

Thesis Project Portfolio

The Smithinator: Recumbent Vehicle Design and Entry for the 2020 ASME Human-Powered Vehicle Challenge

(Technical Report)

Investigating the Expanding Role of Makerspaces in Fostering STEM Engagement and Inclusivity in K-12 Education

(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 and Applied Science

Coke Smith Matthews

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Department of Mechanical and Aerospace Engineering

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The discrepancy between U.S. math and science scores versus other advanced industrial nations, along with the underrepresentation of women and people of color in STEM-related fields, has called into question the American education system. Experts agree that a leading cause of this phenomenon is the inability to spur interest in STEM at a younger age (DeSilver, 2017). Along with improving the quality of the standard curriculum, there needs to be an emphasis on making classes more interactive and engaging. One attempt to do so that is recently gaining traction is the adoption of makerspaces into schools and libraries. Makerspaces serve as collaborative spaces that encourage creativity and hands-on exploration of science, engineering, and design. Further, they provide an opportunity for cultivating a community of women and minority groups interested in STEM. My STS thesis will investigate the expanding role of makerspaces in k-12 education, and their ability to foster engagement and inclusivity in STEM, by examining the Charlottesville Public School System as a case study.

My technical thesis contains the design and manufacturing of a human powered vehicle (HPV) for a competition in April. The American Society of Mechanical Engineers (ASME) hosts the competition, which is scored by three events: the design report, drag race, and endurance event. Our 14-member team designed our HPV to meet ASME and self-imposed specifications, while also considering the vehicle's social impact as a means of environmentally-friendly transportation. In doing so, the qualities of speed, safety, sustainability, durability, accessibility, and user-friendliness were emphasized. The majority of the vehicle is self-built, and the tools utilized in its construction are often found in makerspaces, such as 3D printers, 3D modeling software, CNC machines, etc. The ability of nearby makerspaces to provide the tools and

collaborative space for our group reinforces their effectiveness and relevance in the sphere of academia.

The STS thesis found that in the case of Charlottesville Public Schools, makerspaces are successful in bolstering STEM engagement and inclusivity. Students in the STEAM club at Johnson Elementary, along with participants of the Scholar's Lab Makerspace, were notably pleased with their respective makerspace. Further, the success of the Women's Maker Program and Computers4Kids reinforce their ability to promote inclusivity while cultivating a supportive STEM community. This suggests that makerspaces deserve a more expansive role in k-12 education. For the technical portion, the assembly of our HPV was unfortunately halted due to COVID-19. Despite this, our group is proud of the design report produced, and the progress we made on the vehicle's construction. We are hopeful that the guidelines laid out in the report serve as helpful advice and inspiration for future HPV teams.

I would like to pay my regards to Charlie Thel and Landon Smith, along with my family, for the continued support during this process. And a special thanks to my capstone team, Professor Smith, and Professor Ferguson, for the invaluable assistance that you all provided over the past year.