Career readiness Online Challenge:

The sky's the limit!

(999 content words, 160 words for title page, credits, and image captions)

Team number: 20785X

Location: Queen Elizabeth's School, Barnet (London)

Author: Giuseppe Mangiavacchi

British Airways Mach 2 (approximately 2,200 km/h) commercial jet Concorde

Why aeronautical engineering?

The STEM career of aeronautics has interested me greatly from a young age, and indeed my whole team shares a similar interest in this profession. From attending air shows and building model planes to even taking flying lessons to earn my Private Pilot's Licence, aeronautical engineering has always been an aspiration of mine. With my love for STEM, my newfound passion for coding and my allurement to the flourishing field of aviation, I thought that exploring how the design process can be used in this sector would be the perfect opportunity to further my knowledge in this career.

Italian air force Macchi C200 Saetta (left) and Aermacchi MB-339 (right) plane models

RAF Red Arrows at Farnborough 2014 air show

Aeronautical engineers work in designing planes that numerous people use for travel/ entertainment, and are responsible for some incredible feats in mankind. Hence, I have dedicated my submission to learning about how aeronautical engineers identify and solve modern problems.

The Design Process

The design process is key to creating the 'perfect' model. It can be useful in any STEM job, as key goals are set with increased efficiency and teamwork.

To research the design process used by aeronautical engineers, I used numerous sources. Firstly, online research was conducted, and I used them to understand the stages required to produce a functioning aircraft. Secondly, I asked my father, who worked in the Italian Air Force, meaning he was well acquainted with the lengthy design process. I even had the honour of interviewing the commander of Italy's most important airfield (Ghedi): *Colonel Giacomo Lacaita*, who furthered my knowledge.

After my intriguing conversation with the Colonel and my father (and after learning about Boeing's evolved design process), I had a solid understanding of the various steps aeronautical engineers have to take when designing a plane. There are 3 principal stages: discover, design, improve.

The discover stage involves identifying problems and establishing a framework for the project. Engineers focus on 3 aspects:

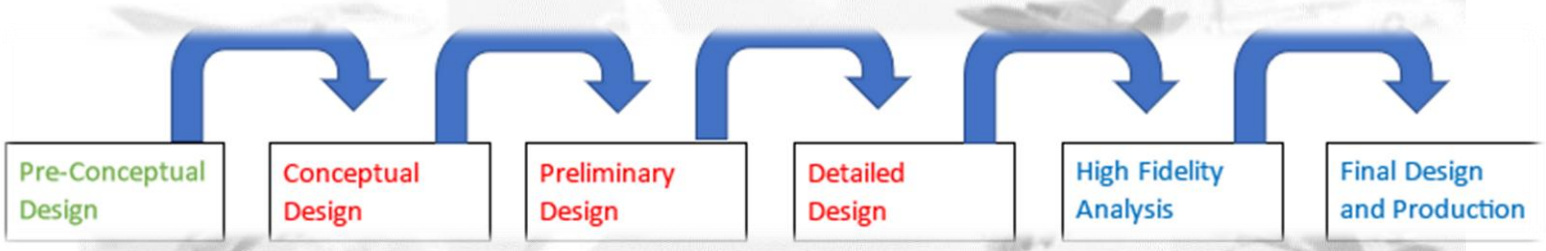
- **Success criteria:** before designing the plane, aeronautical engineers must understand the requirements. Whether it be a multirole fighter or a commercial aircraft, the jet cannot be made without understanding the specification
- **Background research:** whenever a problem is identified, initial research takes place, which is used to formulate early ideas regarding how to overcome the challenge
- **Diverse group:** *Colonel Giacomo Lacaita* highlighted the importance of having a team comprised of people with different backgrounds and different perspectives. He stated that it "provides a completely unique viewpoint to the aircraft design" making the 'conceptual design' stage much faster. For example, a mixed team that has created incredible aircrafts is with the 'Eurofighter Typhoon' (countries such as Italy, UK, Spain, Germany, Austria etc. contributed), or more recently with the 6th generation 'Tempest' (Italian company Leonardo is working alongside MBDA UK, BAE Systems and Rolls-Royce)

The next stage is the design stage. Producing an aircraft that fits the specification requires in-depth design planning and coming up with solutions to the problems that have been identified. Aeronautical engineers focus on:

