Attracting and retaining STEM talent
B/HERT STEM pipeline for digital economy
October 8, 2014

Question for Today
How can we fill the STEM pipeline for the digital economy?
Begin by defining the problem then take a look at:
1) The Optimistic View
2) The Pessimistic View, and finally
3) The Realistic View

The Problem
1) Technology in our personal lives, our businesses and society in general is exploding. To compete locally and globally there is a large and increasing demand for trained engineers, scientists and technologists. Need for training and re-training can only increase.
   a. Well recognized shortfall: Stanford University professor George Foster refers to Australia’s “dire lack of training for the STEM skills” But interest from students is soft.
   a. From 1992 – 2010 declines in Year 12 participation:
      i. Biology down from 35% to 24%
      ii. Physics from 21% to 14%
      iii. Chemistry from 23% to 17%
      iv. Maths stays very high, down from 77% to 72%, but only 10% in advanced, 20% in intermediate, majority are doing basic maths.
      v. Contrast to China, Russia and some European countries where mathematics is compulsory until the end of school, and many higher education students continue with advanced mathematics.
   b. More recently, the Office of the Chief Scientist has reported that a declining percentage of Year 12 students participate in STEM subjects and that 30 per cent of our students score below OECD levels of minimal competency in STEM subjects.
2) Our education system is fragmented – most STEM students are concentrated in schools with a high socio-economic status.
3) In general there is a poor understanding of career opportunities in STEM industries by careers counsellors, teachers, students and their families.
4) The problem of STEM education is rooted mostly in schools, where we try to attract students into choosing STEM subjects so that their minds will be open to STEM professions.
a. Once in the pipeline at tertiary level, science and engineering education at universities is not too bad.
b. Biggest weaknesses are workforce placement and the attribute training that will ease them into the workforce and see them remain there.

6) Fundamentally, when it comes to schools education, there is a market failure.
   a. Prerequisites were heavy in my day, almost non-existent today.
   b. Teachers are not required to be discipline specialists. For example 23% of Australian secondary mathematics teachers have never themselves studied a single tertiary mathematics subject.
   c. Teacher salaries are low and workplace practices are not optimised for productivity.

7) Australia is falling behind on some of the innovation indices, certainly on productivity relative to comparable countries like the US and Germany.

8) Our universities are world class, with six in the top 100, but rankings are based mostly on our research capability, not on the adaptability and workplace readiness of our graduates.

9) As a result, we are unprepared for the new era that we are entering.
   a. What new era? you may ask. Call it the robot era. Or the era of extreme automation. At its core will be artificial intelligence on steroids. Whatever it is called, the new era has started.
   b. Oxford University did a study last year that reported 47% of jobs will be computerised and permanently disappear in the next twenty years. That’s fast! Who knows, could be worse!
   c. We’ve seen changes in the workforce at least as large in the past, such as in farm jobs, but in that case the rate of change was centennial, now it is decadal.

10) To cope, we need a superb education system.
   a. As former Harvard University President Derek Bok said, “If you think education is expensive, try ignorance.”

The Optimistic View

1) The Federal Government will be wise, bipartisan and will take a long-term view.
   a. The Federal Government will adopt the recommendations of our Chief Scientist, Ian Chubb, the calls from the BCA, and the calls from ATSE, for a national strategy that will cover education, research, industry, innovation and community awareness.
   b. Ian Chubb will elaborate his views this afternoon. I totally support his approach.

2) Government will fix the broken market mechanisms.

3) Schools will embrace new teaching techniques and technology, and will train teachers in their use.

4) Unions will see the societal need for reform and embrace modern workplace practices with an emphasis on outcomes, ongoing professional improvement and productivity.

5) In return for better pay, teachers will accept performance management and larger classes.

6) Masters and PhD graduates will look forward to becoming teachers and all teachers will be trained in the discipline they teach.

7) Universities will reintroduce pre-requisites, and mathematics will be compulsory through to the end of year 12.

Chances? Not high.

The Pessimistic View

1) Nothing changes.
   a. We repeat for the next five decades piecemeal variations of what we have done for the previous five decades.

2) Parents will advise their children to study law and finance.

3) Australia will slip behind the rest of the technologically developed world.
   a. Employers will complain there are not enough skilled STEM graduates
   b. Parents will complain there are not enough STEM jobs, and
   c. B/HERT will continue running seminars like this one.
The Realistic View

1) Here’s what I think we can and should do.

2) First, stop with the pessimism. It makes us dysfunctional!

   a. If the federal government is broken, let’s collectively do what we can by working with
      i. state governments
      ii. industry in its broadest sense, and
      iii. schools and universities

3) Captains of industry and academia should open the windows of their offices in Canberra and
   every Australian city to loudly call out the need for a national strategy for education, research,
   industry and innovation. It’s crucial. And it has to be integral so that government does not
   continue to throw money and resources into politically motivated, short-term pursuits.

4) Industry can help in many ways.

   a. In the first place, continue to sponsor education programs and send out staff to talk to
      students – it is important.
   b. But do more. Let schools and universities know what kind of core skills are necessary now and
      in the future. Successful industries are successful because they can read the tea leaves five,
      ten and fifteen years into the future, so share your knowledge.
   c. Make sure your money is spent on modern pedagogical approaches rather than more of the
      same.
   d. When supporting programs, think national rather than local.
   e. As captains of industry who know organizational dynamics, argue the case that students are
      better off in a larger class with a brilliant teacher than a smaller class with an ordinary or poor
      teacher.
   f. Welcome our students for workplace training.

