

Malcolm A. MacIver

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Education

2001 PhD Neuroscience, University of Illinois and the Beckman Institute of Advanced Science and Technology, Urbana IL
1996 Course work only of dual Ph.D. in cognitive science and philosophy, Indiana University, Bloomington IN
1992 MA Philosophy, University of Toronto
1991 BSc Double major in computer science and philosophy, University of Toronto, graduated with High Distinction
1986 AEE Electrical Engineering Technician, Confederation College, Thunder Bay, Ontario Canada

Professional Experience

2022-present Professor (Joint between Dept. of Mechanical Engineering & Dept. of Biomedical Engineering), Dept. of Neurobiology (Courtesy), Dept. of Computer Science, (Courtesy), Northwestern University
2016-present Professor (Joint between Dept. of Mechanical Engineering & Dept. of Biomedical Engineering), and Dept. of Neurobiology by Courtesy, Northwestern University
2010-2016 Associate Professor (Joint between Dept. of Mechanical Engineering & Dept. of Biomedical Engineering), and Dept. of Neurobiology by Courtesy, Northwestern University
2003-2010 Assistant Professor (Joint between Dept. of Mechanical Engineering & Dept. of Biomedical Engineering), and Dept. of Neurobiology by Courtesy, Northwestern University
2001-2003 Postdoctoral Fellow, Division of Engineering and Applied Science, Computation and Neural Systems Program, and Center for Neuromorphic Systems Engineering, California Institute of Technology, Pasadena CA

Honors and Awards

- 2022 Keynote speaker, Computational Cognitive Neuroscience 2022
- 2018 US Embassy science ambassador visit to New Zealand, with lectures and round-table discussions in Dunedin, Wellington, and Auckland.
- 2017 Keynote speaker, German Zoological Society 110th Annual Meeting. Bielefeld, Germany.
- 2014 Symposium speaker for American Association for the Advancement of Science session on biologically inspired robotics, Chicago IL
- 2014 Plenary Speaker at the International Congress of Neuroethology, August 2014, Sapporo Japan.
- 2013 TEDx Caltech “The Brain” closing speaker, “Can We Expand Our Consciousness with Neuroprosthetics?” Jan 18, 2013.
- 2009 Received Presidential Early Career Award for Science and Engineering from Barack Obama at the White House
- 2009 Recipient, National Science Foundation CAREER Award
- 2006 Invited Distinguished Evening Lecturer, MBL at Woods Hole Summer Course in Neural Systems and Behavior
- 2003 Invited Panelist, *Issues at the Intersection of Art and Science*, Center for Neuromorphic Systems Engineering at Caltech and the Art Center's Alyce de Roulet Williamson Gallery, Pasadena CA
- 2003 Recipient, Center for Neuromorphic Systems Engineering NEURO Art Installation Development Award for **Body Electric**
- 2001 Best Exhibit, Beckman Institute for Advanced Science Open House
- 1999 Selected to attend the Telluride Neuromorphic Engineering Workshop
- 1997 Beckman Institute for Advanced Science and Technology Research Assistantship
- 1995 Scholarship to Attend the Princeton Lectures on Biophysics
- 1994 McDonnell Summer Institute in Cognitive Neuroscience Scholarship
- 1993 Cognitive Science Summer Research Fellowship, Indiana University
- 1992 Summer internship, Artificial Intelligence, Canadian National Research Council
Developed automatic natural language explanations of military jet engine faults
- 1991 Graduated with High Distinction (University-wide graduating class GPA Award)

Statement of Core Areas of Effort

The major research goals of my laboratory are 1) the evolution and mechanisms of planning in the vertebrate brain, with application to human decision making regarding climate change; and 2) mechanics, neurobiology, and information theory of the control of sensory structures for information harvesting. The unifying theme that spans both domains is search, broadly construed —be it searching inside the skull for a more effective path in light of an organism’s reinforcement history and current estimates of an adversary’s position, as in planning, or searching outside the skull to guide the body with respect to sensed cues, as in information

harvesting. A characteristic of my work is interweaving theory, computation, robotics, evolutionary/comparative methods, and experiment to address relatively unsimplified natural behaviors from multiple perspectives. Similarly, in my training of graduate students and postdocs I have emphasized integrating these diverse approaches. I have trained 6 postdocs and 14 graduate students (12 Phds, 4 current trainees). One (a URM) is Associate Professor of Mechanical Engineering (biofluidynamics) at Florida Atlantic University, one (female) is Associate Professor of Applied Math (computational biology) at the University of Auckland, one (female) is currently a postdoc at the University of Minnesota (computational and experimental neuroscience, Redish lab), another is a postdoc at the RIKEN Center for Computational Science in Japan. Eight graduates and three postdocs are in top technical/managerial positions at Google, Microsoft, Apple, Intuitive Surgical (robotic surgery), HDT Robotics, and Murata Vios (medical diagnostics).

I am dedicated to mentoring students to be “full stack” neuroscientists who are as conversant in math and computer science as they are with behavior, evolution, and neurophysiology. I emphasize training in communication, both to other scientists and to the broader public through involvement in cultural productions discussed further below. In addition to mentoring my trainees to be well-rounded, I’ve brought integrative computational approaches to the larger community of graduate students in engineering and neuroscience through a number of graduate level classes, including Neuromechanics, where students learn to connect insect nervous systems to mechatronic devices, and Computational Neuroethology and Neuromechanics, where students traverse key literature in these domains while building computer simulations of both the biomechanics and sensory acquisition capabilities of a leading model system.

I have been very active in engaging the wider public in the scientific work of the lab. This began before my first position, while still a postdoc at Caltech, where I competed for and obtained \$10K in funding for a collaboration with an internationally known interactive installation artist, Simon Penny. Our work, *Body Electric*, was shown at the *Williamson Gallery* in Pasadena. It enabled participants to move through a darkened space and interact with hidden floating objects that could only be detected through a virtualized form of electrosense, with electric images painted on a rendering of the participant’s body. Since then my efforts to combine art and science have continued and involved an internationally exhibited piece in which a dozen different species of weakly electric fish formed a “choir” of sonified electric fields under control of the participant/conductor (*scale: New York Times*, A Beijing Exhibition on Art for the 'Post-Human Era'). Further work has included science consulting and script advising for TV shows (*Caprica*, prequel to *Battlestar Galactica*) and movies (*Tron Legacy*, *Terminator Genisys*, *Avengers: Age of Ultron*, among others), and the development of an animated short (YouTube: *Our short-sighted inner fish*) detailing our discovery of a very significant “grade shift” over the water to land transition 400 million years ago where eye size tripled over a short period. Finally, I have frequently participated in an annual Robot Block Party at the Museum of Science and Industry, giving the public an opportunity to learn about and interact with our bio-inspired robots. In all of these efforts I involve my graduate students and undergraduates in the laboratory to train them in how to make basic science research meaningful for the public.

Contribution to Science with select references

A. I discovered a key shift in visual systems and their capacity at the water-to-land transition 340 million years ago. I showed that eye sizes tripled over the span of the transition, and created computational visual ecology simulations showing that the total visual space that could be inspected increased by approximately one million-fold. Dan Eric Nilsson, a leader in the evolution of vision, wrote in a published commentary “If they are correct, we have to rewrite the story about how vertebrates conquered land.” I have since begun to show evidence that the transition had a larger impact in the overall structure of the terrestrial vertebrate brain than previously appreciated.

MacIver, M.A., Schmitz, L., Mugan, U, Murphey, T.D, and Mobley, C. D. (2017) “Massive increase in visual range preceded the origin of terrestrial vertebrates.” Proc. Natl. Acad. Sci. U.S.A., 114(12): E2375-E2384. (PMCID: PMC5373340). [YouTube animation](#); [TedXCaltech talk on evolution and future of consciousness](#).

MacIver, M.A., Finlay, B.L. (2022) “The neuroecology of the water-to-land transition and the evolution of the vertebrate brain.” Philos Trans R Soc Lond, B, Biol Sci (PMCID: PMC8710882).

B. Building on the paleontological work and earlier interest how sensory volume to motor volume ratios relate to neural control, I’ve provided the first computational evidence for a selective benefit of planning in a common naturalistic behavior, terrestrial predator-prey interactions. Specifically, the utility of planning varies as a function of visual range and habitat complexity. Remarkably, planning is no better than habitual/reactive/innate routines in many common environments. The work strongly suggests a negligible utility to planning in underwater habitats, and high utility in savannah-like terrestrial habitats when combined with long range vision. This work has led, with Dan Dombeck, to development of a novel high throughput automated laboratory task for the study of planning in rodents, which is at the core of the present proposal. Whereas many prior tasks for studying planning in non-human mammals were highly simplified and resulted in behavioral indicators of planning rapidly diminishing with automaticity, computational and behavioral evidence suggests that the presence of a less predictable robotic pseudo-predator provides a context where automaticity is slowed or absent. Applying this research to human’s facing threats when temporal discounted future harms fail to motivate is challenging; we’ve suggested a method of calibrating the level of concern among citizens according to the best predictive models through having people participate in climate prediction markets.

MacIver, M.A. Neuroethology: From Morphological Computation to Planning (2009). In: *The Cambridge Handbook of Situated Cognition*, Robbins P. & Aydede, M. (eds). Cambridge University Press: Chapter 26, 480-504.

Mugan, U. and MacIver, M.A. (2020) “Spatial planning with long visual range benefits escape from visual predators in complex naturalistic environments.” *Nat Commun* 2020 Jun 16;11(1):3057. (PMCID: PMC7298009). [Mindscape podcast interview](#).

Hunt, L.T, Daw, N.D, Kaanders, P., MacIver, M.A., Mugan, U., Procyk, E., Redish, A.D., Russo, E., Scholl, J., Stachenfeld, K., Wilson, C.R.E., and Kolling, N. (2021) “Formalising planning and information search in naturalistic decision-making.” *Nat Neurosci* 24(8):1051-1064. (PMID: 34155400).

Espinosa, G., Wink, G.E., Lai, A.T., Dombeck, D. A., and M. A. MacIver (2022) Achieving mouse-level strategic evasion performance using real-time computational planning. arXiv.

Cerf, M., Matz, S. C., & MacIver, M. A. (2023). Participating in a climate prediction market increases concern about global warming. *Nature Climate Change*, 13(6). <https://doi.org/10.1038/s41558-023-01679-4>

Cerf, M., Matz, S. C., & MacIver, M. A. (2023). Participating in a climate futures market increases support for costly climate policies. *Nature Climate Change*, 13(6). <https://doi.org/10.1038/s41558-023-01677-6>

Lai, A.T., Espinosa, G., Wink, G.E., Angeloni, C. F., Dombeck, D. A., and MacIver, M.A. (2024) A robot-rodent interaction arena with adjustable spatial complexity for ethologically relevant behavioral studies. *Cell Reports* [Jan 25;43\(2\):113671](#). doi: [10.1016/j.celrep.2023.113671](https://doi.org/10.1016/j.celrep.2023.113671).

C. Through a combination of a custom infrared videography system for fish behavior, a partially automatic 3D tracking system, and a series of computational models, I calculated the full array of sensory signal input that occurs when weakly electric fish pursue their live prey. This was done for active electrosense, passive electrosense, and lateral line mechanosense. Prior to this work, all physiology in this model system was with the use of stimuli that excited the full array of sensors simultaneously. Following my work, various laboratories started testing the effect of small dipole signal sources with similar spatial and temporal frequency content as I documented occur with live prey. This has resulted in the discovery that active electrosense is processed in two pathways with very different properties: one pathway dedicated to full body stimuli, which occur during communication behaviors, and one pathway dedicated to prey-related focal stimuli, which occur during prey capture behaviors. Broader significance includes understanding the mechanisms by which first order sensory nuclei differentially process different types of signals through descending feedback control of filtering properties of neurons. Most recently I have begun to work on the larval zebrafish model system and quantification of prey capture in this system and associated visual signals. My objective is to use the full suite of tools I’ve developed within my electric fish research (quantitative behavioral analysis, modeling, simulation, and robo-physical models) to a system where neural circuits are more easily probed with modern imaging and genetic tools, with the overall objective of obtaining a mechanistic understanding of how sensing, mechanics, and neural circuitry is interwoven for high agility in complex environments.