- **Design reinvention:** in the conceptual design stage, rough sketches and designs are constantly created and tweaked. Designers seek to create a design that meets requirements, including aerodynamics and thrust: weight ratio, as well as determining fundamental aspects such as the shape of the fuselage, ailerons, rudder, and elevator
- **Narrowing down the design:** at this point, many designs would have been opted out of production due to high expenses/other reasons. Final calculations and simulations (potentially on CAD) are carried out to help tweak the aircraft model to fit inside design parameters
- **Preparing for production:** in the detailed design stage, engineers must turn the chosen design into a prototype of what the end product may look like. This includes flight simulations to test the plane functions

The final stage is the improve stage, where the team test the prototype made in the previous stage and improve it before production. They focus on:

- **Testing:** the prototype goes through high fidelity analysis, meaning it operates almost exactly like the final plane will. It may go through test flights to identify any limitations and correct them, to ensure the plane is ready for the production stage

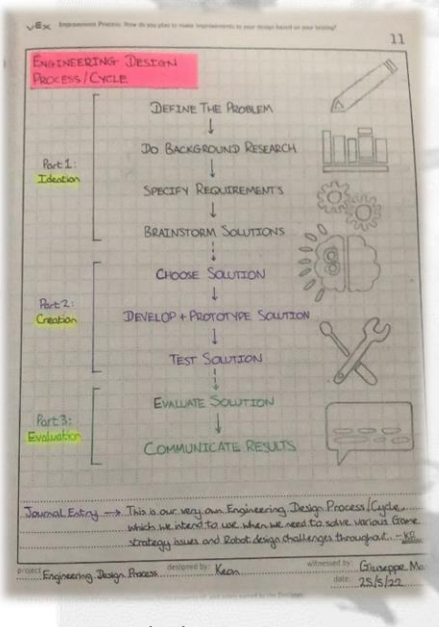


Design process I created on the Zoom call with the help of *Giacomo Lacaita*

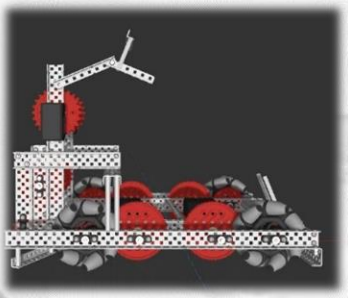
The process used by Boeing to design and develop and airplane

Our Design Process

Our approach to designing robots doesn't actually differ excessively from the professional's approach. As seen in the picture of the engineering design process our team uses (left) we start initially by 'defining the problem' and researching ways around them. After that, our team brainstorms initial designs/ solutions, using a 'success criteria' (Part 1).



In Part 2, we begin by choosing a final solution that fulfils our success criteria, and then we immediately design our robot on CAD (left), in order to visualise how our robot will look. The final section is about building and improving the design. Up until this stage, our design process is very similar to that used by professionals in the field of avionics.



However, our 'Part 3' differs largely. Our team communicates its results with other teams within our school to help everyone improve. Of course aeronautical engineers rarely present their airplane design to other countries, as there is a great deal of competition between air forces.

How has VEX benefitted 20785X?

Occasionally, students complain saying "How will learning this benefit me in real life?". However thanks to VEX, my whole team has been able to learn countless life skills that we can apply in any career. We have learnt crucial skills such as teamwork, problem-solving and time management. Instead of textbook-based learning, we learn to apply our skills in practical ways. We build on our knowledge of building and programming (including C++ and Python) while simultaneously having fun! Nevertheless, perhaps the most important thing

to takeaway is resilience, and to never give up. In general, VEX has played a pivotal role in helping us develop career skills that will stick with us forever. We've discovered the importance of planning, learning to handle disappointments, and have all learnt how to be team players. With so many children benefitting from VEX, I really do believe that **the sky's the limit!**

A team picture after we won Teamwork and Excellence in our very first competition in VRC: all thanks to the design process!

(Team members from left to right: Giuseppe, Keon, Kayilai, Shuban, Timi, Danyal, Mukunth)

Credits

1) Text sources:
   - https://www.researchgate.net/figure/Overall-Aircraft-Design-Process_fig1_269202071
   - https://monroeaerospace.com/blog/the-three-stages-of-aircraft-design/
   - https://www.engineeringclicks.com/aircraft-design-process/
   - https://www.airbus.com/en/products-services/commercial-aircraft/the-life-cycle-of-an-aircraft/design

2) Image/ background sources:
   - https://en.wikipedia.org/wiki/Concorde
   - https://www.boeing.com/commercial/737max/design-process-and-people.page
   - https://en.wikipedia.org/wiki/Supermarine_Spitfire
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