University of Manitoba: "What's the Big Idea?"
Series 4, Episode 1: PHIL FERGUSON

TITLE
Nation-Building in the Sky: How UM is Shaping Space Stewardship

INTRO MUSIC FADES IN

INTRODUCTORY MONTAGE

1. https://www.youtube.com/watch?v=1U6xbpYRia8
   Final Countdown and Liftoff on the CRS-21 Mission! NASA's Kennedy Space Center, 2021
   "10-9-8-7-6-5-4-3-2-1" *sounds of rocket blasting off* "Stage 1 propulsion is nominal."

2. https://www.youtube.com/watch?v=nF8sz7YfzGs
   Elon Musk's Space Monopoly: How NASA Paved the Way
   "Imagine a world where one person holds the keys to the cosmos. Where the final frontier is no longer a shared human endeavor but the private playground of a single billionaire."

3. https://www.youtube.com/watch?v=PyMdC5x8Cec
   Elon Musk now controls two-thirds of all active satellites, The Independent, February 2025
   "Elon Musk now controls two-thirds of all active satellites orbiting Earth."

4. https://www.youtube.com/watch?v=55xUYuSgxNk
   Who owns outer space? | LSE iQ Podcast
   "Rather than the nationalism and competing political ideologies that drove the first space race, the new space age is as much about money as it is about scientific discovery and national glory. Against the growing democratization of space, can any nation or company really lay claim to any part of it?"

5. https://www.youtube.com/watch?v=BWPy3jwpgkA
   Software for Space: Democratizing the Space and Satellite Ecosystem, Intel Newsroom, 2024
   "Imagine a world where more and more satellite resources are actually helping us to monitor and improve and mitigate climate change."

   Phillip Ferguson
   "We need to find a way to be responsible stewards of space, and in Canada, we're poised to be leaders in that. It strengthens our economic prosperity; it strengthens our ability to live and work on the land. I like to think of it as a nation-building project, like the railways were."

INTRODUCTION

MICHAEL: Welcome to Season 4 of UM's award-winning podcast, What's the Big Idea? I'm your host, Michael Benarroch, President and Vice Chancellor at the University of Manitoba. We're starting season four with a bang or a blast off.

My guest is Phil Ferguson. He's an aerospace engineer in our Price Faculty of Engineering and the president of the Canadian Aeronautics and Space Institute. Nothing special, just a rocket scientist. He studied at MIT before the gravity of our campus pulled him in. Phil established and runs UM's STARLab, which attracts students from around the world. He and his students have built amazing things, including satellites that launch from the International Space Station to study asteroids.

Ferguson models how space innovation can be in service to people and communities, not just markets. And he tells me he has big ideas for helping more people reap the rewards of having a satellite in orbit. Stay with us. Season 4 is going to the stars.

MUSIC FADES OUT

MAIN INTERVIEW

MICHAEL: Phil, I've been looking forward to our conversation. I became more familiar with your work, a couple of years ago. And I knew we had to have you on What's the Big Idea. So, I'm so glad that you're here today. You told me that your big idea is that space isn't just the next frontier. It's a shared environment. And I don't think we all consider it that way. But to protect it, we need to design a future that's both sustainable and inclusive. One that connects people on Earth without compromising the planet or the cosmos. So, I think this is really exciting. But why do we need to think about space in that way?

PHILIP FERGUSON: When I think about the space industry, and I worked there for 10 years before I became a faculty member here at the University of Manitoba, we were doing great work. We were making robotics for the space station. We were making satellites that sensed the Earth. We were making lots of different things for space. And yet, I came to realize that a lot of the people in this country and around the world are not benefiting from these huge space programs that we're doing. And it's because of cost. When a space mission costs a billion dollars to launch, it's very difficult for people, say, like in the Arctic or in the northern part of Canada to access that technology. And so, what I thought we needed was a strong research program to improve the access of aerospace technology for the people that need it the most, like the people in the northern parts of Canada that are experiencing climate change four times faster than the rest of the world. And we need to turn. We need to change the way that we think about aerospace technology and not just make it for the big companies and the big governments, but also to do it with communities for communities.

MICHAEL: And so why wouldn't government do that?

