Sustainable AI enabled Smart Greenhouse based Gerontechnology for Aging-in-Place and Assisted Living as an Interdisciplinary Service-Learning Project in First-Year Engineering

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Abstract

This work-in-progress project is an ongoing, planning-phase effort to potentially integrate artificial intelligence (AI), machine learning (ML), and intelligent greenhouse technologies for the aging into a first-year engineering service-learning experience. The initiative is in an early conceptual stage, with current work focused on evaluating low-cost, classroom-ready components that could support hands-on learning for introductory engineering students. These efforts contribute to a broader vision of sustainable nutrition, environmental monitoring, and therapeutic horticulture for older adults in nursing homes and aging-in-place environments. Collaboration among engineering, business, nutrition, nursing & health professions faculty, and nursing-home partners is guiding technical feasibility, regulatory oversight, scalability business practices and curricular alignment. Planned instructional activities center on benchtop smart-greenhouse prototypes that introduce sensing, actuation, solar energy, and Internet-of-Things (IoT) data collection. Prototype systems may incorporate temperature, humidity, and soil-moisture sensors, automated lighting and irrigation, and exploratory AI/ML features such as detection or human-machine interaction using cameras or robotics as sustainable gerontechnology (also sometimes referred to as gerotechnology). These platforms aim to provide scalable, safe entry points into systems thinking, sustainability, and interdisciplinary problem solving. The learning context emphasizes smart homes and assisted-living environments, including potential connections to the Minka House aging-in-place model home. Students will explore how automation, accessible monitoring, and AI-enabled tools could enhance small-scale food production, horticultural therapy, dementia-friendly design, and socialization for older adults. Ethical and societal considerations, including technology acceptance, equity, and sustainability, are integrated as reflective components. As the project evolves, faculty will continue to assess feasibility, safety, usability, and applicability to long-term care contexts. Future phases may expand into undergraduate research, senior design, and interdisciplinary coursework, contributing to ASEE's scholarship on socially relevant, community-engaged engineering education.

Background

- Engineering education increasingly emphasizes sustainability, ethics, and societal impact; EOP advances systems thinking and human-centered design. [1]
- First-year, project-based engineering courses can introduce sustainability and systems early while supporting engagement and retention. [2]
- Small-scale IoT platforms (Arduino/Raspberry Pi) enable hands-on sensing, control, and data-driven reasoning in introductory courses (Fig 1). [3]
- Gerontechnology for aging-in-place, including nursing home contexts that prioritizes safety, accessibility, and acceptance for nutrition support. [4]
- Use open-source hardware/software and Creative Commons learning resources where possible to reduce cost and enable reuse/scaling. [1,5]
- Interdisciplinary project integrates engineering, nutrition, gerontology, and international business (cost/value and supply chains) for scalable solutions. [1][4]
- This Work-in-progress effort is at the conceptual phase and is intended to be aligned with the EOP sustainability frameworks and ASEE scholarship, allowing faculty to iteratively evaluate feasibility, pedagogy, and alignment before large-scale implementation or assessment. The expected implementation is in 2026.

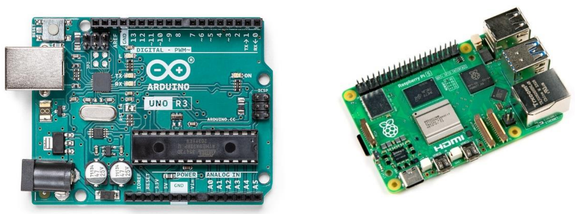


Figure 1 Example educational microcontroller (Arduino) and microcomputer (Raspberry Pi)

Preliminary Instructional Plan (First Year Engineering)

- **Planned activities are intentionally introductory, modular, and scalable, aligned with the Engineering for One Planet (EOP) framework**
- **Resources explored for in-class systems thinking related activities include a desktop smart greenhouse, IoT devices or AI enabled technology and planned instructional concepts**
- **Proposed Module 1: Gerontology Context with Aging-in-Place & Assisted Living**

Figure 2 The Minka House provides a real-world contextual anchor for student learning, illustrating how intelligent systems may support: Gerontechnology, Aging-in-Place and Assistive Living concepts and Introduce the 4Ms (What Matters, Medication, Mentation, Mobility).

- **Proposed Module 2: Nutrition & Accessible Fresh Food**

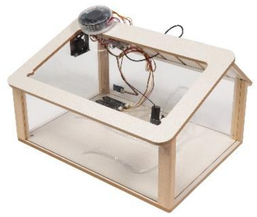


Figure 3 This commercially available, classroom-ready system serves as a conceptual reference platform for first-year engineering activities (Ardiuino/Pitsco). Smart greenhouse technologies (IoT, climate control, fertigation) can improve economic and environmental sustainability, while group-based gardening and nutrition activities foster meaning, connections and socialization, helping reduce isolation and support mental health.

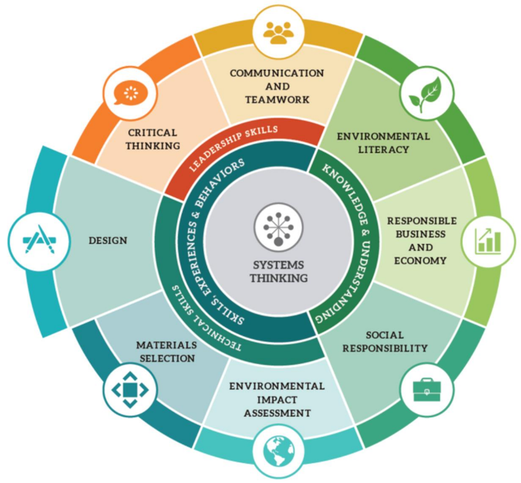
- **Proposed Module 3: Business Module**
  - Develop **sustainable business models** (e.g., circular/service-based, product-life extension, stewardship) that fit community needs and market constraints.
  - Plan **responsible value-chain collaboration** (supplier/distributor/customer coordination) using sustainable supply chain principles to manage impacts, risks, and performance.
  - Build a **scaling strategy** through cross-sector partnerships and **social entrepreneurship** approaches for expanding impact beyond a pilot (community, government, and industry alignment).

- **The conceptual framework is guided by an interdisciplinary and community-centered approach: engineering faculty (systems, hardware, AI concepts), nursing and health professions (aging, usability, safety), nutrition (food systems, horticultural relevance), and business (scalability, sustainability practices).**

Impact

The proposed course activities engages first-year students in hands-on IoT, automation, and AI learning while fostering systems thinking and sustainability. The project also promotes interdisciplinary collaboration among engineering, health, business, and community partners for scalable, ethical solutions. If fully adopted, this project will impact approximately one hundred students per academic year.

EOP Learning Outcomes



Conclusion

This work-in-progress explores a conceptual integration of AI-enabled IoT greenhouse systems within ENGR 108. Spring 2026 efforts focus on refining activities, evaluating hardware, and mapping to ASEE EOP outcomes. The greenhouse serves as a systems-level, sustainability-focused design context for first-year students. Interdisciplinary collaboration between engineering, nutrition, gerontology, and business continues to guide feasibility, ethics, and educational relevance. Fall 2026 planning includes expanded team projects and preparation for future curricular scaling.

Future Work

- Expanded service-learning pilots
- Undergraduate research experiences
- Senior design projects
- Interdisciplinary coursework
- ASEE scholarship on community-engaged engineering education

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Acknowledgements

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