abstr. 7**: 681.

Ayers, J., Currie, S., Kinch, J. and Pereira, W. (1982) Adult lampreys can recover from complete spinal cord transection. **Soc. Neurosci. Abstr. 8**: 868.

Eaholtz, G., Ayers, J. and Carpenter, G.A. (1982) Correlated cinematographic and electromyographic analysis of behavior in the lamprey. **Soc. Neurosci. Abstr. 8**: 607.

Bratton, B. and Ayers, J. (1982) Electric organ discharge patterns in the skate (Rajidae) and their relation to behavior. **Soc. Neurosci. Abstr. 8**: 609.

Currie, S. and Ayers, J. (1982) Gradual loss and partial recovery of a proximal motor reflex following spinal transection in lampreys (Petromyzon marinus). **Soc. Neurosci. Abstr. 8**: 870.

Eaholtz, G., Ayers, J., and G. A. Carpenter (1984) *IN VIVO* recordings reveal discharge patterns underlying different behaviors in larval sea lampreys, Petromyzon marinus. **Soc. Neurosci. Abstr. 10**: 631

Margolin, L, D. Kaufman and Ayers, J. (1985) Development of command system function during transformation in the Sea Lamprey. **Soc. Neurosci. Abstr. 11**: 1287.

Kaufman, D., Margolin, L and Ayers, J. (1985) Behavioral analysis of the recovery of command system function following spinal transection in larval and adult sea lampreys. **Soc. Neurosci. Abstr. 11**: 589.

- Swain, G. P. and Ayers, (1986) Development of descending reticulospinal systems during transformation in the Sea Lamprey. **Soc. Neurosci. Abstr. 12:** 318
- Ayers, J. and Wilbur, C. (1986) Recovery of swimming following spinal transection is enhanced at lower temperatures in larval sea lamprey.. **Soc. Neurosci. Abstr. 12:** 1574
- Lee, K. and Ayers, J. (1986) Quantitative analysis of feeding behavior in the American Lobster, **American Zoologist 26:** 98A.
- Ayers, J. and Rovainen, C. (1987) Correlation of Swimming Behavior with the Activity of Identified Giant Reticulospinal Neurons in the Lamprey Spinal Cord. **Soc. Neurosci. Abstr. 13:** 620.
- Wilbur, C., Margolin, L, and Ayers, J. (1987) The effect of temperature on the chronology of behavioral recovery following spinal transection in metamorphosing Sea Lamprey. **Soc. Neurosci. Abstr. 13:** 1287
- Margolin, L, and Ayers, J. (1987) The effect of temperature on the quality of recovered swimming following spinal transection in metamorphosing sea lamprey. **Soc. Neurosci. Abstr. 13:** 1287.
- Lee, K. and Ayers, J. (1987) Substrate specification of feeding strategies in the American Lobster, **American Zoologist 27:** 56A
- Margolin, L, and Ayers, J. (1988) Development and recovery of command function by the pontine locomotor region in the lamprey. **Soc. Neurosci. Abstr. 14:** 653.
- Swain, G. P, and Ayers, J. (1988) Regeneration of the pontine locomotor region in the sea lamprey. **Soc. Neurosci. Abstr. 14:** 657.
- Davis, B. M, Ayers, J., L. Koran, J. Carlson and S. B. Simpson (1988) Time course of salamander regeneration: behavioral and anatomical analysis. **Soc. Neurosci. Abstr. 14:** 656.
- Margolin, L. and Ayers, J. (1989) Reflex depression results from anaesthesia rather than spinal shock following spinal transection in the lamprey. **Soc. Neurosci. Abstr. 15:** 321.
- Lee, K. and Ayers, J. (1989) Electromyographic analysis of the subunits of Feeding Behavior in the Lobster, **American Zoologist 29:** 37A
- Ayers, J. (1990) Analysis of the functional activity of regenerating giant reticulospinal neurons during undulatory behavior in Lamprey. **Soc. Neurosci. Abstr. 16:** 488
- Jordan, S. and Ayers, J. (1991) Recruitment of Reticulospinal Neurons during Swimming Command Microstimulation in Lamprey. **Soc. Neurosci. Abstr. 17:** 944.
- Ayers, J., Fletcher, G. and Hoff, K. (1991) Macintosh platforms for teaching Laboratory Computing, Biomechanics and Neuroethology. **Soc. Neurosci. Abstr. 17:** 522
- Garner, L. K., Anderson, M. C. Ayers, J. and Davis, B. M. (1991) Changes in ventral horn synapses in salamander spinal cord following thoracic transection with correlations to behavior. **Soc. Neurosci. Abstr. 17:** 943

- Schlichting, L. and Ayers, J. (1996) Behavioral Sequencing during Adaptation to Current and Surge in the American Lobster. **Soc. Neurosci. Abstr.** 22: 529.
- Ayers, J., Metha, A. and Dragich, C. (1997) Modeling Locomotor Command Interactions in the Lobster. **Soc. Neurosci. Abstr.** 23: 478
- Ayers, J., L. Schlichting & C. Wilbur, (1998) Reverse Engineering Behavior In The Lobster By Finite State Analysis. Abs Soc Neuroscience, 63.17.
- Ayers, J. McGruer, N, & Adams, G. (1999) MEMs Sensors for Biomimetic Underwater Robots,. Abs. Soc Neuroscience 25: 1904
- Ayers, J. (2000) A Biomimetic Architecture For Sensing, Modulation, And Sequencing Autonomous Behavior,. Abs. Soc Neuroscience 26: 805
- Ayers, J. (2001) A Biomimetic Architecture For Sensing, Modulation, And Sequencing Autonomous Behavior, Proc. Int. Cong on Neuroethology, Bonn, 6: 329
- Ayers, J., A. Volkovski, N, Rulkov, A. Selverston, H. Abarbanel & M. Rabinovich (2003) Building a CNS for the lobster robot with INLS electronic neurons. Soc. Neurosci. Abs 278.14
- Ayers, J.; N. Rulkov; Y. Kim; A. Volkovskii; A. Selverston (2005) Hybrid Neuronal Architectures for Biomimetic Robot Controllers, Soc. Neurosci. Abs 753.18
- Knudsen, D., Ayers, J., N. Rulkov (2006) Synthesis and control of CPGs with neurons based on principles of nonlinear dynamics. Soc. Neurosci Abs, 448.20
- Ayers, J., N. Rulkov, D. Brady, A. Westphal, M. Hunt. (2008) Controlling a Lamprey Based Robot with an Electronic Nervous System. Soc. Neurosci Abs, 376.21

INVITED PRESENTATIONS AT INTERNATIONAL CONFERENCES

- A Lobster Based Ambulatory Robot Controller*, Zentrum für interdisziplinäre Forschung Conference: “Prerational Intelligence in Robotics: From Sensorimotor Intelligence to Collective Behavior. Universität Bielefeld. Germany, May 16, 1994,
- Biologically-Based Robots in Surf-Zone Mine Countermeasures*. Carl Menneken Lecture in Mine Warfare. Naval Postgraduate School, Monterey, CA, January 19, 1995.
- A Reactive Walking Robot Architecture for Operation in Current and Surge*, Environmental Session, *A Biologically-Based Undulatory AUV*. Contributed Papers Session. *A Generic Biologically-Based Control Architecture*, Vehicles Session. Panel Member, Environments Session. Chair: Contributed papers session. **International Symposium On Autonomous Vehicles in Mine Countermeasures**. Naval Postgraduate School, April 4-7, 1995, Monterey, CA.
- Biologically-Based Robots for Littoral Zone Remote Sensing*, Carl Mennekin Lecture on Mine Warfare. Naval Postgraduate School in Monterey, California. January 16, 1997
- Finite State Analysis of Behavior*. Artificial Ethology Conference, Lanzarote, Canary Islands, July 2, 1998.

Lobster Robots, 2nd, International Symposium in Frontiers in Crustacean Neuroscience. Hamburg, Germany, July 12, 1999

Biomimetic Robots for Shallow Water Mine Countermeasures, Plenary Lecture 4th International Conference on Technology and the Mine Problem, Naval Postgraduate School, Pacific Grove, CA. Session Leader: Autonomous Underwater Vehicles. March 15-16, 2000.

Lobster Robots. Keynote Speech. 1st International Symposium on Aqua Bio-Mechanisms, Tokai University Pacific Center, Honolulu, HI August 27, 2000.

