Next Top Engineering Scientist 2015 Judges report

The seventh annual "Next Top Engineering Scientist competition" was held from 9am to 6pm on Saturday August 1st, 2015. The question posed was "If a New Zealand student uploads a video clip that goes viral, how long will it take before 1% of the world's population has seen it?" Teams calculated answers that ranged from just a few minutes through to never.

The quality of submissions was generally high, with many teams using innovative approaches to solving the problem, including an increasing number of teams making use of computer programming.

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 definition of a viral video
- The characteristics of the video (e.g. language, length and genre)
- The potential audience
- The propagation channels (e.g. youtube, facebook, twitter, etc.)

Participation Statistics

We had 179 teams from 68 schools participate this year (from Dargaville and Whangarei up in the north down to Oamaru and Dunedin in the South).

146 teams had four members and 33 teams had three members.

The break down by year level was as follows:

Year 11	*1*
Mixed year 11/12	*2*
Mixed year 11/13	*1*
Year 12	*70*
Mixed year 12/13	*29*
Year 13	*76*

A total of 173 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

Epsom Girls Grammar had the most entries from a single school, with twelve teams competing. They were followed by Lynfield College with ten teams and ACG Parnell College and Botany Downs Secondary College, both with nine teams each.

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

ACG Parnell College (9)
ACG Senior College (1)
ACG Strathallan College (1)
ACG Sunderland College (1)
Aorere College (1)
Auckland Grammar School (1)
Auckland International College (2)
Baradene College (4)
Botany Downs Secondary College (9)
Burnside High School (4)
Campion College (1)
Carmel College (6)
Christ's College (1)
Dargaville High School (1)
Diocesan School for Girls (2)
Epsom Girls Grammar School (12)
Freyberg High School (1)
Glendowie College (4)
Green Bay high School (2)
Hamilton Boys' High School (1)
Havelock North High School (2)
Heretaunga College (1)
Howick College (3)
Kaiapoi High School (1)
King's College (1)
Kristin School (2)
Logan Park High School (2)
Long Bay College (1)
Lynfield College (10)
Macleans College (8)
Marlborough Girls' College (2)
Matamata College (2)
Morrinsville College (4)
Mount Albert Grammar School (3)
Mount Maunganui College (3)
Nayland College (2)
Nelson College (2)
Northcote College (1)
Onehunga High School (1)
Otago Boys High School (1)
Pakuranga College (1)
Palmerston North Girls' High School (1)
Queen Charlotte College (1)
Rangitoto College (4)
Rotorua Girls' High School (2)
Rutherford College (3)
Sacred Heart College, Auckland (1)
Sacred Heart Girls' College Hamilton (3)
Saint Dominic's Catholic College (3)
Saint Kentigern College (5)
Selwyn College (4)
St Cuthbert's College (1)
St Kevin's College, Oamaru (2)
St Patricks College (1)
St Paul's Collegiate, Hamilton (2)
St Peter's College, Epsom (3)
St Peter's School Cambridge (3)
Takapuna Grammar School (4)
Taradale High School (2)
Tauranga Girls' College (2)
Thames High School (2)
Wanganui High School (1)
Wellington College (1)
Wellington Girls' College (1)
Western Springs College (1)
Westlake Boys' High School (3)
Westlake Girls' High School (3)
Whangaparaoa College (3)
Whangarei Boys' High School (2)

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 after 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. The final three teams were examined by a total of four judges and a consensus was reached as to who had won.

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.

It was pleasing to see that most teams had a well written summary at the start of their report. The length of these summaries varied dramatically from one or two sentences through to a whole page. Ideally a summary should outline the solution method and the solution reached, without going into too much detail. While most teams included their solution in the summary, many did not provide enough of an outline of the method they used to reach their conclusion.

