

Examiner's Report - New Zealand's Next Top Engineering Scientist 2011

The 2011 competition was held on Saturday 1st October, with students working from 8am through to 5pm. The competition question was "If a severe Tsunami warning was issued, how long would it take to evacuate the 13,000 people who live on Te Atatu Peninsula?" 117 teams took part with entries from 65 schools all over New Zealand.

This was the third year the competition has been run and the general standard of entries was very high. As with previous problems, coming up with a solution required some sound problem-solving skills typical of those needed and employed in the Department of Engineering Science. This year's question lent itself particularly well to computer simulation, although only one team used this approach. We hope that the participants all enjoyed the competition and learnt something in the process.

The problem specified was, as usual, very open-ended and challenging. The question deliberately did not specify what caused the Tsunami, where it originated or exactly how large it was or what evacuation methods were to be employed. The exact answer was not, in fact, that important to the judges (although several staff members do live on Te Atatu Peninsula, so have a personal interest in the results). What was of interest to the judges was the process followed in coming up with the answer, as well as the ability of the teams to put their ideas together in a well structured document and develop and present quantitative arguments to support their conclusions. It was of course not possible for all of the issues and questions to be addressed in the time available – this was all part of the challenge.

It should be noted that the entire judging process was done "blind", with the judges having no idea of the identity of the teams they were judging. Judging was done using only the team ID number for reference and the identities of the teams were only revealed to the judges after they had identified the winning and highly commended teams.

The entries were initially examined by four academic staff from the Department of Engineering Science. Each of these members compiled a short list of the entries they considered to be the best. This entire short list was then independently examined by two Professors within the Department of Engineering Science, one of whom is the current Head of Department. Both of these judges independently came to the same conclusion as to the winning entry. Together they identified the runners up and the highly commended list.

Included below is the list of results showing the winners, runners up and highly commended entries. This list is followed by some brief specific comments for each team.

Overall Winner (\$6000) of the Pullan Prize

Team 1014 from Garin College, Nelson (Year 13).
Benedict Morrissey, Matthew Ruffell and Michael Shanaher

Runners Up (\$2000 for each team)

Team 1034 from St. Cuthbert's College, Auckland (Year 13)
Elynn Yang, Harim Lee, Jimin Kang and Vicky Tai

Team 1075 from Kings College, Auckland (Mixed)
Ashish Pandey, Jamie Beaton, Richard Ngo, and Harry Gower

Highly Commended

Team 1001 from St. Peter's College, Auckland (Year 12)
Nicholas Twort, Angus Craig, Thomas Taylor and Michael Fitzpatrick

Team 1037 from Botany Downs Secondary College, Auckland (Year 13)
Tzu-Han Lin, Chinmay Pandit, Mirendra Aruldasan and Bryan Ma

Team 1054 from St. Kentigern College, Auckland (Year 13)
Frazer French, Conor McCowan, Andrew Hughes and Matt Ansell

Team 1055 from Lincoln High School, Lincoln (Mixed)
Hadleigh Frost, Daniel Morris, Marcus Stenfert Kroese and Matthew Young

Team 1117 from ACG Sunderland College, Karaka (Mixed)
Albert Lei, Christopher Petty, Frano Ivan Stanisic and Miso (Hannah) Kang

Individual Comments

- 1001 Well written report, with nice use of online resources such as population data (Waitakere Council) and geographical data (google maps). Very sensible use of staged evacuation, and good implementation of a statistical estimation when computing average travel times to congregation points.
- 1002 Nicely considered response to the problem, with some inventive touches such as the fluid dynamical modelling of populations. Also good use of online resources such as google maps, and it is pleasing to see assumptions listed at the end of the report.
- 1003 A well written report which considers several important aspects of the problem. Good use has also been made of sources of information available in the public domain. Great effort.
- 1004 Well thought out response to the problem set, including sensible calculations of the evacuation times, although it would have also have been interesting to factor in differing times to the designated pathway from different parts of the peninsula. Nonetheless, an excellent effort.

