Crystal Zhang
Team #7833B

**Aerospace Engineering Process and How our Team can Relate to it**

The STEM career that I chose for this challenge is aerospace engineering. Aerospace engineers are engineers who design, develop, test, and produce aircrafts, spacecrafts, and systems and equipment to be used in those aircrafts/spacecrafts. We chose aerospace engineering because it seemed like a very interesting and dynamic career. It is also a career that is similar to VEX robotics since robotics has been used in aerospace engineering for many years.

[This image shows an aerospace engineer working on an aircraft.]
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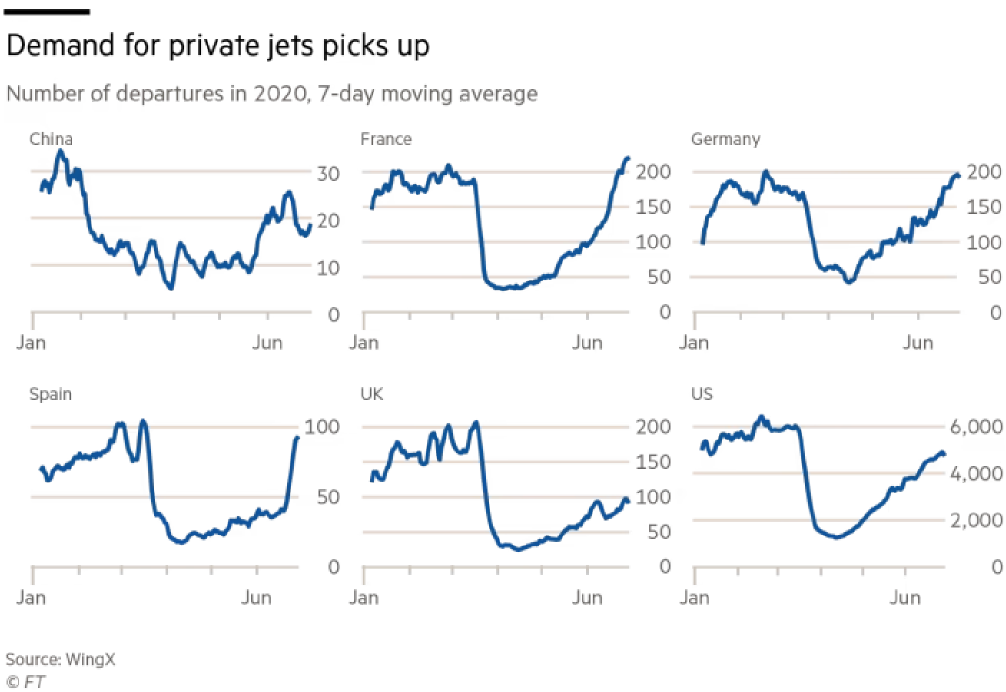
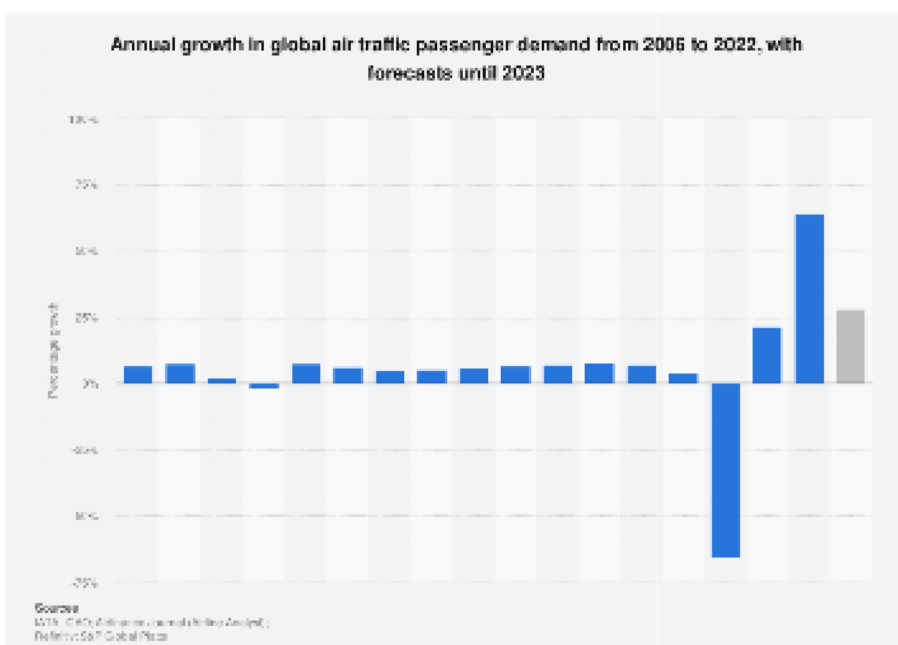
To learn about aerospace engineering, we used an article written by a student at PennState College of Engineering titled "What is Aerospace Engineering?" To learn about the aerospace design process, we used an article written by OneMonRoe Aerospace titled "The Three Stages of Aircraft Design" and an article written by Yuvraj Domun titled "Aircraft Design Process Overview."

