DropTES: The Stepping Stone into Space Activities and its Contribution to the SDGs

Interviewee: Dr. Thorben Könemann, Center of Applied Space Technology and Microgravity (ZARM)

Fabio Richard Diaz Palacios, Project Coordinator, Universidad Católica Boliviana (UCB) "San Pablo"

Date: Interview conducted with ZARM on 27 September 2022 and with UCB on 8 September 2022

Background:

The Drop Tower Experiment Series (DropTES) is offered by the United Nations Office for Outer Space Affairs (UNOOSA) in collaboration with the Center of Applied Space Technology and Microgravity (ZARM) and the German Aerospace Center (DLR). DropTES is a hands-on opportunity under the Hypergravity/Microgravity Track of the Access to Space for All initiative, for student teams to conduct microgravity experiments at the Bremen Drop Tower in Germany, which is a ground-based laboratory with a height of 146 meters. UNOOSA supports the travel expenses of the team, DLR funds the 5 drops or catapult launches, and ZARM provides the accommodation and also technical support during the preparation and experiment campaign. So far, teams of international students from 6 institutes have benefited from 7 rounds of experiments having conducted many different types of scientific experiments and technology demonstration missions.

ZARM's Integration Hall ©UNOOSA


Bremen Drop Tower ©ZARM

Rounds	Awardee Institute(s)
1st round (2014)	German Jordanian University (Jordan)
2nd round (2015)	Universidad Católica Boliviana "San Pablo" (Bolivia)
3rd round (2016)	Instituto Tecnólogico de Costa Rica & Universidad de Costa Rica
4th round (2017)	Warsaw University of Technology (Poland)
5th round (2018)	University of Bucharest & Politehnica University of Bucharest (Romania)
6th round (2019)	Politecnico de Milano (Italy)
7th round (2020)	Universidad Católica Boliviana "San Pablo" (Bolivia)

List of Awardees

Interview: First, we talked with Thorben from our partner, ZARM.

Thorben has been working on the DropTES programme from the beginning ©ZARM

Q: What is the objective of DropTES and why has your organization decided to work on it?

DropTES provides educational opportunities to foster the skills of students, international cooperation, and build capacity for space-related missions through microgravity experimentation, especially targeting developing countries. DropTES experiments are done at the fundamental level. Students can gain hands-on experience using basic breadboard designs and start their development of skills in a space-related environment with easy access. ZARM is affiliated to the University of Bremen, therefore providing educational opportunities to students is at the core of our daily work. Through the discussion with UNOOSA and DLR, we came up with the idea to open this opportunity to a larger group of students in all United Nations Member States.

Q: How does DropTES contribute to the Sustainable Development Goals?

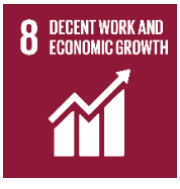
"DropTES is a stepping stone to space activities."

Drop Tower Capsule at Integration Area ©ZARM

DropTES is a stepping stone to space activities. It is the entry point to learn how to conduct research and how to design and test an experiment in the space environment. It is the very beginning of the gradual learning path for developing nations when they consider of getting involved in space-related activities, hence, contributing to SDG 4 Quality Education.

Not only does it provide an educational opportunity, DropTES also provides access to a very unique ground-based microgravity facility. There, the participating teams learn how the facility works and how to use it, along with deepening their scientific and technical knowledge of the microgravity environment and their experiment itself. It gives them a unique chance to achieve important skills and know-how that opens up new perspectives for them on the job market; thus, contributing to SDG 8 Decent Work and Economic Growth.

And last but not least, there are many different types of experiments in various science fields that can be conducted at the drop tower: from life science such as biology, to physical science such as material science and fluid dynamics, to technology demonstration. We are open to new and innovative experiment ideas to be conducted at our facility and we have seen many interesting and promising ones in the past. We are aware that these science and technology applications that were tested in the drop tower will lead at some point to other innovations as well, contributing to SDG 9 Industry, Innovation, and Infrastructure.



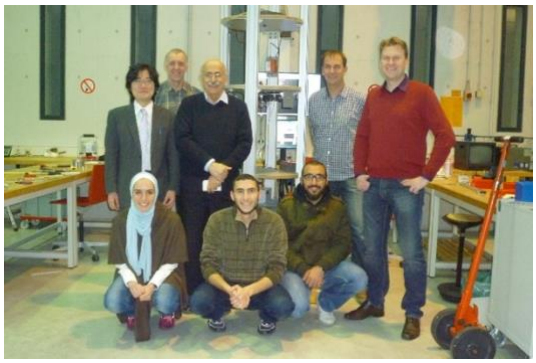
Q: What is the current status of DropTES?