PHILIP FERGUSON: Government tries. I think that they try really hard, but I think government is also torn because they have one mandate which is to support businesses and to support corporations to make lots

of money. Their other mandate is to support Canada and Canadians, and I think sometimes those two things conflict. What they need is a kick in the pants. This industry needs to be kicked in the pants a little bit and say let's put community first and let's co-develop this with community members and see where we get to and that's what we're trying to do at STARLab.

MICHAEL: So, let's think a little bit about the co-development and then get into why this is so beneficial. So, you're looking at leveraging space through the lenses of sustainability, fair access, and even reconciliation. Maybe not the same approach as a Musk or Bezos, right? And what they're trying to do. But I think that there's a great example of the project you're leading now, with your students, that involves building a satellite with people of Chesterfield Inlet, in Nunavut. I read that this is the first ever remote-sensing satellite co-developed with and operated by an Arctic community. First of all, what exactly are you co-developing?

PHILIP FERGUSON: What we're doing is we're trying to detect ice thickness and ice quality from space. And this is becoming a bigger and bigger problem now that climate change is affecting the way that people live and operate in the Arctic. And so, what the hunters and trappers need is better information, particularly in the spring and in the fall, as the ice is changing rapidly, to know where the safe places are for them to travel. But of course, we as engineers, aerospace engineers, or remote-sensing science or remote sensing scientists, we can't do this on our own because we don't know what safe ice looks like or what unsafe ice looks like. The experts in that are on the land, in the communities. These are also experts in how to create equipment that can survive extreme environments and space is definitely extreme. So, the researchers, and I use that word in every sense of that word, researchers in Chesterfield Inlet, Nunavut are part of our research team. They're paid members of our team and they're contributing to satellite design, remote sensing systems design, and ultimately, the way that they will operate this spacecraft. It's integral to the whole project. We're building it right now.

MICHAEL: And it’s going to relay information that will be interpretive about levels of sea ice or breakdown of sea ice and then that will impact where they hunt?

PHILIP FERGUSON: Yes, exactly. Where they travel, where they hunt. This project, I should add also, was conceived by myself and the late Dr. David Barber. David Barber and I talked about this years ago to say, hey, you know what's needed right now. There are a lot of satellites, in space right now, that measure sea ice thickness. But none of those satellites are accessible to the communities. We need a satellite that's actually built by the communities and operated by the communities. And when that data dovetails in, with other Canadian assets, like the RADARSAT Constellation Mission satellites, built right here in Winnipeg, by the way, this together now adds an incredible source of data and information that the community can now act on and in an accessible way.

MICHAEL: So, the community is going to control the satellite. Information’s going to flow to the community. And then they’ll map routes.

PHILIP FERGUSON: That's right. Exactly. And I think the other key aspect about this too is data sovereignty and data security, right? So, I mean, it's one thing for the government of Canada to build a bunch of satellites, take some pictures of their backyards, the community's backyards, and then try to sell it to them. We're turning that on their head and saying, hey, you know what? This is their data. They

collect data about their communities, and they use that data for the safety and prosperity of their own communities.

MICHAEL: So, when I think of a satellite, you're talking about building this satellite and having the community help to build it, provide some of the knowledge, I think of some really high-tech device, looking like a spaceship that goes up there. What is this satellite?

PHILIP FERGUSON: Yeah, no. So, these satellites are very small. They're also high tech, but they're very small. This satellite's about the size of a carton of milk.

MICHAEL: A carton of milk?

PHILIP FERGUSON: A carton of milk. Yeah, exactly. And because we're building them so small and we're building them with the same kind of electronics that shows up in your cell phone. These satellites cost us less than $50,000 to build and less than, a couple hundred thousand dollars to launch, but for well under half a million dollars, we can make a space system that can change the lives of communities, right? When we do it with the community. And that's what's so key to this accessibility. It's small, and because it's so small, we can leverage all the rockets that are launching, every week. So, SpaceX is launching their Falcon 9 rocket, three or four times a week right now. Many of those are what we call ride-share missions, where they offer little spaces on the rocket for small satellites like this. So, we have opportunities to launch every week, if we want them. And this is adding to that accessibility that I was talking about before.

MICHAEL: So, in this small carton of milk, what kind of technology is in there? What can that technology do?