According to OneMonroe Aerospace, "Whether it's a small single-engine husky or a massive Airbus A300-600ST, aircrafts are designed in a three-stage process." These three stages are the Conceptual Design stage, the Preliminary Design stage, and the Detail Design stage. But before these three stages, the problem, or demand, must be identified. According to an article titled "Aircraft Design Process Overview" written by Yuvraj Domun, examples of these demands include a growing demand for private jets, or A320's. After the key requirements and criteria of the new product are determined, then the next step is to "determine how realistic it is to create this product through a feasibility analysis."

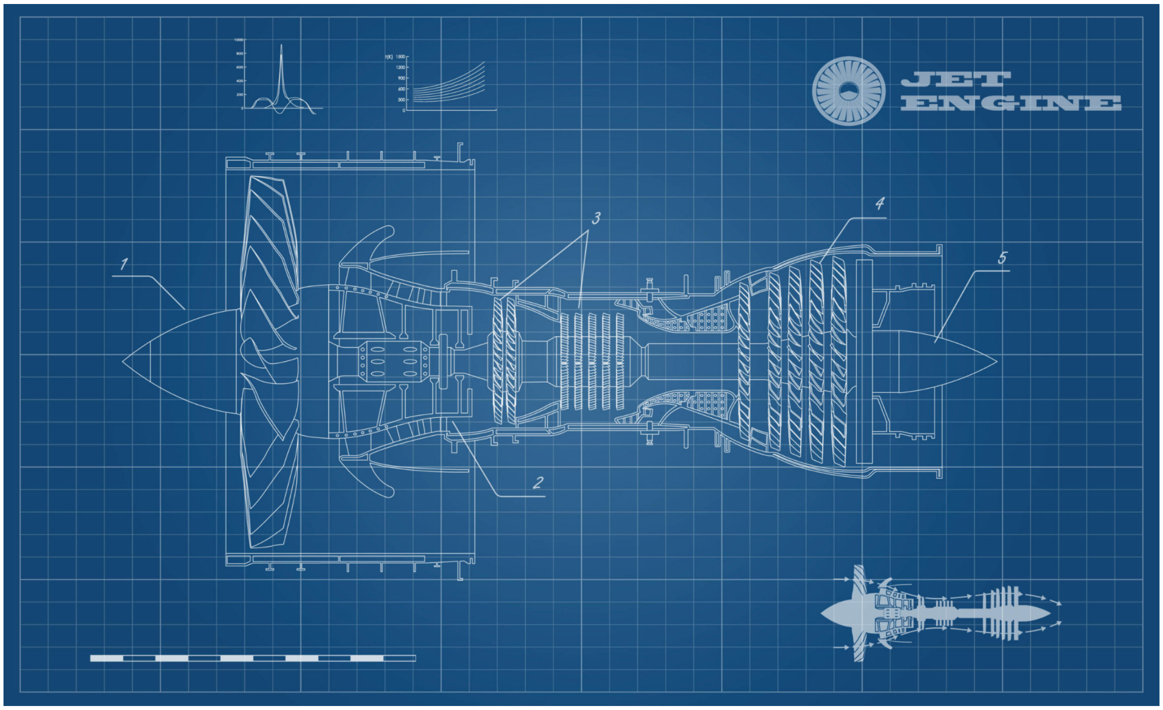



[This image shows graphs that show that demand for private jets have increased.]
Credit: WingX



[This image shows the growth in demand for traveling by air until 2023.] Credit: Statista

Next, in the Conceptual Design stage, aerospace engineers identify the constraints, which are limits or restrictions. Examples of constraints may be budget, time, shape, wing location, engine size, strength, and many more. They will also brainstorm ideas for the aircraft by creating rough sketches that follow all the aircraft's constraints.




