Michigan State University
College of Engineering; Dept. of Electrical and Computer Eng.
ECE 480 Capstone Design Course Project Charter

Sponsoring Company/ Organization: Michigan State University

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Phone and Best Time of Day to Call: M-F, 8:00 AM – 5:00 PM

Background Information:

Business Case:

- Natural gas is poised to become the primary fuel for utility scale fossil fuel electrical generators in the United States due to its abundancy and relatively low-cost and favorable emissions properties when compared to coal fuel. In 2016, MSU has made a transition to 100% natural gas fuel to generate electricity and steam heat at its power plant. Opportunities for improvement exist at utility plants to increase the safety of handling natural gas.
- The increase in use of natural gas in utility plants has introduced new safety concerns for those facilities handling of natural gas that formally handled coal. This has created opportunity for new methods to detect and reduce the potential hazard of natural gas leaks and releases in those and other facilities that handle natural gas.
- This product will be positioned to avoid potentially explosive levels of natural gas by the early detection and timely response to leaks. Such a system can be of interest in protecting facilities and reducing losses so it may be attractive to insurance companies and life safety system design engineers. It can also be used to detect smaller natural gas leaks that carry an environmental risk of the release of methane that has a relatively high greenhouse gas potential as regulations of the release of methane are expected to increase.

- There are few competitive barriers to marketplace entry for the design of a distributed natural gas leak detection system. Many of existing sensors are expensive and require substantial wiring throughout a facility. The model proposed here is an inexpensive network of readily deployable sensors that communicate with a monitoring system via wireless technology making the capital installation costs minimal and maintenance and testing easy to perform by field unit replacement. This competitive environment creates a low entry barrier for simple, cost-effective solutions that can be reliably adopted.
- Novel and demonstrated technology and low cost are the key factors for sustaining a competitive advantage for this system. The wireless network and built in redundancy of having a network of low cost sensors avoids an expensive capital expenditure to hardwire such a detailed system. Ease of maintenance is also a competitive advantage. Demonstrated reliability on a major research university campus power plant is another competitive advantage.

Project Intellectual Property Considerations:

- A Non-Disclosure Agreement is not required.
- The design team may post their work on the course website.
- The student Design Team will not be working with technology contained in pending patents not yet granted, but may be generating patentable technology.
- The electronic design can be shown.

Opportunity Statement:

- What **clearly defined Customer Problem** you hope to solve with this project?
    - Demonstrating that a distributed network of many low cost, wireless-enabled sensors to detect methane atmospheres and perhaps other poisonous or low oxygen atmospheres reliably throughout a facility is the key solution that is sought in this project.
    - The problem can be solved in 13 weeks with a team that has knowledge of interfacing existing sensor technology with wireless communication and writing software that can monitor, pinpoint, and alert the need for a response by facility or other personnel.
- Does this problem exist now, or in the future?
    - This problem exists now.
    - The window of opportunity will remain open for as long as natural gas is used as a fuel to support utility generation or other process heating needs.
    - Many things can drive the window of opportunity closed but most drivers would include either no longer using natural gas as a fuel or sufficient changes to piping, valves, and other sources of leaks to make this technology no longer needed.
- Who is the customer?
    - End users could be power plants, factories, commercial process and space heating applications and even residential. Insurance companies and life

safety and property loss prevention engineers may also be key stakeholders for such technology.
    - The ECE 480 Design Team will deliver their project to campus utility plant engineers and operators and potentially key stakeholders such as insurance company engineers.
    - The benefit to MSU of this project is increasing life safety and protecting the MSU micro-grid utility generation assets that are presently fueled by natural gas which is about a $300M to $400M investment.

Deliverables:

- Describe what is to be delivered at the end of the semester.
    - MSU is looking for a technical solution to reliably detect even small leaks of natural gas at key areas of the point of use of natural gas delivery or handling such as the burner fronts of large industrial power boilers. In order to pin point small leaks, a network of small, low-cost, and networked sensors will have to be deployed around key areas to detect and identify the likely source of the leak. Demonstration of the sensing network in situ together with the monitoring and alerting software are deliverables to this project.

Goals:

- Describe what success will look like at the end of the semester.
- Goals should be SMART
    - **Specific** – Detect and identify the likely source of natural gas leaks.
    - **Measurable** – The measurement system will be if the system can detect leaks and make actionable alerts to personnel.
    - **Attainable** – This project is achievable to students with little or no industrial experience. Full access to experienced campus utility engineers is guaranteed.
    - **Relevant** – This is a real-world problem that exists at MSU and is expected to increase as more facilities use or handle natural gas.
    - **Time Bound** – This project is achievable and is an integration of physics, engineering, safety, environmental protection, and loss avoidance.

Scope:

- In scope:
    - Integrate methane sensors with wifi transmitters and program a spatial network monitoring the devices with consideration for the practical issues of convective currents of air around operating industrial equipment.
- Out of scope
    - Market these devices

    - Getting accreditation or approval for use of these devices for safety system use.
- Clearly list chipsets, software, equipment, test set-ups, working systems, etc. that will be supplied to the Design Team to facilitate their efforts and keep project cost reasonable.
    - A test environment will be provided
    - Small existing natural gas leaks will be used
    - The test environment will be a scaled down version, but will be able to represent a potential for a larger application.
    - Access to campus subject matter experts responsible for the operation and response to natural gas leaks.

Constraints:

- List all constraints on the project team.
    - Must demonstrate a working prototype in an industrial environment.
    - Must work with MSU campus engineers involved with utility generation and potentially issuers of insurance for industrial workplaces for input.
    - Propose and validate (test) or implement a reliable, creative, and low-cost solution within critical infrastructure.

Project Team: (Completed once semester begins)

Name	Responsibility

Faculty Advisor: (Assigned by ECE Dept . based on project requirements)

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