

WEBINAR SUMMARY

Astronauts as the Origin of Space Society

Naoko Yamazaki & Doug Millard

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Doug Millard: We shouldn't forget the first astronaut, Laika, the first animal in space. Laika flew in 1957; she didn't return, but it was all part of the intense research programme leading up to putting a human in space. The first human astronaut was Yuri Gagarin, the Soviet cosmonaut, who flew into space in April 1961. A couple of years later, he was followed by Valentina Tereshkova, the first woman to fly in space. July 1969 was the unforgettable first moon landing with pictures being returned - very grainy, black and white pictures from the moon, as Neil Armstrong and then Buzz Aldrin took the first steps on another world in space. In 1981, the first US space shuttle flew, called 'Columbia', and it was the first test flight to introduce the shuttle program, which flew for many decades. The first British person in space was Helen Sharman, in May 1991. This was a collaboration between the Soviet Union and the British government, and Helen flew to the Mir space station, a tremendous space station that flew for many years and caught many headlines during its existence in orbit.

However the space station we will be focusing on today is the International Space Station, which was launched in 1998, and many modules were added over subsequent years. In recent years we've been hearing a lot about the private space sector, and the subject of 'space tourism'. Dennis Tito is arguably the first space tourist and he flew with the Russians in April 2001. 2010, a decade later, was the first commercial supply mission, and that signalled a major adjustment of the US space sector and how there was a far more equitable balance between the public sector (NASA and the government institutions) and the private sector, in this case, SpaceX. Then we come to April 2010, to our guest speaker Naoko Yamazaki, who was the second Japanese woman to fly into space on the discovery of the international space station.

Just a few months ago, we had the first all-civilian space flight - this was a SpaceX launch up to the space station in September 2021. Hopefully, in a few hours, Yusaku Maezawa will become the first Japanese tourist to visit the ISS. We've been blessed over the decades with an astonishing history of human space flight, but you could say that we are now entering a new space age where more people can fly into space, and there are far more missions being launched into space.

There have only been a few hundred people that have gone and ventured into space - the bulk have been American with 347 people, but also 123 Russians, and then there are also Japanese, Germans, Chinese, French, Canadians and Italians. There are also others, including two British astronauts, Helen Sharman and Tim Peake, amongst the 35 other nationalities who have flown.

Q&A Discussion with Doug Millard and Naoko Yamazaki:

Doug Millard: Naoko, I was wondering where did this all begin? What motivated you to become an astronaut?

Naoko Yamazaki: Well, like many other astronauts, as a child I was inspired by sci-fi movies like 'Star Wars' and 'ET' and 'Space Odyssey'. During my childhood there were no Japanese astronauts yet, so I didn't consider becoming an astronaut as a career path - I was just dreaming of travelling to space one day. When I was older I learnt about some of the astronaut programmes at NASA, and then gradually a Japanese astronaut was selected, and that's when it clicked in my head that that's what I wanted to do.

Doug Millard: How did you go about doing it, after you realised this was something you wanted to do?

Naoko Yamazaki: When I was a student, I wasn't sure how to become an astronaut, but I liked engineering a lot so I first became an aerospace engineer. I started working at the Tsukuba Space Centre for the Japanese space exploration agency. I then applied to become an astronaut, but when I first applied, I was rejected because I lacked work experience. On my second trial, I was selected as an astronaut candidate. Some of my colleagues got selected as an astronaut on their third time and others said it was their fifth or sixth time - everyone was very encouraging.

Doug Millard: What did you have to do, in your case, in between your first and second attempts, to do better than next time?

Naoko Yamazaki: I think gaining work experience is very important. It's very important to have leadership, followership and team-building experiences, as well as international collaboration. Those kinds of experiences will make you a better astronaut candidate.

Doug Millard: Can you give us an idea of the types of tests that you had to undertake in order to qualify or be accepted as an astronaut candidate?

