DropTES: The Opportunity to Expand Your Horizon and its Contribution to the SDGs

Interviewee: Dr. Nabil Ayoub, Project Coordinator, German Jordanian University

Dr. Renato Rimolo-Donadio, Project Coordinator, Instituto Tecnologico de Costa Rica (TEC)

Date: Interview conducted with GJU on 18 October 2022 and with TEC on 30 November 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 and new GraviTower Bremen Pro located at ZARM in Bremen, Germany. The Bremen Drop Tower is a ground-based laboratory with a height of 146 meters and for offering experiments under the condition of weightlessness of excellent quality (10-6 g0). Moreover, scientists and engineers from all over the world benefit from the longest microgravity experiment duration on Earth (9.3 seconds with ZARM's world-wide unique catapult launch system; alternatively 4.7 seconds with the standard drop mode) - available up to three times a day. And now with ZARM's new GraviTower Bremen Pro, experiments can be performed up to 960 times a day, which are not limited to microgravity (max. 2.5 seconds, < 10-4 g0). A partial-gravity option is soon available, e.g., to realize Moon and Mars gravity levels for experimenting in extraterrestrial conditions. However, the partial-gravity option is not available in the context of the 8th round of DropTES and only microgravity experiments can be carried out.

UNOOSA supports the travel expenses of the team, DLR funds the 5 drops or catapult launches at the Bremen Drop Tower or half-days at the GraviTower Bremen Pro, and ZARM provides the accommodation and also technical support during the preparation and experiment campaign. So far, 7 teams of international students from 6 institutes have conducted different types of scientific experiments and technology demonstration missions across seven rounds of DropTES.

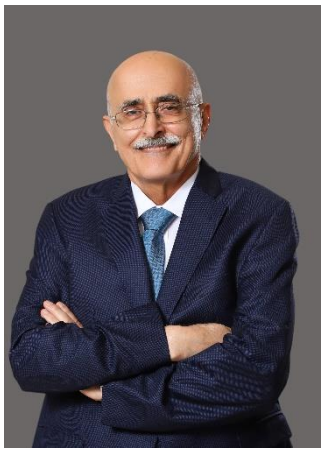
DEADLINE FOR APPLICATIONS: 22 JANUARY 2023

FIND ALL THE DOCUMENTS AND REFERENCE MATERIALS at the DropTES Rounds page:
https://www.unoosa.org/oosa/en/ourwork/access2space4all/DropTES/DropTES_Rounds.html

Other Useful Documents:

- Read an interview with ZARM and 2nd/7th round awardee here:
  Access to Space for All initiative for Sustainability: Interview Series Article #3 Sept 2022 "DropTES: The Stepping Stone into Space Activities and its Contribution to the SDGs"
- Visit each DropTES awardee's page for more information:
  https://www.unoosa.org/oosa/en/ourwork/access2space4all/Awardees.html

Interview: First, we talked with Nabil, who was the Project Coordinator of the 1st round awardee, German Jordanian University.



Nabil has been engaged in microgravity experiments in GJU and American University of Madaba ©Nabil Ayoub

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

This project started with the students' ideas. There is a big interest in space among the young generation in Jordan. When students at the German Jordanian University (GJU) saw that DropTES was open for calls, they approached many professors in engineering asking if their project would be feasible. Since they were not able to confirm and get the backing they needed, as a last resort, they came to me, a physics professor. I just told them that as long as the law of physics is not being violated, anything can be done. From there, we discussed for countless hours how to investigate the stability of tether dynamics for satellites with electromagnetic tether systems using a mass damper.

We see benefits in space and in microgravity, as it opens up horizons for new and innovative ideas such as this. As a university professor, I am always looking for interesting themes for student graduation projects, and new research and development in the space environment really allows the students to think outside the box and also for us as educators not to be stuck in traditional education. Mixing and merging the many traditional sciences that have been done on Earth with space is connecting and building new ideas.

"Research and development in the space environment allows students to think outside the box."

Q: What was the objective of your project?

Team members preparing the sensors for the detection of the tether oscillations at ZARM ©Nabil Ayoub

The dynamics of electromagnetic tethers have been studied for de-orbiting, orbital boosting, and station-keeping of satellites. However, the electromagnetic tether system has been found to be inherently unstable by itself. The main objective of the proposal was to investigate the stability of tether dynamics for satellites with electromagnetic tether systems using a Tilger, a mass damper. (Find the details in team's final report here) For me, it was a very interesting idea that the students came up with to find a solution for the additional amount of energy that need to be used in satellite thrusters, and I wanted to support them all the way.