PHILIP FERGUSON: So, in that little carton of milk, we have a power system that's batteries and solar rays that charges itself and makes sure that it has enough power to collect data over the Arctic. We have a communications system so that we can communicate that data to the ground. We have a control system that uses the latest advancements in machine learning to point this spacecraft where it needs to point to collect the data. And then all of that is monitored by additional artificial intelligence to try to understand if something is going wrong, how can it fix itself, or phone home if it needs help. So, there's a lot of high-tech stuff that we've built into this small spacecraft, at a fraction of the cost of what these large spacecrafts would cost.

MICHAEL: And what's their life cycle?

PHILIP FERGUSON: It depends on how high they are in orbit. The first satellite that we launched, we launched a satellite in 2023 as part of a geology mission. That one lasted about a year because it was in a low orbit. This one we're expecting to last about seven years. So, two years of operation and five years of de-orbit to get it out of space.

MICHAEL: Now, you've also worked on drone-based platforms, essentially solar-powered airships or blimps, as we call them. And you're working on this to bring better internet access to Northern communities, right?

PHILIP FERGUSON: Absolutely. This is another area of accessibility. This project is called ACCESS. It stands for Arctic Community Connectivity for Equity, Sustainability, and Service. And what this is trying to do is leverage satellite communications technology to provide high speed internet access to the hunters and trappers on the tundra, on the sea ice and out on the land, when they're away from their communities, to give them the security that they need to stay safe and understand how the climate is changing around them.

MICHAEL: So how does it do this? I'm thinking of a drone.

PHILIP FERGUSON: Yeah, well, exactly. And so right now, many of us in Manitoba and around the world have Starlink internet, but that requires a relatively large satellite dish, which is difficult for people to carry with them on a sled or a snowmobile or something. So, what we're doing is mounting Starlink equipment, so the equipment that can access high speed internet from space, mounting that on the top of an airship and then connecting that down through a power system, so hundreds of kilograms of batteries and solar panels, through to a Wi-Fi terminal basically. And it will broadcast this signal down to the cellphones of the hunters and trappers, when they're out on the land. So now they have the capability to phone their elders or their family members or their healers or other hunters that are out on the ice, to talk to them about their conditions, phone home if they have any trouble, if they get lost or stranded on the sea ice. And now they've got a quick solution, which they haven't yet had.

MICHAEL: And so essentially, you can create a system where there's no communication gaps.

PHILIP FERGUSON: Exactly. I was in a meeting in Winnipeg last year, it's called the Hudson Bay Consortium, and it was all about search and rescue and they came to me and said we have this gap right now of research and rescue. We have problems of people get stranded on the ice and I asked them, how many times per month do you go out to rescue people and they said about 10 to 15 times a week. 10 to 15 times a week that they're going out to rescue people that sadly, oftentimes those stories don't end well. So, I had a woman come to me and ask me if the drone systems that we're building could help find the body of her son who perished a week prior. And yet she flew to Winnipeg to talk to researchers about how to improve communications in the Arctic. It’s a powerful need that's out there and one that we have the capacity to solve, using aerospace technology, but only if we do it in this co-developed way that improves access.

MICHAEL: Is it possible then? Suppose a hunter's going out. You've got this communication system. Is it possible then to track the person? Have like a tracking device and that way you could always you could always know where they are?

PHILIP FERGUSON: Yes, it's possible. We need to make sure that we balance that with the privacy of the hunters and trappers, as well. But this, again, is why it's so important that it's not just a bunch of us here in Winnipeg making a solution and delivering it to the Arctic. We're there often and we work with the community, and we learn from them, learn from their experience on the land and learn about their constraints.

MICHAEL: We're talking about a lot about Northern security and Arctic security now. Being able to improve communications networks, monitoring networks, kind of extrapolating from the community need to Canada's need.

PHILIP FERGUSON: Nobody would argue with the statement that a connected Canada is a strong Canada. So, a Canada where we can communicate with everybody, from coast to coast to coast, strengthens our security, it strengthens our economic prosperity, it strengthens our ability to live and work on the land and I like to think of it as a nation-building project, much like the railways were.

MICHAEL: Can I just go back to when you first started to think about this? What made you think about moving in this direction of this application, for satellites and drones?

