Evening Standard
FUTURE LONDON

Find out how STEM is changing the world — and how you can too

WELCOME to the Evening Standard's new Future London STEM Project — a series for young people (and interested older people) that takes a fresh look at science, technology, engineering and maths (STEM) and considers the amazing impact they make on the world. We know 2020 has been a really strange year when it comes to learning. During lockdown, lots of young people struggled to keep up with their classroom work from home. Now everyone gets to see their friends and teachers again, but there's a lot of catching up to do. It can all feel a bit overwhelming.

So we decided to launch the STEM Project to celebrate science, technology, engineering and maths, and understand more about how they are changing the world — and how you can be part of that change in the future.

Working with universities and learning organisations, we're setting a series of STEM challenges which ask you to think about how you might solve a real-life problem. Our first challenge is about aeroplanes and how they are designed to fly. By testing lots of paper planes, we're challenging you to find the one that flies the furthest.

We've asked aeronautical engineer Hania and engineering student Tatjana to give us some tips and consider how they would approach the task. They also explain why engineers use testing to improve their designs. Hania has also answered some questions about what she does in her job as a systems engineer, to give you an idea of what it might be like if you designed actual planes for a living (not just ones made of paper!).

F-16 Fighting Falcon: This plane inspired Hania to become an engineer

Hania is just one of the inspiring people who work in STEM who will be talking to us as part of this series. We'll be hearing from professors who run space missions, computer engineers who use their maths to do magic, and biomedical engineers making our bodies work better.

We hope you'll get involved with the challenges and enjoy meeting the people who are building the future. If you want to share your challenge results we'd love to hear from you: email us at **stem.challenge@standard.co.uk**

To find out more about aeronautical engineers and to design our paper plane challenge, we collaborated with Stemettes, an award-winning organisation that inspires and supports young women into STEM careers. If you enjoy this challenge, you might like to take part in their half-term Explore events where they bring together young women, nonbinary young people and people from across the STEM industry, for networking, inspiration and learning. Find out more by heading to **stemettes.org/explore**.

Like Stemettes, we believe that science, technology, engineering and maths are open to everyone. We hope our challenges encourage you to think the same. Find more information, at **standard.co.uk/futurelondon/stem**

> *Like Stemettes, we believe that science, technology, engineering and maths are open to everyone*

MY LIFE IN STEM: HANIA MOHIUDDIN, AEROSPACE SYSTEMS ENGINEER

HANIA Mohiuddin, 32, is an aerospace systems engineer working for Leonardo, an aerospace, defence and security company. The aerospace industry encompasses everything from civilian and military planes and helicopters, to drones and vehicles built for space, such as rockets and satellites.

Systems engineers like Hania usually work in teams designing and testing the mechanical, electrical and computer systems that provide control, guidance, propulsion and other things essential for the operation of aircraft and other aerospace vehicles.

After growing up in Pakistan, Hania studied for an aerospace engineering degree at Sheffield University specialising in avionics, and then a masters degree at Cranfield University. She is chair of the British Human Powered Flying Club, a STEM Ambassador and a member of the Royal Aeronautics Society and the International Council on Systems Engineering.

How did you become interested in aerospace engineering?

