Next Top Engineering Scientist 2014 Judges report

The 2014 competition was held from 9am to 6pm on Saturday August 2nd. The question posed was "If Mt Taranaki erupted how much would it cost the aviation industry?" Teams calculated answers that ranged from just a few thousand dollars (for a tiny eruption) through to 675 billion (for an eruption of apocalyptic proportions).

The quality of submissions was generally high, with many teams using innovative approaches to solving the problem.

As with previous years the competition problem was purposefully constructed to be open-ended in nature. To answer the problem required teams to make sensible assumptions around various aspects of the problem including (but not limited to):

- the nature and duration of the volcanic eruption
- the prevailing weather conditions around the eruption time
- whether gross or net profit should be analysed
- what constitutes "The aviation industry"

Participation Statistics

We had 186 teams from 76 schools participate this year (from Whangarei in the north down to Dunedin in the South).

154 teams had four members, 31 teams had three members and one team gallantly competed with two members (after losing a team mate due to illness).

The break down by year level was as follows:

Year 11	*6*
Mixed year 11/12	*3*
Year 12	*63*
Mixed year 12/13	*34*
Year 13	*80*

A total of 179 teams managed to get a report in by the 6pm deadline and we had many "Action shot" photos submitted during the course of the day. These photos were uploaded to our department facebook page and can be viewed at: www.facebook.com/engsci

Macleans College had the most entries from a single school, with twelve teams competing. They were followed by Lynfield College with nine teams competing.

The following schools competed (with the number of teams entered by each school listed in brackets)

ACG Parnell College (8)
ACG Sunderland (1)
Alfriston College (1)
Aorere College (1)
Auckland Grammar School (1)
Baradene College (2)
Bayfield high school (1)
Birkenhead College (2)
Botany Downs Secondary College (4)
Burnside High School (4)
Cambridge High School (1)
Carmel College (3)
Christ's College (1)
Destiny School (1)
Epsom Girls Grammar School (8)
Freyberg High School (2)
Green Bay High School (4)
Hamilton Boys' High School (1)
Havelock North High School (1)
Hillcrest High School (1)
Howick College (4)
Kaiapoi High School (1)
King's College (2)
Kristin School (4)
Logan Park High School (2)
Long Bay College (1)
Lynfield College (9)
Lytton High School (1)
Macleans College (12)
Manurewa High School (2)
Matamata College (2)
Morrinsville College (1)
Mount Albert Grammar School (8)
Mount Maunganui College (1)
Mt Roskill Grammar School (1)
Napier Girls High School (3)
Nayland College (2)
Nelson College (2)
Northcote College (1)
Onehunga High School (2)
Ormiston Senior College (2)
Otago Boys High School (1)
Otumoetai College (2)
Pakuranga College (4)
Palmerston North Girls' High School (1)
Papatoetoe high school (1)
Pukekohe Christian School (1)
Pukekohe High School (5)
Putaruru College (1)
Queen Charlotte College (1)
Rangitoto College (5)
Reporoa College (1)
Rongotai College (2)
Rotorua Girls' High School (1)
Sacred Heart College, Auckland (4)
Sacred Heart Girls' College Hamilton (2)
Saint Kentigern College (8)
Sancta Maria College (1)
Selwyn College (2)
Spotswood College (1)
St Cuthbert's College (1)
St John's College, Hastings (1)
St Patricks College Wellington (1)
St Peter's College, Epsom (3)
St Peter's School Cambridge (2)
Takapuna Grammar School (6)
Tauranga Girls' College (1)
Wairoa College (1)
Waitakere College (4)
Wanganui City College (1)
Western Springs College (1)
Westlake Boys' High School (1)
Westlake Girls' High School (2)
Whangaparaoa College (2)
Whangarei Boys' High School (3)
Woodford House (1)

Judging

Judging was blind, so that judges could not tell which school an entry had come from. The identity of each team was only revealed to the judges after they had finished selecting the winning entries.

Judging was done in two rounds, using academic staff from the Department of Engineering Science, who are experienced at reviewing technical reports. For the first round each judge was allocated a selection of reports to review, from which they identified the best reports amongst their allocation to put forward into the final round. During the final round of judging all finalists were again closely reviewed by a pair of experienced judges who determined the place getters and highly commended teams.

