ORGANIZATION AND APPROACH

The Physiological Sensing Facility (PSF) organizes intellectual exchange and fosters direct engagement with interdisciplinary scientists and engineers. To that end, the facility cultivates a broad understanding of both engineering/technology and biosciences research as a prerequisite to drive both sensor development and sensor application. The PSF seeks researchers from engineering, agriculture, biology, biomedical, and other life sciences areas to approach the PSF with ideas, needs, and capabilities that can adapted and applied to the development of new technologies. Based on identifying user needs, the PSF searches for ways to direct new developments in biological sensing technologies that will have significant impact in many research areas.

Future advances in basic research are limited only by imagination and the availability of quantitative sensor technology. The Physiological Sensing Facility (PSF) at Purdue University will drive rapid adaptation of campus research infrastructure to allow Purdue to take a leadership position in the development and application of advanced biological sensing technologies as tools for discovery.

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Goals

- Create a new paradigm in sensor science and technology that is centered on development of tools for discovery in bioscience research.
- Generate individual sensor technologies that will, in turn, stimulate a large number of funded innovative research projects.
- Create an environment to stimulate and manage interdisciplinary sensor technology development.
- Provide basic infrastructure to allow scientific research to be conducted with these new technologies.
- Promote integration of biosciences and engineering disciplines in the development and application of advanced sensor technologies.

Current Research Areas

- Agriculture
  - Regulation of division and elongation during root growth.
  - A self-powered temperature and pH sensor for long term monitoring of the ruminant gastrointestinal system.
  - Biosensors for phytohormones.
  - Understanding and predicting postmortem muscle metabolism and pork quality.
- Biomedical
  - A multifunctional microinjection microsensor probe array for experimental drug application for research in the physiology of a mechanically injured Guinea pig spinal cord.
  - Microscopy-based data acquisition for self-referencing optically coupled biosensors.
  - Combining cell sorting with microchip-based cell physiology as a new tool for high throughput research and drug discovery.
  - Development of multifunctional nanoflow microanalytical bioprobe sensors for basic research and clinical diagnostics.
  - Measurement of nitric oxide in the cardiovascular system.
  - Dynamic neurotransmitter measurements from living neural systems.
  - Fundamentals of designing neural biomaterial interfaces at the nanoscale.
- Environment
  - An autonomous aquatic microsensor network for monitoring civil water infrastructure.
  - An array-based screening method for developing biosensors for organic pollutants.
  - Self-referencing sensors to study the transport of heavy metals in plants.
  - Development of an arsenate biosensor.
- Food Safety
  - Development and characterization of nanocomposite materials for the detection of pore-forming toxins.
- Space
  - Microfluidic ion sensor array (MISA) for monitoring gravity responses in single cells.

Enhancing Research Capabilities with Sensor Technology & Application

Serving as a resource for basic agricultural, biological, and biomedical researchers, the Physiological Sensing Facility (PSF) provides scientists with a mechanism not only to use new biosensing capabilities for basic research, but also to inaugurate new research initiatives. The PSF actively organizes new research teams for the development of novel sensor technologies (electroanalytical, biosensors, optrodic, MEMS, microfluidics, nanosensors, to name a few) to enhance campus capabilities. Through the PSF, engineers can utilize facility capabilities to test and adapt new technologies and biological findings in the development of new sensor technologies. The collaborative, multidisciplinary environment of the PSF provides learning opportunities for graduate students, as interdisciplinary individuals, to become the future leaders in biological sensing.

Facility Infrastructure

The Physiological Sensing Facility is housed in the Bindley Bioscience Center at Purdue's Discovery Park. The facility evolves dynamically with the creation and completion of research projects and teams. The two parallel missions of sensor development and application are supported by these dual service capabilities within the facility. Basic capabilities of the facility that are expected to remain constant include:
- Cell, Tissue, and Plant Culture.
- Basic Bioanalytical Instrumentation.
- Data Acquisition and Signal Amplification.
- Microscopy and Imaging.
- Micro/Nano Positioning.
- Animal Implantation Suite.

CAPABILITIES

Cell culture facilities to grow cells for sensor fabrication (cell based sensors), sensor testing (biomolecular-based cell sensors), and basic bioresearch (growing cells for basic research).

Basic bioanalytical instrumentation testing of biomolecular activity to fabricate and compare new sensor technologies.

Custom-designed data acquisition and signal amplifiers to evaluate and apply new sensors to basic research.

Customizable computer-based, multi-channel data acquisition capabilities to interact with assorted transducer technologies used in various biosensor approaches.

Data acquisition systems capable of interacting with microscopy-based image acquisition and micropositioning systems to facilitate use of advanced sensor modalities (self-referencing sensor technique, surface scanning microscopy).

Integrated capabilities to facilitate automation of sensor fabrication that enable selective membranes to be applied to individual sensors constructed in microarrays using video feedback control of a micropositioning system.

Microscopy and imaging to evaluate and document microfabricated structure and to view sensor positioning near cells and tissues.

Custom-designed and controlled micropositioning systems to control sensors.

Implantable biosensors for in vivo measurements in the Bindley small animal suite.

Key Technologies

- Scanning Self-Referencing Electroanalytical Sensors.
- Scanning Self-Referencing Optically-Coupled Biosensors.