Nelson, M.E., MacIver, M.A. (1999) Prey capture in the weakly electric fish *Apteronotus albifrons*: Sensory acquisition strategies and electrosensory consequences. *Journal of Experimental Biology*, 202(10):1195-1203. PMID: 10201661

MacIver, M.A., Sharabash, N. M., Nelson, M.E. (2001) Prey-capture behavior in gymnotid electric fish: motion analysis and effects of water conductivity. *Journal of Experimental Biology*, 204(3): 543-557. PMID: 11171305

Patterson, B.W., Abraham, A.O., MacIver, M.A., & McLean, D. L. (2013). Visually guided gradation of prey capture movements in larval zebrafish. *Journal of Experimental Biology*, 216, 3071-3083. PMID: 23619412

Bhattacharyya, K.D., McLean, D. L. & MacIver, M.A. (2017). Visual threat assessment and reticulospinal encoding of calibrated responses in larval zebrafish. *Current Biology* 27, 2751–2762.

Bhattacharyya, K.D., McLean, D. L. & MacIver, M.A. (2021) Intersection of motor volumes predicts the outcome of ambush predation of larval zebrafish. *Journal of Experimental Biology*. 224, jeb235481. PMID: 33649181

J37 Jay, M., MacIver, M.A., & McLean, D. L. (2023). Spinal basis of direction control during locomotion in larval zebrafish. *Journal of Neuroscience*. May 31; 43(22): 4062-4075. <https://doi.org/10.1523/jneurosci.0703-22.2023>

D. I have co-developed (with Todd D. Murphey) a new theory of active sensing, called energy-constrained proportional betting, and validated it across a disparate set of species and sensory modalities. It combines in the same formal method the energy costs of sensing and the information benefits of sensing, and predicts small movements that animals make with their sensory organs when signals approach the threshold of discriminability.

Snyder, J.B., Nelson, M.E., Burdick, J. W., MacIver, M.A. (2007) Omnidirectional sensory and movement volumes in electric fish. *PLoS Biology* 5(11): e301. PMID: 18001151

MacIver, M.A., Patankar, N. A., Shirgaonkar, A. A. (2010) Energy-information trade-offs between movement and sensing. *PLoS Computational Biology* 6(5): e1000769. doi:10.1371/journal.pcbi.1000769. PMID: 20463870

Miller, L. M., Y. Silverman, M. A. MacIver, and T. D. Murphey (2015). Ergodic Exploration of Distributed Information, *IEEE Transactions on Robotics*, 32(1), 36-52.

Chen, C., Murphey, T.D., and MacIver, M.A. (2020). Tuning movement for sensing in an uncertain world, *eLife*, 9: e52371. [Video](#).

E. I developed the first technological system to implement the form of sensing used by weakly active electrosensory organisms. This pioneering work is now being built upon by several laboratories in Europe, Asia, and the US. [Video overview](#).

Solberg, J. R., Lynch, K. M., & MacIver, M. A. (2008) “Active electrolocation for underwater target localization.” *Int J Rob Res*, 27(5), 529-548.

Bai, Y., J. B. Snyder, Peshkin M., and MacIver, M.A. (2015) “Finding and identifying underwater objects with active electrosense.” *Int J Rob Res*, 34(10):1255-1277.

Bai, Y., Neveln I.D., Peshkin M., and MacIver, M. A. (2016) “Enhanced detection performance in electrosense through capacitive sensing.” *Bioinspr Biomim*, 11(5):055001 (PMID: 27501202).

F. I have characterized key principles of the generation of propulsion from median fins found in weakly electric fish along with many other organisms such as cuttlefish. We have also performed flow structure characterization, and examined stability and maneuverability implications. Some of the more important findings have included discovery of convergent evolution of mechanical optimal locomotion (all undulatory swimmers swim with a ratio of 20:1 of wavelength to amplitude, and that this maximizes thrust); that inwardly counterpropagating traveling waves are often used by these swimmers to simultaneously enhance maneuverability and stability; and that flow structures emanating from these fins have unique features compared to tail-flapping type swimmers. Broader implications include a) the first time an animal propulsor has been characterized to an extent sufficient for high performance, well-controlled robotic implementation; b) quantitative modeling of traveling waves—a key substrate of many modes of animal movement—and their potential neural basis.

Sefati, S., I. Neveln, E. Roth, T. Mitchell, J. B. Snyder, M. A. MacIver, E. S. Fortune, and Cowan, N. J. (2013). Mutually opposing forces during locomotion can eliminate the tradeoff between maneuverability and stability. *Proceedings of the National Academy of Sciences*, 110 (47) 18798-18803. PMID: 24191034

Bale, R. A., Shirgaonkar, A. A., Neveln, I. D., Bhalla, A. P. S., MacIver, M. A., Patankar, N.A. Separability of drag and thrust in undulatory animals and machines (2014). *Scientific Reports* (4), <http://dx.doi.org/10.1038/srep07329>. PMID: 25491270

Neveln, I. D., Bale, R., Bhalla, A. P. S., Curet, O. M., Patankar, N. A., MacIver, M. A. (2014) Undulating fins produce off-axis thrust and flow structures. *Journal of Experimental Biology*, 217, 201-213. PMID: 24072799

Bale, R., A. P. S. Bhalla, I. D. Neveln, M. A. MacIver, and N. A. Patankar (2015). Convergent evolution of mechanically optimal locomotion in aquatic invertebrates and vertebrates. *PLoS Biology*. PMID: 25919026

Full List of Peer Reviewed Journal Articles

***Asterisk indicates Co-Corresponding Author**

J38. Lai, A.T., Espinosa, G., Wink, G.E., Angeloni, C. F., *Dombeck, D. A., and M. A. *MacIver. (2024) A robot-rodent interaction arena with adjustable spatial complexity for ethologically relevant behavioral studies. *Cell Reports* [Jan 25;43\(2\):113671. doi: 10.1016/j.celrep.2023.113671](https://doi.org/10.1016/j.celrep.2023.113671).

J37 Jay, M., MacIver, M.A., & McLean, D. L. (2023). Spinal basis of direction control during

locomotion in larval zebrafish. *Journal of Neuroscience*. May 31; 43(22): 4062-4075. <https://doi.org/10.1523/jneurosci.0703-22.2023>

J36 Cerf, M., Matz, S. C., & MacIver, M. A. (2023). Participating in a climate prediction market increases concern about global warming. *Nature Climate Change*, 13(6). <https://doi.org/10.1038/s41558-023-01679-4>. Invited policy brief: Cerf, M., Matz, S. C., & MacIver, M. A. (2023). Participating in a climate futures market increases support for costly climate policies. *Nature Climate Change*, 13(6). <https://doi.org/10.1038/s41558-023-01677-6>

J35 MacIver, M.A., Finlay, B.L. (2022) The neuroecology of the water-to-land transition and the evolution of the vertebrate brain. *Philosophical Transactions of the Royal Society B*. <https://doi.org/10.1098/rstb.2020.0523>.

J34 Hunt, L.T, Daw, N.D, Kaanders, P., MacIver, M.A., Mugan, U., Procyk, E., Redish, A.D., Russo, E., Scholl, J., Stachenfeld, K., Wilson, C.R.E., and Kolling, N. (2021) Formalising planning and information search in naturalistic decision-making. *Nature Neuroscience*, <https://doi.org/10.1038/s41593-021-00866-w>.

J33 Bhattacharyya, Kiran D. and McLean, David L. and MacIver, M. A. (2021) Intersection of motor volumes predicts the outcome of ambush predation of larval zebrafish. *Journal of Experimental Biology* Mar 1;224(Pt 5):jeb235481. <https://doi.org/10.1242/jeb.235481>.

J32 Mugan, U. and MacIver, M.A. (2020) Spatial planning with long visual range benefits escape from visual predators in complex naturalistic environments. *Nature Communications*. [Video explainer](#).

J31 Chen, C. Murphey, T.D, and MacIver, M.A. (2020) Tuning movement for sensing in an uncertain world, *eLife*. Videos: [Behaviors](#), [Application of theory to a robot](#).

J30 Bhattacharyya, Kiran D. and McLean, David L. and MacIver, M. A. (2017) Visual threat assessment and reticulospinal encoding of calibrated responses in larval zebrafish. *Current Biology* 27, 2751–2762.

J29 MacIver, M.A., Schmitz, L., Mugan, U, Murphey, T.D, and Curtis D. Mobley (2017). Massive increase in visual range preceded the origin of terrestrial vertebrates. *Proceedings of the National Academy of Sciences*, 114(12):E2375-E2384. doi: 10.1073/pnas.1615563114 [Link to Open Access PDF](#).

Video explainer/outreach: <https://youtu.be/I19usgWHJLc>.

Commentary: Evolution, an Irresistibly Clear View of Land, by Dan-E. Nilsson. *Current Biology*, 2017, <http://dx.doi.org/10.1016/j.cub.2017.05.082>. Response by MacIver & Schmitz: [http://www.cell.com/current-biology/comments/S0960-9822\(17\)30648-6](http://www.cell.com/current-biology/comments/S0960-9822(17)30648-6).

J28 Krakauer, J.W., Ghazanfar, A.A., Gomez-Marin A., MacIver, M.A., and David Poeppel (2017). Neuroscience Needs Behavior: Correcting a Reductionist Bias. *Neuron*, 93(3): 480-490.

J27. Fang, S., Peshkin, M. and MacIver, M. A. (2016) Human-in-the-loop active electrosense. *Bioinspiration & Biomimetics*, vol 12, issue 1, pp. 014001, 12/2016, doi:10.1088/1748-3190/12/1/014001.

J26. Bai, Y., Neveln I.D., Peshkin M., and MacIver, M. A. (2016) Enhanced detection

performance in electrosense through capacitive sensing. *Bioinspiration & Biomimetics*. doi:10.1088/1748-3190/11/5/055001.

J25. Miller, L. M., Y. Silverman, M. A. MacIver, and T. D. Murphey (2016). Ergodic Exploration of Distributed Information. *IEEE Transactions on Robotics*, 32(1), 36-52. [Link to video](#) explaining the algorithm (Script and narration: MacIver).

J24. Bale, R., A. P. S. Bhalla, I. D. Neveln, M. A. MacIver*, and N. A. Patankar (2015). Convergent evolution of mechanically optimal locomotion in aquatic invertebrates and vertebrates. *PLOS Biology* 2015, DOI: 10.1371/journal.pbio.1002123.

J23. Bai, Y., J. B. Snyder, M. A. Peshkin, and M. A. MacIver, Finding and identifying underwater objects with active electrosense (2015). *The International Journal of Robotics Research*. DOI: 10.1177/0278364915569813.

J22. Bale, R. A., Shirgaonkar, A. A., Neveln, I. D., Bhalla, A. P. S., MacIver, M. A., Patankar, N.A. Separability of drag and thrust in undulatory animals and machines (2014). *Scientific Reports* (4), doi:10.1038/srep07329.

J21. Neveln, I. D., Bale, R., Bhalla, A. P. S., Curet, O. M., Patankar, N. A., MacIver, M. A. (2014) Undulating fins produce off-axis thrust and flow structures. *Journal of Experimental Biology*, 217, 201-213.

