# The Bolivian team winners of the DropTES research fellowship: "We are creating a new 3D printing technique for space exploration"

**Interview conducted on 10 September 2020**

**Institution:**

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**Team leader:**

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**Team members:**

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Eng. Jhon Ordoñez Ingali

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**Background**

The United Nations Office for Outer Space Affairs, in partnership with the Center of Applied Space Technology and Microgravity (ZARM) and the German Aerospace Center (DLR), offer the Drop Tower Experiment Series (DropTES) as one of the opportunities under UNOOSA's Access to Space 4 All Initiative. DropTES allows selected teams to advance their research work by performing experiments in microgravity conditions at the ZARM facilities in the Bremen Drop Tower in Germany. This tower is a ground-based laboratory with a 146 meters high drop tube that enables short microgravity experiments in a variety of fields, such as fluid physics, combustion, thermodynamics, material science and biotechnology.

*The team outside the Engineering Faculty Department at Universidad Católica Boliviana*

**How did you learn about DropTES?**

We learnt about DropTES in 2014, during what was one of the first rounds of the fellowships, thanks to social media. Some of us actually won the DropTES round in 2015, with an experiment focused on biomedical research under microgravity conditions. At the time, it was a slightly different team: we were all employed at biomedical company PFM S.R.L., the only one in Bolivia working with medical devices made with Nitinol, a biomaterial that is a combination of nickel and titanium, which is great for this area of research, because it has memory shape and pseudo-elasticity properties.

Five years later, in 2020, the current team were all working and teaching at Universidad Católica Boliviana “San Pablo” in La Paz, as research engineers at the Research, Development and Innovation in Mechatronics Engineering Center (CIDIMEC).

We always try to find opportunities to conduct hands-on research, and we thought DropTES would once again be a great chance to advance our field of work. We were delighted to hear we had been selected as winners of the latest round, opening doors for us to use the facilities at ZARM for our current research.

**What does your current experiment focus on?**

This time, our research is not on biomedical products but on space technologies, an area that some of the members were already working on. Our current DropTES experiment brings together 3D printing, on which we have been working for a while, especially on the subject of Rapid Prototyping which Fabio teaches at University. We also opened a 3D printing lab at the university in collaboration with industry partner Print3D in Bolivia, that's why Khalil, the Technical Manager of the company, is part of our team.

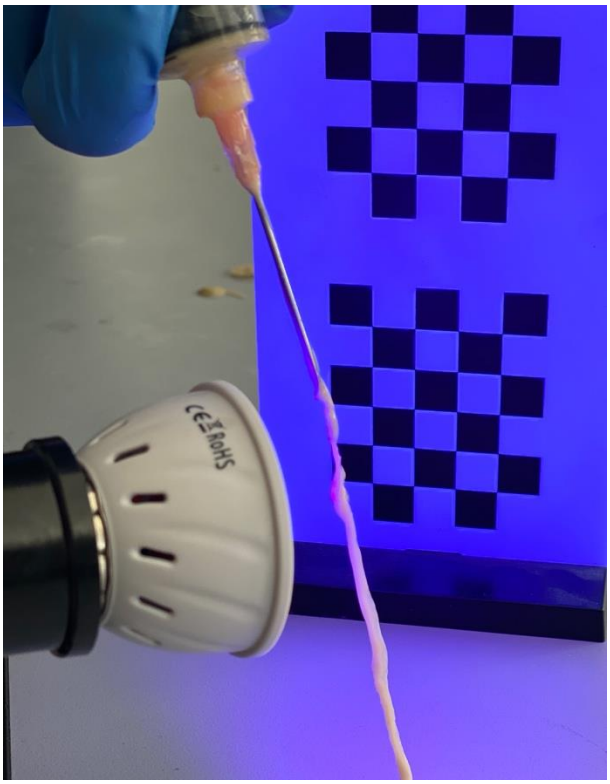
3D Printing is the state of the art for space exploration. As materials and machinery cannot be easily sent to space missions – it takes too long, is complex and expensive - the ability to build things in space is fundamental to advance space endeavours, and 3D printing provides a solution for this. As an example of the importance of 3D printing in space, NASA has had a competition for building habitats for deep space exploration through 3D printing for a few years now

(https://www.nasa.gov/directorates/spacetech/centennial_challenges/3DPHab/index.html)

Manufacturing in space can't be done the same way as on Earth. Our experiment creates an entirely new 3D printing technique that can be done exclusively in microgravity conditions. We called this new technique Microgravity Liquid Printing (MLP). It is based on solidifying liquid resin through UV rays, printing a model without any support structures. The superior view of the designed device looks as follows:

