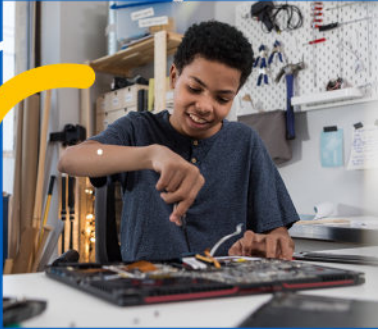


# NEXT ENGINEERS



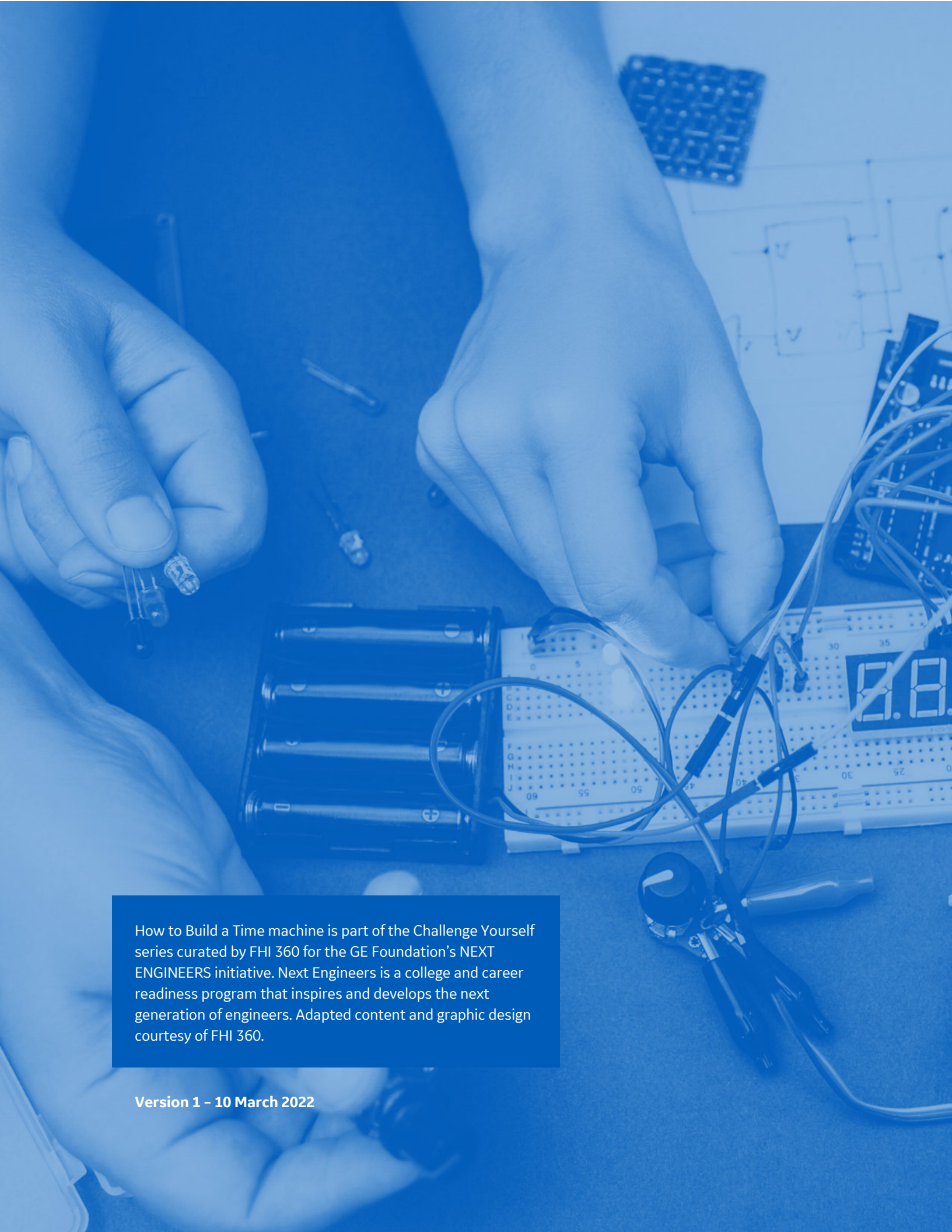
CHALLENGE YOURSELF

## The James Webb Space Telescope Part 2: How to Build a Time Machine

Aerospace Engineering



GE Foundation



How to Build a Time machine is part of the Challenge Yourself series curated by FHI 360 for the GE Foundation's NEXT ENGINEERS initiative. Next Engineers is a college and career readiness program that inspires and develops the next generation of engineers. Adapted content and graphic design courtesy of FHI 360.

