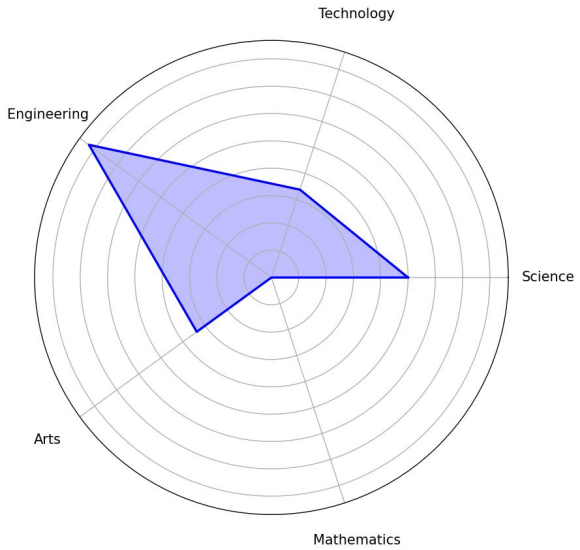
Curricular



ENGINEERS OF THE AIR: BUILDING LIKE HERTHA MARKS AYRTON

Duration	Age	Difficulty
45-50 min	13-14	Low
#EXPERIMENTATION #ENGINEERING		

DESCRIPTION

In this activity, students will build a handheld fan inspired by the studies of Hertha Marks Ayrton on airflow and ventilation. Using simple materials, they will test their design by attempting to blow out a candle from a set distance.

The project integrates mechanical engineering principles, cultural context, and gender visibility through hands-on experimentation and artistic design.

ACTIVITY OBJECTIVES

- **Apply concepts of mechanical engineering and fluid dynamics through a collaborative fan-building challenge.**
- **Understand and reflect on the scientific and social contributions of Hertha Marks Ayrton.**
- **Encourage equitable participation and leadership across genders in STEAM contexts.**
- **Integrate cultural awareness and artistic expression in the personalization of fan designs.**
- **Foster creativity and iterative problem-solving through prototype testing and redesign.**

KEY COMPETENCES (EU)

- **Numerical, scientific and engineering skills:** These are developed by applying physics principles (forces, motion, fluid dynamics) and by building the fan as a technological tool.
- **Digital and technology-based competences:** Encouraged through the search for information about Hertha Marks Ayrton and the use of online resources (videos, templates, etc.).
- **Interpersonal skills, and the ability to adopt new competences:** Students investigate, experiment, reflect, and discuss, developing self-learning abilities and critical thinking.
- **Cultural awareness and expression:** By working in groups, collaborating, debating ideas, and addressing topics such as gender equality (highlighting the role of women in engineering), and thought decorating and personalizing the fan, as well as recognizing historical figures like Hertha Marks Ayrton.
- **Entrepreneurship:** By designing their own fan, devising improvements, and proposing new applications, creativity and problem-solving are fostered.

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MATERIALS

Pencil

Ruler

Scissors

Glue

- Provided by students
- Provided by the teacher/institution
- Downloadable Elements

Colored pencils / Crayons

Five Wood depressors (11cm x 1cm)

Wire

Colored sheets

Pliers

Computer with internet connection

Screwdriver

Candle

Downloadable (click here): Fan templates

PREVIOUS PREPARATION

- Create work groups (2-3 participants)
- Download the required materials
- No installation required.

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CONTEXTUALIZATION AND ADAPTATION

In this activity, we will learn about **Hertha Marks Ayrton,** an engineer and inventor who was a pioneer in the study of airflow and ventilation, connecting to the role of women in the history of engineering.

We will build a fan, and with this fan, we will take on the challenge of blowing out a candle from a set distance, applying basic concepts of physics and fluid mechanics.

We will see how engineering surrounds us, and how inventions that may at first seem very simple — like a fan — can have multiple uses, as we will explore throughout the activity.

In order to get into the context for this activity, below we have a video about the history of the fan that we recommend watching before starting the session:

Watch video 📽 - "History of the fan"

History of the fan

Now that we've taken a look at the history of fans, let's explore how inventions that make our lives easier actually come to be.

Where do necessity, design, and creation intersect? They all come together in the focus of today's session: **engineering,** a discipline dedicated to finding smart solutions to recurring problems that need to be solved. Some of this great inventions that made our life easier could be: fans, washing machine, windshield wiper, mobile phones, calculators, etc. When you think of an engineer, what image comes to mind? Do you know any famous engineers, past or present?