J20. Sefati, S., I. Neveln, E. Roth, T. Mitchell, J. B. Snyder, M. A. MacIver, E. S. Fortune, and Cowan, N. J. (2013). Mutually opposing forces during locomotion can eliminate the tradeoff between maneuverability and stability. *Proceedings of the National Academy of Sciences*, 110 (47) 18798-18803.

J19. Neveln, I. D., Bai, Y., Snyder, J. B., Solberg, James R., Curet, O. M., Lynch, Kevin M., & MacIver, M. A. (2013). Biomimetic and bio-inspired robotics in electric fish research. *Journal of Experimental Biology*, 216, 2501-2514.

J18. Patterson, B.W., Abraham, A.O., MacIver, M.A., & McLean, D. L. (2013). Visually guided gradation of prey capture movements in larval zebrafish. *Journal of Experimental Biology*, 216, 3071-3083.

J17. Ruiz-Torres, R., Curet, O. M., Lauder, G. V., & MacIver, M.A. (2012). Kinematics of the ribbon fin in hovering and swimming of the electric ghost knifefish. *Journal of Experimental Biology*, 216, 823-834.

J16. Curet, O.M., Patankar, N. A., Lauder, G.V., MacIver, M. A. (2011) Mechanical properties of a bio-inspired robotic knifefish with an undulatory propulsor. *Bioinspiration & Biomimetics*, Jun;6(2):026004. Epub April 7, 2011, doi:10.1088/1748-3182/6/2/026004.

J15. Curet, O.M., Patankar, N. A., Lauder, G.V., MacIver, M. A. (2011) Aquatic maneuvering with counter-propagating waves: a novel locomotive strategy. *Journal of the Royal Society Interface*, July 6; 8(60):1041-50 Epub Dec 22, 2010, doi: 10.1098/rsif.2010.0493. **Cover**.

J14. MacIver, M.A., Patankar, N. A., Shirgaonkar, A. A. (2010) Energy-information trade-offs between movement and sensing. *PLoS Computational Biology* 6(5): e1000769.

doi:10.1371/journal.pcbi.1000769.

J13. Curet, O.M., AlAli, I. K., MacIver, M.A., Patankar, N. A. (2010) A versatile implicit iterative approach for fully resolved simulation of self-propulsion. *Computer Methods in Applied Mechanics and Engineering*, doi:10.1016/j.cma.2010.03.026.

J12. Shirgaonkar, A. S., MacIver, M. A., Patankar, N. A. (2009) A new mathematical formulation and fast algorithm for fully resolved simulation of self-propulsion. *Journal of Computational Physics*, 228, 2366-2390.

J11. Postlethwaite, C. M., Psemeneki, T. M., Selimkhanov*, J., Silber, M., MacIver, M. A. (2009) Optimal movement in the prey strikes of weakly electric fish: A case study of the interplay of body plan and movement capability. *Journal of the Royal Society Interface*. Published online Oct 8, 2008; doi:10.1098/rsif.2008.0286; published in journal 2009.

*Undergraduate researcher.

J10. Shirgaonkar, A. A., Curet, O.M., Patankar, N. A., MacIver, M. A. (2008) The hydrodynamics of ribbon-fin propulsion under impulsive motion. *Journal of Experimental Biology* 211: 3490-3503.

J09. Solberg, J. R., Lynch, K. M., & MacIver, M. A. (2008). Active electrolocation for underwater target localization. *International Journal of Robotics Research*, 27(5), 529-548.

J08. Snyder, J.B., Nelson, M.E., Burdick, J. W., MacIver, M.A. (2007) Omnidirectional sensory and movement volumes in electric fish. *PLoS Biology* 5(11): e301.

J07. Nelson, M.E. and MacIver, M.A. (2006) Sensory acquisition in active sensing systems. *Journal of Comparative Physiology A* 192: 573-586.

J06. MacIver, M.A., Fontaine, E., Burdick, J. W. (2004) Designing future underwater vehicles: principles and mechanisms of the weakly electric fish. *IEEE Journal of Oceanic Engineering* 29(3):651-659.

J05. Nelson, M.E., MacIver, M.A., Coombs, S. (2002) Modeling electrosensory and mechanosensory images during the predatory behavior of weakly electric fish. *Brain, Behavior, and Evolution* 59(4): 199-210.

J04. MacIver, M.A., Nelson, M.E. (2001) Towards a biorobotic electrosensory system. *Autonomous Robots* 11, 263–266.

J03. MacIver, M.A., Sharabash, N. M., Nelson, M.E. (2001) Prey-capture behavior in gymnotid electric fish: motion analysis and effects of water conductivity. *Journal of Experimental Biology*, 204(3): 543-557.

J02. MacIver, M.A., Nelson, M.E. (2000) Body modeling and model-based tracking for neuroethology. *Journal of Neuroscience Methods*, 95(2):133-143.

J01. Nelson, M.E., MacIver, M.A. (1999) Prey capture in the weakly electric fish *Apteronotus albifrons*: Sensory acquisition strategies and electrosensory consequences. *Journal of Experimental Biology*, 202(10):1195-1203. **Cover.**

Invited Book Chapters, Commentaries, etc

I05. MacIver, M. A. (2023) Evolution: Blinking through deep time. *Current Biology*, Dec 18; 33(24):R1292-R1293. doi: 10.1016/j.cub.2023.10.019.

I04. MacIver, M. A. (2013) Engineering Health and Sustainability through Consciousness-Enhancing Technologies, *McCormick Magazine*, Spring 2013, Northwestern University, pp. 18-19.

I03. MacIver, M. A. Fitting Science and Screen [Book Review]. *Science*, 6 May 2011: Vol. 332 no. 6030 p. 665. DOI: 10.1126/science.1205130.

I02. MacIver, M.A. Neuroethology: From Morphological Computation to Planning (2009). *The Cambridge Handbook of Situated Cognition*, Robbins P. & Aydede, M. (eds). Cambridge University Press: Chapter 26, 480-504.

I01. MacIver, M.A. (2001) How building physical models can reduce and guide the abstraction of nature. *Brain and Behavioral Sciences* 24(6):1066-1067.

Video animation

2017. Our Short-Sighted Inner Fish. Written and Produced by Kristin Pichaske in collaboration with Malcolm A. MacIver. Animation by Kaleida Studios and Cartuna. Animators: Julie Gratz, Kevin Ryan, and Kinga Nagorka. Music and Sound: Noah Pardo. [Link to video](#). 95,000 views.

Serious Game

2020. Survival. Programming by German Espinosa. Art by Alexander Lai. Written to illustrate simulation environments used in the Mugan & MacIver 2020 *Nature Communications* study. [Link to browser based game](#).

Art Collaborations

2023 A dialogue between the scientist Malcolm MacIver and artist Dario Robleto explores how art and science both contemplate—and seek to overcome—the physical and temporal limits of human life. The discussion touches on the question of how art might provide a model for long-term thinking, especially in times of societal and ecological transformation. Presented in conjunction with the exhibition The Heart’s Knowledge: Science and Empathy in the Art of Dario Robleto. [Video of event](#).

2019 **Emergent Horizons [course for artists and engineers]**, with Iñigo Manglano-Ovalle. We inhabit and think within a bubble of space and time, the shape and size of which are rarely an object of thought. The first multicellular animal’s bubble, 700 million years ago, extended only to the body surface. With hundreds of millions of years our event horizon has been pushed out to

what we do in the next few minutes and days. Now we need to not only vividly imagine but also care about more distant horizons. How can we bootstrap our imagination to do this in art and in science? This class will emphasize experiential art that is also informed by cognitive and perceptual science.

2016 **Risk [course for artists and engineers]**, with Michael Rakowitz. We can view several looming existential threats to humanity as examples where the increase in risk is too shallow to trigger our usual motivated responses, like the parable of the frog in the warming pot of water not ever realizing it was getting too hot to live. The smokestack can be considered an icon of this idea: without a long chimney, people would fight the pollution, but by making pollutants go high into the atmosphere, we put the risk below the threshold of action. Examples of this problem include the rise of CO₂, the fall of biodiversity, and increasing inequality

At the heart of this class is the hope that students will develop an ethical program as individual artists and designers. Students will be asked to approach their research and project in ways that range from countering risk to increasing the gradient of risk so that we must act now. Indeed, sometimes we need better monsters.

2011 **scale**, Malcolm A. MacIver, Marlena Novak, and Jay Allan Yim. **translife**, International Triennial of New Media Art. **National Art Museum of China**, July 27—August 17, 2011, Beijing, China. **Documentation:** [Exhibit Statement and Video at this web location](#). Estimated participation: 10,000. [New York Times review of the show](#).

2010 **scale**, Malcolm A. MacIver, Marlena Novak, and Jay Allan Yim. World premiere at the **STRP Festival of Art and Technology in Eindhoven**, The Netherlands, Nov 18-28 2010. The [STRP](#) Festival is one of the largest e-culture events in Europe which melds music, art & technology together. 30,000 people visited the festival during the premiere.

2003 **Body Electric**, Malcolm A. MacIver and Simon Penny. **Williamson Art Gallery** in the Art Center College of Design in Pasadena CA, April 15-June 29 2003. Part of the NEURO exhibition developed by the Caltech Center for Neuromorphic Systems Engineering and the Williamson Art Gallery. **Documentation:** [Exhibit Statement and Video at this web location](#).

Select movie and TV Series Science Advising

2022 Advisor, American Film Institute, *When the Forests Burn*

2021 Advisor, American Film Institute, *Children of Change*

2015 Advisor, *Terminator Genisys*

2015 Advisor, *The Avengers: Age of Ultron*

2013 Advisor, *Superman, Man of Steel*

2010 *Tron Legacy*

2009-2010 Robotics & science script consultant for SyFy Channel's prequel to *Battlestar Galactica, Caprica*, Seasons 1 & 2. Collaborators: Jane Espenson and Michael Taylor.

Peer Reviewed Conference Proceedings

C15. Espinosa, G., Wink, G.E., Lai, A.T., Dombeck, D. A., and M. A. MacIver. Achieving mouse-level strategic evasion performance using real-time computational planning. Under review, RSS 2023.

C14. Mugan, U., M. A. MacIver. How sensory ecology affects the utility of planning, 2018. Conference on Cognitive Computational Neuroscience, Philadelphia PA. Sept 2018.

C13. Mamakoukas, G., M. A. MacIver, and T. D. Murphey, Superlinear Convergence Using Controls Based on Second-Order Needle Variations, 2018. IEEE Conference on Decision and Control, Miami Beach FL.

C12. Ugurcan, M., M. A. MacIver, and M. Peshkin, Information-theoretic approach to sensor selection, 2017. The 8th International Symposium on Adaptive Motion of Animals and Machines, Sapporo Japan.

C11. Mamakoukas, G., M. A. MacIver, and T. D. Murphey, Feedback Synthesis for Controllable Underactuated Systems using Sequential Second Order Actions, Robotics: Science and Systems, 2017.

C10. Mamakoukas, G., M. A. MacIver, and Todd. D. Murphey. Sequential Action Control for Models of Underactuated Underwater Vehicles in a Planar Ideal Fluid. American Control Conference, Boston MA, 2016.

C09. Neveln, I. D., L. M. Miller, M. A. MacIver, and T. D. Murphey, Improving Object Tracking through Distributed Exploration of an Information Map, IEEE Int. Conf. on Intelligent Robots and Systems (IROS), 2014. Pages: 3441 - 3447, doi: 10.1109/IROS.2014.6943042.

