REX 1727B

Dulaney High School
Timonium, MD

Career Readiness Challenge

Matthew A. Marcelo C. Mingni D. George F.
Davy L. Caleb M. Bhargav S. Logan T. Nerissa W.

WHY BOEING?

Boeing is a leading player in the aerospace industry, known for designing and producing a wide range of products, including airplanes, satellites, and missiles. Founded in 1916 by William E. Boeing, the company has played a pivotal role in revolutionizing the commercial aircraft sector. As it expanded and added more assets to its portfolio, Boeing diversified its offerings and began producing military-grade surveillance and engagement equipment, as well as communication satellites.

To dive into Boeing's use of the engineering design process, our team looked into the many online resources that Boeing put out documenting how they utilized the engineering design process in their projects.

THE DESIGN PROCESS

Problem-solving is crucial in creating new technology, such as addressing design safety concerns. Boeing uses the engineering design process, which includes identifying and defining the problem, researching, developing, and testing potential solutions, to streamline new technology development and improve existing ones. This iterative process ensures that the final product is safe, reliable, and efficient, especially important for ensuring the safety of Boeing aircraft and passengers.

Figure 1: Boeing's Steps In Their Design Process.

Likewise the same steps of approaching and solving a problem are conducted when designing and creating a robot for VEX robotics. Each year a new challenge in the form of a game is revealed and teams must design, build, and refine their robot for competition.

BASIC RESEARCH AND DEVELOPMENT

Boeing has a long-standing tradition of investing heavily in research and development (R&D) to stay at the forefront of technology and constantly improve their products. Their use of R&D in the design process is a crucial aspect of their success and has enabled them to develop some of the most advanced and innovative aircraft in the world.

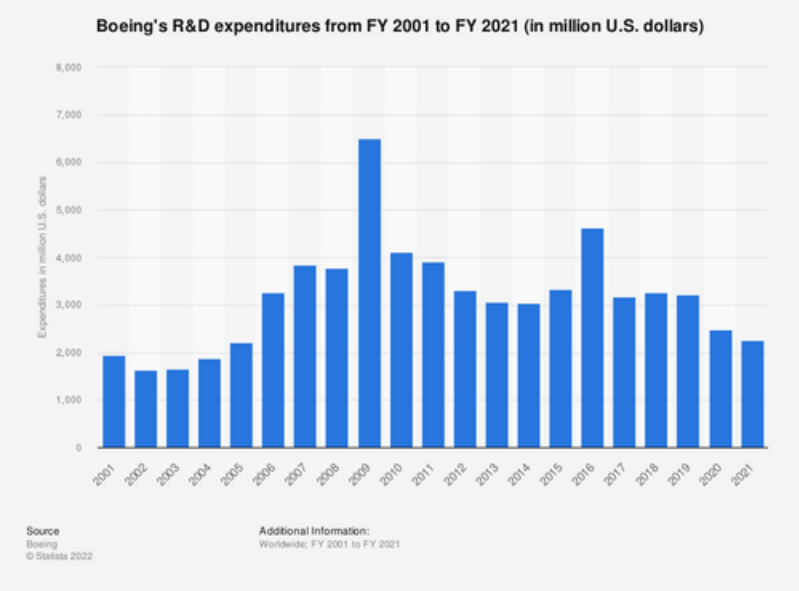


Figure 2: Graph of Boeing's Expenditures on Research and Development from 2001 to 2021.

Our VRC team also prioritizes coming up with different and innovative designs. Every season right after the game is revealed, we'll meet and throw around any potential design ideas we have and weigh their pros and cons. We strive to make this as comprehensive as possible so we can properly decide on a design to start prototyping.

DEFINING THE PRODUCT AND PROGRAM

One of the main ways that Boeing identifies the need for a new product is through customer feedback and market research. They analyze market trends and demand for different types of aircraft and consider the needs of specific customer groups such as airlines and governments.

Regulatory requirements also play a crucial role in defining the need for a new product at Boeing. The company must comply with all federal and international regulations, including those related to safety, noise, and emissions. This means that they must consider the latest regulations when designing new aircraft and make sure that their designs meet or exceed these requirements.

Figure 3: Image of one of Boeing's research and development facilities located in Korea.

Figure 4: Boeing's research and development facility located in South Carolina.

Similar to how Boeing accounts for consumer wants and regulations, our team considered game strategy and regulations when designing our robot. One thing we noticed this year specifically, was the value of the four rollers on the field. Since, they are swing points it was important for us to score the rollers quickly and efficiently.