PHILIP FERGUSON: I had a conversation with some of the Inuit people in Chesterfield Inlet. I was traveling there with some other researchers from the Center for Earth Observation Science, and I was introduced to them through David Barber. And they said to me that they feel like they're in the dark, a little bit, that they don't have the information that they need to stay safe and to respond to the threats that climate change is posing to them. And one of the things that they did is, she pointed to a ship that was out in the bay, and she said, see that ship there? We don't know where that ship is from. We don't know what that ship is doing. Sometimes they send little boats to shore and they're there for a while and they go back. The sound of the ship is scaring away the beluga whales. And if they were to have an environmental disaster, we don't know how we would respond. And she said, if I can know one thing, it would be when is the next ship going to come in our harbor? And I said, we know that information. You know, Canada is a leader in tracking ships using satellites. It's called AIS or Automated Information System. And yet, we're not delivering that data to the people that need it. So, when I started to learn about these inequities and the fact that in Canada, we're leaders in aerospace, we're leaders in aerospace right here in Manitoba. And yet we don't have solutions to these problems yet. I thought, this needs somebody to step up a whole research lab, a whole research community, like what we have here at the University of Manitoba to solve these problems. So that's what really kind of led me into it.

MICHAEL: That's fascinating. And I wanted to ask you one more question about the community. You said that they're involved in the research because they understand cold weather. They understand the Arctic. Can you give me an example of something you've learned that you've incorporated into the satellite?

PHILIP FERGUSON: We've learned a lot about how to get cold mechanisms to work. People always say if you've got a broken snowmobile, the best person to ask how to fix it is an Inuit person that lives in the Arctic. I've heard stories of people that have been able to make snowmobiles work with sticks on the ground that they can find. Ways to provide clearances, ways to lubricate equipment to keep them functioning in extremely cold weather. One of the challenges in space is that we have these incredible, what we call thermal gradients. So, one half of the satellite that's in the sunshine will be very hot, like 80 degrees Celsius, and the shaded side will be minus 30. And so, we have challenges of metal that's expanding and contracting. And so, we've been able to learn about tolerancing and mechanical design from the Inuit that do this every day.

MICHAEL: You've also written about-how many satellites there are and some of the environmental challenges. So, satellites end up burning up in the atmosphere, right? And they release chemicals that can harm the ozone and especially with growing numbers. And so, given your focus on satellites in the Arctic, how worried should you be and as an engineer, do you think we can design better satellites that might be more environmentally friendly?

PHILIP FERGUSON: Absolutely. I think the adage of reduce, reuse, recycle applies in space also. So, a lot of organizations, NASA, the Canadian Space Agency, the United Nations have started putting out new regulations on how people need to remove their satellite from orbit so that it doesn't pose a collision hazard, first of all, to other spacecraft. Now, like you say, what most people do is they just deorbit the spacecraft, so it burns up in the atmosphere. And while that was fine, in the early days of the space program, where we were maybe re-entering a dozen spacecraft a year, now it's thousands. And so, what we're starting to think about is, well, what are the chemicals that we're putting into these spacecrafts?

Most of it is aluminum, but we also have some pretty nasty chemicals in there too, like cadmium, like lithium, like lead. And these are things that we probably don't want to have in the upper atmosphere. So, we're looking at ways to detoxify spacecraft so that when they do burn up, first of all, they burn up entirely, so that we don't end up with blazing balls of metal that come flying through somebody's house. But then secondly, what does remain in the atmosphere is more inert.

This is an active area of research that we're getting into. We've also developed some space systems with local companies here, like Precision ADM in Winnipeg, that does additive manufacturing or 3D printing to build little thruster modules, that we can extend the life of spacecraft and allow them to steer clear of other spacecrafts so that they don't collide with one another. Because a spacecraft that's collided with something else is two problems. Number one, it's a dead spacecraft and you can't control it. But number two, that one spacecraft has now turned into thousands of pieces of space debris that now pose hazards to other spacecraft. So, we're developing technology that allows us to move out of the way, to prevent collisions, to remove the spacecraft from orbit, but also materials that allow us to maybe consider the environment a little better.

MICHAEL: Do they crash in space?

PHILIP FERGUSON: They have crashed.

MICHAEL: Really.