   Note: vacation employment is no longer a compulsory requirement for graduating from engineering
   at Monash University and I believe at most universities. Why not? Partly, kids are working anyway,
   but mostly because there are simply not enough willing companies.

   g. Be net absorbers. Hire PhD graduates! Hire Masters graduates. Get over fear of hiring people
      who are too educated. Hire people more talented than yourselves. In the USA and Germany
      70% of PhD graduates work in industry. In Australia, it’s just 30%.
   h. Participate in product oriented research. Such as the bionic eye projects led either by Monash
      University or Bionic Vision Australia, or the automation projects at the Universities of Sydney
      and Queensland.
   i. Engage with universities. Everybody blames universities for lack of engagement, but it takes
      two to tango. At my company Axon Instruments most of our new products came from us
      reaching out to experts within universities like Caltech, Stanford and Chicago.
   j. I anticipate that the Higher Education and Workforce Initiative that Brian Fitzgerald will
      describe later today implements some of these approaches.
   k. Participate in CRCs and help preserve them.
   l. Lastly, ATSE is promoting new metrics that would value impact and engagement. We will need
      your support to get the ear of department heads, government and universities to adopt these
      metrics, because collaboration is harder than non-collaboration.

5) Universities, what can you do?

   a. Reciprocate on the recommendations made for industry.
   b. Be creative when it comes to workforce placement and attribute training.
      i. At Monash University our PhD program used to be based exclusively on the thesis, but now
         we include 3 months skills training as part of the new PhD.
      ii. We have a cohort PhD where up to 16 PhDs commence at roughly the same time to tackle
          big projects
iii. Our Engineering faculty now places half a dozen students to work as a single team for work experience, providing an unprecedented capability for the employer.

c. More broadly, convey the proper advice to PhD students. There is too much emphasis on training PhD students for academic careers. Instead, we should train for and show respect for careers in industry.

6) Public good organizations can help. Three examples from my own experience:

a. ATSE’s STELR program provides in-curriculum training for Year 9 students for eight weeks. It is currently running in 20% of secondary schools across the nation. It is a hands on, topical program sponsored primarily by Orica but also the Australian Power Institute, Rio Tinto and other companies, several universities, private foundations, philanthropist, and governments in the early days. This is a high-impact collaboration.

b. We are also leading a new program named ISME (inspirational science and maths education), a collaboration of ATSE plus three universities. This is funded through the Australian government’s AMSPP program (Roslyn Prinsley). It will develop at least five authentic, multidisciplinary classroom modules that will be made available nationwide.

c. Cosmos for Schools, by Cosmos Magazine. We are not strictly a public good organization, but we don’t make much money. This program excites me more than any other programs that I have been involved in. The value proposition is a link to breaking news stories. This is exciting for students and teachers alike. Promotes English literacy, science knowledge and understanding, careers. Supports teachers with content delivered on a silver plate, but if they want they can customise and extend.

7) Math skills. We should build mathematics into the context of other subjects. That’s what happens in the real world. You can’t be a financial advisor without using some maths. You can’t be a real-estate salesperson without using some maths. It is not hard to build maths into other subjects, just needs a coordinated approach.

a. Parliament needs maths skills too. There is a push for 60% of graduates to go to university. There is a push for smaller classes and thus more teachers. Then politicians and community leaders complain that students are entering university with low ATAR scores. Of course they are, that’s a basic arithmetic certainty.

8) Teacher training

a. Ideally we would legislate for a postgraduate model, like in Finland, but even without legislation, we can get there. The Universities of Melbourne and Western Australia are 100% there. Monash University is 80% there.

9) Schools, what can you do?

a. Career awareness is crucially important. For students. For career advisors!

b. Too many parents, students and career advisors think that you study science because you want an academic career. But industry demand for STEM employees is huge, even in companies that are not STEM companies. Think about how many software engineers are employed at our nation’s banks. The past, present and future competitiveness of banking is driven by IT. And it cannot be simply imported, first, because our banks are at the leading edge and second, because the requirements of each bank are unique.

c. We are sending the wrong message about alignment of training and careers. Only 17% of physics graduates work in a physics related career. Only 50% of law graduates work in the legal profession.

d. Invest in excellence. I noticed that Peter Corkill is here, JMSS does a brilliant job. Not everybody can be like that, but equality of opportunity does not mean getting rid of JMSS.

e. Be modern. Teaching mathematics and science should use real world subject matter, and real world tools such as computer aided design software and statistical analysis software. Use gaming software such as the Australian developed Mathletics and use gamification techniques to spice up the curriculum.
Some tests of this kind are already taking place. The Victorian Curriculum and Assessment Authority has five schools using Mathematica software in class and during exams. This is about as high-end and real-world as you can get, it will be interesting to see their evaluation at the end of their trial.

All of these proposals under my Realistic View will have their challenges, but it is hard to believe that they could be bad for students and one thing for sure – repetition of what has been done in the past is not working either. It is time to be bold.

Summary
To summarize, I’ll boil what I have said down to two statements:

First, if I look back over the various proposals that I have articulated, the majority involve teachers as the educator, the career advisor, the one providing inspiration. So first up, industry, government, schools, universities, we should all be investing in supporting and encouraging teachers.

Second, in all of our approaches we have to incorporate modern technology and focus on teaching employees and employers how to be adaptable in a rapidly changing world.

Here’s hoping.
Thank you