Thesis Project Portfolio

Leafy-Link: An Automated Hydroponic Growth System
(Technical Report)

The Role of the CHIPS and Science Act on US Semiconductor Manufacturing and Supply Chain Security
(STS Research Paper)

An Undergraduate Thesis

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Sociotechnical Synthesis

The technical project designated Leafy-Link is an automated hydroponic growth system designed to simplify the process of growing microgreens. This project was developed by four 4th year undergraduate students, including three electrical engineering majors and one computer engineering major. The system is targeted primarily toward restaurants that want locally sourced produce with minimal effort. Leafy-Link has a number of integrated sensors measuring variables such as temperature, humidity, and pH to ensure continued optimum growing conditions. The system also employs the use of a microcontroller to automate the water misting and grow light cycles, aligning them with the ideal conditions of the chosen microgreen. There are a number of preset growing options for commonly grown microgreens, allowing users to simply select the corresponding preset for their chosen microgreen. Users will also be informed of the system's humidity, reservoir water level, pH level, and other useful information such as the current growth duration via the touchscreen LCD. The LCD serves as the input/output (I/O) device, displaying the system environment information and providing a convenient way to turn off the grow lights or the water pump. The screen is also used to configure the growth settings on startup and to notify the user when intervention is necessary. By providing its customers with a low-maintenance and efficient system for growing microgreens, Leafy-Link supports the growing trends of environmental sustainability, locally sourced food, and public health improvement.

The research paper examines the role of the Creating Helpful Incentives to Produce Semiconductors (CHIPS) and Science Act in bolstering US semiconductor manufacturing and supply chain security (SCS), alongside an analysis of the interplay between society and technology in the semiconductor industry through science, technology, and society (STS) frameworks. The 2020-2023 global chip shortages, driven by supply-demand mismatches and production disruptions, exposed vulnerabilities in the semiconductor supply chain and cost the US economy an estimated $240 billion in 2021. The CHIPS Act, passed in 2022, allocates $24 billion to a 25% tax credit on qualifying semiconductor manufacturing capital expenditures and an additional $52 billion to direct private sector investments, including $39 billion for manufacturing, $11 billion for R&D, and $200 million for workforce development. These private sector investments aim to enhance domestic production and mitigate future shortages.

The paper provides an overview of the semiconductor industry and its supply chain, details the causes of the shortages, and discusses the CHIPS Act's funding priorities and their implications for SCS. Through an STS lens, it explores technological determinism—where semiconductor advancements shape societal structures—and the social construction of technology (SCoT), highlighting how social and economic forces drive industry development. The CHIPS Act reflects social constructivism by addressing societal needs through legislative action, while its outcomes fuel technological determinism, transforming industries like healthcare and AI. To ensure semiconductor SCS, strategies like expanded production capacity, standby fabrication facilities, and stronger diplomatic ties for material sourcing are recommended, while sustaining the CHIPS Act's momentum and fostering global partnerships will further strengthen SCS, US technological leadership, and economic stability.

The centuries-old goal of decreasing the effort and resources required to grow food has led to numerous impressive agricultural developments. Modern technological advancements such as the light-emitting diode (LED) and computers have unlocked a new level of farming automation and efficiency. Leafy-Link, our technical project, uses semiconductor-based technologies, including a microcontroller, sensors, relays, and a touchscreen interface, to demonstrate how embedded computing can democratize 'smart farming' for smaller-scale applications. The critical role of semiconductors in smart systems like Leafy-Link connects directly to the focus of my research paper on the CHIPS and Science Act. The recent advances in technology-driven agriculture align with societal demands for sustainability, public health, and reliable food sourcing. However, the efficacy of such systems depends on a reliable supply of semiconductor devices, which are integral to the microcontrollers and sensors enabling automation and real-time environmental monitoring.

The 2020-2023 global chip shortages exposed vulnerabilities in the semiconductor supply chain and threatened industries reliant on embedded computing, including agriculture. The CHIPS Act addresses these challenges by incentivizing domestic semiconductor production and fostering SCS, ensuring the availability of chips for applications from hydroponic systems to national defense. Leafy-Link showcases how semiconductors enable small-scale smart farming to meet local sustainability goals, while the CHIPS Act research evaluates the legislative support for a secure, scalable chip supply, strengthening U.S. technological and economic resilience. This synergy highlights the interplay between practical innovation and systemic policy in advancing societal needs.