C08. Silverman, Y., L. M. Miller, M. A. MacIver, and Murphey, T.D. (2013) Optimal Planning for Information Acquisition. Intelligent Robots and Systems (IROS), 2013 IEEE/RSJ International Conference, p5974-5980, Tokyo Japan. doi: 10.1109/IROS.2013.6697223

C07. Shahin Sefati, Izaak Neveln, Malcolm A. MacIver, Eric Fortune, Noah J. Cowan (2012). Counter-Propagating Waves Enhance Maneuverability and Stability: A Bio-Inspired Strategy for Robotic Ribbon-Fin Propulsion. Biomedical Robotics and Biomechanics (BioRob), 2012 4th IEEE RAS & EMBS International Conference on, pp. 1620-1625. DOI: 10.1109/BioRob.2012.6290909.

C06. Yonatan Silverman, James Snyder, Yang Bai, and Malcolm A. MacIver (2012) Location and Orientation Estimation with an Electrosense Robot. Intelligent Robots and Systems

(IROS), 2012 IEEE/RSJ International Conference on, pp.4218-422e, 7-12 Oct. 2012. doi: 10.1109/IROS.2012.638617.

C05. Bai, Y., Snyder, J. B., Silverman, Y., Peshkin, M. and MacIver, M.A. (2012). Sensing Capacitance of Underwater Objects in Bio-inspired Electrosense. Intelligent Robots and Systems (IROS), 2012 IEEE/RSJ International Conference on, pp.1467-1472, 7-12 Oct. 2012. doi: 10.1109/IROS.2012.638617.

C04. Snyder, J., Silverman, Y., Bai, Y. MacIver, M.A., (2012). Underwater object tracking using electrical impedance tomography. Intelligent Robots and Systems (IROS), 2012 IEEE/RSJ International Conference on, vol., no., pp.520-525, 7-12 Oct. 2012 doi: 10.1109/IROS.2012.6386251.

C03. Epstein, M., Colgate, J.E, MacIver, M.A. (2006) Generating Thrust with a Biologically-Inspired Robotic Ribbon Fin Source. 2006 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS) Beijing, China. pp: 2412 - 2417, DOI: 10.1109/IROS.2006.281681.

C02. Epstein, M., Colgate, J.E, MacIver, M.A. (2005) A Biologically Inspired Robotic Ribbon Fin. Proceedings of the 2005 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), workshop on Morphology, Control, and Passive Dynamics.

C01. MacIver, M.A., Lin, J.L., Nelson, M.E. (1997) Estimation of signal characteristics during electrolocation from video analysis of prey capture behavior in weakly electric fish. Computational Neuroscience: Trends in Research, 1997. Plenum Press. pp. 729-734.

Select Online Talks

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| 2023 | Evolution and mechanisms of planning through the lens of predator-prey dynamics, robotics, and artificial intelligence. Northwestern Institute on Complex Systems Seminar Series, Nov 11, 2023. https://www.youtube.com/watch?v=vINeoZ1Tm1E |
| 2023 | Does terrestriality advantage planning in vertebrates? University College London NeuroAI Series. Feb 15, 2023. https://mediacentral.ucl.ac.uk/Player/3G8IdbD0 |
| 2023 | Does terrestriality advantage the emergence of cognition? Penn State Extraterrestrial Intelligence Center. Feb 2, 2023. https://psu.mediaspace.kaltura.com/media/PSETI+SeminarA+Does+terrestriality+advantage+the+emergence+of+cognitionF+-+Malcolm+MacIver/1_5qwk12uy |
| 2022 | Keynote for the 2022 Conference on Cognitive Computational Neuroscience in San Francisco. https://youtu.be/E98sfm6x9Eg?t=240 |
| 2022 | “Generative Adversarial Collaboration” for the 2022 Conference on Cognitive Computational Neuroscience. Other Participants: Nathaniel Daw, German |

- Espinosa (NU), Jessica Hamrick (DeepMind), Mark Ho (Princeton), David Redish (U Minnesota), Bradly Stadie (NU), Jane Wang (DeepMind). Part 1: <https://youtu.be/11A1fouQg7E>. Part 2: <https://youtu.be/Bej9IHXh6ic>.
- 2021 Sensory and ecological bases of plan-based action selection. Allen Institute for AI, Embodied AI Lecture Series. April 21, 2021. <https://www.youtube.com/watch?v=VXgV2cjfB00>.
- 2019 Terrestrial sensory ecology provides a selective benefit to planning. COSYNE workshop 'Beyond trial-based choice: decision-making in naturalistic and temporally extended environments' in Cascais Portugal. <https://youtu.be/Q3H-5Z3-6gM>.
- 2018 Mechanically optimal movement in fish and its coupling to information harvesting. University of Auckland, Auckland Bioengineering Institute. Auckland New Zealand. <https://www.youtube.com/watch?v=gAHcUyP3IDE>.
- 2018 How sentience changed after fish invaded land 385 million years ago. UQAM / ISC 2018 Summer School in Animal Cognition - The other minds problem: animal sentience and cognition. University of Quebec, Montreal Canada. https://youtu.be/HI7fXIP_mjo.
- 2014 Electric fish robotics. AAAS National Meeting, Symposium on “Intelligent Autonomous Robots: Biologically Inspired Engineering”, Chicago IL. <https://vimeo.com/87924126>.
- 2013 Can We Expand Our Consciousness With Neuroprosthetics? TEDx Caltech, January 2013. Pasadena CA. <https://youtu.be/gj2zx1kEjKM>.
- 2011 Energy, Information, and the Emergence of Choice. FQXi Conference, Copenhagen. <https://youtu.be/dRDfwsuBNb4>.

Invited Talks at Professional Symposia

- 2023 Natural behaviors, brains & computations. Oct 1-3, 2023. Grand Tetons National Park, WY USA.
- 2023 Caltech Symposium on Neuroscience and the Principles of Evolution. Apr 28, 2023. Pasadena CA USA.
- 2023 How mammals use stealthy visual updates during evasion of a predatory robot. Jan 18, 2023. Active Sensing: From Animals to Robots. Weizmann Institute, Tel-Aviv, Israel.
- 2022 Workshop “Senses in Motion: Sensory Processing in Freely Moving Animals” Oct 17 2022, Sainsbury Wellcome Centre, London, UK.
- 2022 Drivers of learning across timescales: an evolutionary perspective. Aug 25, 2022. Keynote for Computational Cognitive Neuroscience, San Francisco USA.

- 2019 Terrestrial sensory ecology provides a selective benefit to planning. March 5 2019 COSYNE workshop 'Beyond trial-based choice: decision-making in naturalistic and temporally extended environments' in Cascais Portugal.
- 2018 How sensory ecology affects the utility of planning. Computational Cognitive Neuroscience, September 5, Philadelphia 2018 USA.
- 2018 Evolving from reactivity to deliberation: steps in getting more time to think. Santa Fe Institute Workshop on the Origins & Implications of Time in Physical & Adaptive Systems. Santa Fe, New Mexico.
- 2018 How sentience changed after fish invaded land 385 million years ago. UQAM / ISC 2018 Summer School in Animal Cognition - The other minds problem: animal sentience and cognition. University of Quebec, Montreal Canada.
- 2018 Animal habitat as an evolutionary driving force for the development of planning systems. J. B. Johnston Club for Evolutionary Neuroscience, San Diego, CA.
- 2016 Mechanically optimal movement in fish and its coupling to information harvesting. Fifth annual winter workshop in the neuromechanics and dynamics of locomotion, Tulane University, New Orleans LA.
- 2015 Electric Fish Robotics. 7th International Symposium on Adaptive Motion of Animals and Machines. MIT, Cambridge MA.
- 2014 Vision versus electrosense. 26th Annual Karger Workshop in Evolutionary Neuroscience. November 2014, Washington DC.
- 2014 Electric fish robotics. AAAS National Meeting, Symposium on “Intelligent Autonomous Robots: Biologically Inspired Engineering”, Chicago IL.
- 2013 Vision versus electrosense: Mechanics and sensing in prey capture behavior of larval zebrafish compared to electric knifefish. Janelia Farms Conference, “Dynamics of Prey Capture and Escape” March 2013, Ashburn, VA.
- 2013 Can We Expand Our Consciousness With Neuroprosthetics? TEDx Caltech, January 2013. Pasadena CA.
- 2013 Vision versus electrosense: Mechanics and sensing in prey capture behavior in larval zebrafish compared to electric knifefish. Symposium keynote for “When Predators Attack,” Society of Integrative and Comparative Biology, January 2013, San Francisco, CA.
- 2012 How Knifefish Swim: Spanning the Gap Between Eel-like and Trout-Like Swimming. Weakly electric fish meeting, International Congress of Neuroethology August 2012, College Park MA.
- 2012 Sensory and Motor Spaces and the Emergence of Multiple Futures. Computational Neuroscience Annual Meeting, July 2012, Atlanta GA. (keynote).
- 2012 Sensory and Motor Spaces and the Emergence of Multiple Futures. Summer

- School in Cognitive Sciences, “The Evolution and Function of Consciousness,” June 30-July 9, Montreal Canada.
- 2012 “From electric fish to robot fish and back” PINC Conference, Amsterdam,
- 2011 “Energy, Information, and the Emergence of Choice” FQXi Conference, Copenhagen.
- 2011 “Energy-Information Trade-Offs between Movement and Sensing,” Gordon Conference on Neuroethology.
- 2011 “Energy-Information Trade-Offs between Movement and Sensing.” International workshop on bio-inspired robots, Nantes France (keynote).
- 2011 “Energy-Information Trade-Offs between Movement and Sensing.” German Society for Neuroscience, Gottingen.
- 2010 “Infomechanics and the bone-brain continuum.” Swiss Federal Institute of Technology, Life Science Symposium on Engineering Life, Lausanne, Switzerland.
- 2009 “The development of a bio-inspired magneto-electrosensory navigation module.” Office of Naval Research Symposium on Bio-inspired Systems, Washington DC
- 2009 “Biomechanical constraints on sensory acquisition in weakly electric fish” Society for Integrative and Comparative Biology, Symposium on Sensory Biomechanics, Boston, MA
2008. “Acquiring information under mechanical constraints” Fourth International Symposium on Adaptive Motion of Animals and Machines, Case Western Reserve University, Cleveland, OH
- 2007 “Sensory and movement volumes in animals: Implications for control” Symposium on top-down influences in active sensing. International Congress of Neuroethology, Vancouver BC Canada
- 2007 “Infomechanical specializations for maximizing prey capture in the knifefish” Satellite meeting on electrosensory organisms, International Congress of Neuroethology, Vancouver BC Canada
- 2007 “Robotic electrolocation: Active underwater target localization with electric fields.” Solberg, J.S., Lynch, K.M., and MacIver, M.A. International Conference for Robotics and Automation, Symposium on Bio-inspired Perception, Rome, Italy. Presenter: Solberg.
- 2006 “From morphological computation to planning: insights from neuroethology,” Tenth International Conference on the Simulation and Synthesis of Living Systems (ALife X), Workshop on Morphologies, Motion and Cognition, Bloomington, IN, USA
- 2006 “Generating Thrust with a Biologically-Inspired Robotic Ribbon Fin.” Epstein,

