



The International Space Station is *one big buffalo*

and we want to use *every bit of it*

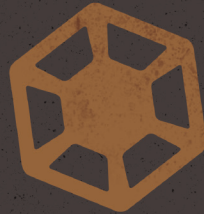
Greg Vialle has a plan to save the ISS – it's not what you're thinking.

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Space sustainability has become a critical issue for the industry and is dominating conversations with increasing frequency and urgency. Deorbiting spent space hardware is being touted as the solution, but this approach is anything but sustainable.

A few teams are looking to alternative options and one of the more intuitive is on-orbit recycling.

Greg Vialle, founder and chief ideator at Lunexus Space takes us through the fundamentals.



Why has deorbiting become the default solution for space debris?

There's no place to take space junk right now. There are no depots to send satellites to, and there's no real graveyard orbit in low Earth orbit range. It's as easy to deorbit something as it is to take it to a depot, fuel-wise. But without alternatives, deorbiting is the default solution.

What philosophical disagreements do you have with the way space sustainability is being tackled today?

At the rate we're putting stuff into orbit, we'll hit about 70,000 satellites by 2030 - that's our carrying capacity before we start seeing problems with collisions. Even if you're de-orbiting everything, you're still going to hit that number, it's just going to be a little bit later.

'Who can think that vaporizing space grade materials in our upper atmosphere at a rate of kilotons per year could possibly be a good idea?'

What's the difference between recycling and reusing space materials?

We often conflate recycling with reusing. Take Starlink - they're not de-orbiting because their stuff is wearing out, they're de-orbiting because of obsolescence. They've changed their design three times in six years. You recycle materials, you reuse components. The beauty of recycling is that materials can be reconfigured into whatever the market demands.

What's the value of space debris and how retrievable is it?

We don't have anything to recycle in space, and we struggle to recycle stuff on Earth. There are some advantages to doing things in a vacuum - you don't run into atmospheric effects of oxidation. In the short term, we're looking at consolidating debris and using it as shielding for radiation or micrometeoroids. It's similar to how we downcycle materials on Earth, like turning old tires into playground mats. There are ways to put this 'junk' to good use in orbit while we figure out how to turn it into higher-value products.

Why do you believe recycling in orbit is a valid solution and what will it take to shake up the industry's fixation on deorbiting?

I started thinking about this a dozen years ago when DARPA hosted the first 100 Year Star Ship Symposium. I began looking at how you would recycle and regenerate *everything* on a generation ship going to Alpha Centauri, traveling at a fraction the speed of light, no stopping for supplies.

Two years ago I participated in NASA's Orbital Alchemy Challenge focused on recycling in orbit, and took home two awards that were the genesis of my company, Lunexus Space.

Wasting what we've already paid 'the gravity tax' on getting into orbit, just to have to re-mine, re-refine, and relaunch it seems pathologically shortsighted. It costs about \$4 US per gram to get anything into space (except humans - they're more expensive). What if you could source your feedstock materials from what's already in space? What if you could sell your manufactured goods to customers already in space?

What if, in solving both of those business problems, you could also incentivize 3rd parties to clean up space debris and consolidate it in orbital hubs of innovation and commerce?

Who can think that vaporizing space grade materials in our upper atmosphere at a rate of kilotons per year could possibly be a good idea? A number of people think that what *will* light a fire in the industry will be loss of life due to a deorbit incident. I'm hoping that good outreach, education and messaging will energize the public to get on board with recycling as a better alternative before then. Deorbiting is only the third worst alternative - we definitely don't want to be leaving stuff in place to create Kessler Syndrome, or a fear driven moratorium on space development.

What will it take for the industry to view space debris as a resource, rather than a problem?

We are putting new satellites up at a frenetic pace, doubling about every 2 years approaching Moore's Law type of growth. ▶

The commercial satellite market in LEO is projected to hit \$20B in the next year or two.

Even with new technologies like Starship, there are only so many launch windows in a year - the more crowded it gets, the smaller the launch windows. At some point, the launch industry will not be able to meet the demand for mass on orbit.

Viewing obsolete hardware as a resource is something our terrestrial recycling companies struggle with. This is because we're sitting on a pile of resources, and we have an established infrastructure of mining and refining dating to the dawn of the Industrial Revolution, it's hard to compete.

In LEO, there is no such infrastructure, and what we've been dumping there happens to be the exact same space-grade materials we need to build new space hardware.

'Orbit Recycling' who were planning on transporting aluminum-based debris to the moon for recycling has gone silent. 'CisLunar' have shifted to electric propulsion and power processing units (PPU's). What is happening in the orbital recycling and manufacturing world?

The tech startup world is built mostly on the VC model. Venture capitalists want returns in a 5 year timeframe or faster, so startups pivot to nearer-term products. But creating a commercial space-to-space economy isn't a sprint, it's a marathon.

This is where governments can and must help, which is why I created a petition at www.change.org/RecycleISS, and why I'm building a consortium of space companies to propose recycling the International Space Station instead of deorbiting it in 2030. The gaps in doing this are not just technological; there's a whole framework of liability and international law, and really, a whole economic system needed.

CisLunar Industries is part of this consortium, and is still very much invested in the vision of recycling space debris. PPU's are something they needed to develop for their own needs, for which they've found a side market. Remelting metal takes a lot of power! It took over 50 years of government funding, but the infosat industry now has a commercial economy. It will take at least a decade of government investment in orbital manufacturing and recycling.

What I am proposing is that governments use the ISS itself as

'look, if you can't mine defunct satellites—made of refined, space-grade materials in low radiation orbits near Earth—how do you expect to mine an asteroid'

the primary incentive for private companies to innovate orbital recycling.

