ECE Strategic Vision: Focus Areas

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Environmental Sensing and Monitoring (ESM)

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- Total average expenditures per year approximately $900-1000k
- Currently have 6 PhD students and 7 MS students

Why ESM and why ECE @ PSU

Most of the leading institutions working in environmental sensing are focused on the environmental, oceanographic, and atmospheric sciences. However, there is a strong movement within environmental sensing towards deployment of large numbers of sensors (and collecting large amounts of data), lowering the cost of sensors (necessary for deploying large numbers), reducing the size of sensors, consuming lower power and performing autonomous (on-board) signal processing and efficient data transmission. These trends are partly driven by advances in big data analytics but also by the increasing availability of unmanned platforms. Both massive sensor deployments and using aerial and underwater unmanned platforms (drones) provide new ways to sense but also place severe restrictions on size, power and communication data rates. The areas of sensor system development, on-board signal processing, controls, communications, and power are all core to Electrical Engineering. At Portland State, we propose to focus on the <u>Electrical Engineering</u> challenges associated with the future of environmental sensing and monitoring.

Table 1 Major societal challenges that impact environmental sensing and monitoring. Engineering responses to these challenges point towards potential niche Research & Education (R&E) opportunities.

	Societal Challenges	Engineering Responses	Pillars & Cross-Cuts[1]	R&E Tracks
1	Ocean health	Sensing, Monitoring	P4, CC1, CC2	A,B,C,D
2	Estimating marine life abundance	Sensing, Monitoring	P4, P5, CC1, CC2	A,B,C,D
3	Tracking terrestrial wildlife	Monitoring	P4, CC1, CC2	A,B,C
4	Underwater exploration & mapping	Autonomous exploration	P4, P5, CC1, CC2	A,B,C,D
5	Efficient agriculture	Sensing, monitoring	P4, CC1, CC2	A,B,C
6	Clean water access/pollution	Sensing, monitoring, resilience	P2, P4, CC1, CC2	A,B,C

Research programs align with education opportunities; together these are defined as "R&E tracks." Five such tracks have been identified and related to the aforementioned societal challenges. Three of these have been identified as potential "niche" tracks, meaning that few other engineering programs address these research topics explicitly. In order to differentiate PSU's research and education portfolios, hiring and investment decisions shall target these niche tracks.

Table 2 Research and education programs to be developed to address the large-scale societal challenges noted in Table 1.

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[1] Abbreviations: (P1) reimagine engineering education, (P2) transform the resiliency of physical and cyber systems, (P3) reinvent the built environment for human health, (P4) bend the carbon and environment footprints, (P5) weave the computational fabric – from sensors to decisions, (CC1) data science and machine learning, (CC2) community engagement

	Research & Education Tracks	Niche	Societal challenges
A	Signal Processing	No	1-6
B	Electromagnetics and Acoustics	Yes	1-4
C	Machine Learning and Data Analytics	No	1-6
D	Underwater Robotics, Controls	Yes	1,2, 4
E	Autonomous sensing	Yes	1,2,3,4

Research objectives: Faculty members with expertise in multiple niche ESM areas will enable PSU to:

1. Enable an integrated approach to identifying and solving environmental problems
2. Enable faculty to pursue large ESM-related, interdisciplinary, high-impact grants
3. Create high visibility within research community
4. Sustain a consistent and balanced graduate student body in signal processing and related areas

Table 3 Opportunities for research collaboration

PSU	D. Jay, J. Fink
Regional	Metron Inc. (Portland), University of Washington Applied Physics Laboratory, Pacific Northwest National Laboratories, Oregon State University, Environmental Laboratory U.S. Army Engineer R&D Center (Portland), Oregon Department of Transportation
National	Naval Research Laboratory, Naval Oceanographic Office, University of California San Diego (Scripps), Naval Postgraduate School, Johns Hopkins Applied Physics Laboratory, University of Texas Applied Research Laboratory, Penn State University Applied Research Laboratory, Space and Naval Warfare Center Pacific, The Nature Conservancy

Table 4. Partial list of current and future funding sources

Office of Naval Research, North Pacific Research Board, Nature Conservancy, Oregon Department of Transportation, National Oceanic and Atmospheric Administration, National Science Foundation, Oregon Water Resources Board, The Freshwater Trust, NASA, Institute for Natural Resources, DARPA, US Army Corps of Engineers, Department of Interior, US Department of Agriculture, Oregon BEST, EPA, Paul G. Allen Family Foundation, The Gordon and Betty Moore Foundation

Educational objectives: A diverse ESM engineering faculty will permit the ECE department to offer a wide range of ESM engineering courses, with the following objectives:

1. Providing solid fundamentals in remote sensing methods (electromagnetic, acoustic)
2. Establishing vigorous signal processing and embedded systems MS and PhD tracks
3. Expanded coursework in fundamentals and applications of machine learning coursework and applications
4. Developing curriculum on underwater robotics
5. Emphasizing interdisciplinary curriculum

Hiring Target: To support the development of a research group in the area of environmental sensing and monitoring we anticipate needing 5-6 faculty members with substantial externally supported research funding. This is essential to support PhD students and Postdoctoral researchers. M. Siderius, H. Lei, and J. Lipor form the initial core researchers for this area with J. McNames (currently chair), R. Campbell (instructional faculty), D. Hammerstrom (Professor Emeritus) also providing support to the group. We request 2 additional tenure track faculty hires for this area, starting in Fall 2020.