**Version 1 – 10 March 2022**

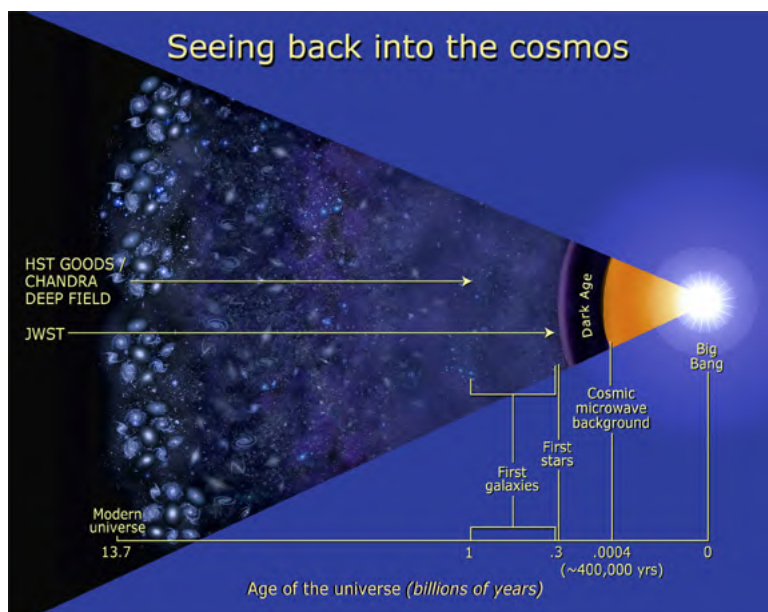




## The James Webb Space Telescope Part 2: How to Build a Time Machine

### NERD OUT

The James Webb Space Telescope is designed to see objects in space further away than any other telescope ever, thus seeing further back in time than we have ever done. Scientists hope to see back in time almost to the moment of the Big Bang, the birth of the universe. This was about 13 billion years ago when the very first stars and galaxies were born.



An illustration of how far back in time Webb will be able to see.

Image by NASA and Ann Field used under fair use

<https://www.jwst.nasa.gov/content/about/comparisonWebbVsHubble.html>

It will only be able to do this by collecting and concentrating the tiny amounts of light that come from these very distant and very dim objects. But to collect enough light to make a clear image you need an enormous 6.5 m (21 feet) wide mirror. That is over two stories high. The Hubble Space Telescope's primary mirror is only 2.4 m (7.87 ft) wide.



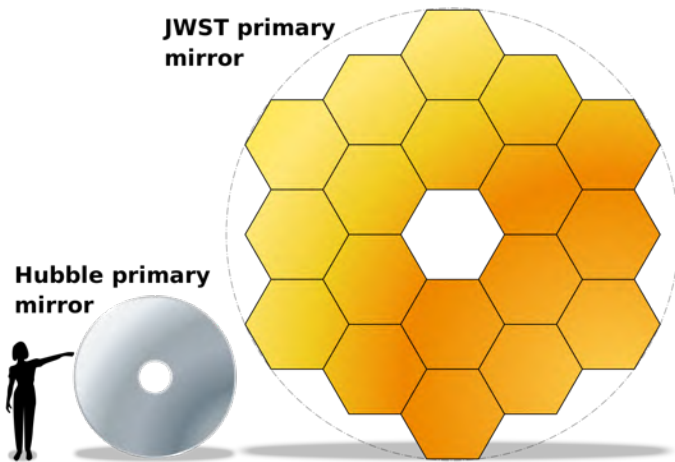
### HAVE A THINK

The James Webb primary mirror has 18 regular hexagonal segments, each 1.32 m flat to flat.



In a regular hexagon all the sides are equal in length. Can you calculate the actual surface area of the James Webb primary mirror?

