

## Question 1:

*Dear Cheap Astronomy – Could a terrorist or some other nutcase take over the ISS.*

On the whole, terrorists aren't all that bright - though to be fair, that is mostly due to lack of formal education rather than raw brain power. Financial backing by various nefarious interests has seen terrorists destabilize governments and industries and even fly planes into buildings, but this is mostly just about some drones being handed easy money so they can buy guns, explosives and flying lessons in order to kill or maim unarmed civilians. Terrorism does not need much in the way of strategic thinking and the phrase terrorist mastermind is a contradiction of terms.

So, the idea that a group of terrorists could organise themselves in a crack team of operatives, let alone sit down and calculate the launch and rendezvous parameters required to send a spacecraft to the ISS is laughable. And you can't just buy a spacecraft off the shelf, nor can you launch it from any existing facilities, without someone noticing. And even if they could get into space, the terrorists would also need the design specs for ISS docking ports and build a compatible mating interface – and even then the ISS crew could just use their maneuvering thrusters to shift the ISS by a few centimetres any time the terrorists ever got close to to a dock.

There are various Bond villain scenarios where you might build your own underground launch facility with a roof that opens and closes (Dr No). You'd have to staff that facility, which means not only paying the staff, but since it's a remote location, you'll need fly-in fly-out teams because even bad guys want a weekend off now and again. And if you're an equal opportunity employer you'll also have to think about parental leave and mobility aids and of course everyone will want a superannuation scheme. Remember that Simpson's episode? Of course you could staff the whole installation with terrorists, but remember they're not the masterminds they're made out to be - most having never been to school let alone university – so, are they really the best people to be put in charge of lots of hugely expensive and highly explosive infrastructure?

Other Bond villain options are that you launch an ISS assault from your own space station (Moonraker) that no-one knows about because it has a cloaking device – a cloaking device which was presumably operational throughout the entire construction process and no-one ever noticed that various bits of infrastructure were being shipped up into orbit and then disappearing. Alternatively, there's the miraculous plastic surgery option (Thunderball), where your terrorist ends up looking exactly like one of the astronauts and is able to swap places on launch day.

Perhaps the most plausible scenario, would be the standard movie script where a real astronaut, has some ideological beef with his or her employer or his or her country and so agrees to help out the bad guys.

However, it is unlikely that an ideological beef will be a strong enough motive for any relatively stable and well-educated person to undertake a suicide mission, particularly on the promise of an invisible deity making it all worth their while, after the fact. But perhaps that rogue astronaut could fly some bad guys on board, or put some kind of remote control device on board that allows the ISS to be taken over after they're gone.

But there's still going to be an after story. How likely is it that the astronaut flies back to Earth, as the ISS is taken over, destroyed or whatever and no-one ever puts two and two together? While the movie script often have people saying, "I'll just disappear" this is not an easy thing to do, unless you want to spend in the rest of your life living in a hut in the steadily-shrinking Amazon jungle, which is an unusual life-choice to follow, after having been a freaking astronaut.

If instead we consider the possibility of 'some other nutcase – and here apologies and genuine respect to those dealing with a real mental illness. But, it turns that out NASA has actually documented detailed procedures for dealing with a suicidal or psychotic astronaut in space. Essentially, the astronaut's crewmates should bind his or her wrists and ankles with duct tape, tie him or her down with a bungee cord and inject him or her with tranquilizers if necessary.

"Talk with the patient while you are restraining him," the instructions say. "Explain what you are doing, and that you are using a restraint to ensure that he is safe." It would be a stressful and morally-conflicting intervention, but it can be managed with sensitivity and empathy. And remember, these are real astronauts who have plans in place for most eventualities, work very effectively in teams and are pretty much masterminds. Takes the guns and explosives out of the equation and terrorists have no chance.

## **Question 2:**

*Dear Cheap Astronomy – OK maybe you can't physically take over the ISS but what about a cyberattack?*

So firstly, I have no expertise in cyber-anything, so feel free to hit the off switch now. If you are still with us, then yes a cyberattack on the ISS is totally possible. Needless to say, NASA doesn't go out of its way to let people know how they might go about that and there's no danger of anyone gleaning anything useful from my naïve ramblings on the subject, I'm just going to list a few things on the public record.

The ISS wasn't connected to the internet prior to 2010, but that didn't stop a computer virus and various malware items getting onboard anyway, via astronauts' laptops. And speaking of laptops, the theft of ground-based personnel's laptops around that same time saw a set of what are described as ISS command codes being shared on the internet. It is generally the case that the biggest holes in any cybersecurity strategy are your employees – and generally not because they're acting out of malice, they're just being normal people.

Nonetheless, there are various documented incidents of backyard hobbyists and alleged employees of foreign governments hacking into NASA systems. It's that NASA is necessarily more vulnerable than anyone else, indeed the opposite is probably the case. But, it is NASA, so there's a certain trophy status for whoever can get in and some high-profile political damage can be caused by nefarious foreign governments. And overlaying any motivations of braggadocio or vandalism, there is the possibility of stealing some highly lucrative intellectual property.

And remember that NASA is not only a government agency, but also a civilian government agency – so it's kind of obliged to publicly report any cyber-breaches that take place, whereas under the same circumstances many military or private organizations probably wouldn't tell anyone. So, the extent to which NASA is being publicly hacked, probably represents how much everyone else is being privately hacked.

The whole space economy and the internet have pretty much intermeshed over the last decade or more, with much of the content and functionality of the internet now dependent on satellites - and much of the functionality and operations of satellites is dependent on the internet, or at least, on the internet-of-things. And there are always vulnerabilities in the system. Even in 2019, you can still steal employees laptops and smartphones and you could load some kind of malware onto those devices – and despite best efforts, hackers are still finding ways to steal log-in passwords that get them past firewalls and encryption – in other words, it's still the case that employees are the weakest link.

The risk of the ISS taken over by cyber terrorists is more realistic concern than terrorists actually getting aboard it, the crew and mission control would still have opportunities to intervene and over-ride any nefarious tinkering with networks and software. Also, there are opportunities for regular upgrades of hardware and security protocols – and since the staff, that is, the astronauts never leave the office, they are not a major vulnerability. What is of more immediate concern to the space economy is all the uncrewed and still operational satellites up there, few of which are being regularly monitored or upgraded and hence are a lot more vulnerable to being taken over without anyone noticing. So, there's a risk a private company or a country might lose a satellite and whatever function it served - and there's also some risk of a satellite being weaponized, either because it does have a weapon of some kind, or it can be maneuvered around to collide with something else.

Of course, Orbital navigation requires some pretty high level math and physics calculations and most satellites only retain enough fuel for a few correction burns now and again. So, on the bright side, it's highly unlikely you could find a satellite with enough fuel to allow you to decelerate it down to the ISS's orbit, which is lower than the orbits of most commercial satellites. But, if someone decides they just want to create a lot of space junk higher up then that could be a problem.