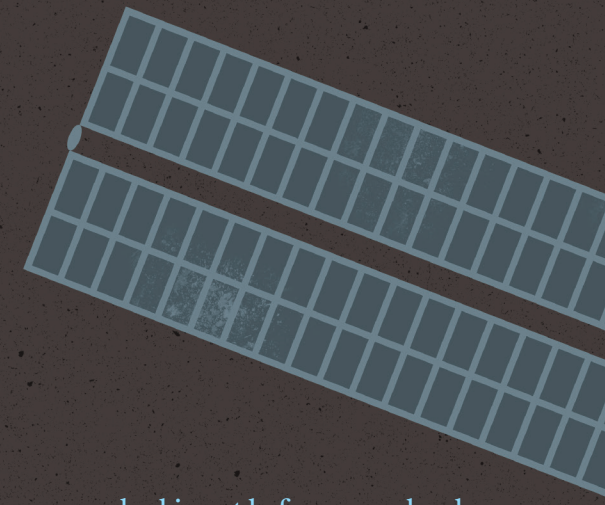
Is there a segment that the orbital recycling movement should focus in on as a gateway for orbital recycling in order to demonstrate its value to the wider industry?

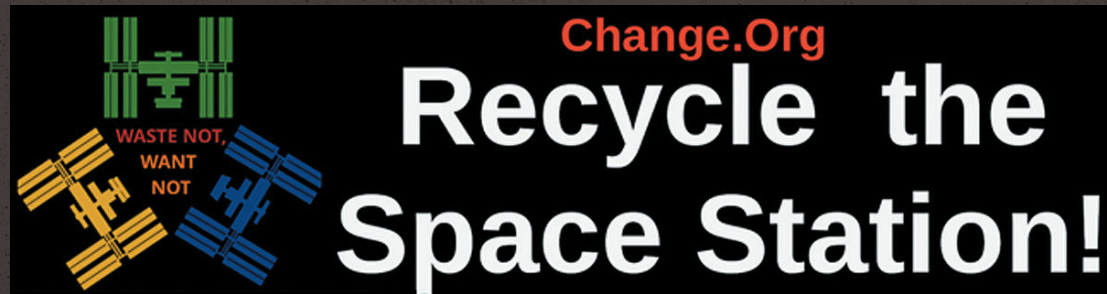
The ISS is 430 metric tons of space-grade materials, and the biggest bang for buck in converting to feedstocks that can kickstart a manufacturing economy in LEO. It's one big buffalo, we want to use every bit of it, advancing the industry enormously, including potentially helping the recycling industry on Earth with new tech.

What timeframe are we looking at before space hardware is being repurposed commercially as a reliable service?

Let me first note that repurposing, reusing, and recycling are not all the same thing. Recycling is taking the materials out of the product and reconfiguring them into feedstocks that can then be used where they provide the most value by market demand. Reusing and repurposing are what you do with products. Recycling, you do with materials.

There may be a use for let's say, the ISS cupola to be repurposed as a microgravity greenhouse research facility. Wire harnesses on the ISS might be reused in new systems. Due to vacuum welding and aging, a lot of the ISS will best serve humanity by being recycled into feedstocks for new space infrastructure, using new technologies like 3D printing and vacuum deposition. You no longer have to design stuff to survive launch when you are already in space. In the case of Lunexus, we are trying to recycle solar arrays in space, ►





not reuse them. We think we can leverage the abundant vacuum in space to manufacture thin film, roll out solar arrays, 'ROSAs', to make 100 times the surface area for every array we recycle from old silicon wafer tech.

We need to start with the ISS in 2030 when it's scheduled for decommissioning.

There will be challenges in turning recyclates into feedstocks that will allow hardware and infrastructure to be made in orbit. On Earth, no single company builds space hardware from raw materials; they buy parts and subcomponents from other B2B companies. We're working hard to develop a slew of manufacturing technologies that can work without gravity, align with others' progress, and match the debris-capturing capabilities many ventures are working on. It won't happen overnight, but it will gradually come online in the 2030s.

What resistance have you faced from players who prefer to look the other way when you mention the topic?

NASA has published white papers explaining why the ISS has to be deorbited. When recycling comes up, the idea often gets deflected to turning the ISS into a museum or tourist destination, which is a different effort. I agree with NASA that this isn't a great idea. The ISS is falling apart, and even if tourism becomes feasible, it would only compete with the commercial stations being developed to replace it. We need to reach for the future, not cling to the past.

As for recycling, it won't matter what condition the ISS is in, it'll all go in the shredder, except for parts we can reuse as they are. You don't even need to move the station. Just build a depot at one end and start feeding the ISS into it.

I also hear a lot about why it's better to mine the moon or asteroids. But look, if you can't mine defunct satellites, made of refined, space-

One of Lunexus Space's 'Recycle the Space Station!' bumper stickers.
Image Credit: Lunexus Space

grade materials in low radiation orbits near Earth, how do you expect to mine an asteroid in deep space, composed of unknown minerals (of uncertain value), electrostatic dust, and rubble?

What's something you didn't know about orbital debris recycling at the start of the year?

How many new companies are in the Capture, Service Transport sector (what others may call space tugs or OTVs).

I had a conversation with another space company founder who told me they'd counted 200. There are still a lot of pieces that need to fall into place to realize servicing in space, but this is a critical piece.

How would you describe what you do to someone who knows nothing about the space industry or orbital debris?

We recycle solar cells in space. In orbit, everyone has them, and everyone needs more.

Where can people reach you?

Find me on LinkedIn! Or come visit the website.

lunexus.space