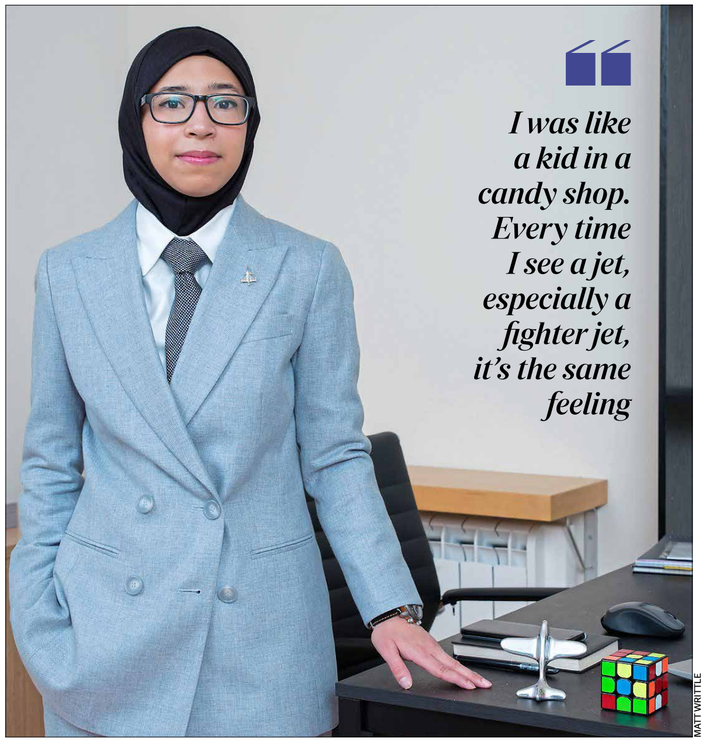
"I caught the aviation bug in my early teens ... I saw a documentary about aircraft and one of those aircraft was an F-16 Fighting Falcon. A few days later I had a dream that an F16 landed on my house and I got into the aircraft and I flew off. It was such a vivid and exciting dream: that I was sitting in this flying machine, and felt so curious about how it was flying so fast, and all the sound. Since then I've had that curiosity, wanting to learn more and more about the different systems in an aircraft."

What did you do next?

"I read a lot of books, researched on the internet, and looked at pictures of aircraft. I remember drawing the F-16 so many times that I could draw it from memory. I just tried to learn about aircraft and how I could become an aerospace engineer. I also used to make paper aeroplanes, and build aircraft models from balsa wood. There's no better way to learn than to make things."

What subjects did you study at school in Pakistan?

"Maths, physics, chemistry and biology. I knew even at that time that I needed to be good at maths and physics to proceed. I also did a pre-engineering [qualification] that's equivalent to GCSEs or A-levels in the UK."



MATT WRITTLE

> *I was like a kid in a candy shop. Every time I see a jet, especially a fighter jet, it's the same feeling*

Were there any parts of your degree course that you found difficult?

"One of the most challenging things I found was [computer] programming and coding. The way I dealt with it was just never giving up, I kept studying even after I finished university and I kept practising it in my spare time."

How did you get involved with restoring a vintage fighter jet when you were at Cranfield University?

"There used to be an RAF base at Cranfield during the Second World War, and it has a really rich history in aerospace and aviation. There's a project based there to restore a Lightning [a fighter jet in service with the RAF from the Sixties to the Eighties]. I asked if I could get involved and did some on the restoration of that aircraft. I got the opportunity to crawl inside it and look around, which was a bizarre but equally epic experience. I was like a kid in a candy shop. Every time I see a jet, and especially fighter jets, it's the same feeling."

Exciting projects: Hania Mohiuddin says she has been curious about aircraft since her early teens and used to practice making planes from paper or balsa wood

Avionics, broadly speaking, is about the electronic systems used to control and fly an aircraft. Why did you choose to specialise in this aspect of aerospace engineering?

"Avionics is not just the study of wires and circuitry. It includes, for example, the LCD screens used by the pilots in the cockpit, and the motors and servo-motors [an essential component in controlling an aircraft].

"The reason I chose this specialism is I have always had an interest in mechatronics, even before I knew it was called mechatronics! Mechatronic engineering is the electrical and mechanical systems combined, and how to control those systems. Mechatronics and avionics are interlinked."

Tell us about your first aerospace job, as a systems engineer for the Martin-Baker aircraft company.

"One of the reasons I chose to work at Martin-Baker was because their work saves the lives of pilots. They make ejector seats for fighter jets and crash-resistant seats for other military planes and helicopters.

