Hi, this is Janet for Cheap Astronomy, www.cheapastro.com. This is SISS, Science on the ISS – and today's episode is *Project Sidekick.*

Something that every astronaut over the last fifty years has come to accept is that you won't get far in space without Ground Control watching your every move. Well, OK – astronauts do get brief down time and they do get plenty of meal and sleep breaks. But apart from that, you've generally got Ground Control in your ear and on your back the whole day long.

But, to go off on a tangent for a moment, it is worth noting that *a whole day long* on the ISS is quite a different proposition to *a whole day long* down on Earth. For a start you experience around 15 sunrises every 24 hours on the ISS, but there's more to it than that. Fans of US space missions may recall that wake-up songs were standard on all Space Shuttle missions – but, on the ISS, wake-up songs are only occasionally played on special occasions. This is mainly because it was an American initiative – where wake-up songs on the Space Shuttle always coincided with the start of the working day in Houston.

However, the international crew of the ISS have multiple masters - Houston for the Americans, Korolyov for the Russians, Darmstadt in Germany for the Europeans and Tsukuba for Japan. So, the start of the working day in Houston just isn't relevant anymore. Nonetheless, all the astronauts across all the nationalities that are aboard the ISS do stick to the same coordinated start and end to their working day and they generally share the same meal breaks too. Their day is determined by Universal Coordinated Time (UTC), which is what used to be known as Greenwich Mean Time. So, ISS astronauts start a standard day at 0700 UTC. However, for the various Ground Control people involved, 0700 UTC is 2am Houston time, 11am Moscow time, 9am in Darmstadt and 4pm in Tsukuba – give or take any daylight saving adjustments.

And even then, individual and team schedules can get shifted around, according to different mission requirements. Big events that need everyone on deck, like an EVA or a docking or berthing can't always be scheduled in UTC daytime – so Ground Control sometimes has to adjust sleep schedules to ensure that everyone is awake and fresh, well ahead of such critical events. So, on the ISS, the concept of *a whole day long* is a pretty fluid concept.

Anyway, whatever time your workday starts, you've got Ground Control in your ear and on your back – and now plans are now afoot to have Ground Control watching your every move in a much more literal sense. To avoid unnecessary brand promotion, let's just say a certain small and squishy IT firm's off-the-shelf *HoloLens* product has been sent to the ISS to trial what is known as *Project Sidekick*.

The idea behind *Project Sidekick* has been the subject of enough science fiction stories that it shouldn't take you long to get the idea. You put on a *Hololens* headset, which positions a transparent visor in front of your eyes. There are miniature cameras mounted on the headset so that Ground Control can see whatever you can see. And the visor is also a projection screen so that Ground Control can display a 3D visual schematic to overlie whatever you may be looking at through the visor – and while all that's going on you will continue to get Ground Control audio in your ear.

Project Sidekick will trial two modes of *Hololens* operation. In *Remote Expert* mode, both you, the astronaut, and a remote operator back on Earth will be dealing with a real time issue, something

unforeseen where neither of you really know what to do next – although Ground Control has a lot more resources to call upon and can bring in experts who know a lot more about the particular issue that you're dealing with. That remote expert can ask you, the astronaut, to quite-literally look at the problem from a different angle – and then get that visual data sent back to Earth – so both the astronaut and Ground Control can first diagnose and then fix the problem by working together as a team.

But secondly, there's *Procedure Mode*, where you, the astronaut, walk into a room with your *Hololens* headset on and the remote operator draws a line across your visual field, from point A to point B, and tells you – *Dave, please move that box from point A to point B*. So, you the astronaut, become Ground Control's remote monkey – although they will be very nice about it and thank you for your contribution. From the astronauts' perspective becoming a remote monkey does at least allow a mind-numbing and menial task to be done quickly.

Two *HoloLens* headsets arrived at the ISS in December 2015 – which was actually the second set that were sent up, the first set having been lost in the Space X CRS 7 mid-flight failure of June 2015. The *Project Sidekick* trial will have different astronauts wear a *HoloLens* headset, to firstly try out *Remote Expert* mode – where Ground Control is the astronaut's sidekick - and also *Procedure Mode*, where the astronaut is Ground Control's sidekick. It's hoped that if *Project Sidekick* works out then the pre-launch training of an astronaut crew could become significantly shortened in the future – meaning we can get new crew up there faster and cheaper – and they will be a crew who are fully operational from the get-go.

In the longer-term, the *Project Sidekick* concept might also be useful for deep space missions, where the long-distance transmission delay can make it impossible to have a meaningful two way conversation with Ground Control. Imagine that something breaks on a mission to Saturn – and there's more than an hour's transmission delay between the spacecraft and Earth. One of the astronauts could put on their *HoloLens* headset, inspect the damage and also provide some audio commentary. Then that audio-visual recording could be sent back to Earth. Armed with that recording, the boffins in Ground Control could then see for themselves, in a very literal sense, what the problem is, by playing-back the recording through an identical *Hololens* headset. Then Ground Control could figure out a solution, develop a step-by-step repair procedure and then undertake that procedure in a mock-up of the Saturn-bound spacecraft, while the operator was wearing a *Hololens* headset – and then that audio-visual recording of the repair procedure could be uploaded to the spacecraft and the astronauts could then play it back through their own *Hololens* headsets.

Using a *Hololens* in *Procedure Mode*, Saturn-bound astronauts wouldn't have to follow a long written procedure – instead, they would just be able to put on their *Hololens* and look around the cabin and a little flashing arrow would appear in their visual field to identify plug A – and then another little flashing arrow would be appear directing them to socket B. And, if they didn't get it right the first time around, they could just replay that bit of the recording again.

However, here we need to go off on another tangent for a moment to explain why none of this could actually happen today. While it might sound easy to upload and download high definition audio and video files from space, in fact this is not easy at all. As the twenty first century has progressed, space exploration has becoming increasingly hampered by data bandwidth. While camera technology has improved by orders of magnitude in the last few decades – as has our ability

to get spacecraft out and around the solar system – data transmission via long-wavelength radio just can't carry all the data that we could feasibly collect out there. For example, it's taken us a good year or more to get back all the data back from New Horizons' fifteen minute fly-by of Pluto, which took place in July 2015.

As we covered in SISS Episode 6, we are currently developing the technology to enable much faster data transmission via deep space laser links. But until that system becomes reality, there is still a role that the *Hololens* system can play in deep space exploration now. Still images taken by the Curiosity rover, have been composited together using a platform called *Onsite* to create a virtual 3D environment, about the size of a small room, within which Earth-based viewers wearing *Hololens* headsets can feel *a bit like* they're on Mars – and take in a new perspective of the geology and the geometry of the terrain that is *virtually* around them. While this environment is built with real rover imagery, the time required to download the imagery from Mars and then build the 3D environment means the rover has generally moved on long ago. But it's still an opportunity to develop the skills that will be needed when we do eventually have the bandwidth to allow us do something more operationally-meaningful in virtual reality.

if you want a taste of what that might be like, get yourself to the Kennedy Space Centre in Florida, where you'll find *Destination: Mars* – a sideshow exhibit where you get to wear a *Hololens* headset and can look around a portion of the Martian surface, while a virtual Buzz Aldrin and other NASA folk give you a narrative about what you're looking at – along with the standard spiel about space, the final frontier, our children's children and other inspiring clichés. Maybe it's just Disney science, but it is still science and it is a genuine glimpse of what's to come – and it's a 3D glimpse at that.

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