Question 1:

Dear Cheap Astronomy – If we did colonise the Solar System, what would we do with the different planets?

It remains to be seen if we will spread out across the solar system. While we starting to feel more confident about avoiding a mass extinction asteroid strike, a super-volcano eruption could just as easily end civilization as we know it. There's also the more mundane scenario of where our population keeps growing, we run low on resources and then fight a bunch of wars over what's left, pretty-much trashing what's left of the ecosystem in the process.

But OK, there's reasons to be optimistic that none of those things will happen and we will expand our range across the solar system. Getting to that point involves an unpredictable train of events driven by mostly unpredictable economic drivers, but some basic principles should prevail. The most important principle is that we'll go where the money is. It's daft to think anyone is going to foot a multibillion dollar budget to establish and maintain an off-world colony just for the heck of it – nor could the tenants could afford the rent without a vibrant space-economy working in the background.

It is conceivable that in the coming decades bases will be established on the Moon, much as they are on Antarctica now. Once one country settles in then others will follow, just to make sure they can get a piece of the action, as soon as someone figures out what the action is. For Antarctica, the main action is the noble pursuit of science, though no doubt there's a bit of fossil fuel and mineral prospecting going on as well. I mean, no-one's that noble. Moon bases will probably follow the same model with a fly-in fly-out workforce doing months or years long stints there, ostensibly for science, but with an eye out for other opportunities. However, the cost of maintaining lunar bases would be a couple of orders of magnitude more than Antarctic ones, so there will be more pressure on governments to achieve some kind of return on investment which is likely to result in them opening up opportunities to private industry.

As we discussed previously, tourism and mining are the obvious opportunities to open up. Once you've got tourists coming to the Moon on a regular basis, then you could start looking looking at trips further afield, since it's a lot easier to launch from the Moon than Earth. As for mining, regular listeners will be aware we think the Moon will be the future centre of asteroid mining, where it makes more sense to bring rocks to the refinery than to take the refinery to the rocks, so we'll be crashing $#!+ on the Moon and then sorting through the rubble – presumably on the far side away from the tourists.

If crashing $#!+ on the Moon works out then crashing $#!+ on Mars will take it to a new level since Mars is next to the asteroid belt. Being that much further away from Earth, it's more likely people are going to stay on Mars for years, if not decades, so the prospect of having children and growing old on another planet may then become a reality.

Of course, there are other places to live in the solar system – potentially anywhere if you are willing to invest in the energy costs of maintaining a habitat. But, economics will determine what we do and where we go. So, while you could live on a balloon floating in the clouds of Venus and while you could live on Pluto with enough central heating, it's not clear what you could do in an economically-useful sense in either location. A holiday in the Venusian clouds would be a holiday in dense fog, while Pluto would be pretty much a holiday in the dark –

although there should be just enough light to make out the shapes of some interesting nitrogen ice formations. So, if tourism isn't a goer, it's hard to see what else would draw people or industry to such places in the short-term. But in the long-term, our industrial endeavours might have expanded to what's achievable by a Kardashev Type 1 civilisation, who through technological advances will have access to orders of magnitude more energy than is currently accessible by us and hence have much more capacity to exploit resources across the Solar System. And since we just raised this whole new perspective so late in this episode, you've probably already guessed that this will be the subject of Part 2.

Question 2:

Dear Cheap Astronomy – If we colonised the Solar System, Part 2

In part 2, we are looking into the far future which has access to speculative technologies, which may or may not come to pass. Indeed, as we stated in Pt. 1 we may never get beyond leaving a few footprints on our local satellite before civilization as we know it collapses. But if we assume the rise of technology can be kept on its current trajectory indefinitely, then sure, all sorts of things could become possible.

But this is Cheap Astronomy, so we have lay out some wet blankets. Firstly, warp drive just isn't going to happen and any speed that even approaches light speed is a) going to require an absolute $#!+-ton of energy and b) would be insanely dangerous with respect to collisions with small particles, let alone big particles. If we could manage just one percent of the speed of light that's still an insanely fast 11 million kilometres an hour. At that speed you might manage to get to Pluto in around 23 days – although let's call it 30 days, since you will need survivable periods of acceleration and deceleration at either end of the journey.

But, given that we're dealing with advanced technologies, it remains to be seen whether taking over the Solar System actually requires us to be all over it. Alongside developing the future capacity to fly at insanely-fast speeds, we should also see some major advances in robotics. including telepresence, that is the ability to see and touch the things that your robot sees and touches. So, why put your own life at risk if you can just send a robot. While light-time radio delay eliminates the possibility of real-time decision-making, artificial intelligence and robot redundancy would work nearly as well – in other words, if one robot makes a mistake, you just tell the next one to follow a different algorithm.

Anyway, whether it's us pulling the levers, or the robots doing it for us, these are the sorts of things we could be doing out there. On Mercury, you'd have an abundance of solar energy and good mining prospects, with any non-organic mineral deposits available on Earth also being available there. Mining-wise the same goes for Mars. Venus' surface is pretty inaccessible, but its dense atmosphere represents a great source of CO_2, useful for photosynthetic food production, or you could lyse it for the oxygen, or you could combine it with H_2O to make methane if we're still doing mundane chemical rocketry in our far future. As for water, well there's a bit on the Moon and a bit more on Mars and probably a lot more in the outer asteroid belt past the frost line. There's also water on the ice moons of the gas giants along with an abundance of hydrogen available from the gas giants themselves.

Farther out, there's a Kuiper belt full of ice blocks, although the further out you go the more it's just empty space, with just the odd occasional speck of something.

But sorry, we are going to have to keep laying on the wet blankets – this is Cheap Astronomy where just because something could happen doesn't mean it will happen. Regardless of the seemingly magical transformations that future technologies may bring, the basic principles of return on investment will still apply. So, for example, no-one's going to be sucking CO2 out of Venus' atmosphere unless there's a genuine need for it and unless the benefit gained outweighs the cost of gaining it.

So, getting back to basics, it's likely our next short-term step is to start sourcing rare Earth metals from near-Earth asteroids. This will require a refinery and probably a permanent human presence on the Moon, where we'll first crash and then refine asteroid ore. If we can manage that much, then you have a good rationale to start sourcing off-world water for the lunar bases. And OK we'd maybe then consider starting to make rocket fuel off-world, although you'd want a decade or more of quality assurance testing before anyone hopped aboard such a moonshine-fuelled spacecraft. After that it's all pretty-much science fiction – until we really do manage these first next steps. Fingers crossed.