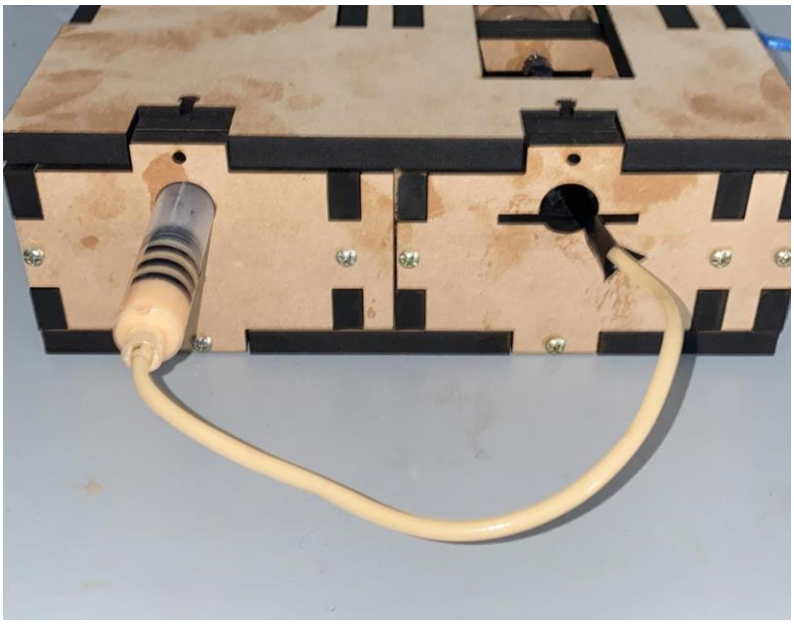

*3D digital prototype design*

There is no left, right, up or down in space. While on Earth the liquid resin would drop down before solidifying, in space it floats, so that there is time for it to solidify into the shape needed. The experiment takes advantage of the "Drop Tower" at ZARM, that allows researchers to simulate microgravity conditions by conducting four falls/tests as catapult mode, each one with a different velocity of extrusion and solidification time. The first approaches to this technique under terrestrial conditions was conducted as in the following picture:



*First vertical extrusion test*

The shape we are trying to print now, to begin with, is a straight line, like a tube floating in space. We could then progress toward more complex shapes. One of the challenges we are currently facing is trying to make the material solidify quickly, in around 9 seconds. It requires a lot of work. We are constantly adjusting the parameters of our experiment. The picture below shows the latest prototype of MLP device.



*Latest MLP prototype*

*Guillermo and Gabriel test the resin extruder and solidification system*

3D printing in space is an exciting research topic and we are particularly proud to be creating something specifically for space exploration. DropTES focuses on countries without existing space expertise and technology. As interest in space grows in Bolivia, we hope the technique we are creating will help us advance Bolivia's capabilities in space technology, as well as expanding possibilities for space exploration worldwide.

*Khalil is working with the Computer Aided Design (CAD) that will be later manufactured by Miguel with the laser cutting machine*

**How could the central idea of your experiment continue to develop after DropTES?**

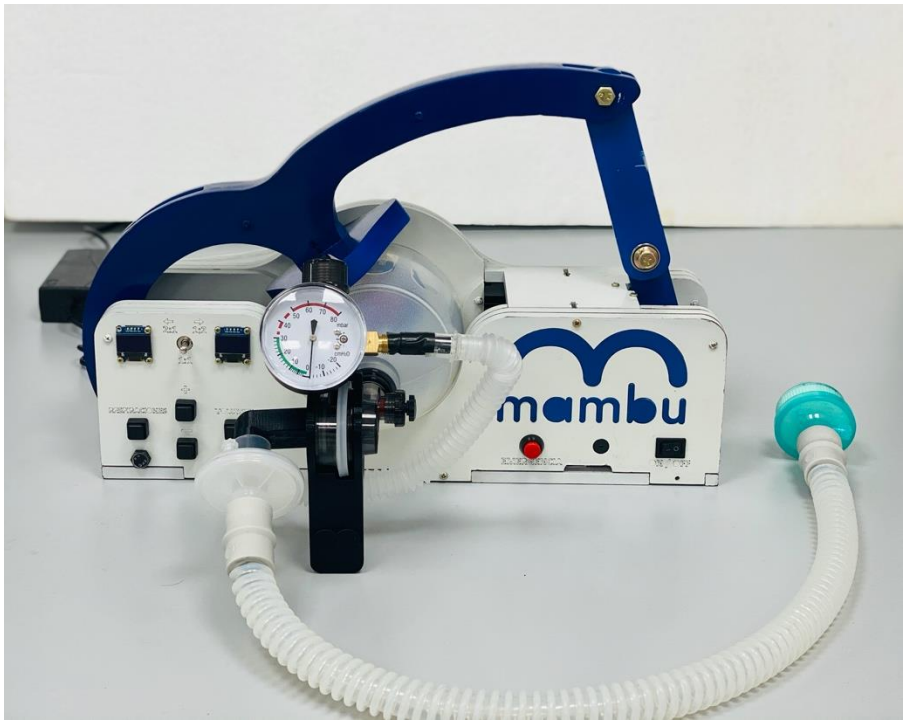
We could establish partnerships with companies to continue this line of research in the future, expanding this topic and its possibilities. Some of the team members are also working on nanosatellites, and the idea is to continue connecting space technology and liquid printing technology in this area. Opportunities for applications are endless.

**How has COVID-19 affected your work?**

We have been heavily affected by COVID-19. In Bolivia, we have been in different degrees of quarantine since March. Engineering research needs a lot of hands-on work with tools – for example we had to build the machines we use for our experiment - so it is hard to progress virtually.