Watch video 📽 - "The woman who tamed lightning | Hertha Marks Ayrton | BBC Ideas"
The woman who tamed lightning | Hertha Marks Ayrton | BBC Ideas

Classroom activity 💡
This is the perfect time for students to research this pioneer and the work she carried out throughout her life. Once they have done this, they can briefly present what most caught their attention about this woman.

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CONTEXTUALIZATION AND ADAPTATION

Note for the teacher 📝

Who was Hertha Marks Ayrton?

- She was one of the first recognized female engineers and inventors in the United Kingdom, standing out in a male-dominated field of her time.
- She was the first female member of the Institution of Electrical Engineers (1899), marking a milestone in opening professional engineering to women.
- She registered a total of 26 patents over her lifetime, many related to mechanical devices.
- She studied electric arcs (a key technology in lighting and welding) and ventilation: she conducted pioneering research on how air moves, applying this knowledge to design better ventilation systems — hence the activity we are doing today, a fan capable of blowing out a candle.
- One of her inventions was used in World War I: Her design for a mechanical ventilation fan was used in the trenches of World War I to disperse poisonous gases, saving soldiers' lives.
- She was also an activist for women's rights: she was an active advocate for women's suffrage and participated in gender equality movements.
- Hertha Marks Ayrton studied how air flows and how waves move. In this project, you are applying similar principles: using manual movement to displace air and generate enough force to extinguish a flame.

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CONTEXTUALIZATION AND ADAPTATION

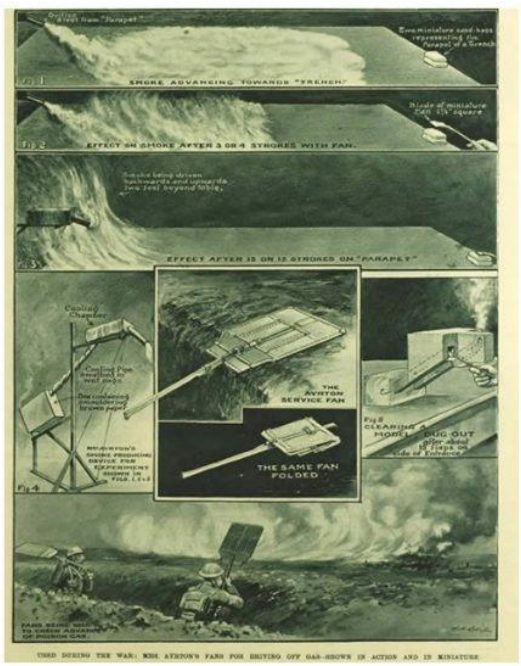
How does this relate to other things in life?

The study of airflow and the use of fans might seem simple, but these concepts are used in many important real-life situations. In **architecture**, for example, buildings are designed with special windows and ventilation systems that use natural airflow to keep rooms cool without electricity. This is especially helpful in hot climates or in eco-friendly buildings that want to reduce energy use.

In **space exploration**, engineers use fans and air circulation systems in spacecraft to make sure air moves properly. Without gravity, air doesn't move the same way as on Earth, so these systems are essential to keep astronauts safe and breathing.

Fans and fluid dynamics are also important in **everyday transportation**. In airplanes, understanding how air flows over wings helps them fly. Inside the plane, fans control temperature and airflow to keep passengers comfortable.

Even in **public health and safety**, like during World War I, Hertha Marks Ayrton's fan design was used to remove poisonous gas from trenches. Today, similar systems are used to ventilate tunnels, mines, and crowded buildings to keep air clean and people safe. In the next images you can see the prototype of her anti-gas fan.



Ayrton anti-gas fan - Hertha Marks design

So, when we build a simple fan in class, we are actually using the same principles that engineers, architects, and scientists use to solve big problems in the real world!

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CONTEXTUALIZATION AND ADAPTATION

Fans as Cultural and Historical Artifacts

Beyond their scientific and practical uses, **fans are also cultural objects** with deep roots in many societies. In **China and Japan**, fans have been used for thousands of years not only for cooling but also in traditional dance, theater, and ceremonies. They are often decorated with art and symbols that represent values, myths, or social status.

In **Spain**, the folding fan—known as the "abanico"—became a fashionable accessory, especially in the 18th and 19th centuries, and even developed its own “language” of gestures. In **Africa**, palm-leaf fans are still handmade in many regions and used in daily life, rituals, or as decorative pieces.

Classroom activity 💡 - Debate

After watching the history of fans, introducing the inventions of Hertha Marks, and looking into what uses to they have in different aspects of everyday life/technology as well as cultural importance, debate with your group:

How do you think access to technology and STEAM education varies across different countries or between genders? Do you think engineering designs are truly made for everyone? (We will get back to this topic at the section “CONCLUSION AND SHARING” while discussing how to make new prototypes of our inventions.

