Science and space travel – part two

Leo Enright: "And that, of course, is the cockpit of the space shuttle, and you got to fly that. It must have been a breeze compared to landing a crippled aircraft on an aircraft carrier. You were talking earlier about the speed you go in orbit and getting up to that speed must be a very violent event."

Edwards: "It's actually incredibly smooth. It's a very well designed vehicle. This is the cockpit. There are over two thousand switches just in the cockpit of the space shuttle and it's really about as complex as that aircraft carrier that I used to fly on and off of when I was in the navy, except that it's operated by only seven people. There are about fifteen systems in the vehicle, whether the computers, the electrics, the hydraulics or what have you. Each of those systems is as complex as one airplane, so it takes a lot of study. And if you want to become an astronaut, you really start laying the foundations when you're five or six years old in the academics and sports you participate in throughout your whole life.

"So we thought we'd show you – if you could go to 'video' – we'd show you just a little bit of a space shuttle launch.

"It's really a pretty remarkable vehicle. It weighs four and a half million pounds at launch and produces seven and a half million pounds of thrust to continuously accelerate the vehicle for eight minutes and thirty-two seconds to get it safely into orbit around the Earth. During the assent, the three engines in the back of the space shuttle, the main engines, are pumping liquid hydrogen and liquid oxygen at a temperature of minus 300 degrees at a rate of one swimming pool's worth every second for eight minutes and thirty-two seconds to get you into orbit. We really want really good scientists and engineers designing this thing, you know what I mean?

"Two minutes and ten seconds into the launch, at 3.7 times the speed of sound and an altitude of 150,000 feet, the solid rocket boosters that you saw there are jettisoned and the vehicle continues uphill on its back, powered by the three space shuttle main engines, until main engine cut-off, at which point you become instantly weightless.

"It takes us about eight and a half minutes to get to orbit and at two minutes into the launch itself, two of the three rocket motors that power the vehicle, the two on the side, the solid rocket boosters, kind of burn like a firecracker really, they have a solid fuel in them. And when that is expended, the computers jettison them from the vehicle so that you don't have the drag. Those solid rocket boosters are recovered by parachute and we reuse them for all the space shuttle launches."

Enright: "Aren't you afraid to get into that thing?"

Edwards: "No, actually. Maybe insanity is a prerequisite to be an astronaut. But no actually, we're not. If I didn't understand how to fly the vehicle, if I didn't have a thorough understanding of the eighty-two pounds of documentation that we take on orbit of how to operate it and how to handle emergency and what have you, it probably would make me a little bit nervous. But it doesn't because, you know, we man up the vehicle knowing that we can do anything that is humanly possible to manage the vehicle throughout its mission, and if it's not humanly possible it just doesn't matter."

Enright: "Are you disappointed that President Bush has decided that the space shuttle should stop flying – that by the end of 2010, that's barely three years from now, there should be no more space shuttle missions?"

Edwards: "No actually. It's time to get out of lower orbit, that's our opinion. We'll talk a little bit about orbit later, about what we're going to do after the space shuttle but there will be no replacement for the space shuttle – the next vehicle will not have the versatility the space shuttle Orbiter does. It will be designed for an entirely different mission, a mission that NASA and the astronauts have wanted to embark on for well over thirty years now."

Enright: "On your mission on the space shuttle you went to a space station."

Edwards: "We went to the Mir space station. The International Space Station is orbiting the Earth today. The flight test programme to build the International Space Station was a series of missions that we flew to the Russian space station back in the late 1990s. Space station Mir - anyone here speak Russian? Mir means peace or Earth in Russian – was a vehicle about half the size of a football field. It was launched in 1986, intended to have a life of only three years, but lasted well into the twenty-first century. So we constructed part of Mir, we sent American crew members up there for long duration missions and we learnt how to rendezvous and dock with the space station with the two hundred and forty tonne space shuttle Orbiter."

Enright: "And, of course, you also learned how to work with foreigners. It was the first real international effort to work together in space."

Edwards: "Very true. Through the Cold War, you could have actually knocked me over with a feather if you had ever told me I would actually fly with a Russian cosmonaut on the space shuttle. But as a matter of fact I did in [unclear] Sharapov, and we had American crew members with those guys as well. And what we found out is of course we had a thousand things in common, the astronauts and the cosmonauts did, and astronauts of all nationalities. And also that the language barrier early in the programme really wasn't much of a barrier at all because we had the common language of science and engineering to talk to each other through, and it actually made things very easy."

Enright: "The whole business of living in space, obviously if you're like Dan Tani or any of the people he lives with currently, the commander on board the space station, they have to live normal lives as well as do their experiments. How can you conduct any sort of normal life when there's no up or down, and all your body fluids are redistributed and…"

Edwards: "It sounds pretty gross."