Neurotechnology for Biomimetic Underwater Robots. Invited Speaker at 2nd Winter Cycle of Science and Technology: Neuronal Flows, Motricity And Neuroinspired Robots, University of Madrid and City of Madrid. Madrid. March 14, 2002

Biologically-based robots for Shallow Water Mine Countermeasures. Keynote Speaker at the 5th Annual Conference on Technology and The Mine Problem. Also Co-Session Chair on Biological and Biomimetic Systems with Dr. Sam Ridgeway. Naval Postgraduate School, Monterey, CA, April 22-25. 2002

Biomimetic Arthropod Robots. "A Systems Approach to Motor Behavior (SAMBA): From Physiology to Biomimetic Models", University of Bielefeld, July 25-27 2002.

Building Biologically Based Robots. Plenary Keynote Speaker at PRISM 2003, *The 23rd Puerto Rico Interdisciplinary Scientific Meeting and 38th ACS Junior Technical Meeting*, University of Puerto Rico, Rio Piedras

Building a CNS for the Lobster Robot using Electronic Neurons. Plenary Keynote Speaker at the 2nd International Meeting on Topical Problems in Non-Linear Wave Physics, Nizhny-Novgorod, September 2003

Building a Nervous System for the Lobster Robot using Electronic Neurons. Plenary Keynote Speaker at the 8th International meeting of the Society for Adaptive Behavior (SAB 04). Santa Monica, CA, July, 2004.

Invited Exhibitor at Nextfest 2005: *The Wired World's Fair*, Navy Pier. Chicago, June 24 – 26, 2005
<http://www.wired.com/wired/archive/13.06/nextfest.html?pg=2>

Electronic Neurons: From Biomimetic Robots to Blast Neurorehabilitation. Keynote Speaker at the 7th Annual Conference on Technology and The Mine Problem. Also Session Chair on Biomimetic Systems. Naval Postgraduate School, Monterey, CA, April 22-25. 2006

Controlling Biomimetic Underwater Robots with Electronic Nervous Systems, Keynote Speaker, International Symposium on Aquabiomechanisms 2006, Okinawa Convention Center, Ginowan, Okinawa, Japan, July 3, 2006

Building Brains for Underwater Robots, Darwin Festival, Salem State College, Feb 5, 2007

Controlling Underwater Biomimetic Robots with Electronic Nervous Systems. International Conference on Robotics and Automation, Workshop on Biomimetic Robots. Rome, Italy April, 2007

http://www.sssup.it/sssup/jsp/detail.jsp?sec_id1=528&sec_id2=72583&lang=it&OBJ_ID=80506

Controlling Underwater Robots with Electronic Nervous Systems (Invited Poster in Innovation Corridor), Bio07, Boston, MA, May 7, 2007

Building Brains for Biomimetic Underwater Robots. Barcelona Cognition Brain and Technology Summer School, September 10-15, 2008, Invited Speaker, Barcelona, Spain,
<http://www.iaa.upf.edu/bcnscs/node/112>

Building Brains for Biomimetic Underwater Robots. IDEAS Boston 2008, Federal Reserve Bank, Boston, MA. October 29, 2008, <http://ideasboston.com/josephayers.aspx>

Speaker, EPSRC/NSF Synthetic Biology Sandpit, Mar 30-Apr 3, 2009, Warrenton, VA

Building Brains for Underwater Robots. NSF US/Taiwan Workshop: Bioinspired Sensing and Actuation Technologies for Civil and Mechanical Systems, Taipai, Taiwan, April 14-18, 2011

Cyberplasm: A biohybrid robot constructed on principles of Synthetic Biology, EPSRC/NSF Synthetic Biology Review Apr 26 2011, Imperial College, London

Ayers, J. (2010) Building Brains for Biomimetic Robots, International Symposium on Synthetic Neuroethology. University of Sussex, Brighton, GB. Sept, 9, 2010.

Building Brains for Biomimetic Robots, The Barcelona Cognition, Brain and Technology Summer School, Universitat Pompeu Fabra, September 15, 2011.

Natural Architectures for Biomimetic Robot Control. NSF/ARO Conference on Locomotion Systems Science. Arlington VA. May, 29, 2012

The Sweet Spot integrating Robotics, Neurophysiology and Synthetic Biology. New Phytologist 4th Symposium on Synthetic Biology. University of Bristol, UK. June 7, 2012.

Natural Architectures for Biomimetic Robot Control. Wyss Institute Symposium: Noise and Rhythm, Harvard Medical School. June 8, 2012

Synthetic Neuroethology. Plenary Lecture. Living Machines: The International Conference on Biomimetic and Biohybrid Systems., La Pedrera, Barcelona, July 10, 2012

TECHNICAL DEMONSTRATIONS for DARPA & the OFFICE OF NAVAL RESEARCH

3 Day Technical Demonstration of Biomimetic Robots. US. Marine Corps, Sea Expo. USS Hornet, Alameda Naval Station. March 19-21, 1999.

2 Day Technical Demonstration of the Lobster Robot for Congressmen on the US Navy Afloat Laboratory, Washington Naval Yard, Washington DC. April 15-16, 2000, Broadcast Live on FOX TV

3 Day Technical Demonstration of the Lobster Robot for the Office of Naval Research on the US Navy Afloat Laboratory at Fleet Week, Manhattan Naval Yard, New York, NY., May 22-24, 2001

3 Day Technical Demonstration of the Lobster Robot for the Senate Armed Services Committee, Washington Naval Yard, Washington DC. July 1-3, 2002

Participated in Office of Naval Research AUV/Modem Fest, Gulfport, MS, October, 26-29, 2001. At Sea Technical Demonstration of the Lobster Robot.

Featured Speaker at ONR Media Day. Boston Naval Shipyard, June 25, 2001

1 Day Technical Demonstration of the Lobster Robot for The Office of Naval Research at the Bowditch Bicentennial Salem Massachusetts, July 13, 2002

5 Day Technical Demonstration of Electronic Neurons, the Lobster and Lamprey Robot for the Office of Naval Research on the US Navy Afloat Laboratory at Charlestown Naval Yard, Boston, MA, June 7-11, 2006

INVITED LECTURES 1990-present

The Lobster: Biological Intelligence as a Model for a Robotic Control Architecture. ONR Conference of Locomotion Control in Legged Invertebrates, National Academy Study Center. Woods Hole, MA Sept 13, 1991.

Correlation of Behavior with Unit Electrophysiology. Scientific Computing and Automation Conference. Philadelphia. PA Sept 11, 1991 Session Chair: Scientific Imaging on the Macintosh.

In Vivo Recording During Behavior. Williams College, November 1, 1991

Correlation of Kinematic and Electrophysiological Analysis on the Macintosh II. SEAM92 Conference of MacSciTech, MacWorld Expo, San Francisco, CA. January 19, 1992. Session Chair: Scientific Image Processing and Analysis

In Vivo recording from Regenerating Reticulospinal Neurons In the Lamprey, Bowdin College, February 20, 1992

Marine Research: The Atlantic Lobster. Presentation to the National Science Teachers Association, Boston, March 27, 1992

Recruitment of Reticulospinal Neurons During Swimming Command Microstimulation in Lamprey. East Coast Nerve Net - Eighteenth Annual Meeting, March 28, 1992. with Sarah Jordan

Effects of Eyestalk Manipulation on Gastric Mill Rhythms in Homarus Americanus. East Coast Nerve Net - Eighteenth Annual Meeting, March 28, 1992. with Alicia Morris

Sonar Biotelemetry from the Lobster Feeding and Stomatogastric Systems, Laboratory de Neurophysiologie Comparee, CNRS, University de Bordeaux, Archecon, France. May 22, 1992

Lecturer in the Neurobiology Course, Isle of Shoals Marine Laboratory, Cornell University, June 1992

Scientific Image Analysis on the Macintosh II. Education Conference, MacWorld Expo, Boston MA. August 6, 1992.