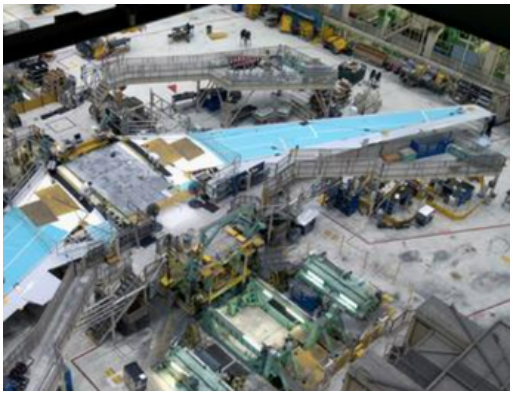
EXECUTING THE PROGRAM

During this design and development stage, Boeing's engineering teams use the information gathered during program planning to design and develop the product. They use advanced simulation, modeling, and virtual testing tools to validate the designs and identify potential issues before physical prototypes are built. This stage also includes the development of production processes, tools, and equipment.

Once the design is complete, the product is subjected to rigorous testing and validation. This includes both physical and virtual testing, such as ground and flight testing, to ensure that the product meets all safety, performance, and regulatory requirements.

After the product has been successfully tested and validated, it enters the production phase. This stage involves the manufacture of the product, including the procurement of materials, components, and equipment. The product is then delivered to the customer, who may conduct additional testing and validation before accepting delivery.

The steps that we follow when designing and constructing our robot closely mirror the steps that Boeing follows. We first thoroughly design all of our robot's subsystems before physically assembling them. From there, we spend time testing and refining our design for our final robot.



Figures 4-5: Images showing construction of a Boeing 737.

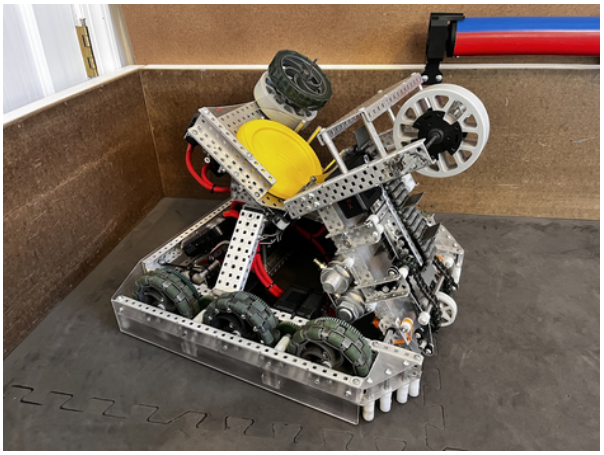
SUPPORTING AND IMPROVING THE PRODUCT

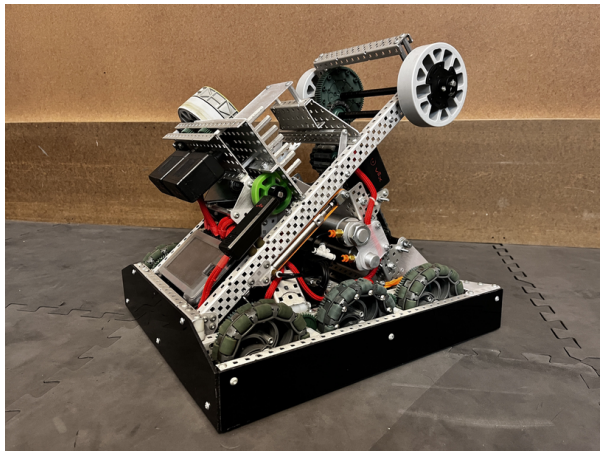
Boeing's support and improvement program for their products is a crucial aspect of their business, ensuring that their products remain safe, reliable, and efficient over their lifecycle. This program includes a wide range of services and activities that are designed to keep their products operating at peak performance and to meet the changing needs of customers and regulatory requirements.

One important aspect of the program is the updating and upgrading of the products. This includes incorporating new technologies, systems, and materials to improve the performance and efficiency of the products. Boeing also modifies its products to meet the changing needs of customers and to comply with new regulatory requirements.

There is always something that can be improved. For Boeing, it may be conforming to new FAA restrictions or sustaining the structural integrity of an older plane. For us, as a VRC team, somethings we focus on are improving the scoring efficiency of our robot as well as adapting our strategy to game rule changes mid-season. Being able to be adapt and improve is crucial to success.

Figures 5-6: Images showing the development of our robot as the season progressed.





WHAT TOOLS DOES BOEING USE IN THEIR DESIGN PROCESS?

Computer-aided design (CAD) and computer numerical control (CNC) are two technologies that Boeing uses extensively in their design process. These technologies allow the company to effectively design, develop, and manufacture their products, ensuring that they are safe, reliable, and efficient.

CAD is a software tool that allows engineers to create detailed 3D models of parts and assemblies. These models can be viewed from any angle, and can be used to create detailed drawings and technical specifications. Boeing uses CAD extensively to design the complex systems and components of their aircraft, including the fuselage, wings, and landing gear. This enables them to create accurate and detailed designs that can be easily modified and updated as needed.

CNC is a manufacturing process that uses computer-controlled machines to cut, shape, and form materials. This technology is used to create parts and components that are precise and accurate, with minimal waste and high efficiency. Boeing uses CNC extensively in the production of aircraft parts, such as the machining of complex metal and composite parts, and the shaping and forming of sheet metal parts.

