SPACE SCOOP: Telescope Sample Script	BUHL PLANETARIUM

Preshow: Universe Unplugged, Electromagnetic Spectrum the Musical

- *Note: stream from Youtube or download via ImToo and play directly from laptop if WiFi is spotty.*

Keynote Presentation

Click: Animated Launch Cape Canaveral, Florida (*Music)*

(Presenter takes the stage at the front of the planetarium with gusto)
Hello and welcome to Space News! Today's scoop comes from Cape Canaveral, Florida…Space Coast USA! Here we can see Space Shuttle Discovery as she blasted off from the launch pad on an historic mission to deploy The Hubble Space Telescope. Hubble has made headlines giving us awesome views of the cosmos for 20 years!

Click: Illustration of Nancy Grace Roman

Let's meet Nancy Grace Roman, the "mother of Hubble." When Nancy was a kid, she and her mom loved to stargaze. Do you guys like to look at the stars at night? Nancy loved looking at the night sky with her telescope, but often the clouds would get in the way. Nancy was thinking like an engineer. She thought, how can we make this better? Her answer? The Hubble Space Telescope. A telescope ABOVE the clouds. Nancy raised telescopes to new heights, and she was a determined pioneer for women in space science and engineering. Let's give Nancy a round of applause!

Click: Hubble Space Telescope Animation

- **IMAGINED** as a telescope that could explore space while orbiting the Earth, high above atmospheric distortions.
- **MADE** at first with a flawed mirror, resulting in blurry images. Hubble had a rocky start, but that was just the first chapter in a story of perseverance and ultimate triumph. But in science and engineering, our motto is "Imagine it, make it, make it better!" Even a "Fail" can be a first attempt in learning—helping us eventually succeed.
- **MADE BETTER** by Space Shuttle Endeavour astronauts, who fixed the Hubble during five days of spacewalks! The Hubble is the size of a school bus, so a whole new mirror was out of the question. Instead, engineers had a clever solution. They devised a big "contact lens" that astronauts installed on the front of the mirror.

Click: Before and After Slide

…And that contact lens helped the Hubble to see better! Look at these before and after images of a distant spiral galaxy (M100).

Click: Back to the Hubble Space Telescope Slide/ Game *show music*

Demo 1: "Treacherous Transfer" of Bowling Pin with Ropes and Platform

Astronauts performed delicate repairs wearing bulky spacesuits and working in a weightless environment in orbit. Teamwork was critical to their success. I need two crew members to work as a team to perform our next engineering challenge!

Experience Goal: the two students on stage will work together as a team to lift and/or move the bowling pin on top of the platform, using the ropes thread through the platform.

Educational Goal: students will appreciate the teamwork required and complexity involved in affecting repairs in space

Equipment

- Flaghouse Treacherous Transfer Set: $65
- Plastic Bowling Pin

Procedure

- Explain first that the goal is to move a bowling pin with ropes from one spot to another.
- Physically demonstrate how to pick up the ropes, apply tension by pulling and walking away from the bowling pin, not pulling straight up.
- Read the room and adjust the complexity of the task to ensure success after a couple tries. It may simply be lifting the bowling pin in unison—or it may be lifting it high and moving it across stage.
- Read the room and jokingly add intensity to the mission, explaining that the bowling pin is a billion-dollar space mission, speaking through a Mission Control voice, etc.

Demo 2: RGB Color Mixing

Once Hubble was fixed, it gave us an incredible view of the universe. And many of those popular Hubble images were created by combining separate red, green, and blue images. Because of the way our eyes work, almost any color can be simulated by combining these red, green, and blue images. I need three more cadets to the flight deck. Here we have red, green, and blue wavelengths of light. We can mix any two of them to make a new color.

Experience: Lead the audience in making predictions about what colors will be made when two or three colors of light are mixed and then have the 3 volunteers on stage try it out.

Education Goal: Students will see that "colors of light add up to white." Students will also appreciate the difference between light and pigments. This is most noticeable when red and green light produce yellow (rather than the often anticipated brown), or when red, green, and blue combine to make white.

Equipment:

- Telescoping LED high lumen police flashlights
- Theatrical gels cut in circles and taped, one over each flashlight: red, green, blue

Tech Tip: Check the batteries before each show. Telescope and focus the flashlights. There are spare gels taped to the inside Stanley lid.

Safety tip: Do not allow students to look directly into the flashlights or point them at the audience. When the demo concludes, collect them from the students, point them down, and click each flashlight through its intensity and strobe options until in the "off "setting.

Click: Electromagnetic Spectrum Slide

Hubble has given us breathtaking views in colors we can see, but it is also gathering data beyond what the human eye can see, in wavelengths such as ultraviolet—beyond violet-or *infra*red, below red.

Click: Whirlpool Galaxy/ "Meet the Fleet" Slide (*added February 2019)*

Hubble is just one of an amazing fleet of space telescopes expanding our view of the cosmos. NASA's Great Observatories studied the Whirlpool Galaxy in three sections of the Electromagnetic Spectrum: infrared, visible light, and X-ray.