Also, with the same leadership, we became busy with another research project to create a new ambu (adult respiratory reanimation bag) based ventilator for COVID-19 patients, made in Bolivia. We started working on this in March, aiming to create a ventilator that could be produced at a fraction of the cost of securing a ventilator on international markets.

The ventilator we created, called MAMBU (https://www.imt.ucb.edu.bo/mambu/), is designed to perform particularly under emergency conditions, in cases when the health system may collapse. We started treating the first patients with the ventilator in April and we have already been able to save more than 20 lives with this technology. Some parts of the ventilator are made with 3D printing, so that it is cheaper and more replicable, thanks to laser cutting. This was sorely needed in Bolivia as the country had a severe lack of ventilators. Today after this interview, we are expecting to receive a technical report for MAMBU from the Bolivian government as the first and unique medical device to provide respiratory support made in Bolivia approved for its secure use on patients.




*The Mambu (Mechatronic Ambulatory Medical Breathing Unit) device*

**Are students at your university and in Bolivia aware of the research you are doing? How is this contributing to changing their perception about possibilities in 3D printing and space technology?**

When we completed our first DropTES experiment in 2015, we presented the research we had been able to do in many conferences. Before this, there were few papers published on the topic we worked on, so we were able to add a lot to the field. Many of our students were excited about it and started thinking in more depth about possibilities in space technology.

At the time when we won the second DropTES fellowship, the country was focused on COVID-19, but now we plan to raise more awareness about the project through UNOOSA, the university and research publications. We are keeping our students involved in the work we are doing by teaching them about rapid prototyping techniques.

The youngest of us in this team are 27 years old. But we already have high-level publications that we have presented in difference conferences. In Bolivia, only one or two universities are publishing research and presenting it at the international level. This opportunity helped us increase the reach of our research and connect us to the international community.

*Fabio, Jhon and Miguel at work testing the extrusion system*

The field of 3D printing is growing quickly in Bolivia: the company we are partnering with at the university, Print3D, is getting into biomedical 3D printing, to produce medical parts such as orthodontic tools and prothesis. We hope our research will open new doors for connecting 3D printing and space exploration in Bolivia, a link that is not established in the country yet.

In Bolivia, it is not common to talk about space. it is not felt as something “real” and achievable for the country. We can be an example for students to find ways to pursue their research and be ambitious about their goals, as well as show that Bolivians can contribute to space technology.

**What do you think are the obstacles that prevent more young people from accessing opportunities in space research and education in Bolivia?**

Last year I was in Vienna for the World Space Forum organised by UNOOSA and it was amazing to see how many opportunities there are to get involved in the space sector at the international level. One of the main issues is that young people in Bolivia don't know about opportunities at the global level or think they are unreachable.

Just a few years ago, basically no one was talking about space in Bolivia because the country has different priorities. To our knowledge, the country does not have aerospace engineering programmes in universities. Our experience is contributing to changing this attitude.

Another key obstacle is lack of funding. Despite the support of our university, it is very difficult to get advanced devices or material for our research because of how expensive they are. Moreover, with the pandemic, all universities have seen their funds cut, often by more than half, making this a particularly difficult year for research. There are in general few grants or programmes for getting financial aid for research in Bolivia. There are few institutions doing research competitions or opportunities. Therefore, the DropTES fellowship really opened new doors for us.

Because of the economic situation in Bolivia, we have learnt to adapt our research to a low-cost environment and to find ingenious solutions with little resources. The ventilator we developed for Bolivia costs around 1,200 USD per unit. The experiment we are now doing with DropTES is low cost, at around 1,000 USD.

**How many research groups are working in the space industry in Bolivia? Do you think your experiment can contribute to changing the attitude toward space in the country?**

We know about less than five research groups focusing on space research in Bolivia. However, interest in space is growing in the country. We already have a space agency and space research technologies are developing, focusing especially on nano satellites. All our neighbouring countries are conducting research on nanosats, because they are cheaper than full-blown satellites but can provide a comparable quality of data and images. We are taking advantage of this growing interest from the government and the private sector.

Bolivia can get closer to space exploration by conducting relevant research like we are doing. Sometimes one has to take the first step in something.

**What do you think the international community, and institutions such as UNOOSA, could do more to help teams like you, especially in developing countries?**

Some time ago, we made a proposal to leverage nanosatellite technology to be able to better monitor forest fires in the Amazon region, that are a huge issue in Bolivia. Since the affected areas in the Amazon cannot be easily reached, our proposal as a university was to deploy a nanosatellite to observe the Amazons, to be alerted about fires more rapidly. However, funds to pursue the idea were not available. The international community could really help by providing more funding opportunities for research projects such as this one, especially in developing countries.

**Would you recommend DropTES to others and why?**

For sure!

Many developing countries think space is not for them. As professors, we think even getting just one student interested in space technology, just changing one life and giving someone the possibility to contribute talent to a new area, is a huge win.

Opportunities such as DropTES, that give scientists the chance not only to advance their research through top tools but also to travel and connect with researchers in other countries, can really open one's horizons. This kind of opportunities are game changers.