A very important part of the modelling process is to make sensible assumptions. Many teams made assumptions that sounded sensible but didn't back their assumptions up with any kind of data. This amounts to building on a shaky foundation of guesswork. The very top teams based their assumptions on real data. At the very upper end, where teams generally had well thought out equations, what tended to separate them was the quality of their assumptions. Some of the very best teams gave a well thought out and detailed analysis of their assumptions, including how changing those assumptions would impact on their solution (see the winning report for an excellent example).

There were some very advanced mathematical models introduced by some teams, however it is always important to think about whether a complex model is helpful or not. Sometimes extra complexity helped obtain a better solution and sometimes it didn't make much of a difference. For example a number of teams modelled the growth of the population of the world, reasoning that the world's population was growing and that 1% of the world's population was hence not a constant. While the population of the planet is indeed increasing, the important question to ask is whether this matters. If we are dealing with a time scale of a few days (or even weeks) then the total population changes by only a very, very small fraction of a percentage point. This means that a simple approximation of a constant population would be perfectly sensible if your model was producing a value on the order of several days or even weeks. Of course if your solution was running into years, then the growing population becomes a very significant factor and it would be wise to include it. Thinking about whether or not to include factors plays a key part in coming up with a realistic solution.

It was surprising to see some teams quoting answers to 8 (or more decimal places). In the event that your model produces an answer with a large number of decimal places you should always think about how many significant figures should be included. This is particularly relevant when there have been many assumptions made, some of which may be off by a fair bit. As an example, an answer of 60.123456789 days is overly precise and would be better stated as 60 days. The extra precision conveys the impression that the answer will be exactly this (which is very unlikely!)

A number of teams came up with two (or more) different solutions or a range of possible values. This is perfectly acceptable, particularly when the solutions are backed up by logic and data. It is often a good idea to use different models to explore different assumptions (e.g. the impact of a video being tweeted by a major celebrity, or how language might affect the appeal of a video spreading to non-English speaking countries).

Obviously the nature of any assumptions made will have a significant impact on the length of time taken. Teams came up with a wide range of different values for the time taken for 1% of the world's population to have viewed the video.

A quick sanity check on these figures can be done by considering the length of time some popular viral videos have taken to reach 100 million views on youtube (while 100 million views isn't equivalent to 1% of the world's population it is in the right ball park and this data is easily available online).

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.

Results

The winners!

The Pullan Prize for first place ($6000):
Team 1153 from Wanganui High School (Year 13)
Elia Nicolin, Amaan Merchant, Julian Schurhammer

Runners up:

($2000 for each team)
Team 1020 from ACG Parnell College (Mixed Year 12/13)
Sheng Wang, Timo van Veenendaal, James Chung, Yu-Hao Liu

Team 1111 from Kristin School (Mixed year 12/13)
Hyeongjin Kim, Yan Tian Zhang, Jack Liu, Marco Tyler-Rodrigue

Highly commended:

Team 1004 from St Peter's School Cambridge (Mixed Year 12/13)
Anthony Wilson, Scott Yearbury, Samuel Frengley, Fraser Rose

Team 1011 from Westlake Boys' High School (Year 13)
George Han, Ritchie Li, Tony Liu, Harry Deare

Team 1052 from Hamilton Boys' High School (Mixed Year 12/13)
Christopher Mayo, David Lee, Jacob Cheatley, Stephen Burroughs

Team 1058 from Auckland International College (Year 12)
Ngoc Minh Thu Nguyen, Miles Lee, Bao Nguyen, Pham Ngoc Quyen

Team 1059 from Wellington College (Mixed Year 12/13)
Logan Wu, Callum Li, Jay Deshpande, Sebastian On

Team 1088 from Saint Kentigern College (Mixed Year 12/13)
Meheer Zaveri, Oscar Sims, Jed Robertson, Kevin Shen

Team 1143 from Selwyn College (Year 13)
Stephen Bayley, Matthew Chen, Kiska Ababa

Team 1144 from ACG Sunderland (Mixed Year 12/13)
Mark Smith, Natasha Manuson, Anurag Nadgir, Tirth Thakar