



Shaun Redgard (captain), Chantelle Booysen, Dr Hendrik Van Heerden (coach) and Edward Lee were declared the winning team at the 2019 International Natural Sciences Tournament, held in Estonia.

# Beating the Russians at their own game

**Three postgraduate students from the University of the Free State (UFS) returned triumphant from the International Natural Sciences Tournament in February, after being declared the winners!**

The tournament was started by Russian scientist Dr Sergey Safanov in 2010 and has been held annually since then, but the UFS team only became aware of it when the current Tournament Director visited the UFS Chemistry Department in the middle of 2018. Participation in the tournament provides a unique opportunity for students to apply their knowledge in solving problems of a practical nature.

After qualifying to attend the tournament on the strength of their solutions submitted online for a set of problems posed by the organisers, the team headed overseas for the three-day event, this year held at the Tallinn University of Technology in Estonia. 'Team UFS' consisted of the captain Shaun Redgard (Department of Chemistry), Edward Lee (Department of Physics) and Chantelle Booysen (Department of Haematology and Cell Biology), as well as their coach, Dr Hendrik Van Heerden.

"There was quite a short period between qualifying and the event, so many of the qualifying teams couldn't make it because they had other responsibilities, or struggled to get visas or funding in time," says Dr Van Heerden. "We found out when we got there that we'd be competing against only five other teams, all from Russia."

Those teams were made up of students from eight different Russian institutions situated between 1 000 km and 4 200 km from Tallinn, which is the capital of Estonia and lies on the shore of the Baltic Sea, across the water from Finland's capital, Helsinki. So although many of the students had travelled some distance to participate in the tournament, this was nothing compared to the more than 15 000 km covered by Team UFS!

The tournament format is that all of the teams are given 10 problems, and have to choose eight to solve. They then compete in round-robin challenges, in which one team acts as the Speaker – presenting the solution to the problem – another is the Opponent and a third is the Reviewer. The Speaker's presentation is limited to 10 minutes, the Opponent's to five minutes and the Reviewer's to three minutes, but there is also back-and-forth discussion and questioning between these speeches, so each challenge lasts just under an hour.

"It's like a debate – you have to defend your scientific solution against other teams," explains Dr Van Heerden. "The Jury judges who made the best scientific argument on both sides."

The tournament was conducted in English, and most of the Jury members were experts from Europe. Asked whether the Russian teams were at a disadvantage because of the language barrier, Dr Van Heerden says that science was the determining factor, so language issues did not matter.

"There were some Russian teams that were very good, but we had stronger arguments for our science than theirs. We simply beat them at their game!" he quips.

During the final, Team UFS acted as the Speaker for 'The Chinese study' problem, the Opponent for 'The Olive' and the Reviewer for 'T-1000'. In all three roles, they did well enough that their combined total score was the highest, making them the winning team. The runner-up was the wonderfully named Team 'How Do You Like That, Elon Musk?', while Team 'Shock Wave' came third.

Dr Van Heerden noted that consideration is now being given to approaching other universities in South Africa about holding a national round of the competition.

# Brain-teasers

*These are some of the problems the UFS team tackled. See if you can solve them!*

## T-1000

The colour of some insects is based not on pigments, but on the surface morphology. Recently, scientists were able to apply a similar approach to metals, as a result of which the surface acquired super-hydrophobic properties and became almost completely black. Suggest your own methods for creating different solid colours of metals only by modifying the surface structure of the metal or alloy itself. Assess the thermal, chemical and mechanical stability of such a surface, depending on what colour is created. Suggest applications for the metal products with such a surface.

## The Chinese study

During 2018 some batches of the drug valsartan, the active substance of which was produced by the Chinese company Zhejiang Huahai Pharmaceuticals, were recalled from the pharmaceutical market. The reason for the recall was the presence of a dangerous impurity, N-nitrosodimethylamine (NDMA), in the active pharmaceutical substance. NDMA is highly hepatotoxic and is classified as a proven carcinogen. Its presence in valsartan is believed to be caused by changes in the production method of the active substance. What do you suppose was the source of NDMA in the active pharmaceutical substance? How should the way it is produced be modified to avoid the appearance of this impurity? Is it possible to effectively purify the supplied substance from NDMA? If this is possible, suggest an alternative production scheme, which excludes the appearance of NDMA in the substance.

## Breakthrough Starshot

Breakthrough Starshot, announced in 2016, is a programme that aims to send micro-probes to the Alpha-Centauri star system. This will be the first interstellar flight of an object developed by humans. The probe used in the programme is a set of measuring instruments weighing 1 gram and equipped with a solar sail. An array of lasers is supposed to be used to accelerate the entire structure to 20% of the speed of light. One of the unsolved problems of the project is the material of the solar sail: since it is accelerated to high speed, the sail can suffer from star dust or overheat by reflected light. Suggest a physical model of the solar sail and your material options, which would have a high light-reflection factor, be heat-resistant, lightweight and durable.

## The Olive

According to various estimates, more than half of all sold olive oil is counterfeit. One of the main methods of adulteration is adding cheaper low-quality oil. This threatens to cause great economic damage to stores and large oil producers, plus cases of serious health problems and even death of consumers have been recorded. To date, the control of quality and authenticity of olive oil requires a series of analyses, which is too labour-

consuming, since each batch of oil must be analysed. Suggest a method, or the minimum possible number of analyses that could be easily applied to numerous samples, to detect the addition of other oils to olive oil in an amount of more than 1% by weight.

## Vitamin sea

With the development of aviation, moving around the world has become very simple and affordable, and within a day you can get to anywhere in the world for work or vacation. Evolutionarily, the human body is not adapted to such a drastic change in external conditions, which leads to significant discomfort and possible health problems. Explain the mechanisms that occur in the body during the adaptation to new environmental conditions when travelling to different climatic zones, and suggest a way to accelerate acclimatisation based on the described mechanisms.

## WALL-E 2.0

In 2009 the commercial communications satellite Iridium 33 collided with the decommissioned communications satellite Kosmos-2251. This collision created a large amount of debris, and increased the mass of industrial waste in the Earth's orbit. Space debris is a severe problem for launching and operating spacecrafts, yet still there are no reliable ways of cleaning it up. Propose your own technology for removing space debris, as well as assess and justify its recyclability.

## Char Ecosystem

The StarCraft series of computer games features the planet Char – a volcanic world with a high temperature (due to which the lava does not freeze even on the surface) and a complete lack of vegetation. However, it is inhabited by a huge number of alien creatures called zergs. Judging by their appearance, all zergs – even the weakest and most numerous of them – are predators. How could the Char ecosystem be arranged then? What serves as food for so many predators if there are no traces of autotrophs on the surface of the planet? Your solution should not contradict the known laws of biology and ecology. You can find more information about this fictional planet at:

<https://starcraft.fandom.com/wiki/Char>.

## Smartdryer

When travelling, a person may need various heating devices – a hair dryer, a kettle, a shoe dryer, a heater, etc. All have a similar operating principle, but they differ greatly in power and efficiency. Offer the concept of a compact universal heating device that performs the functions of the above devices in reasonable time for each case.

*International Natural Sciences Tournament:*  
<http://www.scitourn.com/inst/>