- Lobster Neuronal Network-Based Controllers for Ambulatory Robots*, DARPA Undersea Warfare Program, Arlington Virginia, September 14, 1992.
- The Laboratory Toolbox*. Hypercard Conference, MacWorld Expo, San Francisco, CA. January 6, 1993.
- Correlated Motion and Sensor Analysis on the Macintosh*. MacWorld Expo, San Francisco, CA. January 7, 1993. Session Chair: Enabling Technologies in Scientific Research and Education
- The Lobster as a Model for an Underwater Ambulatory Robot*, MIT Sea Grant, February 9, 1993.
- Lecturer in the Mariculture Course*, Marine Biological Laboratory, Woods Hole. June, 1993
- Sonar Telemetry of Physiological Data from Freely Behaving Lobsters*. SEAM93 Conference of MacSciTech, MacWorld Expo, Boston, MA. August 2, 1993.
- Reverse-Engineering Lobster Control Systems for Robot Controllers*. SEAM93 Conference of MacSciTech, MacWorld Expo, Boston, MA. August 2, 1993.
- The Laboratory Toolbox*. Hypercard Conference, MacWorld Expo, Boston, MA. August 3, 1993.
- The Mac as a Spatial Spectrophotometer*. MacWorld Expo, Boston, MA. August 4, 1993. Session Chair: Cutting Edge Technologies in Scientific Research and Education
- Lobster Locomotion Control*. September 9, 1993. ONR Symposium on Aquatic Locomotion, National Academy of Sciences Study Center, Woods Hole
- A Biologically-Based Controller for an Underwater Ambulatory Robot*. September 27, 1993. Eighth International Symposium on Unmanned Untethered Submersible Technology. University of New Hampshire
- Development and Behavior the Lobster Feeding and Stomatogastric Motor Systems*. November 9, 1993. Stomatogastric Mini-Symposium, Society for Neuroscience Annual Meeting, Washington, DC.
- Adaptive Control of an Ambulatory Underwater Robot*. November 10, 1993, Expeditionary Warfare Office (OPNAV85), Department of Defense, The Pentagon.
- Computational Neuroethology of the Lobster Walking System*. December 9, 1993, Institute of Zoology, University of Hamburg, Germany
- Computational Neuroethology of the Lobster Walking System*. December 13, 1993, Institute of Zoology, University of Köln., Germany..
- Computational Neuroethology of the Lobster Walking System*. December 15, 1993, Institute of Zoology, University of Bonn, Germany.
- Biologically-Based Robots*, December, 1993, Department of Physics, Northeastern University
- Lobster Biotechnology*, March, 28, 1994, National Council, Northeastern University
- Lobster Based Robots*. East Coast Nerve Net - Twentieth Annual Meeting, April 4, 1994.

A Behavior-Based Controller Architecture for Underwater Ambulatory Robots, Advanced Research Projects Agency, Undersea Warfare Program, Arlington, VA. December 12, 1994

Biologically Based Underwater Robot Controllers, Review meeting on **Bio-Locomotion and Rotational Flow over Compliant Surfaces**, Sponsored by ARPA and ONR, Johns Hopkins University, March 20-22 1995. Baltimore

Development of Stomatogastric Mediated Motor Programs In The American Lobster. Boston Area Neuroscience Group, Northeastern University, March 27, 1995 (Poster with Kari Lavalli)

A Lobster-based Underwater Robot Controller, Boston Area Neuroscience Group, Northeastern University, March 27, 1995 (Poster with Lars Schlichting)

Biologically Based Underwater Robots. Electro/95 International, Boston, MA June 23, 1995

Computational Neuroethology of Undulatory and Ambulatory Locomotion. MacWorld Expo. Macs in Science/Technology, Boston MA, August 9, 1995.

Biologically Based Underwater Robots. Boston University Marine Program, Boston, MA November 16, 1995

Opportunities in Marine Biotechnology. Swampscott High School, May 21, 1995.

Computational Neuroethology of Underwater Locomotion. Department of Zoölogy, University of Victoria, Victoria, BC. Feb. 16, 1996

How to be a Marine Biologist. Lynn Classical High School, Career Day, Lynn Classical High School,. June 11, 1996.

Neurotechnology for Biologically-Based Underwater Robots, Marine Biological Laboratory, Woods Hole, MA , December 11, 1996.

Reverse Engineering Marine Animals to Design Underwater Robots. Member of the Faculty of MacWorld Expo in San Francisco. Participant in the Science and Engineering Conference, January 10, 1997.

Neurotechnology for Biologically-Based Underwater Robots, Institute of Marine Sciences of the University of California, Santa Cruz, January 14, 1997.

Neurotechnology for Biologically Based Underwater Robots. DARPA, Defense Sciences Office May 17, 1997.

Career Opportunities in Marine Biology. Lynn Classical High School, Career Day, Lynn Classical High School,. June 11, 1997.

Neurotechnology for Biologically Based Underwater Robots. MIT Department of Ocean Engineering, July 13, 1997.

Biomimetic Underwater Robots. Controlled Biological Systems Workshop, DARPA, Herndon VA. Oct 21, 1997.

Biomimetic Underwater Robots. Mine Warfare Technology Program, Naval Undersea Warfare Center, Newport, RI. December 10, 1997.

Neurotechnology for Biomimetic Underwater Robots. Neurotechnology for Autonomy in Aeronautics and Space Exploration, NASA Ames Research Center, January 14, 1997

A Modular Behavioral-Based Architecture for Biomimetic Autonomous Underwater Robots, Naval Postgraduate School, April 7, 1998

Biomimetic Underwater Robots: DARPA: Controlled Biological Systems Kickoff Meeting. San Diego CA August 4, 1998.

Neurotechnology for Biomimetic Underwater Robots. German National Research Center for Information Technology , Sankt Augustin, Germany. October 23, 1998

Neurotechnology for Biomimetic Underwater Robots. AAIA Robotic Forum, Draper Laboratories, July 16, 1998.

MEMs Sensors for Underwater Robots. DARPA Controlled Biological Systems Program Review, Tucson, AZ. January 4, 1999

Neurotechnology for Biomimetic Underwater Robots. Department of Biology. Northeastern University, February 10, 1999.

Neurotechnology for Biomimetic Underwater Robots. Department of Psychology, Smith College, March, 24, 1999.

Autonomous Underwater Vehicles, IEEE Robotics and Automation Society, Wellesley, MA June 8, 1999

Biomimetic Underwater Robots, Autonomous Systems Laboratory, Peripheral Systems Laboratories, Fujitsu Laboratories, Tokyo, Japan, May 17, 1999.

Behavior-based Underwater Robots, Mini-Brain Program, Hokkaido University. Hokkaido, Japan, May 18, 1999.

Biomimetic Underwater Robots, School of Marine Science and Technology, Tokai University, Shimizu City, Japan, May 19, 1999.

Biomimetic Underwater Robots, Department of Mechanical Engineering, Tokyo Institute of Technology. Tokyo, Japan, May 20, 1999.

Biomimetic Underwater Robots, Underwater Technology Research Center, Institute of Industrial Science, University of Tokyo, , May 20, 1999.

Biomimetic Underwater Robots, Electronics R&D Division, Mitsubishi Heavy Industries, Yokohama, Japan, May 21, 1999.

How to Become a Marine Biologist, Careers Day, Lynn Classical High School, June 8, 2000.

Autonomous Underwater Vehicles, IEEE Robotics and Automation Society, Wellesley, MA June 8, 1999

Biomimetic Underwater Robots, Marine Corps Future Laboratory, Quantico, VA August 17, 2000.

Behavior-based Underwater Robots. 1st Gordon Conference on Neuroethology and Behavior, Queens College, Oxford University. September 2, 1999.

Biomimetic Ambulatory and Undulatory Underwater Vehicles (Lecture and Technical Demonstration). Controlled Biological Systems PI Meeting, San Antonio, Texas. April 11, 2000.

Crustacean Gait Control: Biomimetic Implementation. & Undulating Locomotion: Biomimetic Implementation (2 talks) NASA Workshop on Invertebrate Sensory Information Processing: Implications for Biologically Inspired Autonomous Systems. Johnson Center of the National Academy of Sciences, April 16, 2000.

Biomimetic Ambulatory and Undulatory Underwater Vehicles (Lecture and Technical Demonstration). Controlled Biological Systems PI Meeting, San Antonio, Texas. April 11, 2000.

A Conservative Biomimetic Control Architecture for Autonomous Underwater Robots. International Conference on Neurotechnology for Biomimetic Robots, Nahant, MA.

Biomimetic Underwater Vehicles (Lecture and Technical Demonstration). Controlled Biological Systems PI Meeting, Breckenridge, CO. March 22-23, 2000.

Biomimetic Underwater Robots. International Symposium for the Society for Neuroethology, Bonn Germany, Aug, 2001.

Biomimetic Underwater Robots. Institute for Nonlinear Science, University of California, San Diego. October 8, 2001.

Neurotechnology for Biomimetic Underwater Robots. UCLA Joint Seminars in Neuroscience. The Brain Research Institute and Neuropsychiatric Institute. University of California, Los Angeles, October 9, 2001.

A Conservative Architecture for Biomimetic Underwater Robots. Institute of Marine Studies, University of California, Santa Cruz. October 10, 2001.