Let's meet the fleet! NASA's Great Observatories—Spitzer, Hubble, and Chandra, each have their own focus—particular parts of the electromagnetic spectrum. But these data add up to give us a more comprehensive view. Think of these separate missions as working together as a team in the sky to give us a better understanding of the universe. Teamwork makes the dream work!

- **Hubble** gave us visible light data, showing older, yellower stars near the center, and younger, bluer stars along the spiral arms.
- **Spitzer's** infrared data uncovers the oldest and reddest stars that populate the entire galactic disk.
- **Chandra's** X-ray data reveals energetic emissions from binary star systems that include neutron stars or black holes!

Different wavelength observations reveal different structures in the galaxy. The Whirlpool Galaxy reveals different characteristics in different wavelengths. All these data are different pieces of the puzzle, expanding our vision beyond the colors that human eyes can see.

Click: Firefighter Image

One of the advantages of infrared exploration is that we can see through clouds and dust. We find examples of this here on Earth. A firefighter's most critical job is to save lives. But in a smoky room it may be difficult to find unconscious victims unless they are literally underfoot. By using infrared cameras, firefighters can easily see the glow of a human even when the lights are out and the room is filled with smoke.

Option: Assuming Wif connection, use the slider to switch between infrared and visible light views of the firefighter images on Viewspace:
https://viewspace.org/resources/invisible_universe/earth_scenes/aid_in_infrared

Click: ISSAC Image
From Earth orbit, the International Space Station's Agricultural Camera can see through clouds and use thermal imaging to take the pulse of our planet from orbit—studying crop growth and providing farmers valuable data about what, when, and where to plant.

Demo 3: Infrared Observations
Now, let's "see" infrared in action for ourselves…

Experiences:

1. Bring one student up to make a handprint on a table, revealing that thermal imaging allows us to see the heat left behind even after the hand is removed.
2. Bring three students up, two holding a trash bag to obscure the third student. Aim the thermal imaging camera to look through the trash bag. Have the student behind the trash bag dance around to the delight of the audience.
3. Have the audience in the planetarium do "the wave" back and forth. Point out that regular glasses look like opaque sunglasses, because we are measuring temperature with our camera and can't see past the material to the warm-blooded human mammals beyond ☺

Educational Goals:

- Students will understand that thermal imaging allows us to "see through" certain materials, from the trash bag in our demo, to gas and dust in outer space.
- Students will be introduced to representation color, by seeing themselves in a thermal image in which color is used as a key to reading hotter and colder temperatures. This can introduce the idea of representational color in astronomical images.

Equipment

- FLIR Handheld Thermal Camera with USB input to Mac/ PC $1,199.00
- Laptop with HDMI or VGA input to projector
- Video Projector
- Economy Option: FLIR One Pro Smartphone Adapter for smaller groups

Grand Finale: Full Dome Planetarium Visuals
Now that we've seen ourselves with thermal imaging, let's compare the same object in visible light and infrared. Our destination today is the Orion Nebula! As we fly into this stellar nursey, or star forming region, we'll see a glowing gas landscape, illuminated and carved by high energy radiation and strong stellar winds from the massive hot stars in the central cluster.

First, the Hubble Space Telescope will show us our voyage in visible light. Then, we'll take the same trip again but in Infrared, with data from the Spitzer Space Telescope.

Note: Shudder Flatscreen Projector and play Full Dome animations. If planetarium is not available for presentations, play identical flatscreen versions of the following videos in Keynote.

Hubble is standing by. Is the audience ready? (*Elicit audience cheers).* Hubble: Engage!

Play: Flight through the Orion Nebula in Visible Light- Dome Version
These visible light observations come from the Hubble Space Telescope. The hi-res visible observations show fine details including the wispy bow shocks. Those things shaped like tadpoles are protoplanetary disks! Remember this is a star forming region, and there are exoplanets forming around these stars! (Description adapted from Hubblesite.org)

Alright, next up is the Spitzer Space Telescope view in Infrared. Is the audience ready? *(Elicit audience cheers)*. Spitzer: Make it so!

Play: Flight through the Orion Nebula in Infrared Light- Dome Version
Now let's take the same journey in infrared! This time, the data comes from infrared-light observations made by the Spitzer Space Telescope. The infrared observations generally show cool temperature gas at a deep layer that shows the full bowl shape of the nebula. In addition, the infrared showcases many faint stars that shine primarily at longer wavelengths. *(Description from Hubblesite.org)*

Conclusion: Give yourselves a round of applause!

Our journey today began with Nancy Grace Roman, the Mother of Hubble, making telescopes better by envisioning them in space, above the clouds. And our journey concluded with a technique for looking through clouds and dust, with thermal imaging technology that lets us "see" in infrared. Along the way, telescope technology has been improved, and that has in turn improved our view of the cosmos, with the attitude of *Imagine It, Make It, Make It Better!*

Let's all say together to end our show today: (Lead audience in cheer): Imagine It! Make It! Make It Better!

Thanks everyone for being a part of today's Space Scoop!