Enright: "It sounds like it could be pretty gross."

Edwards: "Well, I guess the answer is that becomes your normal life. If this vehicle, if this room were a spacecraft, we would not be limited to just working here on the floor. We could work on the walls, we could hang off the ceiling. We'd have a tremendous amount of volume to…"

Enright: "Don't try this at home, OK? Don't try to hang from the ceiling."

Edwards: "If you figure out how to do this, clue me in. So the things that on Earth seem to be abnormal, such as hanging from the ceiling, working on a computer and what have you, just become part of the normal routine when you're on orbit."

Enright: "Is it true that astronauts are told never, ever, ever to burp?"

Edwards: "No, not at all. I think we're probably gross as individuals."

Enright: "Is it not true that some things that you would take normally for granted on Earth, you have to be very careful about when you're in space because stuff might come up?"

Edwards: "There are some bodily functions that gravity is a tremendous asset for, that you don't have that in space. But in space, the advantage that you have is the ability to move objects of very large mass. If we were in space we could take a refrigerator and move it with our finger in this room.

"But the down side to being in space is, if I can borrow this prop, if I had a set of procedures here from which I was working on a piece of equipment, and if I were in space and just released it, it would float – and I can tell you from personal experience – to the most remote corner of your spacecraft, through passageways and everything, and you'll never find it until after the end of the mission. It's the most amazing thing. So that is why at NASA we probably use about half the world's supply of Velcro, because if you're done with something, you stick it somewhere so that you know where it is."

Enright: "I saw a very clever trick recently, and there's lots on NASA television nowadays which is available online – if you have a decent broadband connection, which most, some schools have now, most and all should but some schools do – you can actually watch the astronauts in the space station go about their daily work in orbit. And one of the clever things that I noticed was Peggy Whitson had a big sheet of plastic and she taped it to the wall. Every time she needed to look at something, to read something, she shoved it in under the plastic and the plastic kept it in place."

Edwards: "Yes, that's pretty imaginative. They're the kind of engineering solutions you come up with when you spend a few months up there."

Enright: "Yes, I was quite impressed. I think that young lad there wanted to ask a question. Go ahead."

Audience member: "I forget the question."

Enright: "Oh right, well when you think of it we'll have plenty of opportunity, we're going to spend quite a bit of time having a chat."

Edwards: "I think there's one right behind."

Enright: "Yes, we'll take all the questions."

Audience member: "Why not use robots instead of humans on the shuttle?"

Edwards: "In fact we do. Right now there are over two dozen robotic spacecraft that are exploring just our solar system. We have one spacecraft that has actually left the solar system, Voyager. So the exploration of space is really complementary, using both manned vehicles and robotic vehicles."

Enright: "That's an extremely good question. Well done. That's a common controversy in the business. We have a young lady just behind there."

Audience member: "In 'The Simpsons' when Homer went to space, he opened a bag of crisps and they started floating into the air and he was able to eat every single one of them while crashing an ant farm. Would that be able to really happen?"

Edwards: "OK, let me restate that. I've got to say that we got the biggest kick out of that episode of 'The Simpsons' when Homer is floating through the space shuttle and munching on the crisps as he goes along, and I have no video to prove it but I can tell you that, yes, it has been done, and multiple times. And not just with crisps either. M&Ms are kind of a favourite – little easier to get those things into orbit."

Audience member: "Even Maltesers?"

Enright: "Maltesers? Yes, these are very good questions and you're exactly right, Maltesers would be terrific."

Edwards: "We're covering the important aspects of space flight."

Enright: "Absolutely. I saw a man in orbit recently, eating, or drinking Japanese tea, with chopsticks. Now that's some trick."

Edwards: "It's an interesting thing, to go back to what's it like in space. Let's imagine that this is a squeeze bottle of some sort, that there's water in it. If we were to hold it here in the air and squeeze it, all of this water would come out…"

Audience member: "In bubbles?"

Edwards: "…No, not in bubbles, it would come out in a sphere, in the shape of the Earth, and surface tensions would hold all of those molecules together. And it would sit there and it would float like something out of a science-fiction movie. And you can actually squeeze it out and then take a straw and slurp it up. And it doesn't work quite as well for the camera if it's clear, but if it's a strawberry drink, it's all over the place. You always end up with it on your face every time you do it."

Enright: "The bubbles is an interesting question. In fact, one of the Irish experiments aboard the International Space Station is by a very distinguished member of this institution, Dennis Weir. It does, in

fact, involve exactly that, bubbles. And he's using the space station because there's no gravity, to study the way that bubbles perform in weightlessness, where they float around and there's not gravity pulling them down. Your point about bubbles is very well taken."