For DropTES, you need to build a prototype adjusted to the short time in microgravity that you are provided with in the drop tower. Initially, our team started off by taking longer amounts of time to get the desired achievement, so we needed to make the operation time shorter. Also, we had to look at ways to reduce friction.

Q: How does your project contribute to capacity-building in your country and supporting the Sustainable Development Goals?

DropTES has contributed to SDG4 Quality Education, SDG8 Decent Work and Economic Growth, and SDG9 Industry, Innovation, and Infrastructure. As mentioned above, DropTES is a great opportunity for both students and teachers, as it provides the means for high-quality education and it is a programme that helps produce skills and experience for the future of each person's professional life and the workforce of the country. Furthermore, it is a chance for technology innovation, building sustainable infrastructure, and bringing in more avenues for industrial growth.

This interest in microgravity experimentation has grown after the successful DropTES experiment series, and I would like to emphasize how it has further contributed to the support of several more SDGs. While spending four years as the President of the American University of Madaba (AUM), I searched for applications related to microgravity for both AUM students and faculty members. By searching for other platforms and ways of experimenting with microgravity, we learned about the clinostat. A clinostat is a device that simulates microgravity conditions by rotating and negating the effect of gravity. We learned UNOOSA had a programme supporting space technology capacity-building called "Zero-Gravity Instrument Project (ZGIP)", where they distributed clinostats to selected schools and institutions worldwide. We wanted to apply for this opportunity, however, when we reached out, we learned that the programme had finished. According to some market research at that time, we found out that the cost to develop a clinostat was around 1,500 USD. We decided to find a manufacturer and have it developed for us, as we were determined to utilize this device, even with a cost. Through this development, we learned about the instrument and we started to look at scientific fields that it could be applied to, such as biology. Through the clinostat, we studied the behaviour of wheat roots in microgravity. It was fascinating to see that the wheat roots grew 2.5 times more than in Earth-like gravity. Water is an important resource in Jordan, and we believed this finding could be beneficial for agriculture, especially in planting crops in a desert area. This study on wheat plant roots motivated the research team at AUM to further study the effect of microgravity using the clinostat on antidiabetic properties of wheatgrass (Triticum aestivum) in streptozotocin-induced diabetic rats. The results of the study were published in 'npj Microgravity' of Nature Springer in

"Research and development in the space environment allows students to think outside the box."

Clinostats produced at the American University of Madaba ©Nabil Ayoub

Presenting the findings at Jordanian Astronomical Society ©Nabil Ayoub

2020, Vol. 6. This research may also contribute to SDG2 Zero Hunger and SDG 3 Good Health and Well-Being. We also got 60,000 USD in funding from the Jordanian National Science Foundation to develop 3D clinostats. The dissemination of interest in microgravity experimentation and the technology within Jordan is amazing.

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

"The mentality of thinking creatively outside the box and the interest in microgravity experimentation has spread through different universities in Jordan."

This opportunity has helped the German Jordanian University in expanding the horizons of the students, especially for their graduation projects. This mentality of thinking creatively outside the box and the interest in microgravity experimentation has spread through different universities in Jordan, and as mentioned earlier, has become a large movement that allows us to get funding from government research centers. We are truly pleased to see how one experiment has become the beginning of a chain of positive reactions in Jordan.

Q: What are your future plans?

Workshop with high school students ©Nabil Ayoub

After our DropTES experiment, as you can see, we have been doing activities related to clinostats. And we hope to delve further into this by going to high schools in Jordan and introducing clinostats; how they work, how to develop them, and what you can do with them. We are also planning to develop these at a lower cost and automate the clinostat so it is easier for students from different backgrounds such as IT, biology, engineering, etc. to utilize the device for their own research. We also hope that they will become more engaged and interested in microgravity, and in space.

Actually, we have already started this project in 2019. We were able to supervise 3 teams of students from high schools of the Madaba region, and one of the teams won a third-place prize in the category of Space Exploration at the International Science and Engineering Fair (ISEF) which is convened annually in the USA. This international competition comprises of 1700 high school projects from all over the world.

(Right) High school students from Jordan attending ISEF ©Nabil Ayoub

Q: Do you recommend DropTES to other people?

