How to touch Space

Visually impaired people can access resource materials in various ways, to gain a wealth of knowledge on space exploration and the Universe. Information can be made more accessible via models and one's own body.

by **Russ Palmer, SRAT(M), FBIS**

Different types of models have their own unique applications for following space-related events through touch. They can also assist with the understanding of Solar System dynamics and its exploration. Describing the various space vehicles and probes using models enables a blind person to appreciate the different system designs and sizes both based on their possible visual memories and tactile reference points for independent haptic exploration. It can be very difficult to conceptualise these things if you have never seen them before.

One can use their body to represent different perspectives of the Universe. This enables blind people to understand and visualise how planets, solar or star systems and the Universe are made up on different levels. This is a process to adapt the photos and images into bodily experiences.

During this difficult pandemic I have managed to re-kindle my model-making skills through online interaction with my friend Andrew. Before my vision deteriorated this was just a hobby. Now I find it has given me a fresh insight on spacecraft design and sizes. Recently we have been making two kits: a Dragon kit of Mercury Redstone rocket and a Tamiya one with the Apollo spacecraft, and the Lunar Module (LM) inside the adapter on top of the SIV-B.

The whole experience taught me a lot about the surface texture of rockets and spacecraft, as the Apollo displayed different colours of aluminium/chrome/silver details along with the fragile foil construction on the LM Descent Stage. Furthermore, being able to create a sense of depth in colour was most intriguing. Perhaps due to my limited vision I had not realised those intricate details and facts before. However, using my visual memory of these exhibits, I was able to describe how to assemble these kits remotely.

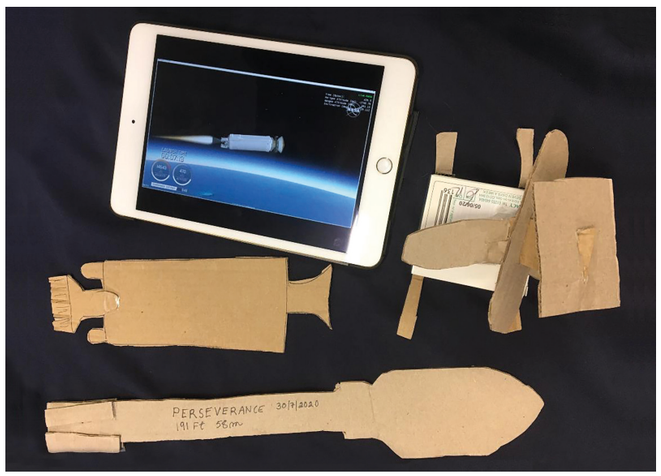
ABOVE
Completed model kits of the Mercury Redstone and Apollo spacecraft.

BELOW
Cardboard cut-out models of SpaceX Falcon and Mars2020 Perseverance live launches.

ONLINE LAUNCHES

With impaired visibility, in following a live launch one craves for understanding the size, shape and staging of the launch vehicle in the process of reaching orbit. These days the multiple cameras assist with this, giving a much more detailed and realistic experience. Watching a live launch, the beauty is to compare the new launch vehicles to previous, familiar designs and to search for the similarities and differences in between.

Back in 2009, when visiting KSC, I was fortunate to see a live rocket launch of Ares I-X, similar in size to one of the Shuttle solid rocket boosters with a fairing on top. I was lucky enough to get hold of one of these models and that has proved to be very useful as a reference point for the new launch vehicles. For the SpaceX DM-2 launch, I had no conception of what the new rocket looks like, so I had to rely on feeling the shape of the Ares I-X scale model and in addition on feeling a cardboard cut-out for the new rocket shape instantaneously hand made by Riitta, my assistant. This cut-out also had raised features which represented reusable boosters. When it came to feeling the top of the rocket it was a total surprise as there



LEFT: RIITTA LAHTINEN / ABOVE LEFT: ANDREW REYNOLDS

SARAH HOLLOWAY

ABOVE
A representation of the Solar System using hands and fingers: left hand for the inner planets, right for the gas giants.

was no pointed escape tower structure like on Apollo capsules. Instead there was a rounded top. This for me seemed unusual aerodynamically. In other words, using the model in connection to the commentary online via my iPad the difference in shape and size of the launch vehicles became more apparent.