"They do physical and computer simulations [to test the ejector seats]. For physical tests they mostly use a static ground test set-up, so you strap crash-test dummies into the testing seat and you eject them remotely. They also have a site in Ireland where they do high-speed tests on a rocket sled.

It's pretty cool stuff!"

What are your top tips for anyone considering aerospace engineering?

"It's not all about just going to lectures and getting good marks. You need to get out there and get involved. In the UK the Institute of Engineering and Technology, the Institute of Mechanical Engineers, and the Royal Aeronautical Society will help you throughout your career — even if you are still at school or university. The other bit of advice I would give is to build things. Just build aircraft, it doesn't matter if they're perfect or not. You may not appreciate them at the time ... but when you get into your professional life, you will see a clear difference between someone who has built things with their hands and learned from their mistakes, and someone who has not."

What most inspires you about your current job?

"The opportunity to work on innovative once-in-a-lifetime aerospace engineering projects excites me very much."

Jason Deans

THE CHALLENGE

Make the paper plane that flies the furthest or for the longest time. You should test your plane and modify it to improve its performance.

You will need
- A4 paper
- Ruler — this will help you press down the folds in your paper
- Card, Blu-Tack, paper clips or small coins — these can add extra weight to your plane and are useful for making modifications
- Tape measure/stopwatch — to measure your plane's performance
- Internet access — to research the best paper plane designs

MAKING a plane by folding a sheet of paper so it has wings and a body seems easy but it's a good challenge if you are interested in aerospace engineering because you need to consider the four principles of flight used in the design of real aircraft:

- **Lift —** the movement of air over and under the wings, keeping the plane in flight
- **Weight (or gravity) —** this is what pulls your plane towards the ground
- **Thrust —** the energy you apply when you throw the plane
- **Drag —** friction with the air that slows the plane's forward momentum

By altering lift, weight, thrust and drag, you can change and improve your paper plane's performance. You might like to experiment with different thicknesses of paper to alter the weight of your paper plane, suggests Hania Mohiuddin, an aerospace systems engineer.

"Think about the weight and how it is distributed around the plane," she says. "It's basically akin to throwing a spear. You can add momentum to your paper aeroplane by attaching small pennies or Blu Tack to the front and see if it makes a difference.

"Experiment with different wing designs as well. If you want your paper aeroplane to go fast then a very thin, dart-like structure like a fighter jet would be best. If you want it to fly serenely through the air but [go] further and more slowly then have bigger wings like a glider."

Tatjana Mandil, who is a final year student studying aeronautics & astronautics at the University of Southampton, also has some tips:

"You want to go for a wide wing area and a forward centre of gravity," she says. "For any sort of gliding object, if you have more air under the wings, you're more likely to sustain flight.

"The easiest way of doing it is making the wings larger. Having larger wings means the plane's body is thinner so there's more weight distribution across the aircraft."

Tatjana also emphasises the importance of iterating — that means testing your plane design, making improvements and then testing the new version again. Iterating is a key problem-solving technique in all engineering disciplines.

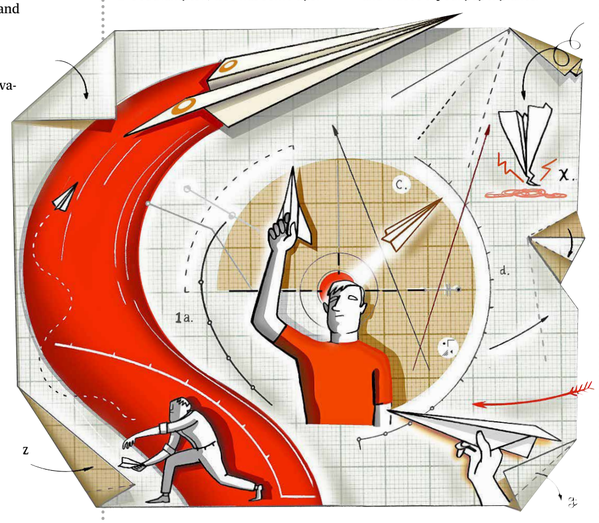
"That happens not only with designing paper aeroplanes but also in large engineering projects," she explains. "You can design something in the best way possible but you won't know how it's going to perform until you start testing. Anything that requires problem-solving usually requires some form of iteration as well.

