Next Top Engineering Scientist Competition Judges Report 2016

The eighth annual "Next Top Engineering Scientist competition" was held from 9am to 6pm on Saturday August 6th, 2016. The question posed was **"What is the fastest humanly possible time for the Olympic 100m freestyle event?"** which was a fitting challenge as the competition coincided with the first day of the Olympics.

The quality of entries was as usual very high. We had 182 teams from 71 schools taking part. See the end of the report for a full list of schools who took part.

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):

- Whether banned substances would be permitted under the definition of "humanly"
- The physical abilities and attributes of the fastest swimmer
- The conditions under which the swimmers were competing (including the size of pool)

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 several 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 second round judges reviewed the top 20 finalists. For the final round of judging the top five finalists were reviewed by a panel of experienced academics who reached a consensus on the place getters.

Comments

What set the winners apart was consistently high quality in all aspects of their report. They all included a well written summary that included their final answer. The quality of their writing was exceptional, being easy to follow and understand. The top entries also made good use of images, diagrams and graphs to get across their points. The mathematical analysis was sophisticated, typically showing more than one approach to solving the problem. Importantly they also made sensible assumptions and discussed the implications of these assumptions.

First impressions matter. Some teams forgot to include a summary, which reduced the impact of their report. Many teams wrote a summary but failed to include their calculated time in their summary. The point of a summary is to summarise both the approach and the findings, so this means it should include those findings!

It is always advisable to do a reality check on any answers calculated. Some teams gave times well under half the time of the current Olympic record. When records are broken by hundredths of a second, it is unreasonable to expect a theoretical fastest time half that of the current record. Similarly a "fastest" time that is slower than the current Olympic record isn't expected. If your modelling produced unrealistic results all is not lost but it is important to discuss why your answer is unrealistic. It is particularly nice if you can identify exactly why your model is inaccurate (e.g. it doesn't incorporate a key variable or makes an assumption that you have subsequently identified as false).

Frequently teams went to great lengths to define the physical proportions and characteristics of their "ideal" swimmer but then did not use any of these proportions in their calculations. If factors aren't incorporated into a model then an in depth discussion of how important these factors are is somewhat superfluous.

The focus of the report should be the modelling phase, rather than the introductory material, yet many introductions took up the bulk of the report. The top entries tended to use only a page or two for their introduction. They also typically used their full allowance of 10 pages, giving them six or seven pages focused on modelling.

It was common to quote answers to many decimal places, e.g. 40.123456 seconds. Quoting answers to this many decimal places is typically not appropriate when the answer is dependent on imprecise inputs (e.g. an estimated drag coefficient). Also the records are only recorded to two decimal places, so within this context one or two decimal places is much more appropriate.

A number of teams used a curve fitting approach to historical data to establish a ballpark figure for the answer. This is an excellent idea although it should be noted that the data needed to be cleaned to remove those records which don't match the assumed conditions. For example "short course" records (set on a 4x 25m lap course) should be removed if you are assuming a "long course" with 2x50m laps (as the current Olympic rules require). Similarly if you assume that high tech full body swimsuits will not be used (as they are now banned from Olympic competition) then those records set with such swimsuits should be removed from the analysis.

If using a curve fitting approach it is important to consider what curve type will best model reality. While a quadratic curve might fit the data well, it is inherently problematic in that it doesn't head towards an asymptote. With a quadratic curve values decrease until the turning point is reached, after which values increase (and this doesn't match reality very well, as we don't expect performances to get worse).

A number of reports looked at incorporating reaction times into the picture. This is a small component but well worth considering, particularly when records are measured to 1/100th of a second. Care needs to be taken not to confuse human reaction time (which has a limit of around 0.1 seconds) with "block time" (the time taken for the swimmer to leave the block). The 0.1s Olympic false start boundary applies to the 100m track event, where sensors measure when the sprinter first applies pressure to the starting block. By contrast in swimming, time to leave the block is what is measured (sensors detect when the pressure has reduced to zero, indicating the swimmer has left the block). A suspiciously low block time (e.g. 0.4s) will result in disqualification. From the buzzer going off it typically takes at least half a second to fully leave the block.