- 1005 Very good treatment of the problem, with lots of different facets being considered, including identification of particularly vulnerable locations such as hospitals. Assumptions are also clearly outlined.
- 1006 Well considered treatment of the problem, with the consideration of age demographics particularly pleasing. Also, interesting use of a negative parabolic function to model congestion, although may have been better to prescribe a function for distance travelled rather than velocity. Overall, an excellent effort.
- 1007 Interesting and very creative attack on the problem, with clear identification of suitable evacuation sites. Well done.
- 1008 Well-considered response to the problem, including novel aspects such as range of siren warning based on their number and volume. Very good effort
- 1009 A well-written report detailing an inventive solution to evacuation of the peninsula. The long evacuation times predicted by helicopter suggest that alternative arranged transport by road might be a better option, nonetheless, and excellent effort.
- 1010 Really nice treatment of the problem, especially the section detailing factors effecting evacuation times, such as time of day, weekend vs. weekday and seasonal effects. The report was left a little unfinished in parts, otherwise, great effort.
- 1011 Excellent treatment of the problem, which considers allotment of total available resources to Te Atatu as well as different modes of evacuation and well considered calculations. Also, a very well presented report. Great effort.
- 1012 Good use of online resources and an intriguing and novel approach using an adapted electrical systems. It would have been great to see more details of this in the report, nonetheless, a fine effort by the team.
- 1013 Very well considered plan, convincing calculations and nicely written report. Somewhat concerned by invoking of Darwin's Law, but otherwise a very good effort.
- 1014 Excellent and comprehensive treatment of the problem, and great use of freely-available software. Furthermore, a very clear and well-presented report. Fantastic effort.
- 1015 Well considered plan, containing convincing calculations for evacuation times. Moreover, a nicely written and clear report. Great effort.
- 1016 Well-written report detailing thorough consideration of the problem. The calculations of notification times by word of mouth were especially pleasing to see. Great effort.
- 1017 A nice treatment of the problem, with good use of available online resources. Consideration of bottleneck effects was especially useful. Good effort.
- 1018 A very thorough treatment of the problem, with a comprehensive set of calculations. It is pleasing to see so many transportation options evaluated. Great effort.

- 1019 Well thought-out response, involving sensible staggering of evacuation by region and existing advanced formula for evacuation times. Excellent effort.
- 1021 Clear plan and pleasingly detailed calculations of the number of vehicles required. Furthermore, a well structured and nicely presented report.
- 1022 Useful identification of possible evacuation locations, and good use of online resources such as population data and traffic flow models. Overall, good effort.
- 1023 Good consideration of possible evacuation areas and the various different options for transportation. Nice effort.
- 1024 A well thought out response, showing good use of information available in the public domain, as well as a novel discharging capacitor model for evacuation patterns. Also, a clear and well presented report. Great effort.
- 1025 Nicely thought out response, considering various options for transportation and some useful calculations. Fine effort.
- 1026 Nicely worked out plan, including identification of vulnerable groups and locations, and convincing calculations. Moreover, a clear and nicely presented report.
- 1028 Good consideration of different scenarios and suitable evacuation locations. Nice effort.
- 1029 Well considered plan, taking into account likely evacuations from other regions of Auckland. Furthermore, a really nicely presented and clear report.
- 1030 A well-thought out treatment of the problem, including considerations of vulnerable groups such as schools, which require transport to be provided. These were back-up with convincing calculations. Good effort.
- 1031 Nicely written; sensible discussion. Reasonable analysis of time to clear vehicles from peninsula. Nice outline of possible extensions to the model. Figures employed in vehicle clearance perhaps optimistic.
- 1032 Separate evacuation corridors for Central Auckland, North Shore, & Te Atatu; very sensible. Nice propagation of uncertainties in calculations of evacuation rates. Calculation of optimal partition of walkers & drivers indicates careful thought & insight – nicely done. Solid discussion of warning duration, though analysis time might have been better spent on evacuation plan. Attempted to answer question “Could population be evacuated”, in addition to “How long would it take?”, perhaps at the cost of analysis time.
- 1033 Nice outline of transport options. Sensible selection of evacuation points. Sensible rounding of figures. Might have given consideration to walking. A very solid report – nicely balance, comprehensive and nicely presented – came across well.
- 1034 Nice, concise description of tsunami wave transmission. Good use of the literature – three notable references. Excellent analysis of traffic flow rates & congestion at critical junction; sensible suggestions to ameliorate bottleneck. Analysis of two driving strategies & a combined driving/walking strategy, though walking analysis perhaps unnecessarily detailed. Excellent.