Edwards: "I should probably mention something here – the occasional antics that you may see being performed by astronauts is not the routine. In fact, every minute of every day is scripted, it's oversubscribed with regards to what the crew have to do. The media love to show the pictures of the spinning banana or a floating sphere of strawberry drink or whatever, but the fact is, the only reason we ever do that stuff is, there's really no time to play around, we do it to take some images of some things that are kind of funny on orbit, in particular to take back to the primary and secondary school faculties in the States and try and capture young people's imaginations."

Enright: "In fact the company that are filming here today have actually filmed aboard the space station exactly that, the toys in orbit and the physics of weightlessness and what happens to various objects when you introduce them into a new environment. There's a whole set of videos – if there are any teachers in the audience that are interested – produced by Agtel aboard the space station with the European Space Agency over the past few years.

"Actually, let's talk a bit about the European involvement. Obviously the big, big European thing is the launch, hopefully, everyone cross their fingers, hopefully the European Columbus module will launch aboard the space station next month after twenty-five years of development and delays. It's finally going to be launched to the space station to allow European astronauts to work in their own laboratory aboard the International Space Station. Of course, you've worked with Europeans at NASA, we have quite a few now attached to the astronaut corps. The whole Columbus module, this is obviously the next step, it makes the space station so much bigger."

Edwards: "It does. This is a picture of the space station pretty much like it looks today, we've just recently attached a new solar ray onto the vehicle. But it's a good opportunity to tell you what's really going on up there. This is not just a very expensive vehicle circling the Earth every ninety-two minutes, it's an orbiting laboratory. The idea is to do research that benefits life here on Earth. Of course, it's a platform to observe the Earth in a variety of wavelengths. We have unmanned, robotic vehicles that can do that. So with all that, do you guys have any idea how much we spend on the space programme back in the States every year? How much?"

Audience member: "Billions."

Edwards: "Billions. Seventeen billion dollars. Now, I'm the first to admit that based on the state of the dollar, seventeen billion is not as much money as it was two years ago, but regardless… Seventeen billion."

Audience member: "So eighteen billion the year before?"

Edwards: "I guess so, I'm with you. For all of the money, that's just one year, that's a lot of money in the life of the programme, do you guys feel connected to the space programme at all? Because to the

astronauts, it's not just an American programme. Obviously it's an international partnership today. But do you really feel connected to the space programme? But do you really feel connected to the space programme at all? Has it impacted your life one iota over the last forty or fifty years? Tell me one way, just one. One specific thing that you've encountered in your daily life that has come from the space programme."

Audience member: "Digital watches."

Edwards: "Digital watches, well maybe."

Audience member: "Frying pans."

Edwards: "Not Teflon, it already existed. Velcro existed as well. Do you guys know what Tang is? The orange drink?"

Enright: "It's not a product in Europe. MiWadi would be the equivalent here."

Edwards: "OK. Just one thing, anyone?"

Audience member: "The CO2 emissions and all the atmospheric changes."

Edwards: "Certainly, space-based remote sensing of the Earth and the ability to diagnose things like global warming, climate change, what have you. Did you know there are over thirty thousand things that you encounter in your daily lives that come from the space programme? Name one. No, not cortex – I mean something really specific. Let me give you an example. Anyone ever have an MRI or CAT scan? Anyone here know someone that did? Come on, work with me. I've had one. A couple."

Audience member: "I haven't."

Edwards: "Good for you. Keep it that way. The digital signalling process that we use in MRIs and CAT scans came directly from software development for Apollo so that we could communicate with the Apollo spacecraft when we were going to and from the Moon.

"Have you ever driven on a highway with grooves in it to channel the water away from the tyres? NASA invented groove highways for airplane runways in the late 1970s and now today they're used on highways. Kidney dialysis machines. Freeze-dried food. The first laptop computer was built under contract for the space shuttle in 1981. Anyone here own a cordless power tool? A battery operated drill? Those things didn't exist until NASA signed a contract with a company called Black and Decker to develop the first battery powered tools so we could use them when we were space walking.

"Like I say, there are over thirty thousand things that impact our daily lives, not the least of which is satellite communications and being able to monitor the climate of the planet, but most of them are highly technical, critical parts of machinery that we use on a day-to-day basis. And frankly it's difficult for the scientists and engineers to familiarise ourselves with that kind of technology. I became an astronaut because I wanted to explore space but also wanted to better things for mankind. And that's what we're doing with the

International Space Station, doing basic scientific research. It may be surface tension. It could be some sort of applied physics. It could be something that has to do with the climate here on Earth. Basic scientific research to try to better life here on Earth for humanity."