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PRIME MINISTER'S SCIENCE PRIZES
AOTEAROA NEW ZEALAND

## 2022 TE PUIAKI KAIPŪTAIAO ĀNAMATA FUTURE SCIENTIST PRIZE

# Explaining the extraordinary behaviour of elastic bands

Benjamin Smith has won the Prime Minister's Te Puiaki Kaipūtaiao Ānamata Future Scientist Prize for his research into mathematically modelling the behaviour of twisted elastic bands. This knowledge can be applied to many types of structural engineering.

Benjy was a Year 13 student at Onslow College when he completed his project.

It all started at the International Young Physicists' Tournament earlier in 2022 with one of the problems presented to him that involved two metal balls connected with an elastic band.

"You twist the elastic band, pop them on a table, and the balls start to spin around each other and then they'll spin back and forth in an oscillating motion," Benjy explains.

"I found that the elastic band itself exhibits some quite interesting behaviour — getting tangled and knotted — and does some rather unexpected things. This prompted my research into elastic bands and the investigation of how materials act when they're twisted or stretched."

"As part of the research, I constructed a device to measure how hard the elastic band pulls when you stretch it and how hard it resists the twisting motion that you apply."

"And using this, I was able to determine that the current models we have for predicting those values don't actually work."

**Measuring the forces**

Benjy says there were several challenges in doing his research. The first was in building the measuring device that was able to measure the small amounts of resistance in the elastic bands.

"Elastic bands can be twisted a large amount before they provide any noticeable resistance. So this means that for the range of angles that I was twisting the elastic band, there was only a very small resistance to that, which made it quite difficult to measure."

Benjy had to design a device that would convert that twist into a large-enough force that could be measured by the force sensors he had available to him.

**Modelling the behaviour**

"Another challenge I had, which I still have, is actually modelling the behaviour – because my research found that the current models aren't actually able to predict what happens."

Benjy says the models he is working with are from the field of finite strain theory, which has existed for a little over 100 years. However, in that time there's only been some progress towards developing a generalised model.

"The current models we have only work for specific shapes of materials and in some cases only specific kinds of materials such as rubber or perhaps metals. The end result would be being able to predict the stresses that occur for any shape of material and therefore being able to predict the shapes that materials will adopt under a particular stress."

“The most satisfying impact from my project has been being able to contribute to this area of research and having that understanding and dialogue with some experts in the field. And then, as a result of that, working on these problems that haven't yet been solved by anyone. I found that to be very interesting and motivating.”

**Applications of this research**

This area of research can be applied to many structural engineering situations, Benjy explains. Two examples are bungee jumping and construction cranes.

Benjy says that when twisted or stretched, materials can suddenly change shape and deform, which can cause very localised stresses at a certain point, which could lead to fatigue and potentially that material breaking.

“If you accidentally twist the bungee cord significantly before the person jumps off the platform this could cause issues.”

“Or, if you have a load suspended from a crane which, due to wind or some other disturbance, starts spinning. Once it starts spinning, you’re effectively twisting the cable, and if that cable deforms because it has already been twisted, then that could lead to it suddenly breaking and dropping the load.”

“Through being able to mathematically model these situations, we can apply that knowledge to the materials we currently have and potentially be able to prevent any instances of that fatigue happening.”

The award comes with a prize of $50,000 to support tertiary education. Benjy has started studying physics and computer science at Te Herenga Waka – Victoria University of Wellington this year and hopes to continue down this path of physics research.

“The thing I like most about physics is that you can use the precise nature of mathematics to describe the real world and be able to predict what will happen using that.”

Onslow College principal Sheena Millar says the school is incredibly proud of Benjy’s achievements.

There have been other students from Onslow College who have won the prize in previous years and Benjy was inspired by them as a junior student, explained Sheena.

“He thought, ‘Could I do that? Is that something I could do?’ And he has. He set the goal and it’s come about because of his belief, his hard work and all the support he has had from teaching staff and mentors who fostered that belief in him. Through his time at the school he has set goals and quietly worked at achieving them.”

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## Mō Te Puiaki About the Prize

**TE PUIAKI KAIPŪTAIAO ĀNAMATA FUTURE SCIENTIST PRIZE**

Awarded to a secondary school tauira student for outstanding achievement in carrying out a practical and innovative science, mathematics, technology or engineering project.

This is one of five prizes awarded each year.

The Government of New Zealand introduced The Prime Minister's Science Prizes in 2009 as a way of raising the profile and prestige of science among New Zealanders, in Aotearoa and internationally.

**www.pmscienceprizes.org.nz/**