- 1035 Nice analysis of the warning duration, though the time required to do this might have been better allocated to the evacuation strategy. Thoughtful design of four separate evacuation corridors. Clearly presented route maps. Careful consideration of number of evacuees as a function of time. Definition of safe zones (after half-way point) seems difficult to justify.
- 1036 Solid comparison of walking- and driving times. Careful analysis of affected zones, though time might have been better spent in other areas. Symbols might have been more clearly defined in places.
- 1037 Nice discussion of the dependence of road capacity on vehicle speed. Thoughtful discussion and analysis of fastest vehicle-walking mix. Would have been nice to analyse different warning day/time scenarios, as suggested in Report's Introduction.
- 1038 Commendable analysis of wave speed & velocity, though perhaps not crucial to subsequent analysis. Parameter estimates (capacities, assembly- & loading times) perhaps optimistic.
- 1041 Succinct explanation & thoughtful analysis of warning duration. Thoughtful selection of assembly points. Comprehensive discussion of school-, hospital evacuation. Careful consideration of evacuation scenarios (day & time). Would have been nice to see a more detailed justification of vehicle evacuation time/speed. Overall, a very solid submission.
- 1043 Very careful analysis of critical junctions. Assumptions perhaps optimistic; would have benefitted from further discussion or analysis. Only considered one scenario (everyone at home).
- 1044 Thoughtful discussion of traffic density and its implication on travel times, though further explanation of model (role of jam density) would have been beneficial. Discussion of warning interval & wave diffraction was nicely done, though perhaps reduced time available for other analysis.
- 1049 Very careful analysis of traffic flow at critical round-about on Te Atatu road – nicely done. Estimate of evacuation time is acknowledged to be optimistic; could perhaps have identified factors whose analysis may have led to a more realistic figure.
- 1050 Simple, but sensible analysis of traffic flow rate. Assumptions clearly identified & explained. Could perhaps have analysed other scenarios.
- 1051 Concise, well written. A more comprehensive analysis of traffic flow – allowing for the impact of congestion at critical junctions, rather than utilising an aggregate flow rate – might perhaps have produced more convincing evacuation time. However, this shortcoming was clearly identified in the report.
- 1052 Concise; nicely written. Would have benefitted from more extensive analysis of traffic flow, identification of assembly points etc.
- 1053 Calculation of height & speed of tsunami wave was done good, but perhaps unnecessary. Identification and discussion of assembly points – nicely done. Would have been nice to consider alternative warning times (day/night, week/end). Evacuation plan takes residents to assembly points at NW Motorway; it would have been nice, perhaps, to extend planning horizon.
- 1054 Clear justification of “safe zone” and identification of meeting points. Sensible analysis of traffic flow rates. Careful consideration of inundation zones – well researched. Analysis of warning

- time-frame perhaps unnecessary, but nicely done. Consideration of critical traffic junctions may have made the analysis even more convincing.
- 1055 Consideration of two scenarios: 12 pm & 12 am; warning period perhaps given too much emphasis, relative to evacuation period. Thoughtful analysis of warning channels & their effectiveness; nice suggestions of future infrastructure development. Nodal analysis in appendix indicates great initiative; would have been nice to see this taken through to completion.
- 1056 A good, solid submission. Very comprehensive discussion of temporary accommodation areas and school evacuation plans. Two scenarios addressed: Weekday & weekend/night. Might have been nice to add a little more discussion of congestion risk, particularly in night/weekend scenario.
- 1057 A good, solid submission. Would have liked to see a little more analysis of bus evacuation times, although the presentation was appropriate for the assumptions made, which provide for ample warning time. Comprehensive account of tsunami generation mechanism, but perhaps consumed time that could have been more profitably spent on evacuation plan.
- 1059 Nice, concise discussion covers all important factors, but the report lacks a clear recommendation of the evacuation time required.
- 1060 Careful analysis of range of siren audibility. Clear identification and explanation of assumptions. Consideration of journey times for walking, cycling, and vehicles. Assumptions adopted lead to a choked motorway, making subsequent analysis of traffic flow very difficult; might have benefitted from further analysis. Overall, a very good submission.
- 1061 Nicely written report – good use of references; symbols could have been more clearly defined in places. Analysis of bus availability might have been extended; assumptions seem difficult to justify. Warning media limited to radio (though analysis was sensible). Plan might have benefitted from additional assembly points. As stated in the summary, would have been nice to consider traffic congestion.
- 1062 Nicely composed – reads well. Might have benefitted from a more evacuation plan (e.g. assembly points, safety zones) and analysis of traffic flows (e.g. critical junctions). Chosen scenario (working hours on a weekday) has been justified, but would have been nice to discuss other possibilities.
- 1063 Thoughtful selection of multiple collection points & -discussion of warning duration. Careful analysis of boat & helicopter evacuation times for critical cases, though more analysis time could, perhaps, have been allocated to other modes. Clever spatial model of at-risk areas and subsequent population calculations; very nicely done. Traffic flow analysis (as acknowledged in summary) could have been extended. It seems that the assumption of 20 vehicles on the road at a time crippled the subsequent analysis, and resulted in an unacceptably large evacuation time.
- 1064 Sensible comparison of driving & walking times. Might perhaps have also considered buses, assembly points, demographics, time of day etc.
- 1066 Clearly written – reads nicely. Thoughtful analysis of wave incidence/diffraction scenarios. Conservative selection of safety zones. Report would have benefitted from additional traffic flow analysis.

