The Future of STEM with VEX Robotics

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STEM Career In Interest

In robotics, design, and creation often involve a collection of a variety of engineering fields. After research, our team saw how aerospace engineering mimicked the various aspects of engineering coming together harmoniously. Aerospace engineering is not simply a collection of concepts from mechanical, electrical, and civil engineering — it is supported by every field of engineering. Regardless of the specific careers the members of 421C are intrigued by, aerospace engineering needs a combination of these careers — making it a highly opportunistic career field for all of our members.

Sources

As a precursor to understanding the basis of the engineering mindset, the paper “The Role of the Professional: An Engineer's Perspective.” was consulted. This provided excellent insight, as well as personal notes from Mr. Happold himself regarding the art of engineering.

To fully understand the sophistication of an aerospace engineer’s design process, two engineers were personally interviewed— former aerospace engineer for commercial airline Air India, Mr. Singh and current aerospace engineer for General Electric, Mr. Richardson. Both of these engineers have designed various components of commercial airplanes flying today and gave considerable insight into the genuine design process of an engineer.

Finally, Project Lead the Way (PLTW), a nationwide program helping introduce primary education students, was used to help base the conceptual understanding of us students of 421C. PLTW’s programs take place as school courses and include VEX products to help stimulate student learning. All members of team 421C partake in a PLTW engineering course.

The Professionals

To most, engineers can be summed up as individuals who create structures and mechanisms to work. However, simply put, an engineer's work does not make something just 'work'. It takes the collection of multiple parts that work together — not always in the most efficient way for each piece. One example, provided by Mr. Richardson, was the fan blades for the GE9X engine. Running countless simulations and calculations, it was apparent that using a steel alloy for the entirety of the blade would provide optimal flexibility and efficiency, however this design would not work in conjunction with the engine as a whole. The blade would be simply too heavy — it would reduce the efficiency of the engine altogether. Mr. Richardson showed us, especially in aerospace, compromises are needed in design. The engineers at GE instead designed a blade with a front piece of steel and body of carbon fiber — the best compromise.

General Electric's GE9X engine

A key point mentioned by Mr. Singh is that 'most' commercial airplanes run their electrical systems on 28VDC. He brought this up to emphasize how engineers adhere strictly to their design requirements. A design could be unparalleled in efficiency in comparison to all other designs, however its cost makes it a viable option. Cost often becomes the biggest underlying factor for design. If everything is designed to perform at the highest efficiency, it will become unrealistic and expensive to produce. As long as a design is made to meet the bare minimum requirements it will prove to be the most viable design

The Students

From an outside perspective, the design process of 421C seems pretty straightforward — adhering to a similar plan as PLTW's design process. However, we have a few significant differences from actual engineers. In our robotics meetings, we often spend a majority of our time building and testing rather than experimenting and simulating. The tests that engineers, aerospace specifically, take make the design process specific and strategic. They understand the characteristics of the assembly they need to design and how it will perform under a theoretical physical world. As students we understand the objectives we need to achieve, for example in this year's VEX robotics competition *Tipping Point* our team decided to design a mechanism to lift up the mobile goals. After discussing possible designs, we decided on a design to test and explore — one of all possible designs. Since we are still learning the mathematical skills that would allow us to determine the best solution without extensive testing, we often go through the redesign phase several times before finding our final solution.

MyPLTW's Engineering Design Process

Another crucial difference is the view of weight and cost. To an aerospace engineer, these two factors are the most important pieces to labeling the effectiveness of the design. As a robotics team, these two factors are often put aside in search of discovering the best possible solution. In VRC (Vex Robotics Competition), we are limited to 8 motors. This gives us a simple template to plan our designs, 4 motors to drive our chassis, and the 4 others to achieve the specific goals of the competition (this typically entails a 2 motor lift mechanism). The components of the competition all weigh less than 4 lbs making it a simple enough challenge to create a robot for our objectives. In a professional career, when that weight extends past 900,000+lbs, it becomes a considerable issue to design a mechanism that maximizes effectiveness vs weight..

Future Careers

All of us on 421C joined robotics for a reason — to learn about engineering. Through the countless meetings we have gained a considerable understanding of what the field engineering entails. After discussions with our entire team, we have seen that engineering can be applied in many interdisciplinary careers. For example, one member became interested in the medical field as well as nanotechnology — two separate fields that have been connected by engineering. Whatever career the members of 421C take interest in, their participation in VEX robotics has helped them learn significant amounts about engineering and the engineering design process which can be applied to a multitude of fields.

Sources

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Mr. Richardson. Interview. Conducted by Arjun Verma, 2 December 2021.

Mr. Singh. Interview. Conducted by Arjun Verma, 30 December 2021.

MyPLTW, https://my.pltw.org/.