The combination of CAD and CNC allows Boeing to design and manufacture products that are safe, reliable, and efficient. CAD allows the company to create detailed and accurate designs, while CNC enables them to quickly and efficiently produce parts and components that meet or exceed their specifications. This also allows them to test and validate the design by simulating the manufacturing process before actually producing it, which helps to identify potential issues and make necessary adjustments.

HOW DO WE UTILIZE CAD AND CNC?

Like Boeing engineers, we also use CAD when designing our robot. This has helped us create many multiple robot designs without physically building it. This has helped save us a lot of money. Another aspect of CAD is how easy it is to edit. If we were to design and build without CAD, we would have run into many issues that we could not have anticipated. One such problem is fitment of parts. Since CAD parts are measured to the exact specifications of their real-world counterparts, if a piece is not able to fit virtually, it won't be able to fit in the real-world.

Figure 7: Render of the CAD model of our current robot design.

Additionally, using a CNC has also improved the precision and accuracy of the parts we create. This has helped to ensure that the robot is built to exact specifications and that all the parts fit together perfectly. The use of CNC has also allowed us to create more complex and intricate parts that would have been difficult or impossible to create by hand.

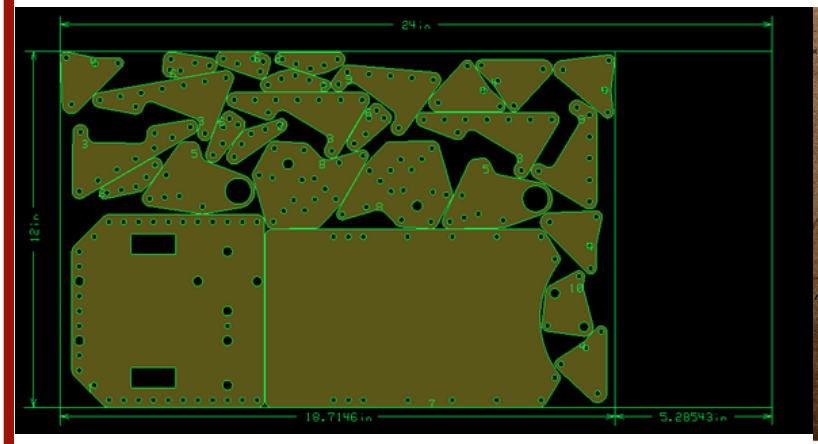


Figure 8: Image showing the CAD sketch of our Lexan fitting within the 12 by 24 inch requirement.

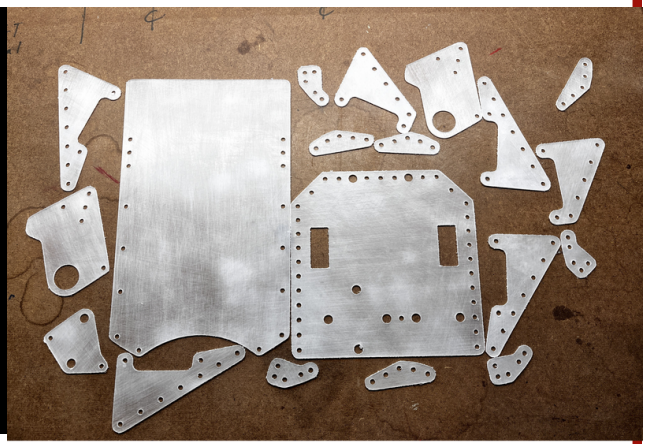


Figure 9: Image of the Lexan pieces cut out using CNC manufacturing.

LOOKING TO THE FUTURE

Participation in VEX Robotics can help in future careers by providing students with hands-on experience in science, technology, engineering, and mathematics (STEM) fields. This experience can help them develop a wide range of skills that are valued by employers in many industries.

One of the key benefits of participating in VEX Robotics is that it allows students to gain hands-on experience in the design, construction, and programming of robots. This can help them develop problem-solving, critical thinking, and technical skills that are highly valued in many STEM fields. Additionally, students learn about the engineering process and how to work in teams, which helps them develop teamwork and communication skills.

Additionally, participating in VEX Robotics can also provide students with opportunities to develop leadership skills by taking on leadership roles within the team, such as team captain, project manager or mentor. These skills are incredibly valuable in and out of STEM related fields.

WORKS CITED

737 MAX - Design Process and People. (n.d.). https://www.boeing.com/commercial/737max/design-process-and-people.page

Boeing Images - 737-700 Interior Construction. (n.d.). https://secure.boeingimages.com/archive/737-700-Interior-Construction-2F3XC5WEY9Q.html

Boeing’s new South Carolina facility moves jobs out of Washington. (n.d.). THE BUSINESS JOURNALS. Retrieved January 12, 2023, from https://www.bizjournals.com/seattle/blog/2014/09/boeings-new-south-carolina-facility-moves-jobs-out.html

Innovation. (n.d.-a). https://www.boeing.com/innovation/

Boeing on track to open new R&D center, now recruiting . (n.d.). https://pulsenews.co.kr/?year=2018