Sensor fusion for Biomimetic Underwater Robots. 2nd Gordon Conference on Neuroethology and Evolution of Behavior, Oxford University August 20, 2002

Neurotechnology for Biomimetic Robots. Lecture at TIAX (Formerly Arthur D Little) September 18, 2001

Developing Biomimetic Underwater Robots IEEE Ocean Engineering Society, MIT, November 7, 2002

Neurotechnology for Biomimetic Robots. American Society for Mechanical Engineering, Northeastern University, November 21, 2002

Electronic Nervous systems for Biomimetic Underwater Robots. Office of Naval Research, Arlington, VA.. March 19, 2003

Electronic Nervous systems for Biomimetic Underwater Robots. Institute for Non Linear Science, University of California, San Diego. March 19, 2003

Electronic Nervous systems for Biomimetic Underwater Robots. Department of Biology and Neuroscience, University of California, Riverside. April 8, 2003

Electronic Nervous systems for Biomimetic Underwater Robots. Robotics Institute, University of Southern California, March 19, 2003

Building Electronic Nervous Systems with INLS Electronic Neurons, Department of Biology, Northeastern Univ, September 12, 2003

Electronic Nervous systems for biomimetic robots. East Coast Nerve Net. Marine Biological Laboratory, Woods Hole, MA April 3, 2005.

Can we build robots with real nervous systems? Department of Anatomy and Neurobiology, Dalhousie University, Halifax, NS, Canada. April 21, 2005

Synthetic Neuroscience: Can we build robots with real nervous systems? Department of Biology, Tufts University, September 30, 2005

Synthetic Neuroscience: Can we build robots with real nervous systems? Lockheed-Martin, Sippican, Marion, Massachusetts. October 4, 2005

Electronic Brains for Lobster Robots, Larimerfest: Retirement Symposium for Prof. James Larimer, University of Texas, Austin, October 28, 2005

Synthesis and control of CPGs with neurons based on Principles of nonlinear dynamics. With Daniel P. Knudsen, Nikolai Rulkov, East Coast, Nerve Net, Marine Biological Laboratory, April 1, 2006.

Augmented Constraint Induced Therapy for Blast Neurorehabilitation. Defense Advanced Research Projects Agency, April 27, 2006. With Edward Taub.

Robotic System for Marine Applications That Mimic Animal Behavior in the Natural Environment, Ocean Science and Technology Conference, Massachusetts Technology Transfer Council, Woods Hole, MA, May 24, 2006

Electronic Neurons: From Biomimetic Robots to Neurorehabilitation, Department of Biology, Northeastern University, September 18, 2009

Controlling Biomimetic Underwater Robots with Electronic Nervous Systems, Boston University Marine Program, September 27, 2006.

Controlling Biomimetic Underwater Robots with Electronic Nervous Systems. Airforce Research Office Workshop on Mobility and Control in Challenging Environments, Olin College, October 6, 2006

Controlling Robots with Electronic Nervous Systems (Poster) Dynamics Days, Boston, MA, Jan 4, 2007.

Controlling Biomimetic Robots with Electronic Nervous Systems, Department of Physics, SUNY Albany,

- Robot Demo. Opening Reception, RoboBusiness Conference and Exposition, Boston, MA, May 14, 2007
- Controlling the Lamprey Robot with Electronic Neurons, Information Systems Laboratories, La Jolla, CA, August 1, 2007
- Biomimetic Approaches to Underwater Robot Control, iRobot Corporation, Burlington, MA, October 11, 2007
- Building Brains for Underwater Robots, Schlumberger/Doll, Cambridge, MA, October 16, 2007
- Building Brains for Underwater Robots, Massachusetts Technology Transfer Center Conference: The Future of Robotics, IBM Corporation, Waltham, MA, October 25, 2007
- Controlling underwater Robots with Neural Networks. EntreTech. Waltham, MA March 18, 2008
- Controlling Underwater Robots with Electronic Nervous Systems, Boston Dynamics, Waltham, MA Apr 29, 2009
- Building a Brain for RoboBee, NSF Computer Science Reverse Site Visit, Arlington, MA June 11, 2009
- Biomimetics of Tactile Sensing, Schlumberger Corp, Cambridge, MA, Sept 15, 2009
- Electronic Neurons for Biomimetic Robots and Neuroprostheses, Neuroscience Program, University of Alabama, Birmingham, Sept 17, 2009
- Controlling Robots with Electronic Nervous Systems. MassTLC Summit: The Future of Robotics, IBM Corporation, Cambridge MA, Dec 8, 2009
- Biomimetic Robots*. CIMIT Forum on Surgical Robots, Brigham and Womens Hospital. Feb 23, 2010.
- Biomimetic Robots*. TechFest 2009-2010, ITT Bombay, Mumbai, India Jan 20-23, 2010
- The lamprey Robot* (w/ Anthony Westphal), Session Chair: Biomimetic Robots. 10th International Symposium on Technology and The Mine Problem. Naval Postgraduate School, Monterey, CA May 18, 2010
- Panel Member: Future of Robotics EntreTech Forum, Foley Hoag Corporate Center, Waltham, MA. April 20, 2010
- Simulation of Sensory Fusion of Hydrodynamic and Optical Flow in the Lobster*. Society for Neuroscience Ann. Meeting, San Diego, CA. Nov. 14, 2010
- Behavioral Patterns of the tenticle of the jellyfish, Sanderia malayensis*, Society for Neuroscience Ann. Meeting, San Diego, CA. Nov. 14, 2010
- Building brains for Biomimetic Robots*, Department of Electrical Engineering. Newcastle, University, Newcastle, GB. Sept 8, 2010.

The Brain. RoboBees Symposium, School of Engineering and Applied Sciences. Harvard University, Oct. 29, 2010.

Building Brains with Electronic Neurons, Office of Naval Research, Arlington, VA. May 16, 2011

Engineered Biological Sensor Integration in Biomimetic Robots, Boston Univ. July 28, 2011

Exteroceptive Reflex Control of RoboBee Search, School of Engineering and Applied Sciences, Harvard Univ., September 8, 2011

Biomimetic Robots for shallow water remote sensing. Defense Threat Reduction Agency, Arlington, VA October 10, 2011

Building Brains for Biomimetic Robots. *The Future of Robotics Meeting*. Microsoft Research Center, Cambridge MA, December 2, 2011

A Conserved Architecture for walking, swimming and flying robots. ONR Bio-Inspired Autonomous Systems Program Review May 24-25, 2012

Natural Architectures for Biomimetic Robot Control. NSF/ARO Conference on Locomotion Systems Science. Arlington VA. May, 29, 2012

Natural Architectures for Biomimetic Robot Control. Wyss Institute Symposium: *Noise and Rhythm*, Harvard Medical School. June 8, 2012

Natural Architectures for Biomimetic Robot Control. National Defense Industry Association, Northeastern Regional Meeting, Nahant, MA. Aug 29, 2012

SOFTWARE SYSTEMS DEVELOPED

- (1) *MacGraph*: (1988-present) Graphics utilities which support general parametric graph editing and statistics, phase response curve and entrainment analysis (*MacPRC*) and use of the Farallon MacRecorder as a digital oscilloscope (*MacScope*).
- (2) *MacLamprey* (1988-1992), a Macintosh based program for the analysis of undulatory locomotion which supports, curvature analysis, and graphical display for timed based analysis of electrophysiological and kinematic data. This program is fundamental to our work on the analysis of undulatory locomotion and received data acquired from video-tape by the program ColorImage (1992-present)
- (3) *SpikeTrain* (1994-present) Macintosh based signal processing application which resolves multi-unit nerve recordings into the activity patterns of individual neurons. The programs interface with ColorImage to acquire *in vivo* recordings from the lamprey CNS and direct correlation with kinematic behavioral analysis Over the past year I have made a major enhancement of this program by completely rewriting it in Pascal and porting it to the Macintosh. This program is fundamental to my collaboration with Prof. Georg Heinzel (University of Bonn) on Real-Time sonar telemetry of electrophysiological data (1991-1995).