- 1067 Careful analysis of zone of inundation & consideration of population demographics. Analysis of traffic flow was sound, but would have benefitted from a discussion of congestion.
- 1068 Good effort. Some nice fact finding re Civil defence procedures, siren location and traffic geography. Little probability modelling on warning system and traffic system use. How fast will the tsunami travel?
- 1069 Nice facts re tsunami types. Good detailed analysis of population profile and means of moving them. Some big assumptions (especially regarding traffic flow) with no volatility around it.
- 1070 Good fact finding. Great that you've included a limitations section. some assumptions (unjustified) and some typos.
- 1071 Nice and comprehensive analysis with some assumptions. Little consideration of volatility and no limitations section.
- 1072 No analysis of tsunami travel and little traffic analysis or volatility consideration. Some unjustified assumptions but good that you are allowing a preparation window.
- 1073 Good job of day/night split. Some discussion of weaknesses with the text. Some unjustified assumptions. Traffic light analysis both interesting and too detailed compared with the other aspects.
- 1074 Nice background reading on New Orleans. Well researched and nice analysis. Would have benefitted from a discussion of volatility and model limitations. Assumptions all nicely laid out though some are "bold"!
- 1075 Some good references and great background research. A detailed breakdown of the communication steps. Nice use of research into simulating traffic patterns during emergencies. A very thorough analysis. Could have stated some limitations.
- 1076 Innovative split between walking and driving (scenario 3). Not very deeply researched and should consider limitations, volatility and tsunami modelling.
- 1077 Good lay out of assumptions with a moderate amount of modelling. Would have benefitted from including references, volatility analysis and limitations.
- 1078 Good executive summary. An actual experiment to work out departure time. Innovative use of contra flow traffic with some nice traffic modelling. The Rugby world cup was a red herring.
- 1079 Some interesting facts and a good effort, although not a great traffic flow model.

- 1080 Good observation of correlation to road damage. Good use of ranges as opposed to point estimates. Counter-flow traffic use and a moderate traffic flow model. Would benefit from a discussion of limitations.
- 1081 Too many detailed calculations on how long the message takes to disseminate, this is well within the error of magnitude. Mode of transport not well justified and no traffic models but a good effort.
- 1083 Good effort with an interesting safe location. Little traffic modelling however and there are more limitations than were outlined.
- 1084 Good executive summary. Good effort although there are a number of large assumptions and there is little modelling.
- 1085 Careful analysis with backup reasoning (e.g. elimination of car transport by appealing to civil defence guidelines removes congestion problems). Circumvents traffic flow and exhibits sharp planning.
- 1087 Interesting idea of triage (priority evacuation) but unlikely to work in absence of evacuation points.
- 1088 Clear intro and very clear layout of assumptions and problem definition. I got excited by your use of the sin function to allow for variability in prep time as a function of time of day/night. Careful rigorous and comprehensive analysis allowing for some volatility. A great report.
- 1089 Very well structured and clearly laid out report. Good analysis and great use of theoretical models (eg three phase traffic theory and maximum inundation model). Very well done.
- 1090 Good work on tsunami modelling and good use of statistics. Little on traffic modelling but a good acknowledgement of limitations.
- 1091 Several pages were repeated. Good go at tsunami modelling but would benefit from considering what are the modelling limitations.
- 1092 I like the colourful intro (it stood out). Consider some model limitations, e.g. where would you get 50 buses from on the peninsula. Detailed data collection and a good effort.
- 1093 I like the opening sentence. Would be good to have considered the congestion effects on traffic and to have included a section on model limitations.
- 1094 Good layout of assumptions. Good mention of alternative models and why they were dismissed. Could have considered traffic congestion effects and discussed model limitations.