Similarly, when following the latest Mars 2020 Perseverance launch it was online. Again, Riitta provided cut-outs to illustrate the shape and dimensions of the rocket and boosters for me to feel during the live launch. Riitta showed me by drawing onto my back where the boosters were going, Stina was reading out the staging and I was listening the transmission commentary using my Bose Soundwear. Basically I was multi-tasking! The extraordinary thing about this setup was that it enabled me to get the real-time experience of what was happening on the live transmission. It was certainly an interesting team effort!

To explain the structure of the Perseverance lander, in particular the Ingenuity helicopter, my perception of this unique device was quite different to the cardboard cut-out Riitta provided me. It was almost like the LM of the Apollo era providing a functional device to do the job. I had not realised it had a cube-like fuselage, two propellers on top of each other and a square-like solar panel feature on top.

Now of course you may find it hard to imagine how a blind person can see visual images, but to my surprise the cardboard cut-outs enabled me to get a grasp of some of the instrumentation on board Perseverance. However, ideally it would be nice to have proper 3D models of the various devices, including the rover and that would allow me to touch and feel the design of the equipment and the rover itself.

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EXPLORING PLANETS

When following a lecture on planets, planetary systems or our Solar System as a whole you need a three dimensional representation of how the system is organised. This includes the distances, planet sizes, orbits and inclinations as well as the moons and asteroids etc, which are talked about. This can be adapted for other star or exoplanetary systems. The describer may be sitting next to me or describe the lecture remotely online.

Sitting side by side, many methods can be used to indicate what is happening in real time. The methods are part of social-haptic communication which uses touch elements to convey information. Take for example Saturn and its moons. If I imagine being in the middle of Saturn, then my outstretched arms would be the ring system. Through moving the arms one can indicate the thickness of the rings and their inclination. This allows me to have a three dimensional understanding of the inner Saturnian system. In this occasion the Cassini division would be where the elbows are and the fingertips would represent the outer shepherd moons.

An alternative approach to the Saturnian »

« system is to use one hand clenched like a fist and the other to draw the ring system and to point at the locations of the moons (possibly not all the 82 moons, but the scientifically interesting ones). For this you can use either the person's back or a surface if there is one. Then the surface details, such as canyons, geysers, crevasses or ice sheets of individual moons can again be drawn on the fist, now representing the indicated moon, and not the planet itself anymore. So the fisted hand itself changes its target as the lecture goes on.

A 3D or moulded relief map of Earth's Moon or Mars would be beneficial for a more accurate and realistic insight. This would allow one to have a hands-on experience on where the features are located in the terrain. On Mars that would mean Olympus Mons, on the Moon perhaps the Apollo landing sites and of course an Earth globe could deepen understanding of the geological features here at home and give them a different perspective.

Some of these methods may also be very suitable for anybody else who wishes to experience relief features through touch and compare that to looking at a photograph. By closing their eyes and using their hands it is surprising how different objects or planets can feel through touch. It actually relays more features and deeper understanding than one realises. Looking at a picture of the Apollo 11 and 17 landing sites does not reveal the fact that the terrain features are very different. The Apollo 17 landing site contours of craters and valleys are only revealed in feeling the relief map or a tactile Moon globe. This is where 3D modelling and printing facilities would be extremely helpful.

ABOVE
Using the body to understand the anatomy of our own galaxy (top) and its spatial relationship to neighbouring Andromeda.

BELOW
A student at NASA's Ames Research Center tries out Getting a Feel for Eclipses, which uses braille and 3D textures to help visually impaired people understand the complex orbital relationship between the Earth, Moon and Sun.

