

**Thesis Project Portfolio**

**Forecasting Breakthroughs: Identifying Future**

**Leaders in the Semiconductor Industry**

(Technical Report)

**Additive Manufacturing: Societal Implications of Adoption**

(STS Research Paper)

An Undergraduate Thesis

Presented to the Faculty of the School of Engineering and Applied Science

University of Virginia • Charlottesville, Virginia

In Fulfillment of the Requirements for the Degree

Bachelor of Science, School of Engineering

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## Sociotechnical Synthesis

(Executive Summary)

*Steps Towards Progress: Societal Change in Product Design and Manufacturing*

*"The only true wisdom is in knowing you know nothing."*

*- Socrates*

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Finally, if you have changed any of the fonts, make sure they are at least consistent across all titles and text.

When considering how products are designed and manufactured, they are often limited by the status quo. Societal norms and expectations tend to guide the course of design and manufacturing. With the advent of additive manufacturing those pressures are lifted and manufacturing can become economically viable at smaller scales. It is important to acknowledge that manufacturing efficiencies have had a large impact on the culture of our society. The technical paper is about the current problems with shoe design. The science, tech and society (STS) paper is about the inevitable cultural change that will result from the switch to additive manufacturing practices.

The technical paper explores how the current landscape of footwear has come to be through societal, cultural, and scientific factors. It then examines the technical problems of modern footwear based on contrasting scientific research and offering a new technical design solution. The new design fits the natural function of the foot, while offering comfort from hard surfaces such as concrete. The main takeaway is that the contrasting scientific papers have bias, and when these are considered, it's clear that a design that incorporates some force absorption but allows the foot to sit flat, in a natural position, with no artificial support is best.

The focus on Additive manufacturing was important to me because it allowed me to explore a solution to some of the circumstances that lead to the current landscape of footwear. Early shoes

in modern society were made with robustness as the primary concern, but with additive manufacturing a shoe can be manufactured specifically for foot functionality and still be robust. The STS paper examines how a shift to additive manufacturing will fundamentally change how economies, government, and overall society is arranged. The shift will create localized manufacturing facilities and allow for manufacturing in house for many parts. Additionally, design limitations will be lifted and customized parts products will become prevalent.

The emergence of additive manufacturing presents new opportunities to advance ethical and responsible engineering. In class, we had Boeing whistleblower, Ed Pierson, talk about the cultural and systematic issues that lead to the Boeing plane crashes. Probably the most critical issue highlighted by Pierson was the absence of engineers in Boeing's three main manufacturing facilities. With the adoption of additive manufacturing into Boeing airplanes, engineers would be back into the manufacturing facilities implementing new parts and components. Not to mention, that parts could be made less evasively and with less design limitations compared to traditional manufacturing methods. From an ethical standpoint, AM's capacity to produce highly customizable, resource-efficient designs also has profound societal implications. For example, the development of AM-enabled shoes addresses critical ethical concerns by directly remedying factors that cause bodily injuries and discomfort, such as poor ergonomics. This not only reduces long-term health risks and the need for corrective surgeries but also demonstrates a commitment to prioritizing human well-being in product design. Such advancements align with sociotechnical principles by considering the broader societal impacts of technology and the interconnected roles of engineers, users, and manufacturing processes.