[This image shows a blueprint made by aerospace engineers.]
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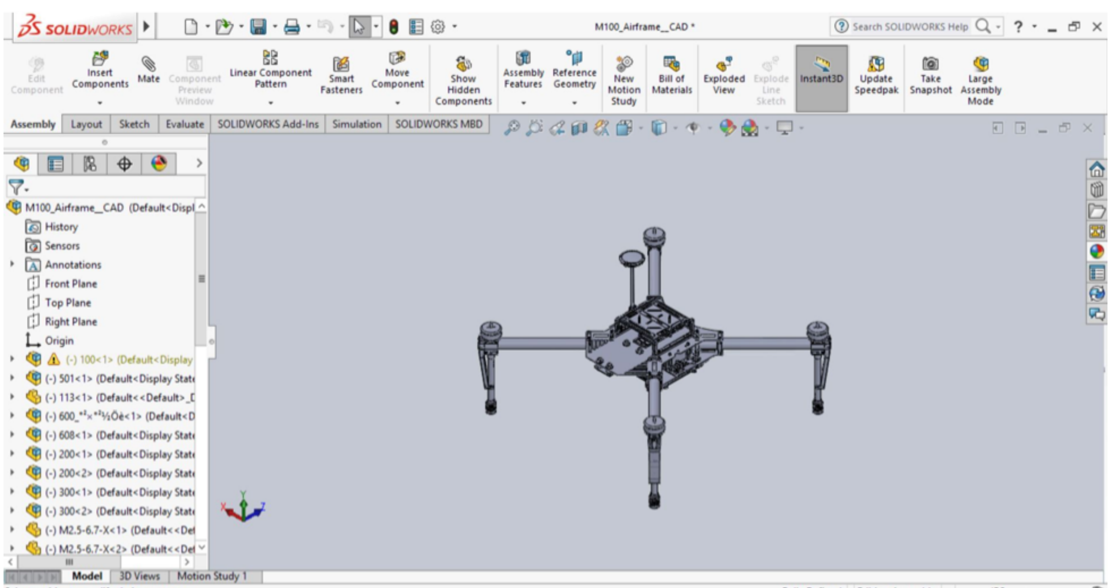

[This image shows an online blueprint made by aerospace engineers] Credit: Purdue University

The second stage is the Preliminary Design stage. In this stage, engineers conduct testing on parts of the aircraft  such as wind tunnels, which are large tubes with moving air inside, used to show researchers how an aircraft will fly, or calculate fluid dynamics, which are "the calculation of various fluid properties, such as flow, velocity, pressure, density, and temperature…" according to Toppr. Other calculations that will be performed are structural analyses and fluid flow. calculations. According to SkyCiv Engineering, structural analysis is when engineers calculate the impact of loads and internal forces on the aircraft, and fluid flow is "the motion of a fluid subjected to unbalanced forces," as stated by BYJU'S.  During this stage, aerospace engineers will also look for defects or flaws and fix them before moving on to the next stage. Basically, in this stage, engineers calculate the elements that the aircraft uses to fly.

The final stage of the process is the Detail Design stage. During this stage, aerospace engineers use their existing designs and knowledge to construct the actual aircraft. They use the aerodynamic, structural, control, and performance aspects that were already built and tested before this stage, and turn these designs into an actual working aircraft. After the aircraft is built, flight simulations are used to test the aircraft design and ensure it functions properly and as it's intended to.

[This image shows an aerospace engineer working on putting the whole aircraft together.]
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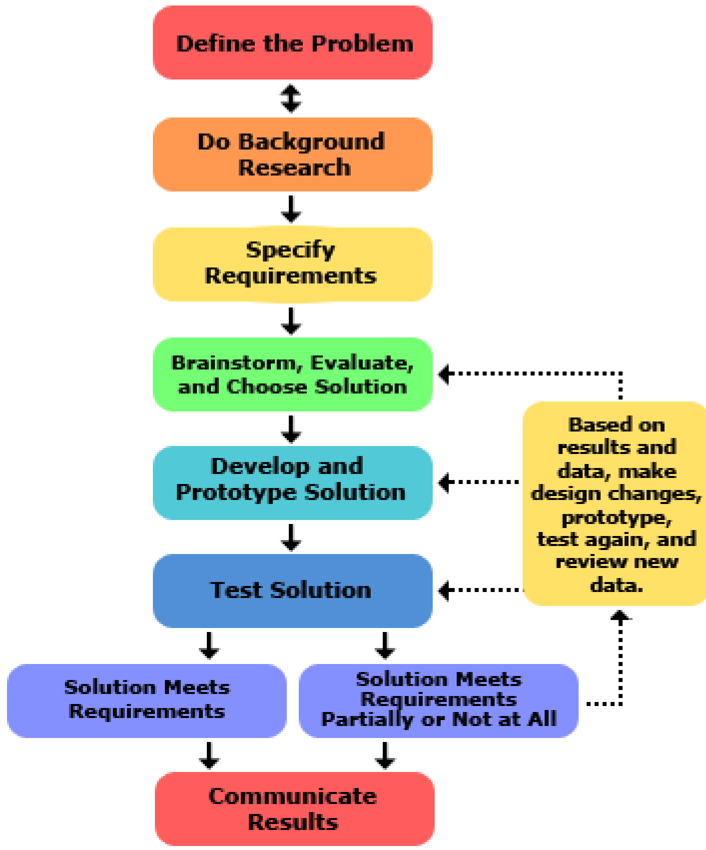
The professional approach to the engineering process aerospace engineers use matches and differs from the approach used by our team. It is different from our team because we use more than three steps/stages to build our robot, while aerospace engineers use three stages to build an aircraft. However, the general process is similar. The engineer process shown below is the one that our team uses.