MAPPING SPACE

Describing the Solar System or the Universe represents challenges. How do you map out the planets, so that a blind person can understand their positions and also, how do you represent how large the Universe is? Let's take the Solar System. If one places the hands side by side thumbs touching spread out flat horizontally, the Sun would be on the left in the watch area of the wrist. The left hand would represent the rocky inner planets: Mercury, Venus, Earth and Mars from little to index finger. Where the thumbs join together that represents the asteroid belt, then the right hand will represent the gas giants: index being Jupiter, then Saturn, Uranus and Neptune – and Pluto on the outer side of the right hand knuckle.

In addition to this simple example, one can represent the Kuiper belt and the Oort cloud. Here the elbow region represents the Kuiper belt, and the Oort cloud will be around shoulder level. This can then be followed by the interstellar region behind the person's back. When zooming out to study the Milky Way, the Solar System will shrink to fit on the fingernail of the left hand with Kuiper Belt and Oort Cloud along the same finger, then the left arm will be one of the spiral arms of the Milky Way including Proxima Centauri, the Kepler system and Sirius for example, shoulder to shoulder will be the central bar in the middle and so, the head will be the central bulge with millions of stars of the Milky Way. In this way one can use the body to zoom in and out within the Universe. This allows the blind person to realise the depths of the Universe in three dimensions.

Finally, if you zoom out even further, you can represent the scaled distance between the Milky Way and Andromeda galaxies by your arms outstretched to the side. Now the Milky Way will be on your left little fingernail and the Andromeda is on your right hand thumb fingernail, and your torso will represent the dust between the galaxies. However, the following illustration of the tilt is not showing the scaled distance as that would be too difficult to achieve. To show the 45° tilt between the galaxies, Milky Way would be on the left hand being flat and Andromeda would be on the right hand tilted 45° as if pushing something away.

The easiest way to think about the structure of the Kepler system is to imagine it being placed at the base of your feet, as your toes are just like the exoplanets in that system – quite snuggly together and very similar in size to each other! Then if we start talking about planetary orbits, it's a bit like being back in the 1960s, trying to do the Twister game! Now you can untangle yourselves…!

One recent enquiry into an Orrery (a mechanical planetarium) got me thinking on how useful these devices could be for blind people. It is clear they are very beautiful and well-thought out hand-made designs of either the inner Solar System (Sun, Mercury, Venus, Earth, Moon and Mars) or the larger Solar System model with all of the planets and their traditional moons. This would be an excellent educational tool for even the able bodied people as one can feel how the planets move around their orbits and their rotary motions, with Venus rotating retrograde and Uranus rolling along on its tilted axis.

Personally I think this is a marvellous traditional 19th century tactile tool that would enable us to have a greater understanding of how the planetary system functions based on haptic exploration. For further details, readers should contact Staines & Son.

AFTERTHOUGHTS

Over these two articles (see *SpaceFlight* Vol 62 No 12 p 24), I have tried to cover a broad spectrum of disability access for different museums, visitor centres, lectures, broadcasts and how to use different tools to illustrate an exhibit or other material formats. A combination of environmental descriptions and independent tactile experiences enables me to have a greater access to different real-time events. In many ways, feeling the Universe has enabled me to gain greater insight. However, it does require a team effort to accomplish this.

I hope this has made you more aware of how people with a visual impairment are able to perceive space and planetary exploration through touch. All of these methods can be used also for educational purposes. If not for this, the students would only be able to benefit from audio information, which might not be so easy to comprehend. Now at least future generations can benefit in getting new immersive experiences through touch and technologies.