Comments

What set the top teams apart from the rest was that they combined excellent modelling with extremely well written reports. Some teams had great mathematical modelling skills but were let down a little by the quality of their report writing while other teams had very well written reports but fell short on the modelling side. To be in the running for first place teams needed to show great modelling skills AND to have presented their work using well-structured, polished writing that was easy to read. Clear diagrams, images and graphs all helped make reports more readable.

Surprisingly few teams produced a well written summary at the start of their report. While many teams remembered to include a section headed "Summary", typically these summaries did not in fact summarise the results! It is very important that the summary at the start of the report includes not only the approach taken but a brief outline of the conclusion reached (which in this instance should have been a dollar value for the cost to the airline industry). A reader should be able to skim through the summary and find both the question the report tackles and the answer reached.

It was vital to determine the likely nature, size and duration of the volcanic eruption, as this had significant implications for the answer. It was however clear that some teams had focused too much of their efforts on researching volcanic information, which left them with little time to develop a model of the situation. While research is important, it only provides a solid foundation for the model and it is the model you build on this foundation that is key to success. A good aim is to spend no more than an hour or two on research, so that you are in a position to make sensible assumptions. This leaves the bulk of the day for modelling and writing up your report.

Many teams picked up on the relevance of the 2010 Eyjafjallajökull Icelandic eruption (which impacted significantly on European air traffic). There was a wealth of information available online about this eruption. Better teams used this information to inform and validate their model. Remember is always useful to think about the validity of your calculations, comparing them against real life scenarios and data if at all possible. While a Taranaki eruption would unlikely be identical to the Icelandic event, reading about the Icelandic eruption provides good insight into the kinds of factors that need to be considered, such as how high and far the ash cloud spreads and how long it takes to disperse (as well as the impact of weather on dispersal)

Some teams came up with not one but two (or even more) models. It is often a good idea to use different models to explore different assumptions (e.g. the impact of a small versus a large eruption, sunny days versus rain, differing wind conditions). Different models can also result if you refine your original model (perhaps after noticing some short comings with the original).

Producing multiple models can be a good strategy if well implemented, as it provides you an opportunity to demonstrate a deep understanding of the problem and the key factors involved. Take care though that you don't produce quantity over quality.

Results

The winners of The Pullan Prize for first place ($6000)

Team **1182** from Matamata College (Year 13)
Renae White, Seamus Bardoul, Philip ten Houte de Lange, Kelly Petersen

Runners up ($2000 for each team)

Team **1097** from Saint Kentigern College (Mixed year 11/12)
Meheer Zaveri, Oscar Sims, Kevin Shen, Jed Robertson

Team **1148** from St Peter's School Cambridge (Mixed year 12/13)
Lachlan Glass, Louis Kohn-Taylor, Fraser Rose, Hayden Fenn-Wells

Highly commended

Team **1042** from Kristin School (Year 12)
Sharn Fonseka, Grant Holtes, Amelia Vincent, Matthew Sinclair

Team **1023** from Macleans College (Year 13)
Samuel Attard, Jim Wang, Benjamin Yi, Jenny Chiang

Team **1132** from Macleans College (Year 13)
Yatharth Mitra, Harpreet Singh, Aditya Arora, Pulkit Kalra