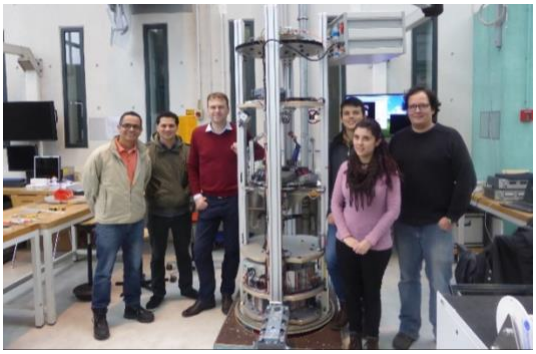
4th round awardee team from Warsaw University of Technology with their solar sail ©UNOOSA

Through our successful cooperation with UNOOSA and DLR, DropTES has evolved into an annual test campaign opportunity. Starting in 2014, we have conducted 7 rounds of microgravity experiments. We are still excited and impressed by the innovative experiment ideas of the DropTES awardees. For example, the 1st round awardee from Jordan came up with the idea for an electromagnetic tether to minimize vibration, an experiment topic we never had before at the drop tower. The 2nd round awardee from Bolivia tested Nitinol, and this was also the first time that such an experiment was performed at drop tower. The 4th round awardee from Poland tested the deployment of the orbiting sails for their 2U CubeSat. They decided not to use our regular drop tower capsule, but to inflate the deorbiting sail in free fall and under vacuum conditions right inside the drop tube. For the team from Bolivia, we were happy when they came back for a second campaign in the 7th round of DropTES to test 3D printing. The value of conducting microgravity experiments at the drop tower was clear to them and they benefited from their broad experience from their 2nd round experiment campaign at ZARM, as they were already aware of the procedures, and we were able to conduct the experiment series in an efficient way.

The programme is always evolving to meet the needs of the students worldwide, and for 2022, we have opened a call for “Expression of Interest”. In this process, student teams from UN Member States can send in their microgravity experiment ideas, and ZARM/OOSA will conduct technical consultation sessions with the teams that submitted their ideas. After this, we are positive to receive even more submission for our fellowship programme during the year.

Q: How has Access to Space for All and the cooperation with UNOOSA helped your organization?





Working together with UNOOSA has expanded our reach and community. We have close ties with European universities, that eventually grew into further collaborations. Now with DropTES in cooperation with OOSA, we can reach out to new universities from all United Nations Member States. For us at ZARM, it is always a highlight to work with international teams from different countries, backgrounds, and cultures. In this way, we are able to learn new things, get sparks for new ideas, and consistently get constructive feedback to improve our support.

(Above) 1st round awardee team from the German Jordanian University ©UNOOSA

(Below) 3rd round awardee team from the Instituto Tecnologico de Costa Rica and Universidad de Costa Rica ©UNOOSA

Q: What are your future plans for DropTES?

GraviTower Bremen Pro ©ZARM

ZARM is very pleased with the outcomes of DropTES and we hope to tighten our strong relationship with UNOOSA and DLR. Furthermore, at ZARM, we have introduced our next-generation drop tower system, the "GraviTower Bremen Pro", which will allow us to now carry out partial-gravity experiments and also much more experiments per day. The partial-gravity mode can be used to test experiments targeted toward the gravitational field of the Moon and Mars, meaning that we can more intensively support any space exploration missions. With the interest in space exploration growing, we hope that this novel facility will open doors and possibilities for emerging nations to get into space exploration. We at ZARM aim at increasing the percentage of female students in the experiment teams. The space community is still quite male-dominated, but we know, there are so many excellent and talented female students out there. It would be great to see them participating in DropTES. For anyone who is interested in applying for DropTES in future rounds, my advice to you is to be disruptive. Generate new ideas that will bring all of us a step forward in technology development.

"Be disruptive. Generate new ideas that will bring all of us a step forward in technology development."

It's our mission to support any new and fresh ideas. (And of course, please read all the application documents and user manual carefully!)

Next, we talked with Fabio, who is the Project Coordinator of the Universidad Católica Boliviana (UCB) San Pablo team.

Q: Why did you decide to undertake this microgravity project? What benefits do you see in space/microgravity environment?

Fabio Diaz participated in both rounds
UCB was awarded DropTES ©UCB

Personally, as a researcher and engineer, I am a big fan of space technologies. Therefore, when I found the DropTES opportunity, where I can combine my passion for material and manufacturing techniques with space research, I had to take it. That being said, of course beyond my personal interests, the knowledge and experience you can gain from conducting tests in microgravity are beneficial to understanding the behaviour of materials. It is also a great platform to start for young researchers who want to work on space activities in the future.

Q: How does your project contribute to capacity building in developing countries and solving the SDGs? How has it helped you and your country?

Contribution to the SDGs is taken more seriously in my country, and also at the university where I work. The SDGs are bringing awareness to the various aspects we need to take action on and are bringing equity in many features of human life. In developing countries such as Bolivia, it is usually difficult to have access to state-of-the-art

technology and education. That is why DropTES, where we can gain access to sophisticated infrastructure that allows us to conduct cutting-edge experiments and obtain technical skills and expertise is truly supporting SDG 4 Quality Education, SDG 8 Decent Work and Economic Growth, SDG 9 Industry, Innovation, and Infrastructure, and SDG 10 Reduced Inequalities.