Credit: ScienceBuddies

In the first step, define, it is similar to aerospace engineering because engineers must first define their problem, or find what they want to build. We would find out what the issue with our robot is, or find what kind of robot we want to build.

In the second step, to do background research, we would research what solutions have worked for other people and how we can optimize their design. Aerospace engineers might research solutions that have worked for other aircrafts in the past and how they can incorporate that solution into their design. This is similar to the Conceptual Design Stage.

In the third step, specify requirements, we would figure out what our robot needs to do and its constraints. For example, we would say that our robot needs to be able to drive, intake and outtake blocks, drop blocks into the goals, and partial/fully park. Its constraints would be its height, width, and length, and other constraints mentioned in the game manual. Aerospace engineers would identify their constraints and what their aircraft has to do. This is similar to the Conceptual Design Stage.

In the fourth step, brainstorm, evaluate, and choose solution, our team would brainstorm multiple design solutions for our robot, evaluate it, and choose the best design solution. Aerospace engineers would choose the best design solution for their aircraft.

In the fifth step, develop and prototype a solution, our team would build our robot and prototype it. This is similar to the Detail Design stage. Our team does not do anything similar to the Preliminary Design stage aerospace engineers use, as we don't really have anything to calculate.

In the sixth step, test our solution, we test our robot, make sure it meets all the constraints, and can successfully do the tasks required to get a high score in the teamwork, skills, and autonomous challenges. This is similar to the flight simulations aerospace engineers use in the Detail Design Stage, where they test their aircraft to make sure it flies properly and everything. If the solution successfully works, our team will start practicing driving with it and program it for autonomous skills. If our design isn't sturdy enough, doesn't work, or can score very little points, depending on how much time we have before a competition, we will rebuild it to fix these issues, and go through the "brainstorm, evaluate, and choose solution," "develop and prototype a solution," and "test our solution" stages again, and repeat if our robot isn't good enough. If aerospace engineers encounter a problem with their aircraft, they will fix the issue, just like we would with our robot.

Finally, the last step is to communicate our results. This whole process would be written down in our engineer notebooks, and some of it would be written down in our personal notebooks. Aerospace engineers might write it down as well, and document it.

The engineer process our team uses is similar to the engineer process aerospace engineers use because they use the same basic steps: Define the problem, do background research, specify requirements, brainstorm and choose the best solution, develop and prototype a solution, test our solution, and finally, communicate results. The aerospace engineering process differs from the one used by our team because their engineering process is split into 3 stages, and ours is split into multiple steps. One of their three stages is the Preliminary Design stage, which completely differs from the steps we use because there are not really any calculations that have to be done other than, for example, the height, length, or width of a part of our robot or something similar to that, before we can start building the robot. Unlike us, calculations of certain elements must be made before aerospace engineers can build their robot.

VEX robotics has prepared everyone on my team and I for a future career. VEX robotics teaches us teamwork, critical thinking, creativity, and innovation skills that can be applied to pretty much every future career, even if it isn't a career in engineering. Personally, I feel that spending two years on a robotics team has increased my interest in robotics, engineering, and programming, and, unlike before, I am starting to consider a career in a field of engineering or computer science when I am older. Furthermore, I have developed a more positive attitude towards working on a team, unlike before, when I did not like teamwork activities and felt that I could do everything better myself, and that everyone on the team just made things worse. Now, I understand that while not everything goes my way, being on a team is helpful because multiple people can share different ideas that I might not have had, I can get help from my teammates when I need it, and that the work can be divided so I’m not doing everything by myself.