- (4) General purpose programs for data entry and analysis of frog kinematics and jump trajectories (1988-1989)
- (5) Ongoing development of *ColorImage* a true color image analysis program which supports the segmentation and quantification of objects from true (24bit) color images of natural scenes and motion analysis from digital movies. We have recently upgraded this program to support the Functionality of NIH Image V1.51, the RasterOps 24STV frame grabber and the Cambridge Research Instruments *Varispec Tunable Filter*. This latter instrument supports real-time digital spectroscopy using the Macintosh. ColorImage is the basis for our current reverse kinematic analyses of lobster locomotion for our ONR Lobster Robot program and lamprey locomotion for our ARPA Undulatory Robot program.. It has been distributed nationally through electronic bulletin boards at National Institutes of Health and MacSciTech for over five years and on the MacSciTech CD-ROM. With Garth Fletcher (1988-1995)
- (6). Development of *Laboratory Toolbox*, a multimedia Hypercard stack which supports acquisition, analysis and data-base management of image, table and sensor data. This stack originated as a project for my course Biological Laboratory Computing and has attracted interest from several local software and hardware vendors who have donated equipment to be supported. I am distributing the *Laboratory Toolbox* Hypercard Stack nationally through the NIMH, MacSciTech and Stanford InfoMac electronic bulletin boards. I am using variants of this program as the basis of a K-12 outreach program (The Johnson School Hypercard Club) to the Nahant School District. (1991-1996)
- (7) Development of *SonarRecorder* and *SonarViewer* (1990-1992) Two utilities for long term sonar biotelemetry using the Massa Products E-326T and E-326R telemetry systems. These programs allow the continuous acquisition of telemetry data from pool hydrophones as well as a radio sonobuoy (*SonarRecorder*) and graphical visualization and statistical analysis of the results (*SonoView*).
- (8) Development of *MotorProgram*, a simulation program for demonstration of stomatogastric, walking, gait and metachronal rhythm pattern generation mechanisms by invertebrate motor pattern generators (1990-1992)
- (9) *Ambulator II*, which implements a finite state machine for the control of omnidirectional ambulation. This program is the basis of our research program for the development of a lobster-based autonomous robot. Over the past year we have added behavioral sequencing and sensor models to this development platform. (1992-present).
- (10) *Undulator II*, which implements a finite state machine for the control of undulatory locomotion. This program is the basis of our research program for the development of a lamprey-based autonomous robot. This program generates control signals for a 5 segment unduator which can generate lamprey, carp, shark and trout motor patterns. (1994-present).
- (11). DTMBN CPGs: A library of LabView-based Central Pattern Generator elements which form the basis of our discrete-time map-based neuron robotic controllers. With Nikolai Rulkov and Dan Knudsen (2003-present). We are also extending these to the RoboLab System with Chris Rogers of Tufts, CEEO.

RESEARCH SUPPORT:

Research Grants and Fellowships

National Science Foundation Training Grant, Department of Biochemistry, University of California, Riverside, Summer, 1968.

U. S. Public Health Service Training Grant, Department of Biology, University of California, Riverside, 1968-1969.

NSF-CNRS, U. S.-France Exchange of Scientists Postdoctoral Fellowship, Centre National de la Recherche Scientifique, Marseilles, 1975-1976.

NINCDS Postdoctoral Fellowship, Department of Biology, University of California, San Diego, 1976-1978, competitive renewal also awarded for 1978-1979.

Analysis of Lamprey Behavior. Funded by Northeastern University College of Arts and Sciences Research Grant Program

Alfred E. Sloan Research Fellowship. Department of Biology, Northeastern University, 1980-1982, \$20,000

Behavioral and Physiological Analysis of Spinal Cord Regeneration in the Sea Lamprey. (1982) Northeastern University RSDF, Ayers, J. \$4,990

Analysis of Neural Circuit Variability. funded by Biomedical Research Support Grant # RR07143.

Regeneration in the Lamprey Spinal Cord. funded by Biomedical Research Support Grant RR07143.

Analysis of behavior with a Digital Camera funded by Biomedical Research Support Grant RR07143.

Development of Interdisciplinary Neurosciences Courses at Northeastern University. With Norman Boisse and Alex Skavenski. Funded by the Northeastern University Instructional Development Fund.

Regeneration of Locomotor Command Systems. Funded by National Science Foundation Developmental Neuroscience and Science and Technology to Aid the Handicapped Programs, BNS 8406880. 1984-1987

Functional Anatomy of Frog Tecto-Motor Systems. With David Ingle. Funded by National Science Foundation, Integrative Neural Sciences Program. January 1, 1988, Dec. 31, 1990

Development of True Color Picture Processing Algorithms. Funded by Apple Computer. June, 1988

Acquisition of an Electronic Still Video System for Color Image Analysis. Funded by the NIH BSRG Support Grant, January, 1989

Development of A Biological Image Processing Facility.(1990) With Kenneth Sebens, Jon Witman., David Ingle, and M.P. Morse, Funded by the National Science Foundation Instrument and Instrument Development Program. (DIR-8917532) \$37,000.

Improvement of Research Facilities at Marine Science Center (1990) K.P.Sebens, P.I. J. Ayers, MP.Morse, J. Witman co-investigators. Funded by the NSF Marine Facilities Program (DIR-9013164) 7/90-6/92, \$160,000

Neuroethological Analysis of Lobster Feeding Using Sonar Biotelemetry (1991) Ayers, J., P.I. Funded by the NSF Neural Mechanisms of Behavior Program, 1991-1992, \$14,000 BNS 9021278

Development of Multi-Channel Sonar Biotelemetry Systems for Analysis of Motor Pattern Modulation (1991) Ayers, J., P.I. Donald Massa, Co-investigator. Funded by the Office of Naval Research, Biological Intelligence Program. 1991-1992, \$40,000 Grant # N00014-91-J-1822

Comparative Analysis of Lobster Feeding and Stomatogastric Motor Programs (1991-1994) Ayers, J., P.I., Georg Heinzel (University of Bonn) co-investigator Funded by the Human Frontiers Research Program. 1991-1993. \$55,161

Development of a College of Arts and Sciences Multi-Media Laboratory (1992) with Gerald Herman. Funded by the College of Arts and Sciences, Northeastern University, \$65,000.

Development of Lobster Feeding and Stomatogastric Motor Programs. (1992) Ayers, J., P.I. Funded by the NSF Neural Mechanisms of Behavior Program, IBN-9121224, 1992-1994, \$79,000

Biological Based Control of Omnidirectional Robot Walking (1992) with Jill Crisman. Funded by the Northeastern University Research and Scholarship Development Fund. 1992-1993, \$9,200.

D. R. Blidberg, PI., Ayers, J., Sergei Kashin coPIs. *Development of a Biologically-based Undulatory Autonomous Submersible Robot.* Advanced Research Project Agency Start Date May 1, 1994, Duration: 18 Months. Direct Costs: \$308,048, Indirect Costs: \$155,467.

Massa Products, Corporation, SBIR Grant. With D. Massa, J. Ayers, D.R. Blidberg and J.D. Crisman. (1994) *Legged Vehicle for Underwater Mobile Operations.* ONR SBIR Phase 1 Proposal Topic # N93-139, Start Date Feb 26, 1994; Duration 18 months. Total Costs \$75,000, Direct Costs to NU \$9,366, Indirect Costs: \$5,432.

Ayers, J. (1997) Summer Marine Biology Institute. GE Fund, \$25,000.

Ayers, J. and Donald Massa Integration of an Ambulatory Robotic System with an Acoustic Lane Marking System for Littoral Zone Mine Countermeasures. DOD 1997 STTR Topic N97T002, \$45,148.

Ayers, J. (PI), Donald Massa, William Vorus, Paul Zavracky, Nicol McGruer, Ranjan Mukherjee, Scott Currie Development of Biomimetic Undulatory and Ambulatory Underwater Robots, DARPA-DSO Biomimetic Systems Program. ONR Grant N00014-98-1-0381. \$2,470,063. March 1, 1998-February 28, 2001

Ayers, J. (1998) Summer Marine Biology Institute. GE Fund, \$23,500.

Donald Massa, David Brady and Ayers, J. (1998) Development Acoustic Lane Marking and Navigation System for Littoral Zone Mine Countermeasures. DOD 1998 Phase 2 STTR Topic N97T002, With Massa Products, Corporation. Total \$749,204

Ayers, J.,PI, (2002) Sensor Fusion Mediation of Exteroceptive Reflexes in a Surf Zone Crawler, ONR Cognitive Neurosciences Program. March 15, 2002- March 14, 2003, \$49,969

Ayers, J., PI (2003) Support for the Aquabiomechanisms II Conference, ONR Cognitive Neurosciences Program \$32,000, Funded September 2002, Conference Held September 2003

Development of Behavioral Set in the DARPA/ONR Lobster Robot. With Yong-Bin Kim , NU ECE, ONR Cognitive Neurosciences Contract N000014-04-1-286. March 15, 2004- March 14, 2005, \$177,986

Annealing Sensorimotor Reflexes in the ONR Lobster Robot. ONR Contract N000140510790 May 2005-March-2006, \$18,497

Map-based Models of Neurons for Implementation of Neurobiological Networks Operating in Real Time DARPA SBIR Phase I. Topic SB052-010 Grant 05SB2-0145 With Nikolai Rulkov, Information Systems Laboratories, Inc. San Diego, CA, \$100,000 total. \$15,100 to NU

Modeling Chaos in Sensorimotor Integration. ONR Contract N000140611037 Sept 1, 2006 - March 30, 2007, \$26,607

Controlling Undulatory Robots with Electronic Nervous Systems, DARPA SBIR Phase II. Topic SB052-010 Grant 05SB2-0145 With Nikolai Rulkov, Information Systems Laboratories, Inc. San Diego, CA. \$750,000 total. \$332,795 to NU.

Massachusetts Technology Transfer Council Assessment Award, Sept, 2006, June, 2007, \$5,000.