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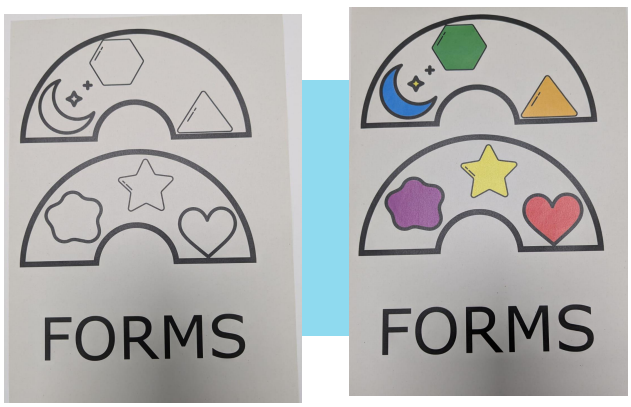
ACTIVITY

Step 1. We mark our 5 wooden sticks using a pencil and a ruler. We will make a mark on each stick, at a distance of 1 cm along the length and 0.5 cm across the width:

Step 2. Using the screwdriver, we make a hole on the marks we just made:

Step 3. We decorate the template we have chosen. There are three different templates: one that is blank, so the students can decide how to decorate the fan; another with simple geometric shapes; and another that features world-famous paintings, such as the Mona Lisa or The Scream.



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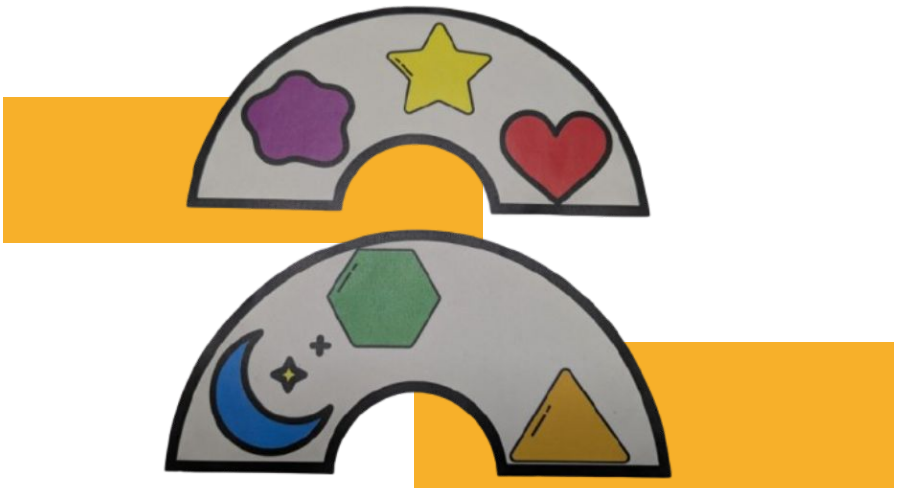
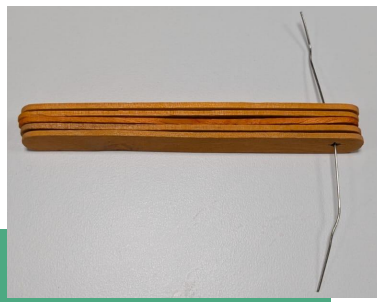
ACTIVITY

Step 4. We cut out the two semicircles, which will act as the fabric or covering of the fan.



Step 5. We thread the wire through the wooden sticks, and with the help of pliers, we bend the ends so that the sticks do not slip off.



We cut and bend the wire so that the sticks stay connected to each other just enough that they can move, allowing the fan to open and close.

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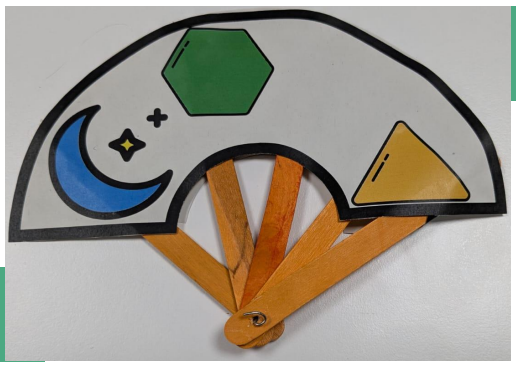
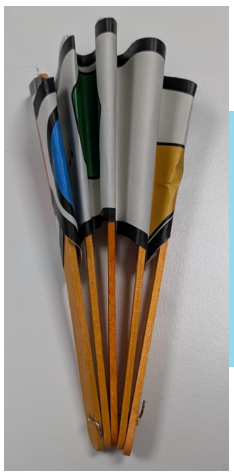
ACTIVITY

Step 6. We apply glue to the bottom part of the wooden sticks, and then we stick them as shown in the picture, attaching one of the decorated pieces we prepared earlier:

Step 7. We turn it over and repeat the same process.