Naoko Yamazaki: JAXA, the Japanese Space Exploration Agency, is hiring new astronauts for the first time in 13 years because Japan doesn't have a big astronaut group - the selection only happens every 5 to 10 years. This time we are not just accepting people of a STEM background, but also those of a non-science background. The height limitation is also becoming more lenient - it used to be 158cm -190cm, but now it's 149cm - 190cm so it's becoming more inclusive. The selection usually takes a year - the first stage is a documentation check and the paper test checking STEM knowledge. The second stage involves medical checks, requiring a couple of days - including checks like a gastroscopy and a large intestine fibre test etc. Interviews are also a part of the second stage. During the third and final stage, I had to spend one week in a closed environmental chamber amongst the 8-10 finalists. We do individual tasks like typing, calculation, and even jigsaw puzzles - an all-white jigsaw with no pictures. There are

also group tasks, like creating a robot together - it's kind of a psychological test. Finally, there are interviews in Houston for NASA and in Japan for JAXA.

Doug Millard: How did you get on with being enclosed and isolated? Was that a novel experience or had you had some practice of being isolated?

Naoko Yamazaki: Yes, it was my first experience being isolated without windows, TV or phones - just eight of us in a small space. It was actually fun - we were all rivals, but at the same time we were friends aiming for the same things.

Doug Millard: During the isolation were you able to follow the passage of time? Did you know when it was day and when it was night?

Naoko Yamazaki: Yes we knew. Inside the chamber, there was no light - it's all artificial, so we relied on the clock. Usually, we woke up at 6 am, and then the lights would switch on, and at 10 pm the lights switched off to simulate nighttime. It's the same as the International Space Station because the ISS rotates around Earth every 90 minutes and we experience 45 minutes of night and 45 minutes of daytime - it's very confusing so we did the same thing in isolation (an artificial 24 hours).

Doug Millard: After you were selected as a candidate, and were well into your astronaut training - I know it involves all manner of different lessons, training and activities - but what struck you as the most challenging?

Naoko Yamazaki: Becoming an astronaut takes years - for me, it took 11 years to get to space. Japan doesn't have its own manned spacecraft so all my training happened in Houston, and Russia (ISS partner countries) so we had to travel a lot - I actually enjoy travelling so I found this very fun. The hardest thing was to keep motivation because there was no guarantee for when I could fly to space. We had to rely on each other and believe in ourselves.

My favourite training was at the National Outdoor Leadership School (NOLS) in Wyoming, which was a team-building exercise. Through this training, we learned leadership, followership, self-management and situational awareness. This training isn't just for astronauts, it's for students, teachers, entrepreneurs, and even congressmen. Our nature is to help one another so that's why it was a good environment. Almost 90% of the training was how to deal with unexpected things like emergencies - we did survival training in the winter in the forest for example. We also had to learn how to deal with things like computer damage or air depletion, so that was very helpful.

Apart from training we also had to do jobs to help each other. I had to help Takao Doi, a senior astronaut who joined the assembly mission of the ISS. I was the capsule communicator (CAPCOM) in the flight control team.

I spent 15 days in orbit. There were 13 crew members including six long-duration crew members. We delivered the Leonardo logistics module and I operated a robotic arm. After installation, we delivered each scientific experiment on the space flight. It weighed about one ton; it's as big as a car but in microgravity, it was easy to carry big items.

Doug Millard: Could you talk about your experience in space? There is one description called the 'overview effect'. There is some debate as to whether it exists or not, but my understanding is that for some when you look down on earth, something changes regarding your perception and understanding of life and existence. Is there anything you can relate to with that?

Naoko Yamazaki: I think so, because before going into space, I considered space as desirable and a special purpose for me, however, once I reached space, especially in microgravity, there was no absolute 'up' or 'down', and it was very strange to me. I then realised that it is the earth that is special and I changed my perspective by 180 degrees.

Doug Millard: In regards to physiology, I mean our bodies are designed for living on Earth; whenever we leave Earth our human body doesn't cope very well. Were you aware of changes to your actual body during the mission and when you returned to Earth?