Support for development of Aquaculture Facilities for Jellyfish at MSC, Schlumber/Doll, Dec, 2007, \$90,000.

Support for a PostDoc in Biomimetics, Schlumber/Doll, January, 2008-2010, \$160,000.

Support for Aquaculture Facilities for Jellyfish at MSC, Schlumber/Doll, Sept, 2008, \$50,000.

Collaborative Research: RoboBees: A Convergence of Body, Brain and Colony, NSF ITR Expeditions. 9/1/2009-8/31/2014 With Harvard SEAS. Total Award \$10,000,000; \$698,045 to NU

Collaborative Research: Cyberplasm - An autonomous micro-robot constructed using synthetic biology NSF CBET Division of Chemical, Bioengineering, Environmental, and Transport Systems, 9/1/2009, 8/31/2012 With UCSF, Univ. Alabama, Birmingham, Newcastle University, Total Award, \$2,700,000; \$538,562 to NU.

Modernization and Enhancement of the Seawater System and Research Infrastructure at Northeastern University's Marine Science Center With Geoffrey Trussel, Steve Vollmer, Matt Bracken. NSF OCE Division of Ocean Sciences. Award Number: 0963010, August, 2010-July, 2013, \$1,768,555

Support for a PostDoc in Biomimetics, Schlumber/Doll, June 2010-May, 2011, \$105,000.

ONR-MURI Utilizing Synthetic Biology to Create Programmable Micro-Bio-Robots With Boston University MIT, Harvard University, Univ. of Pennsylvania Budget: \$4.5M (3 year base), \$3M (2 year option), \$7.5M (total), NU Share \$996K.

Support for a Research Assistant in Biomimetics, Schlumber/Doll, June 2011-May, 2012, \$47,294_

INDUSTRIAL COLLABORATIONS

Schlumberger, Cambridge, MA. We are collaborating with Schlumberger Sensor Physics division on Biomimetic Approaches to active and passive tactile sensing in jellyfish and lobster. They are supporting a PostDoctoral research associate at MSC, who collaborates with several Cambridge-based researchers.

Information Systems Laboratories, San Diego. We have completed both Phase 1 and Phase II DARA SBIR Grants to develop an electronic nervous system for the Lamprey Robot.

Merlin Technologies, San Carlos CA. Merlin Technologies is the developer of the EX-8 Stealth Kayak used by the Navy Seals for shallow water mine countermeasures. We are collaborating in the development of the lobster and lamprey robots to be used as roving satchel charges to be deployed from the EX-8.

Massa Products, Inc, Hingham, MA Donald Massa (President of MPI) has collaborated as a subcontractor on the Lobster Sonar Biotelemetry and the Biomimetic Projects through 2000.

TIAX/Merlin Technologies, Inc. We have a letter of Understanding with TIAX and have submitted an ONR BAA Proposal with TIAX and Merlin Technologies, Inc. to continue development of the lamprey robot.

Fletcher Applied Sciences, Mason NH. Garth Fletcher has collaborated with me from the inception of ColorImage. He developed the color quantization algorithms fundamental to color image segmentation. We have enhanced ColorImage to support color based motion analysis using the Sequence Grabber, providing the only NIH Implementation that supports the video technology in modern Macintoshes.

Abbate Video Consultants, Norfolk, MA . I have collaborated with Mark Abbate on the development of both ColorImage and the Laboratory Toolbox. Abbate Video Consultants developed the serial interface between Macintosh and Sony VCR's and CamCorders which has enabled the motion analysis capabilities of these two projects.

Dynamic Structures and Materials, LLT. We have collaborated with DSM in the development of training algorithms for artificial muscle.

East Coast Seafood, Lynn, MA. I have collaborated with Michael Tourkistas (President, East Coast Seafood) on a project to develop holding conditions to optimize shell hardening in soft shell lobsters. East Coast Seafood is the largest shipper of lobsters in the world.

GW Instruments, Somerville, MA. I supported the GW instruments MacAdios technology in the Laboratory Toolbox Hypercard project. I was featured in their advertisements in Science, Journal of Neuroscience and Journal of Neurophysiology.

POPULAR PRESS and TV COVERAGE:

Lampreys aid paralytics? In **Science Digest 90:** 94. 1984

D. Herold, Lamprey Man. In: **North Shore Sunday 11:** 1-5, 1988

They're building a Fish? **Lynn Daily Evening Item,** June 9, 1994

- Biological-Based Robots **Popular Mechanics Magazine Show**, Discovery Channel, November 16, 1995
(Nationally Broadcast) Rebroadcast on several occasions.
- Macintosh takes a big bite of the education apple. By David Liscio, *Mass High Tech* 14: 13. August 19, 1996
- Remote Reality Robots, By Glenda Chui, **San Jose Mercury News**, May 28, 1998
- Sea Robots to prowl Nahant's Shorelines. By Chris Iacono. **Lynn Daily Evening Item** March 20, 1998
- Here's the catch: cleaner water has meant disappearing lobsters. By Peter J. Howe, **Boston Globe** 4/16/98.
- Ideas: The Bionic Lobster By John Yemma, *Boston Globe Magazine*, June 14, 1998
- Simple Nematode may Give Navy a New Way to Find Mines. By Louis Jacobson. **The Washington Post: Science: Robotics**. August 24, 1998
- Wiggling Through the Waves. By Amy Adams. **New Scientist** Vol160: 32-35. October 10. 1998
- Pentagon Recruiting Bees, Cockroaches and Wasps by Jeff Nesmith .1999 **Cox News Service**
- Marine Camp has no drills: Ocean Lures Kids to Nahant Program. **Lynn Daily Evening Item**, August 14, 1999.
- Frankensteins Lobster? By Marie Lingblom. **North Shore Sunday**, June, 20, 1999. Pp 12-14.
- Pentagon Recruits insects to find land mines. **Riverside Press Enterprise**, July 25, 1999.
- Natural Born Robots, **Scientific American Frontiers**, Public Broadcasting System, November 2, 1999
- Le.top.des.réseaux/nvtechno **Le Monde Interactif** du mercredi 28 avril 1999, Stéphane Mandard
- Robotic Lobsters, Fox 2000, Broadcast in May Fox TV
- Spy Fly: Tiny, winged robot to mimic nature's fighter jets. By Chuck Squatriglia, **San Francisco Chronicle** , November 2, 1999
- PHOTO ESSAY: Robots. By Peter Menzel **Business Week**, Dec. 13, 1999
- Notebook: Don't Tell the Chinese, By Harriet Barovick, Michelle Derrow, Tam Gray, Daniel Levy, Lina Lofaro, David Spitz, Flora Tartakovsky And Chris Taylor, **Time Magazine**. June 21, 1999
- Lego Mindstorms Website**: The BURP Program was featured in the ROBOTNEWS section during the months of Dec, 1999-Jan, 2000.
- BBC, Nature. Robocritters**, Shown in Britain March 2000, To be aired on the Learning Channel in the US
- Biologists and Engineers Create a New Generation of Robots That Imitate. *Life*. By Gary Taubes **Science** 2000 Apr 7; 288(5463) 80-3.
- Building a Perfect Lobster Robot. By Gary Taubes **Science** 2000 Apr 7; 288(5463) 82.

Biobots By Peter Menzel and Faith D'Aluisio **Discover** Vol. 21 No. 9 (September 2000)

RoboSapiens. By Peter Menzel and Faith D'Aluisio, MIT Press, 2000

Robots mimic living creatures. by Yvonne Carts-Powell **SPIE OE Reports** Number 201 September 2000

Pentagon sends robo-lobster on ocean patrol. By Will Iredale **London Sunday Times**, April 1, 2001.

National Geographic Network: The Human Edge: Biobots

http://www.nationalgeographic.com/tv/channel/highlights_edge.html

KQED: Springboard: The Digital Age

<http://www.pbs.org/kqed/springboard/segments/58/>

National Public Radio

http://www.here-now.org/archive/2001/010703_archive.asp

Melted Butter is Extra. By Martha Sutro. Worth Magazine, April 2001. Page 28

Pentagon sends robo-lobster on ocean patrol. By Will Iredale London Sunday Times, April 1, 2001.

The Hero in the Tank: Scientist's Robot Lobsters Could Seek Mines, Save Lives. by Tom Walsh. Boston Herald, June 11, 2001. Page 26.

Meet the Newest Recruits: Robots. By Ann Marie Squeo, The Wall Street Journal, December 13, 2001.