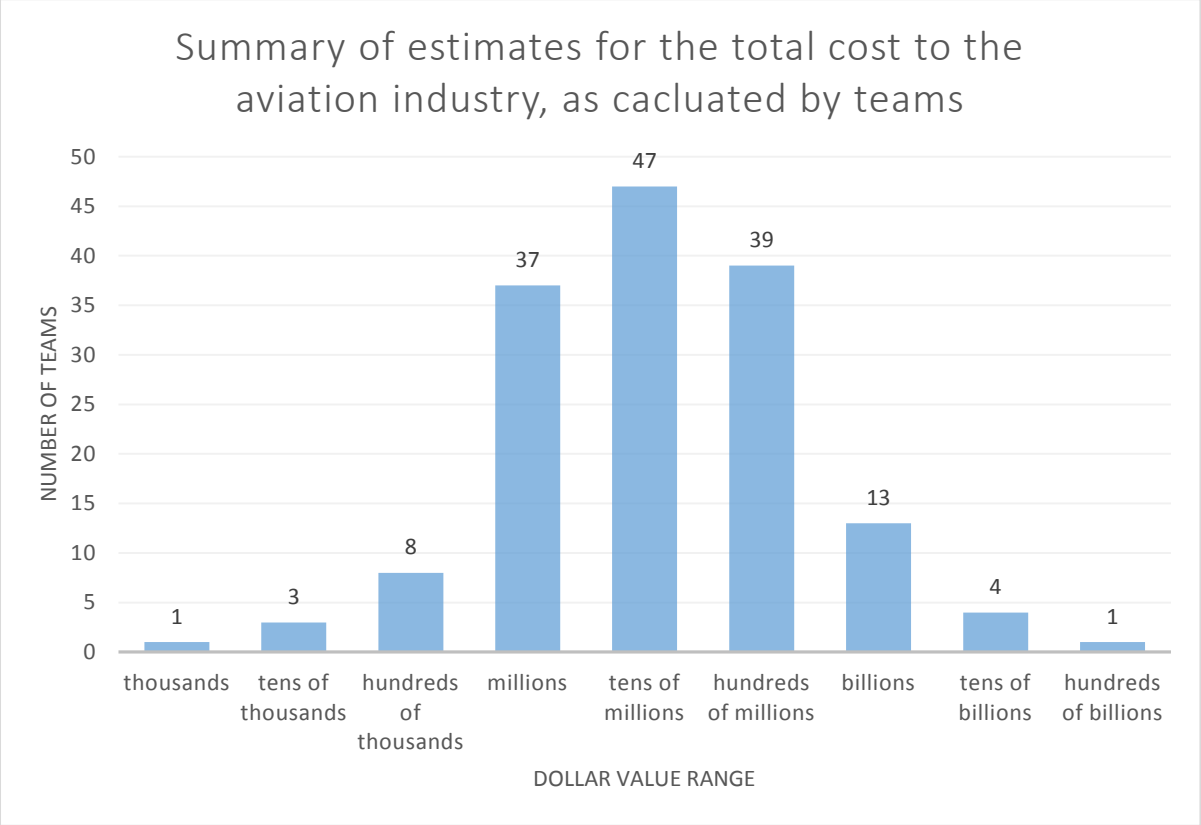
Team **1157** from Western Springs College (Year 13)
Charles Jackson, Tanya Peart, Yue Zhang, Sacha Knight

Team **1155** from Westlake Boys' High School (Year 13)
Danial Valikhani, Matthew Bilton, Jeffrey Choy, Campbell Wang

Team **1110** from Whangarei Boys' High School (Year 13)
Brad Miller, Tim Gordon, Simon Wong, Shaan Hill

Solutions

Obviously the nature of any assumptions made will have a significant impact on the final cost found. Teams came up with a wide range of different values for the cost to the aviation industry, from a few thousand dollars (in the case of a very minor eruption) to in excess of 600 billion dollars (for an eruption of apocalyptic proportions). A summary of the cost estimates are shown below. Note that this analysis is based on the "total cost" reported. Teams which submitted only a daily cost estimate (or failed to come up with a final cost figure) have not been included in the analysis. If teams submitted a cost range then the upper limit has been used.



A quick sanity check on these figures can be done by considering the **annual** revenue from the NZ aviation industry which is around 12 to 15 billion dollars[1]. If, as many teams proposed, the eruption would disrupt only air travel within NZ for a period of around a week then an answer in the billions is unlikely to be correct, unless airports and aircraft are significantly damaged. The actual answer that each team came up was of less interest to the judges that the process that they followed to come up with that answer. Judges were looking for teams that could also put their ideas together in a well-structured document, presenting quantitative arguments to support their conclusions. There were many different ways of attacking the problem, and many different aspects that could have been addressed in developing each team's conclusions. It was of course impossible for all of the issues and questions to be addressed in the time available – this was all part of the challenge.

[1] http://www.transport.govt.nz/assets/Import/Documents/New-Zealand-Airports-Association-New-Horizons.pdf