SISS (Science of the ISS): Mundane stuff

There are a few things that are best left as known unknowns in SISS – like space toilets. But here's a thing. Next time a Mars mission advocate starts jumping up and down and demanding to know why we aren't flying to Mars yet, clear your throat, put up your hand and ask *how are you going to deal with the **underwear** problem?*

Take the ISS as an example. No-one on the ISS has ever done their laundry - seriously. You just discard the old and put on the new. Old items are tossed into the last resupply capsule that visited – which, once filled, is jettisoned to burn up in the Earth's atmosphere. But, even then, a whole 180 spare pairs of briefs *and* socks that you might *think* you need for a six month trip, would take up an awful lot of space and be an awful lot mass to lift off Earth – and that's for each and every crew member aboard. So, it turns out that no-one on the ISS actually changes their underwear every day.

It's not so bad. Everyone washes regularly and everyone lives in 24/7 air-conditioning. So, the crew can stretch it out to maybe once every 3 days – which, for a six month stay, means just 60 changes. Even then, no-one actually launches from Earth with 60 changes of underwear. Because the ISS gets unmanned resupply visits at least every three months, astronauts just launch with a bit of carry-on baggage, since spares will await them at the station, enough to keep going until the next resupply mission arrives.

But, if we are going to fly to Mars, well… you can see problem. Perhaps we will supplement the radiation shielding with fresh underwear, to be slowly replaced by used underwear over the course of the mission. Or… why not invent a space-going washing machine? It can just be a small machine and you can recycle all the water. Let's face it, if we are going to fly to Mars, we are going to be recycling an awful lot of water. A couple of clothes washes a week won't be that much of an extravagance – and the morale boost from having a ready supply of clean clothes will be worth it.

Space laundry is just an engineering problem and the main issue to deal with is *sustained foam*. In Earth's gravity, agitated water and detergent create foam – which rises to the surface and, as more pushes up from below, the top layers steadily disperse into the air above. But, in microgravity, none of that happens. There's no reason for the foam to rise, nor is there a layer of air sitting above the water. Instead you just get a crazy mix of water and air and foam – and the more you agitate it, the more foam you create, until the whole volume becomes foam – *sustained* foam. Sustained foam is not going to get your clothes washed.

So, instead a space washing machine will rely on water jets, to wash but not to soak – and water vapour, to soak but not to wash. Quick-acting suction will then remove any effluent before it can start to foam up. After a few cycles of this, the washed clothes will be tumble-dried with air jets to do the tumbling and microwaves to do the drying. Fan-driven microwave dryers are extremely energy-efficient and we really should be using them back on Earth – but the concept of ground-breaking laundry technology is yet to capture the public imagination.

Mind you, there are many ageing technologies that are still in use on the ISS. Can you believe that astronauts, supposedly the pinnacle of humanity, still drink rehydrated coffee granules through a straw. I mean, *come on*. Fortunately, one giant leap in coffee science is about to be taken. Before

2014 is out, a specially-designed Lavazza coffee machine, will be launched to the ISS. It is called, of course, the ISS-presso.

Brewing coffee in microgravity is just another engineering problem. On Earth, you let the coffee drip slowly through the coffee grounds, infusing coffee goodness into a cup below. Of course, in microgravity, none of that happens. So, instead you need a pressurised system to push the water through the coffee grounds. And it's got to be boiling-hot 100 degree Celsius water, because that's how you make real coffee.

Now, normally, a machine that holds scalding-hot water under pressure is not what you would want on a space station. To reduce any risk of injury, the inner plumbing of the ISS-presso is all steel tubing – and what the heck, back on Earth, scalding injuries in the pursuit of a good cup of coffee number in the thousands each year. It's coffee.

Anyway, now you can start the day in space with fresh underwear and real coffee. So, is it too much to ask that we might also end the day with a relaxing drink – that is, a *drink* drink? The history of alcohol in space is a very short story. Buzz Aldrin may have been one of the first, by taking communion before Apollo 11's moon walk – with a tiny sip of wine and an equally tiny wafer that he had brought along.

It wasn't until the space station era, with its long duration spaceflights that anyone had enough free time to even think about having a *real* drink. A moderate allowance of alcohol was first sanctioned aboard the Mir, for special occasions and to help in 'winding down' after particularly stressful mission events. When this allowance was very occasionally put into action, it involved cognac. The cognac was brought out after the Mir fire in 1997 and again after the Mir hull breach, which was also in 1997. If drinking in space really does help you wind down, then 1997 was a good year for it.

On the ISS, there have only been a couple of demonstration toasts for the media. Despite rumours, it's not likely that anyone has been sneaking drinks aboard since this would have been detected in the water-recycling system. So, the final frontier of drinking in space will probably fall to the space tourists.

But, whatever your poison – be it booze or coffee – who the heck is going want to drink it through a straw and out of a plastic bag? Don Pettit, astronaut and long-term ISS resident, thinks he may have the answer. And, rather than it being an engineering problem, this is just about basic math and physics.

If your pour water into a plastic cup on Earth and then tip it upside down, it falls out again. But there will always be a few drops left, because the cling of the cup's surface is strong enough to hold on to those last few drops. In microgravity, nothing much happens when you tip the cup upside down, but with a flick of your wrist you can give the water enough forward momentum to send it in any direction you choose. However, as Don Pettit deduced, if the cup has a narrow, flattened shape then there's more surface contact between the fluid and the cup, so that the *cling* of the cup is sufficient to hold the fluid within it.

So, by relying on water tension and some clever geometry you can make a cup that will hold fluid in microgravity, but how do you drink out of it? Don Pettit had an answer to that too, by making his cup narrow into a sharp corner along one edge.

That narrowing invokes what is known as *capillary action*, which in microgravity can easily draw the fluid all the way up to the edge of the cup. If you sip your coffee, cognac or whatever from that point, then more fluid will be drawn up by capillary action to replace it. So you have yourself a space coffee cup – or a space wine glass. The fact that your drink remains in your cup, until you've drunk the very last drop may be an unremarkable experience on Earth, but making it happen in low Earth orbit is truly extraordinary.

And by the way, in case you don't drink booze or coffee, the ISS-presso can make hot chocolate. And yes, it can also make tea, including… *Earl Grey, hot*.