- 1095 A good effort although some assumptions were made with no justification and the model was limited.
- 1097 Some unjustified assumptions and some English problems with the report. Great use of pros and cons plus a good layout of assumptions.
- 1098 A good effort with some detailed routes. Limited modelling and would have benefited from considering traffic congestion effects.
- 1099 Very thoughtful analysis of the various considerations needed when building an evacuation plan. However modelling of movements and traffic flow, etc was not obvious, so estimates have little justification.
- 1100 Good introduction and the mathematical modelling is interesting, but not done in enough detail to understand how it all works and where the 112 minutes come from.
- 1101 Very good, systematic breakdown of times. Not clear where resources come from and calculations need to be clearer.
- 1102 Walking at slow speeds means no congestion, so analysis is good but 5 hours seems like a very long time. No use of emergency services included in analysis.
- 1103 Very thorough analysis and well thought through. The presentation was a little bit of a “patchwork” and needed to be clearer in places.
- 1105 Very nice attempt at a rigorous mathematical model. I especially like that assumptions are given clearly. The math model needs more structure in its presentation to ensure it is clear.
- 1106 Great start but possibly too ambitious in final outcome. Mathematical analysis needs more structure.
- 1107 Nice analysis but just a beginning. Need to consider many other factors.
- 1109 Good effort, especially taking congestion into account. Need to justify formulae and errors. Probably should consider other factors too (e.g. schools and the elderly).
- 1110 Great mathematical analysis. Good write up and well structured.
- 1111 Very well reasoned argument and well presented. Need to take the flow effect of traffic into consideration.
- 1112 Very thorough, step by step analysis and well presented. Doesn't account for services like buses moving large amounts of people.

- 1113 Great consideration of traffic from city. Need more structure in presentation of mathematics.
- 1114 Very nice introduction putting the problem in context. Great analysis of tsunami impact time and inland penetration. Nice treatment of traffic flow modelling.
- 1115 Love the packing simulation idea, very good. What about buses and emergency vehicles? Need to consider a co-ordinated effort to transport people off the peninsula that would improve over walking.
- 1116 Good structured analysis. Car estimate likely too high but good worst case. Very well done.
- 1117 Using “safe zones” is a nice concept. Good to see the creation of a model to consider congestion although this would need to be justified. Some assumptions are unlikely to be realistic (eg free flowing traffic after exiting the peninsula)
- 1118 Good analysis although some equations did not print properly. Talked around the fundamental questions. Walking assumption doesn’t consider emergency use of buses.
- 1119 No consideration of congestion in getting to west city. Good idea for bus use and nicely laid out report.
- 1120 Evacuation by bus is a good idea. Report needs more structure to make it clearer.
- 1121 Nice division of the problem into sub problems and well set out. Good to see consideration of congestion and the impact of a diverse population. Well written.
- 1122 Nice calculations for car trips, including congestion. No consideration of congestion on the north western motorway though. Also need to consider where cars enter Te Atatu road.
- 1123 Very thorough presentation except for the mathematical model and its use. Would have liked detail of the Fruin model.
- 1124 Good analysis, especially of what areas would be affected. Should consider use of vehicles for larger distances as necessary.
- 1125 Good tsunami analysis but more detail needed for evacuation model. Running for 14 minutes is not easy either.
- 1126 Good analysis of vehicles out of Te Atatu Peninsula but what about external congestion? Well structured report.
- 1127 Report was a bit hard to read in places and there was no consideration of external congestion. Great work in considering night and day evacuation scenarios.