- M., Colgate, J. E., MacIver, M.A. IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), Beijing, China. Presenter: MacIver.
- 2005 “Explorations in Computational Morphology,” The Canadian Electric Fish Meeting, Merrickville, ON, Canada
- 2005 “A Biologically Inspired Robotic Ribbon Fin.” Epstein, M., Colgate, J. E., MacIver, M. A. IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), Edmonton, AB, Canada. Presenter: MacIver.
- 2004 “Matching of sensing and motor volumes in active sensory systems.” MacIver, M. A., Nelson, M. E., Burdick, J. W. Society for Neuroscience Satellite Symposium on Advances in Computational Motor Control, San Diego, CA, USA. Presenter: MacIver
- 2004 “Matching of sensing and motor volumes and optimality of movements in active sensory systems,” Center for Neuromorphic Systems Engineering 10th Anniversary Celebration.
- 2003 “Neuromechanical design and active sensory systems,” 13th International Symposium on Unmanned Untethered Submersible Technology, Durham, NH, USA
- 2003 “Getting around on a small charge: mechanics, sensing, and biorobotics with the weakly electric fish,” Second International Symposium on Aqua Bio-Mechanisms, Honolulu, HI, USA
- 2002 “Sensing, mechanics, and control: a framework for the integrated understanding of a natural behavior,” The Hebrew University and Caltech 2nd Joint Symposium on Frontiers in Computational Neuroscience, Pacific Grove, CA, USA
- 2000 “A robotic implementation of electrosensory signal acquisition in electric fish,” NASA Workshop on Biomorphing Robotics, Pasadena, CA, USA

Other Invited Academic Talks

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| 1. Northwestern Department of Environmental Engineering Colloquium | 2023 |
| 2. UCL Consciousness Club Series | 2023 |
| 3. UCL NeuroAI Talk Series | 2023 |
| 4. Max Planck for Neurobiology of Behavior, Bonn Germany | 2022 |
| 5. Natural Philosophy Group (inaugural talk), Johns Hopkins University | 2022 |
| 6. Laboratory for Computational Sensing and Robotics, Johns Hopkins University | 2022 |
| 7. Generative Adversarial Collaboration, The Place of Planning | 2022 |
| 8. Roeder Lecture, Tufts | 2021 |
| 9. Columbia University, Zuckerman Mind Brain Behavior Institute | 2020 |
| 10. University of Auckland, Bioengineering Program | 2018 |
| 11. University of Otago, Department of Zoology | 2018 |

12. University of Cincinnati, Department of Psychology	2018
13. Washington and Lee University, Physics-Engineering Seminar Series	2015
14. University of Chicago, Chicago IL, Computational Neuroscience Seminar Series	2013
15. University of Wisconsin, Milwaukee, Dept. of Neurobiology	2013
16. Cornell University, Distinguished Speaker Series, BBS Seminar	2013
17. Grand Rounds, Northwestern Department of Psychiatry	2013
18. University of Washington, Seattle, Dept. of Computer Science & EE	2012
19. iRobot, Durham NC	2010
20. International Neuroethology Congress, Coupled Robot-Animal Systems	2010
21. Northwestern University Institute of Neuroscience Retreat, St. Charles IL	2009
22. Slivka Residence Hall Fireside Science Talk, Evanston IL	2009
23. Dept. of Engineering Sci., U. of Illinois Urbana-Champaign	2009
24. Division of Eng., & Dept. of Ecology and Evolutionary Biology, Brown University	2009
25. Dept. of Biomedical Engineering, University of California Irvine	2008
26. Program in Neuroscience and Cognitive Science, U. of Maryland, College Park, MD	2007
27. Dept. of Mechanical Engineering, Johns Hopkins, Baltimore MD	2007
28. Dept. of Philosophy, Univ. of Chicago, IL, USA	2006
29. Dept. of Physiology, Northwestern U. Feinberg School of Medicine, Chicago, IL	2006
30. IGERT Seminar Series, Machines & Organisms, Cornell University, Ithaca, NY	2006
31. Neuroscience Program, Michigan State University, East Lansing, MI	2005
32. Dept. of Electrical and Computer Engineering, Univ. of Illinois Chicago, IL	2005
33. Neuroscience Program, Univ. of Illinois Urbana-Champaign, IL	2005
34. Dept. of Biology, McGill University, Montreal, QC	2005
35. Dept. of Physical Therapy & Human Movement Sci., Northwestern Univ.	2005
36. Dept. of Aeronautics and Astronautics, Univ. of Washington, Seattle, WA	2005
37. Committee on Computational Neuroscience, Univ. of Chicago, IL	2005
38. Evolutionary Discussion Group, Northwester Univ., Evanston, IL	2004
39. Sensory Motor Performance Program, Rehabilitation Institute of Chicago, IL	2003
40. IGERT Program on Dynamics of Complex systems, Evanston, IL	2003
41. Northwestern University Institute of Neuroscience, St. Charles, IL,	2003
42. Sloan Theoretical Neurobiology Seminar Series, Caltech, Pasadena CA	2002
43. Caltech Bioengineering Seminar Series, Caltech, Pasadena CA	2001
44. Beckman Institute Visualization Seminar Series, Urbana, IL	1998

Contributed Academic Talks and Selected Posters

- 1) 2022 International Congress of Neuroethology (poster)
- 2) 2020 Neuromatch v3 (two talks)
- 3) 2019 Bernstein Conference on Computational Neuroscience (poster & talk)
- 4) 2019 Cognitive Computational Neuroscience (poster)
- 5) 2019 Society for Neuroscience (2 posters)
- 6) 2018 J.B. Johnston Club for Evolutionary Neuroscience (talk)

- 7) 2018 Society for Neuroscience (talk)
- 8) 2018 International Congress of Neuroethology, Brisbane Australia (poster)
- 9) 2017 Adaptive Motion in Animals and Machines, Sapporo, Japan (poster)
- 10) 2016 J. B. Johnston Club for Evolutionary Neuroscience, San Diego, CA (talk)
- 11) 2016 Society for Vertebrate Paleontology, Salt Lake City, Utah (talk)
- 12) 2015 Adaptive Motion of Animals and Machines, MIT Cambridge MA (poster)
- 13) 2015 Society for Integrative and Comparative Biology, West Palm Beach FL (talk+poster),
- 14) 2013 Janelia Farms, Dynamics of Prey Capture and Escape (1 talk, 1 poster)
- 15) 2013 Society for Integrative and Comparative Biology, San Francisco (2 talks).
- 16) 2012 International Congress of Neuroethology, College Park, Maryland (2 posters).
- 17) 2012 International Conference on Intelligent Robots and Systems, Portugal (3 talks).
- 18) 2012 Fourth IEEE RAS/EMBS International Conference on Biomedical Robotics and Biomechatronics, Rome Italy (talk)
- 19) 2012 First International Workshop on Robotic Electrosense (3 posters, 3 talks)
- 20) 2011 American Physical Society, 64th Annual Meeting (poster)
- 21) 2009 American Physical Society, 62nd Annual Meeting (talk, presenter: Curet; talk, presenter Shirgaonkar; talk, presenter: Patankar), Minneapolis, MN
- 22) 2009 Society for Neuroscience (poster), Chicago, IL
- 23) 2009 Society for Integrative and Comparative Biology (talk), Boston, MA
- 24) 2008 American Physical Society, 61st Annual Meeting (talk, presenter: MacIver) San Antonio, TX
- 25) 2008 American Physical Society, 61st Annual Meeting (talk, presenter: Curet) San Antonio, TX
- 26) 2008 American Physical Society, 61st Annual Meeting (talk, presenter: Shirgaonkar) San Antonio, TX
- 27) 2008 American Physical Society, 61st Annual Meeting (video submission to Gallery of Fluid Motion, San Antonio, TX
- 28) 2007 American Physical Society, 60th Annual Meeting (talk, presenter: MacIver), Salt Lake City, UT
- 29) 2007 American Physical Society, 60th Annual Meeting (talk, presenter: Shirgaonkar), Salt Lake City, UT
- 30) 2007 American Physical Society, 60th Annual Meeting (talk, presenter: Curet), Salt Lake City, UT
- 31) 2007 American Physical Society, 60th Annual Meeting (poster, presenter: Curet), Salt Lake City, UT
- 32) 2007 International Congress of Neuroethology, Vancouver BC (talk)
- 33) 2007 International Congress of Neuroethology, Vancouver BC (poster)
- 34) 2007 International Congress of Neuroethology, Vancouver BC (poster)
- 35) 2007 International Congress of Neuroethology, Vancouver BC (poster)
- 36) 2007 IEEE International Conference on Robotics and Automation, Rome, Italy (talk)
- 37) 2006 Biomedical Engineering Society, Chicago, IL
- 38) 2006 Society for Neuroscience, Atlanta, GA (poster)

- 39) 2006 American Physical Society, 59th Annual Meeting, with Neelesh Patankar and Oscar Curet, Tampa, FL (talk, presenter: Shirgaonkar)
- 40) 2006 American Physical Society, 59th Annual Meeting, with Oscar Curet and Neelesh Patankar, Tampa, FL (talk, presenter: MacIver)
- 41) 2005 Developmental Basis of Evolutionary Change, Chicago, IL (poster)
- 42) 2005 Developmental Basis of Evolutionary Change, Chicago, IL (poster)
- 43) 2005 Joint Dept of Neurology and Biomedical Engineering Poster Session (with T. Kuiken & A. Schultz), Chicago, IL (poster)
- 44) 2005 Southern California Joint Symposium on Computational Neuroscience (with J. Burdick), California Institute of Technology, Pasadena CA (talk)
- 45) 2005 Neural Engineering Workshop (with J. Snyder), Chicago IL
- 46) 2004 International Soc. Neuroethology, Nyborg, Denmark (with J. Burdick & M. Nelson) (poster)
- 47) 2002 Gordon Research on Sensory Coding and the Natural Environment (with M. Nelson), South Hadley, MA (poster)
- 48) 2001 International Soc. Neuroethology, Bonn, Germany (poster with M. Nelson)
- 49) 2000 Society for Neuroscience 30th Meeting, New Orleans LA (poster with M. Nelson)
- 50) 1999 Computation and Neural Systems Meeting (CNS), Pittsburgh, PA (poster with M. Nelson)
- 51) 1998 International Soc. Neuroethology, San Diego, CA (poster with M. Nelson)
- 52) 1997 Society for Neuroscience 27th Meeting, New Orleans, LA (poster with M. Nelson)
- 53) 1996 Computation and Neural Systems Meeting (CNS), Boston, MA (poster with M. Nelson)
- 54) 1995 Society for Neuroscience 25th Meeting, San Diego, CA (poster with M. Nelson)

Active Funding

What's the Place for Planning?

Principal Investigator: Malcolm MacIver

Co-Investigators: Daniel A. Dombeck, Northwestern, Matthew T. Kaufman, University of Chicago, Bradly C. Stadie, Northwestern.

The Biology and Technology of Online Planning.

Principal Investigator: Malcolm MacIver

Co-Investigator: Daniel Dombeck

Agency: National Science Foundation, IIS 2123725

Period 9/1/2021-8/31/2025

Completed Funding

How Ecology Induces Cognition: Paleontology, Machine Learning, and Neuroscience

Principal Investigator: Malcolm MacIver

Co-Investigator: Daniel Dombeck

Agency: National Science Foundation, ECCS 1835389

Period 9/1/2018-8/31/2022

Reticulospinal Execution of Innate Decision-Making

Principal Investigator: David McLean

Co-Investigators: Malcolm MacIver, Neelesh Patankar

Agency: National Science Foundation, IOS-ORG 1456830

Period: 5/01/2015-4/30/2019

NRI: Electrosense imaging for underwater telepresence and manipulation

Principal Investigator: Michael Peshkin

Co-Investigators: Malcolm MacIver, Joshua Smith, Konrad Kording, Alex Mahklin.

Agency: National Science Foundation, NSF IIS-1427419

Period: 9/1/2014-8/31/2019

Development of a climate change prediction market for behavioral change

Principal Investigator: Malcolm MacIver

Co-Investigator: Moran Cerf

Agency: Northwestern Institute on Complex Systems

Period 03/01/2015-11/01/2018

A Bio-Inspired underwater robot for station keeping with omnidirectional disturbances

Principal Investigator: Malcolm MacIver

Co-Investigators: Michael Peshkin, Todd Murphey.