From studying how to 3D print in microgravity to pharmaceutical experiments, there are so many interesting ideas that you can test through DropTES. The drop tower is a fantastic platform to experiment with your ideas. I would also like to emphasize that this was also a learning experience for a professor like me, as it opened new values of teaching that are not traditional. In our case, it brought together a team of engineers and physicists, and we all gained a lot from this collaboration by learning to apply the law of physics and relating them to the field of mechanical engineering. We also learned a lot from our partners at ZARM. They were wonderful mentors who advised us through every step of the challenge. We are a global village and cooperation is key to bringing innovative and new ideas to make the world a better place.

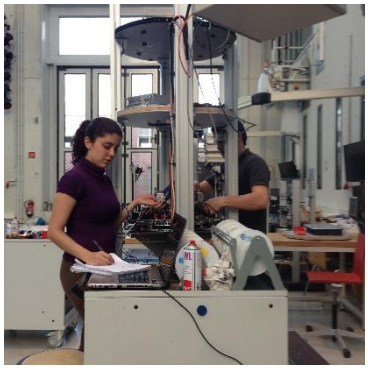
Second, we talked with Renato, who was the Project Coordinator of the 3rd round Costa Rica awardee team formed from Instituto Tecnológico de Costa Rica (TEC) and from Universidad de Costa Rica (UCR).

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

Renato, professor of electrical engineering at TEC, taken from the Drop Tower observatory. ©Renato Rimolo-Donadio

Our journey to Germany started with a student that participated in an UNOOSA activity. She brought the news to us that DropTES was open for applications and we thought it would be an exciting opportunity to submit a proposal. At that time, we were working with remote sensing platforms, but also there were some parallel efforts on CubeSats, so we wanted to relate our experiment to our work. We decided to conduct research to understand the requirements of building robotic systems for satellite applications. It is beneficial to examine these aspects before it is flown to space, and we thought that the drop tower would be a great test bed.

One important aspect of space missions is that we need knowledge from different backgrounds and experiences. Therefore, we focused on building an interdisciplinary team with students from different universities, namely Instituto Tecnológico de Costa Rica (TEC) and Universidad de Costa Rica (UCR). We can proudly say that it was the right approach to have a joint project between two universities, as our team had students who majored in electrical engineering, mechanical engineering, and physics. All of them were strongly motivated to realize this project.



Team members mounting the experiment setup in the drop capsule ©Renato Rimolo-Donadio

Q: What was the objective of your project?

Our team focused on analyzing the dynamics of robotic arm manipulators in microgravity conditions. Under this goal, we constructed complementary robotic arms that were performing movement sequences within the 4.7 seconds of microgravity provided through the drop. The idea was to retain information in microgravity conditions and compare it with normal operation in order to develop an understanding of what needs to be considered when we launch it to space. (To learn more about the details of the experiment, see their report here.)

Q: How does your project contribute to capacity-building in your country and supporting the Sustainable Development Goals?

It has been 6 years since we conducted the DropTES experiment, but the ecosystem around us has been changing for the better. DropTES has allowed us to conduct research and develop space technology and show to the government, academia, and industry that this type of know-how and skills can be fostered in Costa Rica. In 2021, the

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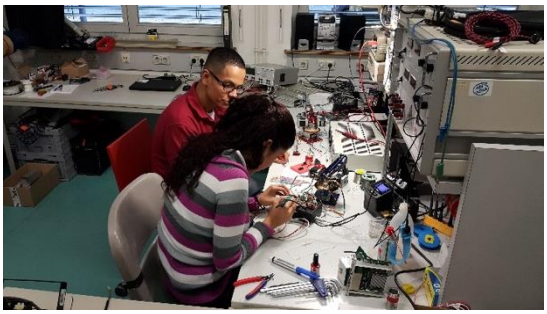
National Congress adopted a law that created the national space agency of Costa Rica which promotes space exploration as a development tool for the country's industry and economy. I believe that our DropTES experiment and the interest that it brought to the country played a role in promoting the ecosystem to realize the formation of this space agency. In that sense, I believe it has links to SDG8 Decent Work and Economic Growth, as it is contributing to the socio-economic development of the country.