"You can take suggestions from other people's design and tests but they may not work for your unique design so it is important that you test early so you can really understand how your design is working."

Good luck!

- *Share your challenge successes with us by emailing stem.challenge@standard.co.uk. You can include pictures and videos of your paper planes!*

ILLUSTRATION: GARRY PARSONS @ MEIKLEJOHN.CO.UK



Up and away with Sheila Scott, the first to fly a light aircraft over the North Pole

FLYING ADVENTURES

HISTORICAL STEM pioneers can also be inspiring. You might be interested in Sheila Scott, a pilot who broke more than 100 aviation records, flew round the world solo three times, and was the first person to fly over the North Pole in a light aircraft. And she did all that in planes that were shorter in length than a double decker bus!

Scott was born and raised in Worcester and trained as a nurse during the Second World War. She only took up flying in her thirties, earning her pilot's licence in 1960.

Once she had caught the bug, Scott began competing in and winning races, and breaking speed records for solo flights in light aircraft. In 1967, she set 23 world records — including fastest solo flight times between London and Cape Town and for crossing the North Atlantic.

Scott had completed her first round-the-world flight the previous year. She started and finished at London's Heathrow airport, and covered about 31,000 miles, flying for 189 hours over 34 days.

She was the first British pilot to fly solo round the world and repeated this extraordinary feat of endurance in 1969-70 in the same aircraft, a 25ft-long, single turbo-prop engine Piper Comanche named Myth Too.

She flew a slightly larger, twin-engined Piper Aztec named Mythre for her third and longest round-the-world flight in 1971, setting off from Nairobi, Kenya and flying over the North Pole to Australia, before heading west to London on a journey that took 55 days.

Scott's endeavours required incredible courage and fortitude, as well as admirable concentration, stamina and flying skill, to spend such long periods alone, dealing with adverse weather conditions and faulty equipment, sometimes nursing her battered plane to the next refuelling stop.

"People often say to me, 'Oh you must have been so alone flying hundreds of thousands of miles, often in appalling weather conditions' but when you're in the sky you don't think of things like that," Scott told The Sunday Times in 1984.

"Flying solo can be a spectacular experience — wondrous cloud formations, romantic sunsets, or cruel tendrils of black cloud, cold and eerie," she explained.

Her achievements were recognised with numerous aviation awards and Scott was given an OBE in 1968. She was the founder and first governor of the UK branch of the Ninety-Nines, an association for licensed female pilots founded by Amelia Earhart, the first woman to make a non-stop solo transatlantic flight.

Jason Deans

ANN WARD

Pioneering pilot: Sheila Scott's first solo flight round the world was in 1966

BRITISH HUMAN POWERED FLYING CLUB
IT'S FLYING — BUT YOU PROVIDE THE POWER

Get involved

Hania Mohiuddin's advice includes: get out there, get involved, build things. While studying at Sheffield University, Hania got involved with building a human powered aircraft (HPA) — where the only source of propulsion is from the pilot. A fellow student introduced her to the British Human Powered Flying Club (BHPFC), which runs competitions and challenges.

Design an aircraft

Hania and her friends quickly sketched out potential HPA designs. From these they developed and built their HPA called Volaticus (which means "winged" or "flying" in Latin). It had a 22m wing span but weighed just 24.5kg — about a third the weight of an average UK adult.

Take Off?

Hania piloted the aircraft in the BHPFC's annual Icarus Cup. (Definitely don't try flying any kind of aircraft at home without talking to an adult.) "We managed to take off, but only very briefly," Hania says. "But that was to be expected. For any new design of an HPA, it takes 10 or more years for it to be perfected as the engineering involved is very intricate."