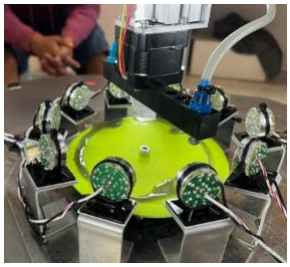
Owing to all of the SDGs we can link to our project, it was strongly supported by our university, as it shows to its students, faculties, and to the entire country that we are able to conduct complex technology development and simultaneously do something good for the country.

Respiratory ventilators developed by UCB ©UCB

Thanks to our participation in the 2nd round of DropTES, we had a highly motivated group of people focused on advanced technology and how to link that with societal projects/problems. This mindset led to us developing respiratory ventilators for COVID-19 patients. This also is connected to SDG 3 Good Health and Well-Being.

Q: Explain in detail the current status, the objective of your project, and why your organization decided to work on it.

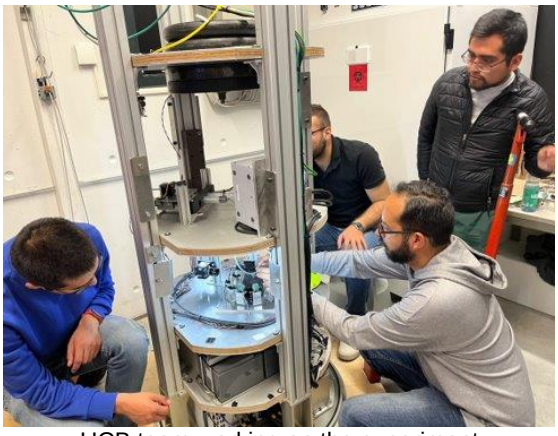
Our idea was to explore a new field of additive manufacturing. We planned to test the feasibility of 3D printing using liquid material without any kind of support structure. For 3D printing, there is an advantage of avoiding the use of any other support material or structure besides the printed outcome itself, since this will lead to quicker printing. We believe that there any many kinds of applications and innovations that can come out of this research that can bring benefits to life here on Earth and also for space exploration.


Experiment Setup ©UNOOSA

Due to the COVID-19 pandemic we had a slow development process after being selected as the 7th round awardee. However, we kept the team focused by doing various science and technical activities that may not have been exactly related to the DropTES project, but kept the students interested. We also used this chance to introduce our project and the concept of additive manufacturing in space to more students.

Finally, in July 2022, we were able to travel to Bremen and actually run the experiment campaign. We were ready with our experiment prototype and excited to make it to Germany, but we were devastated to learn that our luggage (including our experiment prototype!) was lost owing to the issues with air traffic in Europe. We were not able to track where the luggage was. This meant that we needed to rebuild another prototype in Germany from scratch. Thanks to the kind support from ZARM, although it was not the same, we were able to redesign the model with the materials that could be found and purchased in Germany.

With this new prototype, we conducted 2 catapult launches and 3 drop tests. There were many variables that needed to be considered for the tests such as the timing on when to start the extrusion of the liquid resin, the pressure of the extruder, the places of the LED lights, the angle of the camera, so we discussed and changed the setup every time. We changed from catapult launch to drop in the middle of the campaign, and despite the fact that we have less microgravity time (9 seconds


UCB team working on the experiment setup ©UNOOSA

with the catapult launch to 5.3 seconds with the drop), it was the best decision we have ever made. The catapult launch put too much movement and pressure on the experiment, while the drop gave us the right environment in the given short time.

We are now back in Bolivia, analyzing the results of the experiment and putting together a paper to be published at conferences and magazines. We are using this experience to teach new students about additive manufacturing at the university.

UCB team and ZARM watching the drop from the operation room ©UNOOSA

Q: How has Access to Space for All helped your organization?

UCB, ZARM, and UNOOSA team photo ©UNOOSA

Without the Access to Space for All initiative, the opportunity for a Bolivian university to conduct microgravity experiments would not have been possible. We are truly thankful to ZARM, UNOOSA, and DLR for making this happen.

I would also like to emphasize that beyond having an experiment slot, we appreciated how UNOOSA helped promote and share this experience, through their website and social media. For science research, nowadays it is becoming extremely crucial to be able to communicate the importance of science and the outcomes to the general public and influence the young generation, to get more support and engagement. For us, it was a wonderful opportunity to show the world that we are capable of doing advanced technology projects.

Q: What are your future plans?

UCB team photo ©UCB

Besides the work being put to finalize the results, we have been making an effort to promote the experience through workshops and presentations at conferences/events. We will still keep researching new additive manufacturing techniques and materials that can be utilized. We are looking into other fields in which we can deepen our knowledge using the microgravity environment, like chemistry. We are also considering experimenting with CubeSat technologies, such as testing the behaviour of actuator systems under microgravity. We are in discussion with other universities to develop the first Bolivian CubeSat and we believe testing the systems in microgravity would be a great testbed. I would also like to bring more gender equality to the work we do at the university. We will definitely be on alert for new opportunities that will open under the UNOOSA Access to Space for All initiative.

We strongly recommend DropTES to all universities or research institutes like us, that do not have access to the most progressive technology, just like us. It is opening the door to anyone with a good idea and it is truly a life changing experience, especially for students.

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