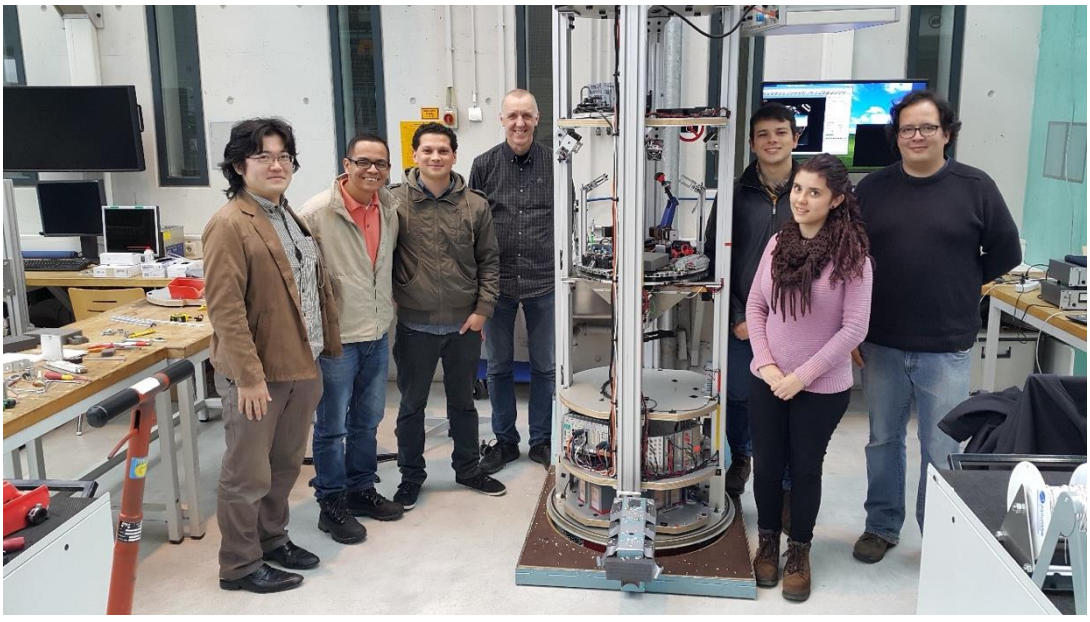
Also, I believe this project has allowed us to contribute SDG4 Quality Education and SDG9 Industry, Innovation, and Infrastructure, as we were able to provide students with relevant educational skills and access to unique infrastructure and information that are not abundant in Costa Rica. It brings talented and motivated students closer to space technology, bridging the space divide between space-faring nations and developing nations. These are results of international cooperation, which fits SDG17 Partnership for the Goals.



Student team members assembling the robotic arms at ZARM ©Renato Rimolo-Donadio

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

This experiment has effectively supported the creation of a stronger space ecosystem within Costa Rica. It has been a fantastic experience for the participating universities as it facilitated the students' career paths and provided an opportunity to motivate young students. The outreach activities we had with DropTES, through various academic presentations and events both domestically and internationally, showed our country that these kinds of projects are possible. We think this has had a positive impact on the young generation, paving the way to engaging with space technology., Today, I see many different new space-related initiatives being active in Costa Rica. We truly thank UNOOSA, ZARM, and DLR for providing us with this first step.



The Costa Rican team, UNOOSA, and ZARM ©Renato Rimolo-Donadio

Q: What are your future plans?

After our DropTES experiment campaign, we saw several initiatives in Costa Rica working on CubeSat technology. Our experiment report and the many data sets from 2016 are openly and freely available, and we believe it has been useful for these initiatives as a reference. These teams not only benefited from the technical perspective, but also from the project management approach and how we formed an interdisciplinary team. We hope to keep the momentum going in the country, by collaborating within the country, to obtain more knowledge and experience to develop more complex space-related technology.

It would be great if we can apply with another student team from Costa Rica, so that they can gain expertise through DropTES, as I can see that it was an important milestone that has influenced the futures of all the students that participated in the 2018 experiment round. It has had a positive effect on their professional development and all of them are engaged with space technology from academia, space agency, or industry.

Robotic arm setup used in the DropTES experiment ©Renato Rimolo-Donadio

Q: Do you recommend DropTES to other people?

Absolutely! DropTES provides you will the full experience; writing a logical proposal, planning the experiment, designing/developing the prototype, coordinating various tasks with the necessary people, conducting the actual experiment, analysing the results, and presenting your findings. It takes roughly a year to go through this life cycle and it teaches the students how to complete a mission, from the beginning to the end. Students also will learn how to work in teams and collaborate with external partners. I recommend this opportunity to all, but especially to students who are interested in progressing their careers in advanced science and technology. The commitment to this project is a life-changing experience for students to build their career paths.


The students from the 2 participating Costa Rican universities ©Renato Rimolo-Donadio

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