Step 8. We fold the paper and the wooden sticks, just as shown below.



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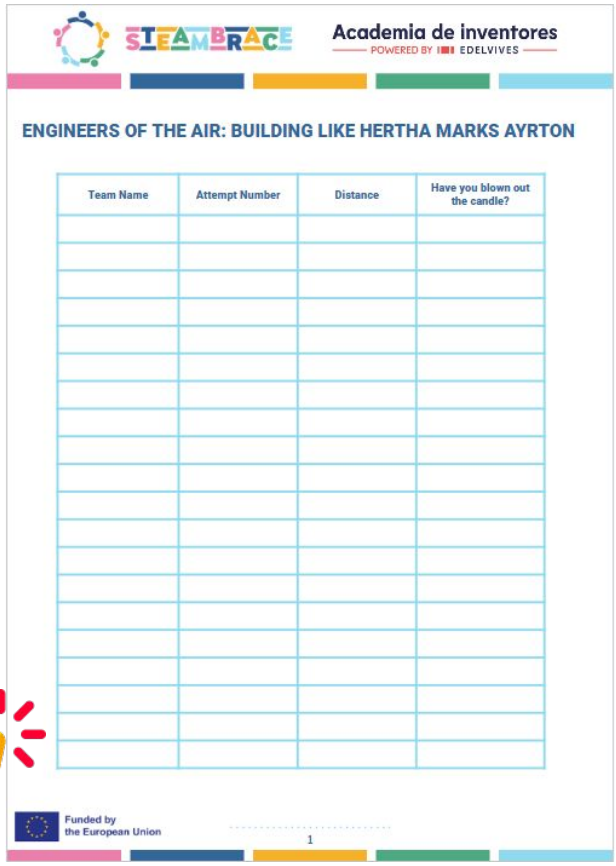
ACTIVITY

Step 9. Now we test how our fan works. From what distance can we blow out the candle using our fan?

Shall we make it a competition and see which team can blow out the candle from the farthest distance? Write down in the following list the teams, the distances, and whether you managed to blow out the candle or not, so we can create a table with all your attempts. Students will fill in a data sheet to compare fan performance.



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Team Name	Attempt Number	Distance	Have you blown out the candle?

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CONCLUSION AND SHARING

With this experiment, we have learned how air moves when we apply a force. By moving the fan, we push air forward; that air pushes the candle flame until it goes out. This phenomenon is related to Newton's laws of motion and fluid dynamics. The larger the surface area of the fan and the faster we move it, the more air we displace, and the greater the force we apply to the flame.

Hertha Marks Ayrton studied how air behaves when it moves and applied that knowledge to create fans that helped ventilate spaces and disperse dangerous gases.

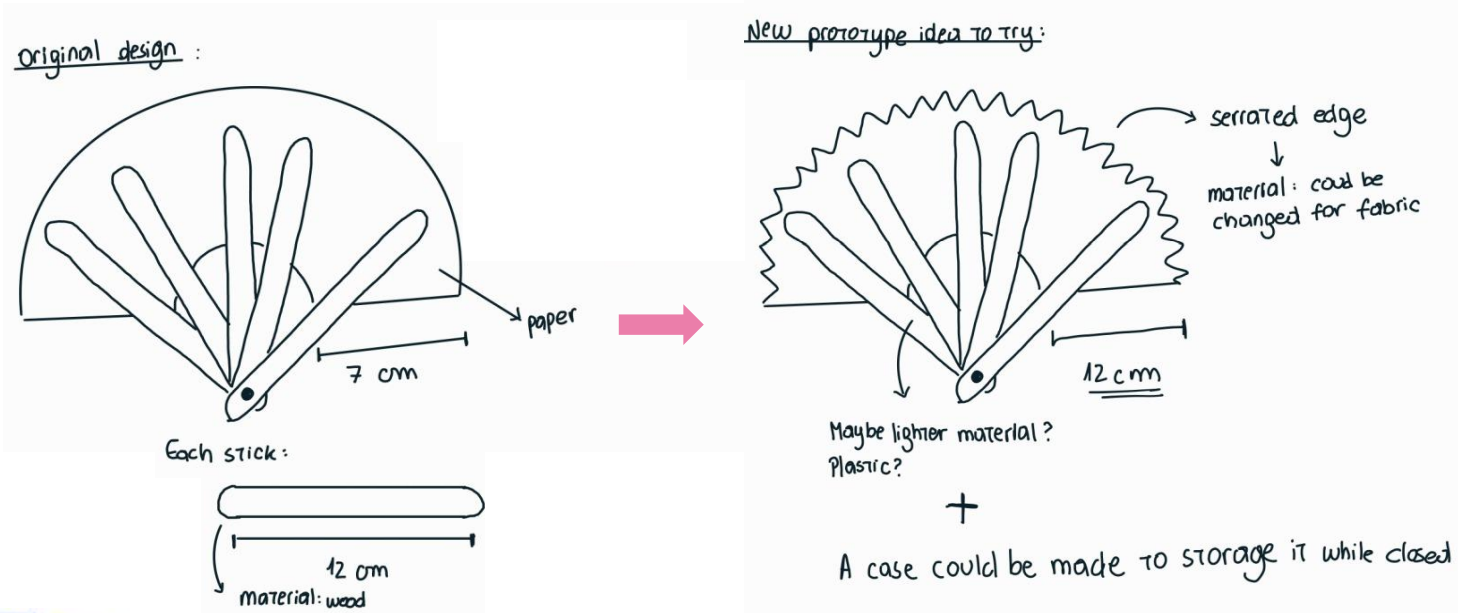
Reviewing our prototype:

- Which part of our fan do you think was the most important for it to work?
- How could we improve the design of our fan to move more air or blow out the candle from a farther distance?
- Do you think there are other everyday objects that use similar principles to our fan?
- In what real-life situations could something similar to our fan be useful?
- How might your own design reflect the different needs of people based on things like age, gender, or where they live?

At this point we encourage students to **sketch a new version of their fans** with the improvements they think could make it's performance better. We may rethink aspects such as shape and materials, this is a great opportunity to propose, to give an idea, an eco-friendly redesign of your fan. For example, you could suggest using biodegradable materials. When thinking about materials and design, it's also important to consider things like whether the materials are easy to access for most people, if they have a big impact on the environment, or if they could potentially cause problems or risks for certain groups, etc.

Expanding idea: Also each student could select one traditional fan and integrate its design language with their engineering fan structure.

An example is shown below:



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Classroom activity 💡 - "Final discussion"

"The fan of the future": In groups, think of a fan or ventilator that could solve a current problem (for example: heat in classrooms, pollution in cities, ventilating spaces without electricity). Each team explains their idea to the rest.

Here are some questions/ideas that may help guide the discussion:

- **Comparison with modern technologies:** How is our fan similar to and different from an electric fan?
- **Making women in engineering visible:** Why do you think it was difficult for Hertha Marks Ayrton to be recognized in her time? What do you think about us talking about her work today in class?

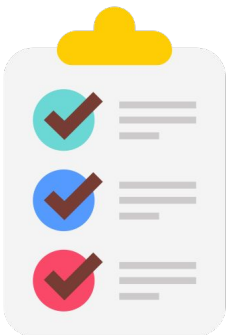
You can share the project social media if any teachers want to share with us their results.

Don't forget to take a photo of your experience and share it with us!

LinkedIn Instagram X

BIBLIOGRAPHY AND REFERENCES

More about Hertha Marks Ayrton:
https://jwa.org/encyclopedia/article/ayrton-hertha-marks



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PROJECT EVALUATION

Activity Objectives	Key Competences (EU)	Evaluation Criteria
Apply concepts of mechanical engineering and fluid dynamics through a collaborative fan-building challenge.	Numerical, scientific and engineering skills	The student applies principles of airflow and motion to build a functional fan and can explain the basic physics involved in its operation.
Understand and reflect on the scientific and social contributions of Hertha Marks Ayrton.	Cultural awareness and expression	The student demonstrates knowledge of Hertha Marks Ayrton's work and articulates her relevance to both science and gender equality.
Encourage equitable participation and leadership across genders in STEAM contexts.	Interpersonal skills and the ability to adopt new competences	The student collaborates inclusively in team tasks, takes initiative regardless of gender, and reflects critically on equality in STEAM.
Integrate cultural awareness and artistic expression in the personalization of fan designs.	Cultural awareness and expression	The student creatively decorates the fan with elements reflecting cultural or historical references, and explains their meaning.
Foster creativity and iterative problem-solving through prototype testing and redesign.	Entrepreneurship	The student improves the fan design based on testing outcomes and proposes realistic innovations considering efficiency and accessibility.

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