Naoko Yamazaki: Yes, I did notice changes to my body. For example, you get taller in space because the space between the vertebrae of the spine gets longer in microgravity. There is also a fluid shift so your brain thinks that there is a lot of water in your body - you have to release some fluid by urine. In space, your body fluid is around 80-90%, so your skin gets dry easily. Recently we found out that around 40% of the long-duration crew members have difficulty focusing in space and even after coming back to earth - we don't know the reason behind that yet.

Doug Millard: Maybe we could use that to consider the future of human space flight and particularly going to Mars, which is a perennial subject of interest. We know that there is an international program around Artemis to go back to the moon with humans and then ultimately to reach out to Mars. What are your thoughts about the challenges of humans going to Mars?

Naoko Yamazaki: The international space station is very close to the Earth - around 400km above, and if something happens, like a medical issue, or an issue with the spacecraft, you can return to Earth within 24 hours. But, for the moon, it takes three days to go back to Earth, and for Mars, it takes at least 6 months to go back to Earth, so we have to be more independent and autonomous in the exploration of the moon and Mars. There is another difficulty for Mars because we have to take into consideration planetary protection. On the moon, we know that no life exists but on Mars, there may be some life, like small bacteria. We don't want to affect Mars' environment with bacteria from the Earth, so we would have to sanitise all equipment to bring to Mars. If human beings go to Mars, we have to think about planetary protection.

Doug Millard: Could you speculate on when humans might actually reach Mars - would you care to give an approximate date?

Naoko Yamazaki: I'm not sure but most likely within 10 years. It definitely could happen.

Doug Millard: If there was one single major challenge for an astronaut going to Mars, what would you say that was?

Naoko Yamazaki: One way to Mars is not too difficult but the return to Earth is probably harder because we need other spaceships and we have to wait for the right timing to go back to Earth - it only comes once every two years. For the round trip, it takes more than 3 years. Then we have to make sustainable space agriculture instead of bringing space food as well as recycling water more efficiently - the ratio right now is 60-70% but we have to make it 100%. Space radiation as well is going to exceed the tolerance limit for humans so we have to protect them somehow. Lastly any medical issues: something could happen that requires an operation on Mars, so we would need to figure that out. There are many challenges that still need solving.

Doug Millard: Could you tell us a bit about your current activity and involvement in space? What are your projects?

Naoko Yamazaki: My current activities include being a member of the Space Policy Committee of Japan - we are creating four commercial spaceports in Japan, including Oita and Okinawa, the horizontal spaceports, which means collaboration with our Virgin orbit and our Japanese startup companies. There are two vertical spaceports as well. I am also a member of the Earthshot Prize council alongside Prince William and Her Majesty Queen Rania of Jordan, which is a great honour. I really respect Prince William's leadership in initiating this Earthshot prize to restore the environment of the earth within the next decade. This year, Prince William announced the first-ever award winners from more than 750 nominations from all continents. The 15 finalists include people from individual cities, companies and the government - there is a 15-year-old girl from India who was one of the finalists and she gave a very inspiring speech at the COP-26. The Japanese start-up company Water Design, which recycles water at a 98% recycling rate, was one of the finalists as well. There is also a book about Earthshot and I contributed to the 'Clean our Air' section.

I'm really impressed by the dynamic of nature but at the same time the power of civilisation. If we unite our strengths together we can definitely achieve big goals. At the same time, Earth is very fragile - the atmosphere layer is very thin, compared to the sun which is very powerful. If we collect all the water from the oceans, rivers and glaciers it is a very small amount so the Earth itself could be described as a spaceship. I hope we can unite our strengths to restore our environment.

Doug Millard: We should say as well that space and largely satellite technology have played a crucial part in understanding how humanity has affected Earth, in monitoring the changes, and in beginning to correct what has been going wrong. Space is so important on many fronts.

Naoko Yamazaki: When I saw Earth from space, it looked alive. While the Earth doesn't have its own eyes, ears, legs or arms, we have the technology to send satellites or even human beings to space to watch the Earth from space, so we are almost playing the role of the 'eyes' for the Earth as well as 'ears'. In my opinion, we need to work together and have harmony on our Earth.

Transcribed by Mia Aikman