I am currently involved in an EU project called SUITCEYES where we focus on smart clothes for deaf and/or blind people. This involves ways of transmitting haptices (messages through touch) onto the body using smart clothes. It enables people to orientate and be active and independent participants in a gaming setting. In future this system could allow all people to have touch-based information on objects and exhibits independently during a museum visit. SF

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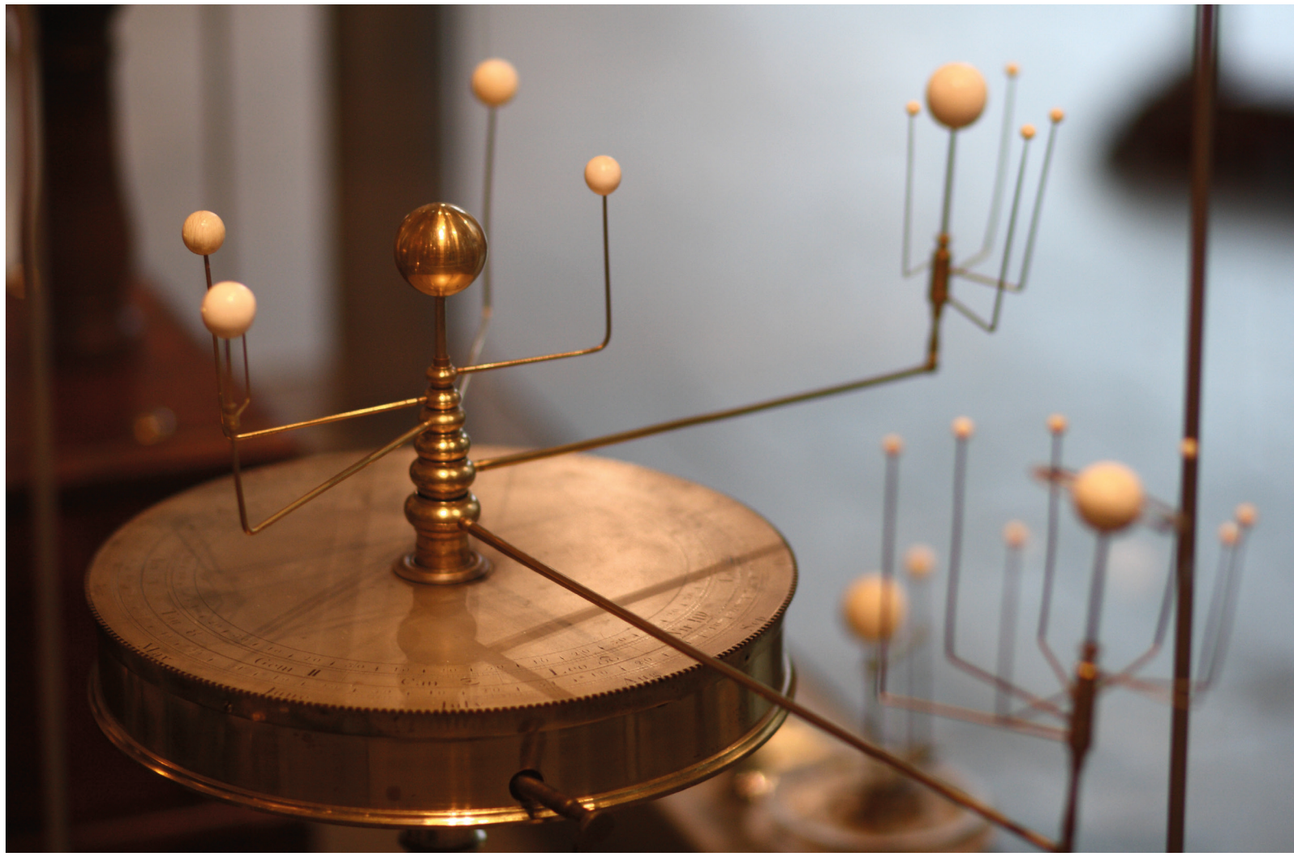
LEFT: SARAH HOLLOWAY / BELOW LEFT: NASA AMES / BELOW: P-D ART



BELOW
Finishing touch: an orrery built in London in 1766 by Benjamin Martin and later used by American astronomer John Winthrop (1714-1779) to teach students at Harvard.