2016 results

The Pullan Prize for first place (\$6000):

Team 1089 from Saint Kentigern College (Year 13) Kevin Shen, Henry Mellsop, James Hansen, Cameron Low

Runners Up (\$2000 for each team)

Team 1046 from Whangarei Girls' High School (Year 13) Grace Elliot, Aria Zhang, Rebeca McKean, Mihi Shepherd

Team 1064 from Hamilton Boys' High School (Year 13) Jacob Cheatley, David Lee, Christopher Mayo, Lachlan Cate

Highly Commended

Team 1007 from King's College (Year 13) Amay Aggarwal, William Wang, Max Wilson, Luke Hindmarsh

Team 1027 from Kristin School (Mixed Year 12/13) David Cui, Hyeongjin Kim, Tina Zhang, Felicity Qin

Team 1066 from St Paul's Collegiate, Hamilton (Year 13) James Krippner, Blair Foster, Craig Stocker

Team 1099 from John McGlashan College (Year 13) Louis Jennings, Luke Nie, James Anderson, Matthew Dockerty

Team 1119 from St Cuthbert's College (Year 12) Noor Al-Shamma, Amy Song, Stacey Tian, Joia Che

Team 1169 from Scots College (Mixed year 12/13) Andrew Tang, Freddie Strauss, Brendan Patrick, Henry Fox

Team 1174 from Sacred Heart College Auckland (Year 12/13) Heinrich Metzler, John Gorham, Conor Nelson, Daniel Koenigsperger

Participation Statistics

We had 182 teams from 71 schools participate this year (from Whangarei up in the north down to Dunedin in the South).

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

The break down by year level was as follows:

Year 13	72
Mixed year 12/13	36
Year 12	59
Mixed year 11/12	3
Year 11	6
Other	6

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: <u>www.facebook.com/engsci</u>

ACG Parnell had the most entries from a single school, with twelve teams competing. They were followed by Lynfield College with nine teams and Epsom Girls with eight teams. See the next page for a complete list of participating schools.

Participation

School	Teams	Mount Maunganui College	1
ACG Parnell College	12	Mount Roskill Grammar School	3
ACG Strathallan College	1	Naenae College	1
ACG Sunderland	1	Northcote College	2
Amuri Area School	1	Onehunga High School	1
Auckland Grammar School	3	Pakuranga College	2
Auckland International College	3	Palmerston North Girls' High School	3
Baradene College of the Sacred		Pinehurst	1
Heart	1	Rangitoto College	5
Birkenhead College	2	Rathkeale St Matthew's Senior	
Botany Downs Secondary College	6	College	1
Burnside High School	1	Riccarton High School	3
Carmel College	6	Rutherford College	1
Cornerstone Christian School	1	Sacred Heart College Auckland	3
Diocesan School for Girls	3	Sacred Heart Girls' College Hamilton	3
Epsom Girls Grammar School	8	Saint Kentigern College	3
Freyberg High School	2	Scots College	1
Glendowie College	4	Selwyn College	3
Green Bay High	1	Southland Girls' High School	2
Hamilton Boys' High School	1	St Cuthbert's College	2
Howick College	2	St Kevin's College	3
Huanui College	1	St Paul's Collegiate (Hamilton)	1
Inglewood High School	1	St Peter's College	7
John McGlashan College	1	St Peter's School, Cambridge	3
Kaiapoi High School	1	Takapuna Grammar School	4
King's College	3	Tauranga Girls' College	4
Kristin School	4	Te Kapehu Whetu	1
Lynfield College	9	Wanganui City College	1
Macleans College	4	Wellington East Girls' College	2
Mahurangi College	1	Wellington High School	2
Marlborough Boys' College	1	Western Springs College	2
Marlborough Girls' College	2	Westlake Boys' High School	2
Massey High School	1	Westlake Girls High School	2
Matamata College	3	Whanganui High School	1
Melville High School	1	Whangaparaoa College	5
Morrinsville College	3	Whangarei Boys' High School	3
Mount Albert Grammar School	2	Whangarei Girls' High School	1