Engineering Process for the Psyche Mission (Part 1 & 2)

[Video 1: Introducing Psyche and the Engineering Process]

[Basic Knowledge]

Fun fact: Did you know that we've visited every planet in our solar system? Not counting Earth, there are seven other planets orbiting the Sun. With spacecraft, we've studied each one. These spacecraft send back pictures and information, or data, that help us learn more about the planets.

But did you know that there are millions of other objects in our solar system that we haven't explored yet? Many of these objects are called **asteroids**.

Asteroids are small, rocky objects in the solar system. Some of them are only as tall as a person, while others are as big as a state. Many of them can be found in the Main Asteroid Belt between Mars and Jupiter.

But there is one out of the millions that is special. Its name is "(16) Psyche". Scientists think that Psyche was the center of a planet that started to form during the creation of our solar system.

So why isn't it a planet now? One idea, or hypothesis, is that Psyche's surface was ripped off through violent collisions, exposing the core.

Because Psyche may be the leftover core of a planet, we hope to learn more about Earth's core by exploring this new kind of world. That's why NASA, Arizona State University (or ASU), and Maxar ~~Space Solutions~~ (formerly known as SSL), are working together to send a spacecraft to this asteroid.

The goal of the NASA Psyche mission is to test scientists' ideas about how the asteroid formed, what it looks like now, and what it is made of.

[Engineering Process]

So how will the spacecraft do all of this? Engineers and scientists are going to design and build tools called "instruments" to put on the spacecraft. These instruments can collect the data needed to check our hypotheses, or ideas about the asteroid.

Engineers and scientists create these instruments by following steps that help them to address problems by creating different designs and using the best one. This series of steps is sometimes known as the **engineering process**.

To understand what this process is like, let's find out what the six common steps are (though keep in mind that there are many different ways to go through these steps).

[Process Outline]

Step 1 is to "Ask."

Before we can find a solution to a problem, we have to ask what problem we're trying to solve. If we are trying to build a device, we have to know what it needs to do first. We can't design anything until we know what we will use it for!

Step 2 is to "Imagine" or "Brainstorm."

After we know what we are trying to achieve, we can try to come up with as many solutions to the problem as we can. This usually means brainstorming several designs. This could also mean using old ideas that we can apply to this new problem or situation.

Step 3 is to "Plan" or "Design"

Once we have several options, we can choose what we think is the best solution. Now it's time to actually design it. For example, in this step we might make diagrams or drawings of all the parts, how they fit together, what they are made of, and so on.

Step 4 is to "Create"

After the final design is finished, we can make it. We take the best design we made in Step 3 and follow it to build our solution to the problem.

Step 5 is to "Test."

The process is not done after we have finished making our device! We have to test it carefully to make sure it really works.

It's important to test the device in conditions that are as close as possible to the conditions it has been designed for. Otherwise, we won't know for sure if our solution has really worked.

Real engineers and scientists who are trying to create things to use in space need to try to recreate the conditions of space as closely as possible here on Earth. Testing in space-like conditions is important because conditions in space are much more extreme compared to conditions on Earth.

Step 6 is to “Adjust.”

If the tests all go well, then we are done. But if there are any problems, we have to use what we learned from the tests to figure out what is not working. Then we have to come up with ways to change the design to fix the problems.

After we have come up with these solutions to these new problems, we can adjust the design, make the device again if necessary, and test it again until we get it right!

That’s the engineering process!

There are many different ways to go through this process. Each step can lead to any of the other steps, depending on what is needed to find problems and create solutions. And when we reach the end, the process can start all over!

In the next video, we will see how the engineering process can be applied to make an instrument for the NASA Psyche mission.

[End Video 1]

[Video 2: Psyche’s Multispectral Imager]

[Psyche’s Multispectral Imager]

In the previous video, we learned about the steps of the engineering process. In this video, we’ll see how this process plays out by looking at how a science instrument for the NASA Psyche mission is made.

Step 1: ASK.

One question scientists have about the asteroid Psyche is “*What does it look like now?*” To answer this question, they need to see the asteroid’s surface well enough to spot features like craters, cliffs, valleys, and plains. They also need to find out how high these features are compared to one another.

Another question scientists have is “*What is Psyche made of*?” This means they need a tool that can identify the different elements present in the asteroid.

Based on what they want to find out about Psyche, they know they need a camera (also called an “imager”) that can give us high-quality pictures of the asteroid’s surface as well as information about what it’s made of.

But what if something happens to the camera? What if it breaks and it’s unable to collect the information, or data, it needs to? To avoid a situation like this, the design will include a backup camera. (So they need two cameras in total.)

Once they know everything that is needed for a particular instrument, the engineers can start figuring out how to build it.

Step 2: IMAGINE/BRAINSTORM.

Remember that, in this step, one method is to look at old designs to see what can be used in this new situation. It takes a lot of time and testing to create entirely new instruments, so often the best way is to get ideas from a design that already works.

Engineers for the NASA Psyche mission decided to base the Psyche camera off of an existing design from another NASA mission, called “Mars 2020.” They agreed that they could make a number of changes to this existing design to fit the needs of the NASA Psyche mission.

Step 3: PLAN/DESIGN.

The Psyche camera is called the “Multispectral Imager,” and it consists of four main parts:

- The Charged Couple Device array (or CCD), which is made of millions of tiny electronic detectors called "pixels" that are sensitive to light. This device captures the incoming light from the asteroid and stores it as data that can be sent back to Earth.

- The filter wheel, which allows the CCD array to look at just one wavelength (or color) of light at a time. This helps scientists to identify different minerals and elements on the asteroid's surface.

- The optics, which is made of multiple lenses. The optics is a telescope used to focus the incoming light onto the CCD array.

- And, finally, the sun shade, which blocks glare from the sun.

The final design for this instrument must be reviewed and improved as much as possible before it is made. After it has been built, it's very hard to make changes to the physical instrument, also known as "hardware."

Step 4 & 5: CREATE & TEST.

Psyche's Multispectral Imager is being designed and built by teams at Arizona State University, or ASU, in Tempe, AZ, and at a company called Malin Space Science Systems in San Diego, CA, and at dozens of other engineering companies around the country. After it has been installed onto the spacecraft, it will be tested further at NASA's Jet Propulsion Laboratory in Pasadena, CA.

Step 6: ADJUST.

If the tests all go well, then the Imager is ready to go. But if there are any problems, the engineers and scientists use the test results to figure out what is not working. Then they come up with ways to change the design to make the instrument work properly.

Sometimes the fixes require changing the hardware, sometimes changing the software used to run it, sometimes changing the way the instrument is operated, or a combination of these.

Once the instrument is on the spacecraft in space, it is not possible to make changes to the hardware. At that point, the engineers and scientists must rely on changes to the software and the way the instrument is used to make it perform the best that it possibly can.

[Conclusion]

That’s how the engineering process works in practice!

This process is used for all the instruments on the Psyche spacecraft, which include the Imager, the Gamma Ray and Neutron Spectrometer, the Magnetometer, the X-band Radio Telecommunications System, and the Deep Space Optical Communications instrument.

Each of these instruments is being carefully engineered to help the NASA Psyche mission reach its science goals.

[End Video 2]