<http://www.neurotechnology.neu.edu/wsj.html>

Mass High Tech Magazine

http://www.masshightech.com/displayarticleDetail.asp?art_id=48711

Information Week

<http://www.informationweek.com/story/IWK20010621S0005> National Geographic Network: The Human Edge: Biobots, August, 2002

Hunter Keeter (2002) ONR Team looks for Autonomy in New Mine Hunting Robots. Defense Daily April 16, 2002

Office of Naval Research Public Affairs

<http://www.onr.navy.mil/media/extra/fact%5Fsheets/robo%5Flobster.pdf>

Wired

<http://www.wired.com/news/politics/0,1283,52766,00.html>

<http://wired-vig.wired.com/news/print/0,1294,59091,00.html>

<http://www.wired.com/wired/archive/13.06/nextfest.html?pg=2>

UCSC ScienceNotes 2002

<http://scicom.ucsc.edu/SciNotes/0201/lo/lobster/>

Animalistic robots ready to unleash by Chris Walz (2003) Pentagram

Boom. By Stephanie Henkel. Sensors Magazine. June 2003

<http://www.sensormag.com/articles/0603/10/main.shtml>

Biomimetics: researchers inspired by the animal world By Scott Kirsner. Boston Globe, June 9, 2003

http://boston.com/business/tech_innovation/news/2003/06/09/at_large.htm

Minesweeper: Coolest Invention of 2003. Time Magazine, December 17, 2003.

<http://www.time.com/time/2003/inventions/invlobster.html>

Exploratorium

<http://www.exploratorium.edu/theworld/bees/robots.html>

Israel: news.walla.co.il

<http://news.iol.co.il/?w=/4/738992>

Biomimetic Robots, by Linda Dailey Paulson, IEEE Computer Society: Computer September 2004. Pp. 48-53

<http://doi.ieeecomputersociety.org/10.1109/MC.2004.121>

They're Robots? Those Beasts! By Scott Kirsner, New York Times, Technology Section September 16, 2004

http://www.biology.neu.edu/pdf/ayers_NYTimes.pdf

These Robots are Wild, Time for Kids, March 4, 2005

<http://www.timeforkids.com/TFK/class/wr/article/0,17585,1032706,00.html>

Technology that Imitates Nature, Economist, Science and Technology Quarterly, June 9, 2005

http://www.economist.com/science/tq/displaystory.cfm?story_id=4031083

Biomimetics: Your Call Radio: NPR, San Francisco, Radio Interview, October 17, 2005

<http://www.yourcallradio.org-archive-101705.ram>

Man's Best Friend: MSNBC Countdown with Keith Olbermann. April 24, 2006.

<http://www.msnbc.msn.com/id/3036677/>

Mother Natures Design Workshop. Business Week. JUNE 27, 2006

http://www.businessweek.com/technology/content/jun2006/tc20060627_504809.htm

Not a simple shell game: Local scientist showcases his RoboLobster Lynn Daily Item, January 20, 2007.

RoboLobsters and Mind Controlled Sharks. ABC News, June 21, 2007

<http://abcnews.go.com/Technology/story?id=1759585&page=3%3Cbr%20/%3E>

Close Encounters. Photo Essay in Mens Vogue. July/August, 2007.

http://www.mensvogue.com/design/slideshows/2007/06/tech_close_encounters

Teaching**COURSES DESIGNED AND IMPLEMENTED:**

General Neurophysiology	
Graduate Neurophysiology Laboratory	
Advanced Cell Biology	
Human Anatomy and Physiology I.	With Laboratory
Human Anatomy and Physiology II	With Laboratory
Human Physiology I.	With Laboratory
Comparative Neurobiology	
Vertebrate Physiology I.	With Laboratory
Foundations of Neural Science	
Special Topics in Neural Science	
Neuroethology	With Laboratory
Biological Laboratory Computing	With Lab/Demonstration
Senior Seminar	
Graduate Seminars	
Neural Mechanisms Underlying Behavior	
Synaptic Transmission	
Behavioral Neurobiology	
Spinal Cord Regeneration	
Lamprey Neurobiology	
Problem Solving in Biological Laboratory Computing	
Neural Engineering	

UNDERGRADUATE HONORS STUDENT

Daniel Knudsen (2005-2006) Thesis Title: Creating Functional Neural Control Circuits Incorporating Both Discrete Time, Map-Based Neurons And Hindmarsh-Rose Electronic Neurons. Behavioral Neuroscience, Class of 2006.

GRADUATE and POSTDOCTORAL STUDENTS:

Bradford Bratton, MS, 1980, Thesis Title: *Electric Organ Discharge Patterns in Raja erinacea and their Relation to Behavior*. Currently: Senior Scientist Howard Florey Institute University of Melbourne

Scott Currie, MS, 1981, Thesis Title: *Recovery from Spinal Cord Transection in Larval and Adult Lampreys*. Currently: Associate Professor, University of California, Riverside

Galen Eaholtz, MS, 1986, Thesis Title: *Recovery of Locomotion following Spinal Cord Transection in the larval sea lamprey, Petromyzon marinus: A Functional Determination*. Currently: Senior Scientist: University of Washington.

Dean Kaufman, MS, 1988, Thesis Title: *Brainstem control of Undulatory Behavior in the Sea Lamprey*. Currently: Senior Scientist, Siemens Corporation

James Kinch, MS, 1988, Thesis Title: *Quantitative Analysis of Undulatory Behavior in Normal and Recovered Spinally Transected Sea Lamprey*. Currently: Vice President, Toxicon Corporation.

Gary Swain, Ph.D. 1989, Project Title: *Correlation of Anatomical Regeneration with Behavioral Recovery of Swimming in the Sea Lamprey*. Currently: Laboratory Director, Department of Neurology, University of Pennsylvania Hospital.

Lee Margolin, Ph.D. 1989, Project Title: *Behavioral and Electro-physiological Analysis of Recovery from Spinal Cord Transection in Adult Sea Lamprey, Petromyzon marinus*. Currently: Senior Scientist, Frederick Haer Associates, Portland, ME.

Karen Lee, Ph.D, 1993. Dissertation Title: *Interactions between Stomatogastric and Feeding Motor Programs in the American Lobster, Homarus americanus*. Currently an Associate Professor, University of Pittsburgh at Johnstown

Sarah Jordan, M.S. 1993. Project Title: *What neurons underly the initiation and modulation of electrically evoked swimming in normal and recovered spinal transected Lamprey*. Currently: Education Coordinator, Shoals Marine Laboratory.

Traci Garofalo, Project Title: *Neuroethological analysis of Arousal and Behavioral Switching in Recovered Spinally Transected Lamprey* MS Granted, 1996. Currently: Veterinary Assistant, Salem MA.

Current:

Anthony Westphal, PhD, Thesis Title: *Sensorimotor reflexes controlling beacon tracking and adaptive behavior in the Lamprey Robot*.

Peter Brannen, PhD, Thesis Title: *Recruitment of projection neurons during behavioral transitions in the Lobster*.

Steven Smith, PhD, Thesis Title: *Recruitment of projection neurons during behavioral transitions in the Sea Lamprey*.

Daniel Blustein, PhD, Thesis Title: *Sensorimotor reflexes controlling beacon tracking and adaptive behavior in the Lobster Robot. Currently a NSF Graduate Fellow*.

Lara Lewis, PhD, Thesis Subject: *Cellular mechanisms of rhythm generation in Lobster Thoracic Ganglia*.

Lin Zhu, PhD. Thesis Subject: *Genomics of Lobster Stomatogastric Neurons*.

Postdoctoral Associates:

Kari Lavalli, Ph. D., NSF Postdoctoral Associate. Project Title: *Development of Lobster Feeding and Stomatogastric Motor Programs, 1992-1994*. Academic Specialist , Department of Biology, Boston University

Jan Witting. Postdoctoral Associate on the DARPA Biomimetic Robot Project, 1999 to 2005 Currently Assistant Professor of Oceanography Sea Education Association, Woods Hole, MA

Kazuo Mori, PhD. Currently postdoctoral associate on the Schlumberger Tactile Sensing Project (2008-2011+)

Service**INTERNATIONAL PEER REVIEW ACTIVITIES:**

Member: External Review Panel, Riken Brain Science Institute, Tokyo, Japan, September, 2004

NATIONAL PEER REVIEW ACTIVITIES:

Reviewer MacArthur Foundation, 2005, 2010

Member: Computational Neuroscience Review Panel, National Science Foundation June 2004, 2011, Cyber Enabled Discovery Review Panel, National Science Foundation, 2011

Member: NSF/NIH Computational Neuroscience Study Section, June 2003

Proposal Reviewer, National Science Foundation, Neurobiology Program, Developmental Neurobiology Program, Integrative Neural Sciences Program, Spinal Cord Research Foundation, MIT Sea Grant

Manuscript Reviewer, Science, The Journal of Neurophysiology, Neuroscience, Journal of Experimental Biology, Journal of Comparative Physiology, A., The Journal of Neurobiology, Experimental Brain Research, IEEE Robotics; Neuroinformatics

First Robotics

Judge: First Regional Robotics Competition, Agannis Arena, Boston, MA. March 28-29, 2008

Judge: First Beanpot Robotics Competition, Matthews Arena, Boston, May 31, 2008

Judge: First Regional Robotics Competition, Agannis Arena, Boston, MA. March 5-7 2009

Departmental, College and University Committees

Member, State of the Biology Department Ad-Hoc Committee, 1979.