PHILIP FERGUSON: Yeah, it's happened several times, by accident. There's actually a hole in the Canadarm right now, on the space station, from a piece of debris that flew through it. There was one catastrophic collision between a communication satellite and a defunct rocket. I think it was a rocket or maybe it was a Russian satellite. It resulted in tens of thousands of pieces of debris that are now being tracked by international organizations, around the world. Sadly, we've also seen a few demonstrations of spacecraft weapons that have purposefully blown-up other spacecraft and resulted in debris clouds, which is generally frowned upon in the international community of space researchers. But like climate change, we all need to work together in this world to make space a safe place for everybody.

MICHAEL: And of course, there's no way of returning these through the atmosphere. They're going to burn up.

PHILIP FERGUSON: Oh, that's right. They will burn up. But in some cases, they may be in space for hundreds of years, depending on the orbit. So, if they're high enough, they could pose a threat for centuries.

MICHAEL: And why do we need so many? Why can't we share information?

PHILIP FERGUSON: That's great question. I think, like everything else, everybody wants to own their own data. So, I think data ownership, data privacy and the space race is still very much active.

MICHAEL: I was just surprised to read how many satellites are up in space.

PHILIP FERGUSON: It's tens of thousands, right? Yeah. So, I think we need to find a way to be responsible stewards of space. And in Canada, we're posed to be leaders in that area.

MICHAEL: You're in another mission. You're leading with LISSA, which is small satellites with big missions, right? This is that notion of protecting Earth's orbital environment. What exactly are you doing there? I think you're doing some work in the South Pole, is that right?

PHILIP FERGUSON: That's right. So, LISSA stands for Little Innovator in Space Situational Awareness. So, it's LISSA with two S's. And it is a small cube set. Now this one is twice as big as ArcticSat. So, not a carton of milk, but more like a toaster, let's call it.

And so, this toaster-sized satellite will launch with a larger satellite that Magellan Aerospace here in Winnipeg is building. That one's called Redwing. The Redwing spacecraft is about the size of a washing machine. And so, a few days into the mission, Redwing will deploy LISSA and the two spacecraft will first take pictures of each other. They're going to do a little ballet, together in space. They're going to fly circles around each other and take pictures and calibrate their sensors.

So, LISSA will have some patches, on it, of known colors and known reflectivity that Redwing will take pictures of and vice versa. On LISSA, we have an infrared camera that's being developed by the United Kingdom's space defense sector. And we're flying that for them, but we're the ones that are controlling LISSA, here at the University of Manitoba, in flying in parallel with the Redwing spacecraft. So, it's the first time ever that we will have done a tandem mission. So, two spacecraft flying information for the purposes of checking out space objects or space junk over the South Pole. And you're right, it is over the South Pole. And the reason why that's important is because we don't have a lot of visibility over the South Pole. Most other places in the world, we have ground-based telescopes and radars that can track objects, but the South Pole, we're kind of blind. And that's dangerous because a lot of spacecrafts' paths intersect over the South Pole and so if they're gonna have any collisions, it's probably gonna be over a polar area. We see a lot in the North Pole, not a lot in the South Pole. So, LISSA and Redwing are trailblazing missions, really, that will be cataloguing these space objects and making sure that we can keep low Earth orbit safe.

MICHAEL: And you have students here at U of M working on this?

PHILIP FERGUSON: We do. Yeah, my whole lab at the Space Technology and Advanced Research Lab or STARLab. They're building these satellites. The University of Manitoba co-owns the satellite clean room called the Advanced Satellite Integration Facility, at Magellan Aerospace. We build and assemble the spacecraft there and then we eventually ship it to the launch vehicle, and we watch it launch and then we operate it.

MICHAEL: So, a kid on the prairie growing up, who has a dream of being an astronaut, maybe not quite becomes an astronaut, but can certainly work on building satellites and being part of that world.

PHILIP FERGUSON: Absolutely. That was me. I wanted to be an astronaut, but I'm colorblind. And so, the astronaut was like, OK, you can't do that. So, let's make stuff that goes into space. And I think more importantly, let's make it accessible so that Manitobans and Canadians can actually use this data for a better future.

MICHAEL: I wanted to be an astronaut, but I have terrible vision, I'm uncoordinated and I'm not very strong.

Laughter

Well, that's really fascinating. And it's amazing that we can do that on this scale. I mean, you don't have to go to NASA we have the companies here in Winnipeg that we could work with. You just talked about the importance of having a Magellan or a Boeing, here in Winnipeg, and obviously you're partnering with them.