Agency: Office of Naval Research, N00014-14-1-0594.

Period: 5/1/14-9/30/17

Cyber-Enabled Discovery in Neuromechanical Systems

Principal Investigator: Malcolm A. MacIver

Co-Investigators: Noah Cowan and Eric Fortune (Johns Hopkins), George Lauder (Harvard)

Agency: National Science Foundation, NSF CMMI-0941674

Period: 9/1/2009-8/31/2015

CAREER: Infomechanics - The interdependence of animal information acquisition and mechanics

Principal Investigator: Malcolm MacIver

Agency: National Science Foundation, IOB-0846032

Period: 8/15/2009-6/30/2015

IGERT: Integrative Training in Motor Control and Movement

Principal Investigator: Melina Hale (University of Chicago)

Co-Investigator: Malcolm A. MacIver, and three others at University of Chicago

Agency: National Science Foundation

Period: 8/1/2009-7/31/2014

The development of a bio-inspired magneto-electrosensory navigation system

Principal Investigator: Malcolm MacIver

Co-Investigators: Kinea Design LLC, Michael Peshkin, Kevin Lynch

Agency: Office of Naval Research, STTR mechanism, Phase II, N00014-10-C0420

Period: 1/5/2010-12/1/2012

Fully resolved simulation of self-propelling fish

Principal Investigator: Neelesh A. Patankar

Co-Investigator: Malcolm A. MacIver

Agency: National Science Foundation, CBET-0828749

Period: 9/1/2008-8/31/2012

scale

Principal Investigator: Malcolm MacIver

Co-Investigators: Jay Allan Yim, School of Music at Northwestern University, and Marlina Novak, Weinberg College of Arts and Sciences at Northwestern University.

Agency: Northwestern Center for Interdisciplinary Research in the Arts

Period: 7/15/2009-7/14/2010

The development of a bio-inspired magneto-electrosensory navigation system

Principal Investigator: Malcolm MacIver

Co-Investigators: Kinea Design LLC, Michael Peshkin, Kevin Lynch

Agency: Office of Naval Research, STTR mechanism

Period: 6/29/2009-1/25/2010

Transforming sensory signals into muscle activations in a behavior with dynamic constraints

Principal Investigator: Malcolm A. MacIver

Co-Investigator: Kevin Lynch (ME)

Agency: National Science Foundation IOB-0517683

Period: 8/1/2005-10/2008

Public Engagement (Links Active in Electronic PDF)

Public Lectures/Interviews

2018 New Zealand Science Festival, Dunedin New Zealand. [Robots: The New Generation](#).

2016 reddit “Ask Me Anything” [PLOS Science Wednesday](#), on our PLOS paper on the convergent evolution of mechanically optimal swimming.

2015 Northwestern University, Lawrence B. Dumas Domain Dinner on New Technologies That Will Be Transformative. Talk title: *Engineering Empathy*

2015 Chicago Museum of Science and Industry, public talk on Electric Fish Robotics in association with their new exhibition on robotics, *Robot Revolution*.

2014 Chicago Council on Science and Technology talk and panel discussion on *The Future of Work*. [Video at this location](#) (<https://www.youtube.com/watch?v=PcQ68vTPXb4>)

2014 PBS TV affiliate WTTW panel discussion on the *Future of Work*, Chicago Tonight. [Video at this location](#) (<http://chicagotonight.wttw.com/node/17033>)

2014 *Big Data in Neuroscience*, talk for the Shirley Ryan Learning for Life Series.

2014 *Cheetahs, Fish, Fingers & Bacteria: The coming menagerie of mechanical cohabitants*. Panel discussion for the Adler Planetarium public event “Hops’n Bots”, with Sangbae Kim (MIT), Antonio Bicci (University of Pisa), and Bradley Nelson (ETH Switzerland).

2014 *The Future of Artificial Intelligence*, interview with the creators of the CBS TV Series *Person of Interest* for Season 3 DVD Extra. [Video at this location](#), at two minutes forty seconds (https://www.dropbox.com/s/2hlp6805vgbwee0/PERSON_OF_INTEREST_S3_DISC_6.m4v?dl=0)

2014 BBC World Service (Interview) on developing robotic fish.

2014 BBC Radio 5 (Interview) on the development of a robot fish.

2014 BBC *Amazon electric fish inspire underwater robotics*. [Story and video at this location](#) (<http://www.bbc.com/news/science-environment-26025563>).

2013 Interview by Jennifer Ouellette for the show Virtually Speaking Science on my biography, science advising to movie makers, and a variety of science topics. [Audio at this location](#) (<http://www.blogtalkradio.com/virtually-speaking-science/2013/09/12/jennifer-ouellette-malcolm-maciver-neuroprosthetics-1>)

2013 *Can We Expand Our Consciousness With Neuroprosthetics?* TEDx Caltech, January 2013. Pasadena CA. [Video at this location](#) (<https://www.youtube.com/watch?v=gj2zx1kEjKM&list=PLsRNoUx8w3rP8morYo0ZmBAwrEpJVr51X>)

2013 Discovery Science Channel, *Alien Encounters* Season 2, Episodes 1-2, Commentator,

March 2013.

2012 *From electric fish to robot fish and back* PINC Conference, Amsterdam

2010-2012. Blogger on robotics, artificial intelligence, and neuroscience for Science Not Fiction, Discover Magazine. Links to posts above.

2011 “Death and the Powers” Public panel on the new robot opera by Tod Machover, with Tod Machover, March 2, 2011, Dean’s Seminar Series, McCormick School of Engineering, Northwestern University. Article and video: http://www.mccormick.northwestern.edu/news/articles/archive/2009-2012/article_852.html

2011 *Science of Cyborgs* March 1, 2011, Directors Guild of America, Los Angeles CA. Talk on movie portrayals of robotics and androids, transhumanism, and the evolutionary basis of consciousness. Article and video of presentation: <http://www.scienceandentertainmentexchange.org/blog/science-cyborgs>

2011 Interview on NPR Chicago affiliate WBEZ *Clever Apes* radio program on the origin and history of consciousness. [Story and audio here](http://www.wbez.org/blog/clever-apes/2011-05-24/clever-apes-13-origin-stories-86999) (<http://www.wbez.org/blog/clever-apes/2011-05-24/clever-apes-13-origin-stories-86999>)

2010 Interview on the National Academy of Engineering Innovation Podcast and Radio Series *Body Intelligence--Does all cleverness and intelligence come from our brains? That may seem logical, but may not be the case.* [Audio here](http://www.nae.edu/Projects/20730/wtop/27253.aspx) (<http://www.nae.edu/Projects/20730/wtop/27253.aspx>)

2010 Science Café “The Evolution of Consciousness” March 17, 2010, Firehouse Grill Evanston IL. [Media coverage of event](https://helix.northwestern.edu/article/thinking-about-next-move-350-million-years-consciousness) (<https://helix.northwestern.edu/article/thinking-about-next-move-350-million-years-consciousness>).

2010 Interview on NPR Chicago affiliate WBEZ *Clever Apes* radio program on the electric fish art installation “scale”. [Story and audio here](http://www.wbez.org/blog/clever-apes/clever-apes-light-sabers-and-fish-choir) (<http://www.wbez.org/blog/clever-apes/clever-apes-light-sabers-and-fish-choir>)

2009-2010 Blogger for the Science in Society Blog, Feinberg School of Medicine. <http://blog.scienceinsociety.northwestern.edu/author/mmaciver/>

2009 Science consultant for TRON Legacy, as part of the National Academy of Science’s “Science Entertainment Exchange Program” to bring better science to Hollywood.

2009 Lecturer for the Illinois Science Council’s Science Café “Body Electric: Lightning, defibs, and Tasers” at Lucky Strike (AMC Theater Building), 322 E Illinois St., Chicago IL.

- 2003 NSF High School Teacher Program, worked with a Los Angeles inner city school district teacher to bring biofluids research to high schools
- 2003 NSF & Caltech sponsored art show, Williamson Gallery in Pasadena, interactive art installation on active sensing with Simon Penny. More details at <http://www.neuromech.northwestern.edu/uropatagium/#ArtSci>

Select Blog Posts

B37. Information Wants to Be Free. What About Killer Information? [Discover Magazine Online. Dec 27, 2011.](#)

B36. The Geek Rapture and Other Musings of William Gibson [Discover Magazine Online. Oct 17, 2011.](#)

B35. Why Did Consciousness Evolve, and How Can We Modify It, Pt. III: Memory, Communication, and Perception [Discover Magazine Online. Aug 8, 2011.](#)

B34. Why Did Consciousness Evolve, and How Can We Modify It, Pt. II: The Supremacy of Vision [Discover Magazine Online. Mar 23, 2011.](#)

B33. Why Did Consciousness Evolve, and How Can We Modify It? [Discover Magazine Online. Mar 14, 2011.](#)

B32. Transhumanism: A Secular Sandbox for Exploring the Afterlife? [Discover Magazine Online. Feb 28, 2011.](#)

B30. A Robots That Evolve Like Animals Are Tough and Smart—Like Animals [Discover Magazine Online. Feb 14, 2011.](#)

B29. A Does AI Need Guts to Get to the Singularity? [Discover Magazine Online. Feb 2, 2011.](#)

B28. A New Robot for the Bestiary: How to Build a Robotic Ghost Fish [Discover Magazine Online. Jan 26, 2011.](#)

B27. The Real-Life District 9—Class and Sci-Fi in South Africa [Discover Magazine Online. Jan 12, 2011.](#)

B26. Would Death Be Easier If You Know You've Been Cloned? [Discover Magazine Online. Dec 27, 2010.](#)

B25. Killing The Dr. Evils of Iran: Is it Open Season On Scientists? [Discover Magazine Online. Nov 30, 2010.](#)

B24. How to Conduct the World's First Electric Fish Orchestra [Discover Magazine Online. Nov 23, 2010.](#)

B23. Mutants, Androids, Cyborgs and Pop Culture Films [Discover Magazine Online. Nov 2,](#)

[2010.](#)

B22. Electric Fish "Plug in" and Turn Their Zapping Into Music [Discover Magazine Online. Oct 23, 2010.](#)

B21. Caprica Puzzle: If a Digital You Lives Forever, Are You Immortal? [Discover Magazine Online. Oct 5, 2010.](#)

B20. I Have Seen the Furniture, and It Is Robotic, [Discover Magazine Online. Sept 28, 2010.](#)

B19. A Robot Science Fiction and the Modding of Our Future, [Discover Magazine Online. Sept 22, 2010.](#)

B18. A Robot That Tries To Rock You Asleep, [Discover Magazine Online. Sept 14, 2010.](#)

B17. Is AI More Common Than Biological Intelligence Across the Universe?, [Discover Magazine Online. Aug 31, 2010.](#)

B16. The New AI: Turn Robots Into Infant Scientists, [Discover Magazine Online. Aug 25, 2010.](#)

B15. Amplifying Our Brain Power Through Better Interactive Holographics, [Discover Magazine Online. Aug 10, 2010.](#)

B14. Inception and the Neuroscience of Sleep, [Discover Magazine Online. Aug 10, 2010.](#)

B13. Why Keep Your Body? Help Yourself to Big Muscles, Cyborg Limbs, and a Big Booty. [Discover Magazine Online. Jul 27, 2010.](#)

B12. When Sci-Fi Plays Play With Your Identity, [Discover Magazine Online. Jul 19, 2010.](#)

B11. Hairshirted Eye for the Irritable Guy: New Study Shows How the Feel of Things Affects Thought, [Discover Magazine Online. Jul 7, 2010.](#)