HINT: The relationship between the distance flat to flat ( $f$ ) and the length of the sides ( $s$ ) of the hexagon is  $f = 1.732 \times s$ .

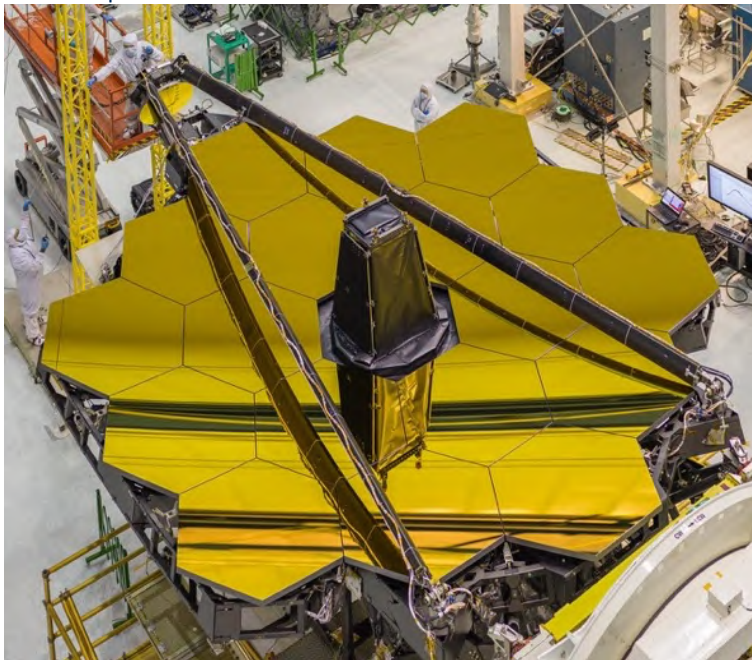


A comparison of the size of a person, the Hubble Space Telescope's mirror and the James Webb mirror.

Image by Bobarino released under a CC-BY-SA 3.0 licence

<https://commons.wikimedia.org/wiki/File:JWST-HST-primary-mirrors.svg>

Overall, the primary mirror is shaped like a large satellite dish. It is parabolic. Parabolas are very good at reflecting all the light they receive to a single spot, the focal point.

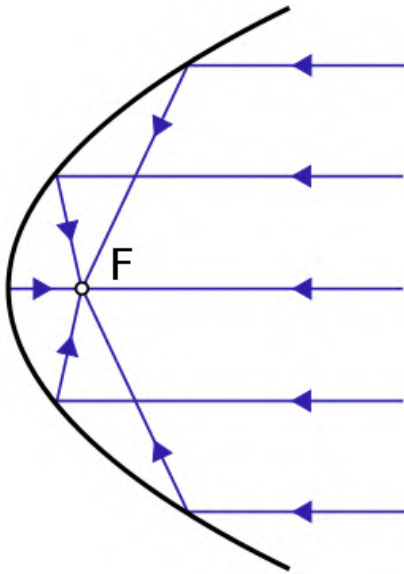


An overhead view of the James Webb Space Telescope primary mirror.

Image by NASA, Chris Gunn used under fair use

<https://webbtelescope.org/resource-gallery/articles/pagecontent/filter-articles/how-big-is-jwst>





A diagram of a parabolic reflector, reflecting light rays to the focal point, *F*.

Image by Filu released under a GNU Free Document license

[https://commons.wikimedia.org/wiki/File:Parabolic\\_mirror-diagram.svg](https://commons.wikimedia.org/wiki/File:Parabolic_mirror-diagram.svg)

Watch the path that the light will take from space to reach the telescope's light detecting instruments in the video called *James Webb Space Telescope Light Path* (0:20) (<https://www.youtube.com/watch?v=y9Z2GbFJWmo>).

Explore more at *Webb Space Telescope* (<https://webbtelescope.org>).



#### HAVE A THINK

Play with this *simulation of a parabolic reflector* (<https://www.geogebra.org/m/kcG3mHKX>) and see if you can figure out why all the light rays are reflected to the same spot, the focal point.

What other objects have you seen that are parabolic reflectors?

Find out more about parabolic reflectors by watching the video called *Parabolic Reflectors* (4:10) (<https://www.youtube.com/watch?v=i0xzAAaHrgk>).