Chairman, University Academic Computer Policy Committee. 1978-1980 Chairman, 1980-1981, 1981-1982, 1984-1985. Reappointed for 1987-1989.

Member, Special Advisory Committee to the Provost for Computer Affairs, Northeastern University, 1984-1986. Member of acquisition committee which specified the University Ethernet Network, 1984-85 and Central VAX8650 System, 1985-1986.

Chairman, Biology Colloquium Committee Northeastern University, 1979-1980, 1984-1985

Member, Committee on Research and Scholarship, College of Arts and Sciences, Northeastern University, 1981-1982

Member, Steering Committee, Center for Marine Science and Maritime Studies College of Arts and Sciences, Northeastern University, 1982 - 1983.

Member, Physiology Search Committee, Department of Biology, Northeastern University, 1982.

Member, Graduate Committee, Department of Biology, Northeastern University, 1980-1985.

Member, Honors Committee, College of Arts and Sciences, Northeastern University, 1983-1984.

- Member**, Director Search Committee, Marine Science and Maritime Studies Center, Northeastern University, 1984.
- Member**, Physiology Search Committee, Department of Biology, Northeastern University, 1984.
- Member**, Physiology Search Committee, Department of Biology, Northeastern University, 1986-1987
- Member**, University Microcomputer Committee, Northeastern University, 1986-1987.
- Chairman**, Word Processing Committee, Department of Biology, 1987-1988
- Member**, University Council on Research and Scholarship, Northeastern University 1988-1991.
- Member**, Information Services Strategic Planning Committee, Office of the Provost, Northeastern University, 1992-1993.
- Member**, Experiential Education Strategic Planning Committee, College of Arts and Sciences, Northeastern University, 1992-1993.
- Member**, Urban Education Strategic Planning Committee, College of Arts and Sciences, Northeastern University, 1992-1993.
- Member**, Academic Computing Advisory Committee, Northeastern University, 1991-1993.
- Chairman**, Research Computing Subcommittee, University Council on Research and Scholarship, Northeastern University 1990-1991.
- Member**, Distinguished Professor Selection Committee, Northeastern University 1989
- Member**, Electrical and Computer Engineering Graduate Program Review Committee, Northeastern University, 1989
- Member**, Faculty Senate, Northeastern University, 1993-1995.
- Member**, College Council, College of Arts and Sciences, Northeastern University, 1979-1981., 1992-1994
- Member**, College of Arts and Sciences Honors Committee, 2003-2005.
- Member**, College of Arts and Sciences Curriculum Committee, 2003-2005
- Member**, Faculty Senate Information Services Policy Committee, 2003-2006. Chairperson, Software Subcommittee 2003-2005.

Service as Director, Marine Science Center, 1991-2001**Facilities Development****NSF Facilities Program Laboratory Addition**

During the summer and fall of 1992, I oversaw the new addition to the MSC main building, This addition provides office/laboratory space to up to 8 visiting scientists.

Bunker 104

With a gift of \$30,000 from Y.T. Li and Associates I oversaw the renovation of the south Gunport and main gallery of Bunker 104. This project achieved:

- (1) Extension of a 4 inch passive seawater supply and return line from the Edwards laboratory to the south gunport of Bunker 104.
- (2) Installation of a 200 amp electrical service to the south gunport
- (3) Installation of a dehumidification system in the south gunport and an exhaust system in the north gunport to prevent condensation in the bunker.
- (4) Installation of a roll top door and crashbar emergency exit in the south gunport
- (5) Sealing and painting the south gunport
- (6) Installation of a halogen lighting system in the south gunport.
- (7) Installation of emergency lighting and exit signs.

Marine Systems Engineering Laboratory

A gift to MSC from Massa Products Corporation supported the renovation of the Generator Room of Bunker 104 area as the physical facilities for the Marine Systems Engineering This adds ~4000 sq. ft. of habitable laboratory space to MSC. This space is currently used as a Lecture Hall and houses the robot program.

Mariculture Laboratory

Through support of R.V. Trappist (Gloucester, MA) we established a mariculture laboratory in Bunker 104 that has been augmented by state funds and is currently used for the K-12 outreach program.

Robotics Laboratory

During 1998, we have renovated the muffler gallery in the Frank Massa Marine Systems Engineering Laboratory to house the DARPA Biomimetic Robot Project.

Biological Imaging Laboratory

The Biological Imaging Laboratory contains 5 Macintosh-based workstations including:

- (1) A Videotape-based motion analysis system
- (2) A Video microscope with color acquisition and segmentation capability.
- (3) A Macrophotography system
- (4) A slide scanner system
- (5) A color flatbed scanner system

Microbiology Laboratories

This provided laboratory facilities for Slava Epstein in addition to a Radiation Laboratory

Running Seawater/Preparation Area

This shared facility is available to all MSC staff and students.

CAS Multimedia Laboratory

Gerry Herman and I established a Multimedia Laboratory in Richards Hall.

New Boats

We received gifts of a 23 ft Steiger Craft from Charles Labron and a 25 ft Allman Cruiser from Richard Andersen. The Steiger craft has been in operation since we received it. We recently restored the Allman in 1996.

MSC Programs

K-12 Outreach

From 1993-2001, we maintained an extensive K-12 outreach program involving primarily the Lynn and Minuteman (Lincoln, Concord, Acton) Regional School Districts. We maintained a formal Junior and Senior High School Outreach program with the Lynn School District in collaboration with the Lynn Business and Educational Foundation that provides financial support.

GE Foundation Marine Biology Experience

Through 1997-1998 we received a grants from the GE Fund to conduct the Summer Marine Biology Institute. 16 students and 8 faculty from 8 College Bound high schools were housed in Northeastern Dorms and bussed to the Marine Science Center for the one week program. This program was featured in GE's Annual Report to Stockholders in 1998.

Marine Biology Concentration/Minor

I established the Marine Biology Concentration and Marine Biology Majors. The programs were initially proposed in 1995 and eventually approved in 1998.

East/West Marine Biology Program

The East/West Program continues as eminent source of leading marine biologists.

Personnel Recruitment:

As Interim Director and Director, I personally recruited the following scientists and staff to MSC

Scientists

Slava Epstein, Senior Research Scientist, Currently Associate Prof. Department of Biology

Dennis Bazylnski, Adjunct Research Associate

Sergei Kashin, Senior Research Scientist

Dick Blidberg, Director Marine Systems Engineering Laboratory

Jim Jalbert, Senior Projects Engineer, MSEL

Steven Chappel, Senior Software Engineer, MSEL

Dr. PoKay Ma, Senior Scientist

Dr. Jan Newton, Adjunct Research Associate

Dr. Roy Turner, Senior Scientist, Marine Systems Engineering Laboratory

Dr. Frank Kirchner, Senior Scientist

Dirk Spennenburg Research Assistant

Dr. Geoff Trussel, Research Associate, Currently Asst. Prof. Department of Biology

Lowell Gray, Adjunct Research Associate

Senior Intern

Al Badger: Senior Intern

Staff

Sarah Jordan, MS. : Education Coordinator.

Captain Douglas O'leary: Maintenance Supervisor/Skipper

Joshua Mahoney Maintenance Assistant/Mate

Cricket Wilbur, MS. Senior research technician

Chris Olcott, Technical Assistant

Dr. Sal Genovese,: Education Coordinator

Elizabeth Clinton, CPA: Administrative Officer

John McDonough: Maintenance Assistant/Mate

COMMUNITY SERVICE:

Member, Computer Curriculum Committee. Nahant School District. Nahant, Massachusetts 1981-1982.

Chairman, Valley Road School Study Committee. Nahant, Massachusetts, 1986-1988.

Member , Conservation Commission, Town of Nahant, 1987-2006. Chairman, 1998-2003

Member, Open Space Committee, Town of Nahant, 1988-1995.

Member, Board of Directors. Nahant Education Foundation, 1994-Present

Member, Board of Directors. Safer Water In Massachusetts (SWIM) 1993-2002

Member, Technical Advisory Committee, Nahant, School District, 1994-1995

Project Leader, Mariculture and Hypercard Clubs and 6th grade science projects, Johnson School, Nahant, MA 1994-1998

Member, Swampscott School District PALMS Leadership Team 1996-1997

Member, Greater Lynn Region School-to-Work Council, 1998-1998