B10. IBM Computer Fails the Turing Test But Just Might Pass the Jeopardy Test. Science Not Fiction Blog, [Discover Magazine Online. June 28, 2010.](#)

B09. The Animal Superpower That Robots Would Love to Have: Great Efficiency. Science Not Fiction Blog, [Discover Magazine Online. June 18, 2010.](#)

B08. Guest Post: Malcolm MacIver on War with the Cylons. [Sean Carroll's Blog. April 26 2010.](#)

B07. Are we 'wired for war' with cylons? [Science and Society Helix Blog, Feb 11, 2009.](#)

B06. "A scary thing happened" --- How to make child's play of disasters. [Science and Society Helix Blog, June 5, 2009.](#)

B05. Homeopathy and the limits of science. [Science and Society Helix Blog, April 5, 2009.](#)

B04. Is it time to shut down the national center for complementary and alternative medicine (NCCAM)? [Science and Society Helix Blog, March 23, 2009.](#)

B03. The Science Entertainment Exchange, Pt II. [Science and Society Helix Blog, Feb 25, 2009.](#)

B02. The Science Entertainment Exchange, Pt II. [Science and Society Helix Blog, Feb 25, 2009.](#)

B01. The Science Entertainment Exchange, Pt II. [Science and Society Helix Blog, Feb 25, 2009.](#)

Trainee Fellowships

2022- Gabbie Wink, National Defense Science and Engineering Graduate Fellowship
2021-2023 Alexander Lai, Neurobiology of Information Storage Training Program
2013-2016 Kiran D. Bhattacharyya, NSF Graduate Fellowship
2013-2015 Matt Green, NSF Postdoctoral Fellowship
2006-2010 Oscar Curet, Diversifying Higher Education Faculty in Illinois Graduate Fellowship

Mentoring

Postdoctoral Associates

Current:

Christopher F. Angeloni (co-mentored with Dan Dombeck)

German Espinosa

Past:

Matthew Hobson Green (Co-supervised with David McLean), 2015-2016. Current position: Data scientist at Nordstrom.

Srinivas Ramakrishnan (Co-supervised with N. Patankar), 2009. Current position: Senior Software Developer at ANSYS, Inc.

Anup Shirgaonkar (Co-supervised with N. Patankar), Current position: Quantitative Strategist in Investment Management, Quantitative Machines.

Claire Postlethwaite (Co-supervised with M. Silber), 2006-Jun 2008: Associate Professor, University of Auckland, New Zealand.

Graduate Students

Current (PhD):

Alexander Lai, Biomedical Engineering

Gabrielle Wink, Mechanical Engineering

Past (PhD):

German Espinosa, Computer Science. Current position: Postdoctoral scholar, Malcolm MacIver and Dan Dombeck.

Ugurcan Mugan, Biomedical Engineering. Current position: Postdoctoral scholar, David Redish laboratory.

Kiran D. Bhattacharyya, Biomedical Engineering. Current position: Robotics engineer, Intuitive Surgical.

Chen Chen, Biomedical Engineering. Current position: Sensor technologies, Apple Computer.

Yang Bai, Mechanical Engineering (with Michael Peshkin). Current position: Engineering Manager, Meta AI division.

Izaak Neveln, Biomedical Engineering. Current position: Caterpillar Inc. Machine Learning in Logistics.

Brad Patterson, Northwestern University Interdepartmental Neuroscience Program. (with David McLean). Current position: In training to be a US Army intelligence officer.

James Snyder, Biomedical Engineering. Current position: Engineering consultant and technology developer for embedded systems.

Rahul Bale, Mechanical Engineering (with Neelesh Patankar). Current position: Postdoc, RIKEN, Japan.

Oscar Curet (with N. Patankar), Mechanical Engineering (2003-2009). Current position: Assistant Professor, Department of Ocean and Mechanical Engineering, Florida Atlantic University, Boca Raton.

Michael Epstein, Mechanical Engineering (with E. Colgate) (2003-2007). Current position: Consulting.

James Solberg, Mechanical Engineering (with K. Lynch) (2003-2007). Current position: Senior Controls Engineer, HDT Expeditionary Systems Inc., Evanston IL.

Northwestern University Interdepartmental Neuroscience Program PhD Student 3 Month Rotations: Mark Agrios (2021), Sam Minkowicz (2017), Chris Mullens (2010), Ricardo Ruiz-Torres (2009), Lydia Wood (2005), Brian London (2004)

Masters students

Current:

Dilan Wijesinghe (Robotics, Professional Masters)

Past:

Kailey Smith (Robotics, Professional Masters, 2022)

Senthil Palanisamy (Robotics, Professional Masters, 2021)

Levi Todes (Robotics, Professional Masters, 2019)

Michael Wiznitzer (Robotics, Professional Masters, 2018)

Luke Shi (Robotics, Professional Masters, 2018)

Abhishek N. Patil (Robotics, Professional Masters, 2016)

Sandra Fang, Mechanical Engineering (2014-2016), Current position: JPL.

Ritwik Ummalneni (Robotics, Professional Masters, 2016)

Sun Yue (Robotics, Professional Masters, 2015)

Yoni Silverman, Mechanical Engineering (2010-2013). Current position: Research engineer at a Chicago area nuclear power controls company.

Aimee Schultz, Mechanical Engineering (2004-2007). Current position: Self-employed academic science paper writer.

Thesis Committees (PhD/MS candidates)

Zachary Laswick, Department of Biomedical Engineering, PhD

Feng Xuan, Department of Neurobiology, PhD

Amy Kristl, Department of Neurobiology, PhD

Sam Minkowicz, Department of Neurobiology, PhD

Hannah Emmett, Dept. of Mechanical Engineering, PhD

Brad Radvansky, Neurobiology, PhD

Tommy Berrueta, Mechanical Engineering, PhD

Georgios Mamkoukas, Mechanical Engineering, PhD

Ana Pervan, Mechanical Engineering, PhD

Meagan Bechel, Biomedical Engineering, PhD

Peter Winter, Chemical and Biological Engineering, PhD

Thomas Harmon, Northwestern Interdepartmental Neuroscience Program, PhD

David Meyer, Mechanical Engineering, PhD

James Aaron Ellis, Biomedical Engineering, MS

Mao Mao, Mechanical Engineering, PhD

Elliot Johnson, Mechanical Engineering, PhD

Matthew Geary, Biomedical Engineering PhD

Brian London, Northwestern Interdepartmental Neuroscience Program PhD

Dhwanil Damania, Biomedical Engineering MS

Vladimir Turzhitsky, Biomedical Engineering PhD

Hariharan Subramanian, Biomedical Engineering PhD

Lexyne McNealy, Department of Physical Medicine and Rehabilitation MS

Michael Siegel, Biomedical Engineering MS

Albert Chen, Biomedical Engineering, PhD

Undergraduate Students

2023- Sydney Schulz
2023- Maya Pandya
2023- Joshua Chi
2023- Joe Wood
2023- Aria Ruan
2022- Judith Marciano, Neuroscience
2022- Lily Browdy, Neuroscience
2021- Ben Zitzewitz, Mechanical Engineering
2021-2022 Ryan O'Patka, CS and Neurobiology
2021-2023 Anthony Ryan, Theater and CS
2022-2023 Max Mcune, Mechanical Engineering
2021-2023 Sam Griswold, Mechanical Engineering
2016-2017 Alfred Astor, Mechanical Engineering & Neurobiology
2015-2016 Jonathan Denose (Electrical Engineering, URM), Michael Smith (Computer Science, URM), Nicholas Ohl (Biomedical Engineering).
2013-2015 Scott Schaper, Mechanical Engineering
2014 Adam Birnbaum
2012-2014 Alexandra Faye Salomon, HHMI Mentoring Fellows Program
2011-2013 Aliza Abraham, Integrated Science Program
2010-2011 Ethan Coffel, Computer Engineering and Integrated Science Program
2010 Leland Gossett, Biomedical Engineering (**Scale** project)
2010 Chris Semple, Biomedical Engineering (**Scale** project)
2010-2011 Kyle Liske, Mechanical Engineering (**Scale** project)
2009-2010 Uzair Admani, Biomedical Engineering
2009-2010 Omar Hassan, Biomedical Engineering
2009 Aravinda Gunda, SINE Intern, George Washington University
2008-2009 Jad Carson, Biomedical Engineering
2008-2009 Benjamin Proznitz, Dept. of Eng Sci and Applied Math
2007-2008, Jangir Selimkhanov, Dept. of Eng Sci and Applied Math
2007-2008, Alec Zopf, Dept. of Biomedical Engineering
2006-2007 Irene Chiang, Dept. Biochemistry, Molecular, and Cell Biology
2006-2007 Alfred Shoukry, Biomedical Engineering
2006-2007 Vicky Huang, Biomedical Engineering
2005-2006 Clif Lin, College of Arts and Science, Northwestern (with T. Kuiken)

2004-2007 Tiffany Keung, Biomedical Engineering, Northwestern 2003-2004
 2004-2005 Marie Kyle, Mechanical Engineering, Northwestern (with E. Colgate)
 2004-2005 Elana Green, Mechanical Engineering, Northwestern (with E. Colgate)
 2004-2006 Colin Tan, Biomedical Engineering, Northwestern
 2004-2005 Karin Stensvad, Mech Engineering, Washington University (with E. Colgate)
 2004-2005 Beth Lapour, Mechanical Engineering, Northwestern (with E. Colgate)
 2004-2005 Ani Chatterjee, Biomedical Engineering, Northwestern

Teaching

Teaching-Northwestern University. Courses Developed:

Scientific and embedded programming with python (ME224).
 Emergent Horizons (DSGN 495/ART 390, with Iñigo Manglano-Ovalle from Dept of Art Theory and Practice, Cross listed between School of Engineering and Dept of Art Theory and Practice)
 Risk (DSGN 495/ART 390, with Michael Rakowitz from Dept of Art Theory and Practice, Cross listed between School of Engineering and Dept of Art Theory and Practice) 2016
 Water (DSGN 495/ART 390, with Michael Rakowitz from Dept of Art Theory and Practice, Cross listed between School of Engineering and Dept of Art Theory and Practice) 2015
 Artists & Engineers Collaborate (DSGN 495, with Jeanne Dunning from Dept of Art Theory and Practice, Cross listed between School of Engineering and Dept of Art Theory and Practice) 2014
 Computational neuromechanics and neuroethology (BME 461) 2004-present
 Neuromechatronics (BME 464) 2004-2013

Teaching-Northwestern University

Advanced systems physiology: Neuroscience (BME401) 2018-present
 Scientific and embedded programming with python (ME224) 2018-present
 Analysis of Biological Systems (BME 306) 2015-2019
 Design Thinking and Communication (DTC) 2013-2018
 Professional Essentials (ME 513) 2008-present
 “Experimental Engineering” (ME 224) 2007-2017
 Introduction to Biomechanics (BME 271) 2009-2013
 IDEA 298 Faculty Advisor for Submersible Team 2007
 “Honors Eng. Analysis 3” 2004-2006

Other Teaching

University of Otago, Dunedin NZ, The evolution of planning, Zool 314, Zool 412, Jul 11 & Jul 13 2018.

Zygon Center for Religion and Science, Chicago IL, Situated Brain and Mind Seminar: “Situated Nervous Systems and Cognition” Feb 18, 2013.

Northwestern University, National High School Institute Cherubs, Theatre Arts Program, guest instructor for “Theatre for Nerds” elective, July 7-8, 2009.

