Hi this is Steve Nerlich from Cheap Astronomy www.cheapastro.com and this is *The robots are coming.*

Well, if you've been operating under the impression that Cheap Astronomy was your one sure stop for the latest in space news – nuh. Completely missed this one. I may possibly be the last person on the planet to know, but it has just come to my attention that on STS 133 in November 2010 they are going to fly to the international space station… a robot. And we are talking a real Isaac Asimov fully form-factored - not just some metal box that does science stuff - robot.

So – sorry about that. I thought we had it all covered back at Episode 47, outlining the then remaining shuttle missions to the ISS, but sometime around March 2010, it was decided to add something special to the STS 133 payload. There's a photo of it with the STS-133 crew - and it really is a bit like one of the crew. From the waist up it's like Bobba Fet except with a gold helmet. It's got arms and hands - and it can type messages on an iPhone.

And OK - from the waist down, well, it's attached to a post so there isn't a waist down - but hey it's definitely a robot - and a space robot as well. And… it's called R2.

So - here's the background. R2 or Robonaut 2 is a second generation design from NASA's Dexterous Robotics Laboratory – and built in collaboration with General Motors. The value of a roughly humaniform robot is that it can operate tools that have been designed for human hands – and can monitor what it is doing via a forward facing binocular visual system, so having a roughly human shaped torso with a head and two arms does start making sense.

Robonaut 2 lacks anything approaching an Asimovian positronic brain and is probably more akin to the Roger Zelazny's Hangman. So really R2 is a telefactoring device but that still means it's a lot more than just a remote controlled machine.

Similar to the thinking underlying Zelazny's telefactor concept, R2 has a degree of autonomy since in event the robot is to be directed from Earth, the long distance uplink/downlink radio delay would complicate effective remote control. So R2 has the capacity to be set tasks and then to see them through to completion, with just periodic status checks. This also means astronauts on the station can direct R2 to undertake various monotonous or repetitive tasks, freeing up astronaut time for other things. This means R2 does have a brain of sorts, actually positioned in its stomach, because its head is full of digital camera gear.

The plan for R2 is to fly it to the ISS and test it out internally – it's not built for operation outside the station where it would be exposed to vacuum conditions and significant temperature variations between sunlight and shade. But, operating inside the station will still be an interesting challenge. Microgravity may have unexpected effects on leverage, balance and lubrication. So for example, in a very literal sense, will elbow grease work in microgravity?

To avoid too much anthropomorphism, let's stick to engineering terms here. R2's data processing unit - the one in its stomach, has the job of managing the operation of its actuators - and interpreting and storing data that is fed back through its sensors. Actuators are the various motors that drive the motion of the robot - allowing its head to move up/down

and left/right and its shoulders, elbows, wrists and fingers to move through a range of motions within the limits of rotary joints.

R2's sensors are mostly visual - it has binocular cameras positioned in its head to give a roughly human-equivalent binocular perspective on the world and an additional infra-red sensor which can see in infra-red but also assists with overall depth perception. R2 also has tactile pressure sensors in its fingertips.

Each arm can support seven pounds (which is just over 3 kg for anyone outside the US) and each finger has a grasping force of five pounds. Now just as a purely academic exercise Cheap Astronomy googled 'force required to choke human throat' - and, not sure how reliable the source is, but (ahem) 5 pounds psi.

Now look, it's unlikely in the extreme, that any of the ISS crew are going to wake up to find a cold metal hand at their throat - since, there's no capacity in R2's brain for any HAL 9000 ideas to start developing. R2's brain is 90% stimulus-response which enables it to follow external commands effectively while the other 10% of its brain allows it to follow pre-programmed pathways – again in response to external commands. Also, R2 stuck on a post.

Still, there was an R1 prototype - that was first set atop a four wheel all-terrain buggy - and later a Segway. And for R2 - they're already talking about legs.

And hey, all that is absolutely fine too - but some keen Cheap Astronomy listeners might remember the story about the FPGA chip back in Episode 71 - being the chip that can learn from environmental feedback and kind of evolve? So, how about we don't give R2 an FPGA chip - that might not end well.

Anyhow, R2's first ride into space in November 2010 could be the start *of a whole new era of space exploration*. Cheap Astronomy also completely failed to notice the Project M white paper released by NASA in February 2010. This proposes that if the US wanted to get back into the Moon mission business quickly (before someone else does), but without all that tedious mucking about with risk management - and occupational health and safety. Well, why not just send a robot?

Even R2 can plant a flag and salute, as well as taking some cool photos and grabbing a few rocks. Technology has improved significantly since 1969, so conceivably you could land a lunar module by remote control without needing Neil Amstrong at the wheel and hopefully return it safely to Earth as well.

The Project M mission plan could potentially revive the Orion command module and the Altair lunar module - but with a dash of green. There is a new focus on using liquid oxygen/methane propellants - which is a little theoretical but should theoretically give you higher density fuel that could theoretically be produced from raw materials on Mars. So, you can see where all this is going.

Our future interplanetary robots might scoot around on all terrain buggies or Segways - or even legs – able to keep their battery backpacks charged with solar panels during the day and perhaps heavier battery stores during the night. So, they could act as an advance

landing party that could work around the clock to prepare a high tech installation for the eventual arrival of the puny, fragile humans from that blue and white orb in the sky.

Thanks for listening. This is Steve Nerlich from Cheap Astronomy, www.cheapastro.com. Cheap Astronomy offers an educational website where we promise to open the pod bay door. No ads, no profit, just good science. Bye.