PHILIP FERGUSON: Yes. And it's that partnership is absolutely critical. Because it's one thing for me to stand up in a lecture hall and lecture on vector calculus and how to point spacecrafts where they need to point. But it's something totally different to actually do it and do it with people that have been working in this industry for decades. And that's one of the strengths of this partnership that we have with Magellan Aerospace. We're training the next generation of space scientists, space engineers, aerospace engineers, and Magellan needs them. You know, Magellan has got incredible contracts of putting spacecraft all around the world and other worlds. And they need the best of the best. And we're creating them right here at the University of Manitoba. But it goes two ways, right? So, the students benefit because they work in a real, satellite-manufacturing clean room and they're learning from real aerospace engineers that have been doing this. But Magellan benefits because they get to see the next generation. They hire them and now they become, the future engineers at Magellan Aerospace. In the last eight years, they've hired a dozen of the students that we've graduated and we're just creating that pipeline and we're making sure that Manitoba stays strong in the aerospace sector.

MICHAEL: So, you've launched a satellite, right? That was the first one from University of Manitoba?

PHILIP FERGUSON: Yeah, we launched it in 2023.

MICHAEL: And you said it had about a one year?

PHILIP FERGUSON: That's right. It lasted for one year. It was collecting data about space geology. So, it was a partnership with the University of Winnipeg.

MICHAEL: What will you take from that to the next satellite that you'll launch?

PHILIP FERGUSON: So, we've learned a lot of lessons about how to put these tiny, tiny satellites together and still have them function properly. I'd say it's still a bit of a work in progress, we're blazing new trails here but we're learning and we're lining up satellites, in the future to launch, as well.

MICHAEL: So, when I became President, I knew a little bit about what you were doing but listening to you speak today and reading some of your work and thinking about your innovations, we're not bragging enough at the University of Manitoba about this. I mean, this is really groundbreaking, and maybe sky-opening. And I think a lot of people probably don't know that this amazing work is happening, here at the University of Manitoba and the Price Faculty of Engineering and that there's amazing opportunities. Now, you did your studies at MIT. You've got this great thing going here at U of M, but you were at MIT. You could have probably gone anywhere. So, what brought you back to the University of Manitoba? And when you look back, what do you feel has been the greatest, rewarding part of that work?

PHILIP FERGUSON: I can answer that with one word, and it's community. And it's not just the community here at the University of Manitoba, which is fantastic. I mean, we've got a community where engineers work with environmental scientists, and they work with medical doctors and pharmacy researchers. But it's the relationships that we have with the communities around us. The University of Manitoba, more so than most, recognizes that a university goes far beyond the boundaries of the campus and extends into the community, in which we operate, but also into the community around Manitoba and in the Arctic. And so that is so inspiring to me because at the end of the day, as an engineer and an engineering researcher, we exist to make technology accessible to people. My wife is a physicist, and she says, engineers are the Oompa Loompas of science. So, the implication is the scientists do all the discoveries and the engineers just kind of make it work. To some people that might be disparaging, but to me, I'm like, no, no, that's, that's right. I mean, we're not the ones that are discovering cold fusion, but we're the ones that, when cold fusion comes about, engineers will be the ones that make it accessible. And that's why this research is so important and why I think the University of Manitoba is so well positioned to lead projects like this, because of the connections that we have with the communities, not just here in Manitoba, but in Nunavut, across Canada and around the world.

MICHAEL: I agree with you. It's about community, but it's inspiring to hear how you've taken your work, the science of it, the engineering, and made it your mission to make it sustainable, one, but also to use it to help some of the most isolated communities in the world prosper and be able to communicate in the ways that we sometimes take for granted, here in the South. So, I want to thank you for taking the time. And it was a fascinating conversation.

PHILIP FERGUSON: Thank you. The pleasure is mine.

MUSIC FADES IN

EXTRO

MICHAEL: I hope you enjoyed this conversation and are ready for more big ideas. Like Phil's research, Season 4 is going to be out of this world. Join me next time when my guest is Asper School of Business

professor Bruno Dyck. He has reimagined capitalism and how business can serve the greater good. And if you like this show, please subscribe, rate and review it. The more we share UM's impact, the more support we build for our teaching and research mission. Thanks for listening and keep thinking big.