Gulbenkian Research Institute, Portugal, “Normative Theories of Brain Function” Feb 2008

University of Chicago, guest lecturer, Dept. of Philosophy/HIPS, William Wimsatt

and John Haugeland, “Boundaries, Modules and Levels” Feb 2006

Guest lecturer, “Animal Behavior” Northwestern University 2004

Teaching Prior to Northwestern University

University of Illinois, “Neurophysiology Laboratory” (PHYSL 416)	1/97-5/97
University of Illinois, “Topics in Neuroethology” (PHYSL 490)	8/96-12/96
University of Illinois, “Introduction to Neurobiology” (BIO 303)	8/94-12/94
Indiana University, “Introduction to Philosophy” (P100)	1/94-5/94
University of Toronto, “How Computers are Used” (CSC104)	1/91-5/91
Indiana University, “Introduction to Ethics” (P140)	9/92-12/92
University of Toronto, “How Computers are Used” (CSC104)	9/91-12/91
University of Toronto, “Computer Programming” (CSC108)	9/90-12/90
University of Toronto, “Science and Pseudo Science” (PHL272)	1/89-7/89
Confederation College, Thunder Bay ON. Digital Electronics, Programming	1/86-4/86

Service

Memberships

International Society of Neuroethology

The J.B. Johnston Club for Evolutionary Neuroscience

Society for Neuroscience

Institute of Electrical and Electronics Engineers

American Physical Society

Scientific Review Panels

NSF Ad-Hoc for Animal Sensation and Movement, and Neural Cluster Program Panels, 2007-present; NSF Neural Cluster Program Panel Meeting, 2008; NSF Animal Sensation and Movement Program Panel Meeting, 2006; MIT Sea Grant College Program, 2006; NIH Sensorimotor Integration Study Section, 2004.

Conference Organization

Organizer: 10th International Symposium on Adaptive Motion of Animals and Machines, 2018 Chicago IL.

First International Workshop on Robotic Electrolocation, August 3 2012, College Park Maryland.

International Society for Neuroethology Symposium “Coupled Robot-Animal Systems,” Spain
2010

Reviewer for the Following *Journals* and Conferences

Advanced Robotics

Animal Biology

Autonomous Robots

Bioinspiration and Biomimetics

Biological Cybernetics

Behavioral and Brain Sciences

Brain, Behavior, and Evolution

Complexity

Cognitive Computational Neuroscience Conference

Current Biology

eLife

Frontiers in Behavioral Neuroscience

IEEE Conference on Robotics and Automation

IEEE Journal of Oceanic Engineering

IEEE Proceedings

IEEE Transactions on Robotics

IEEE Sensors Journal

Integrative and Comparative Biology

International Journal of Robotics Research

International Conference on Artificial Neural Networks

International Congress of Neuroethology

Journal of Biomechanics

Journal of Comparative Physiology

Journal of Experimental Biology

Journal of Neuroscience

Journal of the Royal Society Interface

Journal of Visualized Experiments

Nature Communications

Neurocomputing

Physical Biology

PLoS Computational Biology

PLoS Biology

Proceedings of the National Academy of Sciences

Proceedings of the Royal Society B

Robotics Science and Systems

Science

Science Robotics

Current/Past Advisory Boards

2015-2017 Advisory Board, European Union (H2020 Project no. 640967), a group of 14 scientists from Italy, Austria, Belgium, Croatia, Germany, and France building a swarm of autonomous underwater robots.

2007-2013 FILOSE Advisory Board Member (of three). FILOSE (Robotic FIsh LOcomotion and SEnsing) is a FP7-ICT-2007-3 STREP research project financed by the European Union 7th Framework Program, headed by the Tallinn University of Technology in Estonia, with partners Riga Technical University of Latvia, the Italian Institute of Technology in Genova, and the Universities of Verona and Bath UK. Web site: http://www.biorobotics.ttu.ee/tikiwiki_filose/tiki-index.php.

University Service

2021-present Academic Standing Committee, School of Engineering, Northwestern
 2019-present Office for Research Limited Submissions Advisory Committee
 2018-present Promotion and Tenure Committee, McCormick School of Engineering
 2013-present Segal Design Institute, Research Council Executive Committee Member

2019-2021 Research Integrity Committee, Northwestern University
 2016-2020 Dept. of Biomedical Engineering, Director of Graduate admissions
 2015-2019 BME Undergraduate Program Committee, Faculty Community Committee
 2009-2020 Tech and Ford Safety Committee, Safety Officer for Department of Biomedical Engineering and Department of Mechanical Engineering
 2015 Interviewee for Program Review of the Department of Neurobiology
 2014-2015 Northwestern Neuroscience Proposed Major Steering Committee
 2011-2013 Faculty Senate representative, Department of Biomedical Engineering
 Faculty Senate Committee Chair, Secure Faculty Survey
 2009-2013 Committee on Animal Resources
 2011 Northwestern Interdepartmental Neuroscience Program Review Committee
 2009-2010 Freshman Advising
 2008-2009 BME Admissions Committee
 NUIN Student Interviews
 Organized and ran the ME Dept. Professional Skills graduate seminar series
 Freshman Advising

2007-2008 ME Control and Manufacturing Search Committee
 Organized and ran the ME Dept. Professional Skills graduate seminar series
 Interdisciplinary Committee on Evolutionary Processes
 NUIN Student Interviews

2006-2007 ME Target of Opportunity Ad-hoc Hiring Committee
 Department of Neurobiology and Physiology Hiring Committee
 ME Undergraduate Laboratory Course Renewal Committee
 NUIN Admissions Committee
 Interdisciplinary Committee on Evolutionary Processes

2005-2006 Dept. of Neurobiology and Physiology & Department of Physics and Astronomy
 Hiring Interdepartmental Hiring Committee

- Dynamics and Complex Systems IGERT, managed seminar series on the Mechanics of Locomotion
 BME Departmental Website Faculty Liaison
 2004-2005 BME Graduate Student Admissions Committee
 BME Web Site Faculty Liason
 BME/Department of Physical Medicine and Rehabilitation Neural Engineering Hiring Committee
 BME/RIC Neural Engineering Hiring Committee
 ME/BME Neural Engineering Hiring Committee
 NUIN Retreat Planning Committee
 Research Data Integration and Assessment System Development Committee
 2002-2003 Summer Minority Undergraduate Research Program mentor, Caltech

Select Media Coverage

2019 Sean Carroll's Mindscape Podcast, Episode 39: [Malcolm MacIver on Sensing, Consciousness, and Imagination](#).

2018 Radio New Zealand, Our Changing World. Robots - Nao and the Bristlebots. Interview with Mike Paulin by Allison Ballance on our New Zealand Science Festival engagement in Dunedin New Zealand on July 12, 2018. <https://www.radionz.co.nz/national/programmes/ourchangingworld/audio/2018653987/robots-nao-and-the-bristlebots>

2018 New Zealand Herald. Robot butlers: Don't expect them any time soon. Interview with Jamie Morton. https://www.nzherald.co.nz/nz/news/article.cfm?c_id=1&objectid=12086561

2018 When Stunning Won't Kill, Fish Use Electricity to Communicate. <https://www.insidescience.org/news/when-stunning-wont-kill-fish-use-electricity-communicate>

2017 SciTechNow, PBS TV. Interview by Hari Sreenivasan on PNAS study about why fish came on to land 385 million years ago, initial broadcast July 24 2017. <http://www.scitechnow.org/videos/data-reveals-long-ago-fish-made-leap-onto-land/>

2017 Fish Changed in a Surprising Way Before Invading Land. Ed Yong, The Atlantic Online, March 8 2017. <https://www.theatlantic.com/science/archive/2017/03/in-the-invasion-of-land-big-eyes-came-before-strong-legs/518883/>

2017 Why Did Life Move to Land? For the View. Jennifer Ouellette, Quanta Magazine, March 7, 2017. <https://www.quantamagazine.org/why-did-life-move-to-land-for-the-view-20170307/>

2015 ASME Mechanical Engineering Magazine. Ghost Knifefish in the Machine. https://www.dropbox.com/s/qq7ndhk13hbfsyd/Ferb15a_electrosense_ASME.pdf?dl=0

2015 New York Times Science Take (Video + Article) The Right Ratio to Engineer a Swim. <http://www.nytimes.com/2015/05/11/science/the-right-ratio-to-engineer-a-swim.html>.

2015 Washington Post. How 22 diverse ocean creatures ended up using the same swim stroke. <http://www.washingtonpost.com/news/speaking-of-science/wp/2015/04/28/how-22-diverse-ocean-creatures-ended-up-using-the-same-swim-stroke/>

2015 Los Angeles Times. Would animals swim differently on an alien planet? <http://www.latimes.com/science/sciencenow/la-sci-sn-swimming-animals-convergent-evolution-ocean-bioinspired-alien-20150428-story.html>

2015 PLOS Biology Perspective Convergence on an Optimal Way to Swim, DOI: 10.1371/journal.pbio.1002124. <http://journals.plos.org/plosbiology/article?id=10.1371/journal.pbio.1002124>

2015 Journal of Experimental Biology Perspective, Life converges on solutions to swim optimally. <http://jeb.biologists.org/content/218/17/2663.2.full>

2015 CBS. Movements of fish, bats inspire next-gen robots. <http://www.cbsnews.com/news/movements-of-fish-bats-could-inspire-better-robots/>

2014 Entertaining Science—Scientific advisers for films and television help to bring credibility to the screen — and take some tangible and intangible benefits back to the lab. *Nature*, 3 July 2014, vol 511, p. 113-114. <http://www.nature.com/naturejobs/science/articles/10.1038/nj7507-113a>

2014 How Does a Chicken Tell Time? The New Yorker <http://www.newyorker.com/tech/elements/how-does-a-chicken-tell-time>

2014 Electric Eels Use Their Zaps to Remotely Control Prey. *Popular Mechanics*. <http://www.popularmechanics.com/science/animals/a13205/this-is-what-an-electric-eel-shocks-does-17493859/>

2014 Entertaining Science—Scientific advisers for films and television help to bring credibility to the screen — and take some tangible and intangible benefits back to the lab. *Nature*, 3 July 2014, vol 511, p. 113-114.. <http://dx.doi.org/10.1038/nj7507-113a>

2014 BBC TV: Robot builders inspired by animal kingdom. <http://www.bbc.com/news/science-environment-26222542>

2013 PBS Chicago affiliate WTTW Scientific Chicago with Neil Shubin on development of our electric fish robot. <http://chicagotonight.wttw.com/2013/11/26/scientific-chicago-neil-shubin>

2012 Popular Mechanics, “Meet the Scientists who Make Science Believable” Jan 17, 2012. <http://www.popularmechanics.com/culture/movies/a11747/scientific-advisors-to-the-stars/>

2011 New York Times, “A Beijing Exhibition on Art for the 'Post-Human Era', August 11, 2011. <http://www.nytimes.com/2011/08/12/arts/12iht-translife12.html>.

2011 Profile by the National Academy of Science’s **Science Entertainment Exchange**, June 2, 2011. <http://bit.ly/j3lcPX>.

2011 Written By, April/May 2011. The science and fiction toybox, by Louise Farr. Magazine article on work with science fiction movie and TV makers by the trade magazine of the writer’s guild of America.

2011 Video press release on new fish robot and results published in J. Royal Society Interface (2010), <http://bit.ly/ZKM8h>.

2010 Fast Company. Robotic ghost knifefish swims in every direction, causes brainiacs to high-five. <http://www.fastcompany.com/1718785/robotic-ghost-knifefish-swims-every-direction-causes-brainiacs-high-five-video>

2010 MSNBC. Electric fish could be model for underwater robots. http://www.nbcnews.com/id/40787244/ns/technology_and_science-innovation/t/electric-fish-could-be-model-underwater-robots/- .Vgb9prR6ejk

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