THE Warren CENTRE
FOR ADVANCED ENGINEERING LTD

Submission by The Warren Centre to the Senate's Inquiry into the Shortage of Engineering and Related Employment Skills

Summary

This submission by The Warren Centre for Advanced Engineering addresses Item (C) of the Inquiry's terms of reference, namely, "Options to address the skill shortage for engineers and related trades, and the effectiveness and efficiency of relevant policies, both past and present."

The Warren Centre acknowledges the challenges faced by declining manufacturing sector industries and increased global competition. The Warren Centre recognises a tremendous opportunity for Australia to increase wealth and quality of life through a strategic approach to education and skills. This strategic approach is vital to further fields such as engineering, technology and science, and is required as part of the education curriculum in middle school (ie, late primary to early secondary school – ages 12 to 15).

The Warren Centre is aware of a significant body of research which has identified that school children are making career choices (and consequential subject choices) much earlier than originally thought, well before any formal career exposure or advice is provided.

The Warren Centre contends that the shortage of engineering graduates is directly linked to the fact that fewer than 20% of Year 12 students study relevant science, technology, engineering and mathematics (STEM) subjects, and that Government supported measures are needed to increase this proportion, in line with successful initiatives introduced in the United Kingdom and now being followed in the United States.

These initiatives should

- **be aimed at the middle years of schooling (ages 12 to 15) and;**
- **have the support and full cooperation of business and industry.**

We also note that increased STEM subject participation may be expected to increase the analytical skills of those who leave school after Year 10 and thereby benefit a range of STEM based industries.

The Education Pipeline

University graduates in general, and engineering graduates in particular, are the end-product of an "education pipeline" which stretches over 17 years long. In contrast to the numerous statistics available for the last five years of this pipeline (from Year 12 to the end of a four year Bachelor degree) - see Attachment 1 - few statistics are available for the earlier years, when our children are choosing subjects to match their future work and career aspirations.

The statistics in Attachment 1 highlight what The Warren Centre believes is the most significant factor limiting the supply of future engineering graduates – **the small proportion (under 20% and falling) of Year 12 students studying the STEM combination of mathematics and physics/chemistry which is an admission requirement for a university engineering course**.

Further analysis indicates that **an increase of less than 10% in the number of Year 12 students studying STEM subjects could increase the number of engineering graduates by 50%.**

Current Australian Initiatives

Over the years, a number of initiatives and programmes have attempted to address the shortage of domestically educated engineers, mostly with little success. While there has been a recent increase in the number of students enrolling for engineering degrees, the fact that most of these additional enrolments are in civil engineering suggests that this upturn may simply reflect the higher wages resulting from the shortage of engineers in the commercial mining and infrastructure sectors.

Whilst there are numerous initiatives directed towards motivating and encouraging schoolchildren earlier in the pipeline, these are generally privately sponsored; of variable quality; do not coordinate with each other; and often lack long term follow-up and support. Increasingly, they also compete for classroom time with an ever-expanding school curriculum.

It is also worth noting that career support and advice provided in schools is generally focused on the final years (Years 10 to 12) when students have already limited their career choices through subject selection.

Many reports, including a significant contribution by Professor Robin King for the Carrick Institute on behalf of the Australian Council of Engineering Deans in 2008[1], have recommended an increased focus on early school years. The ANET report, Scoping our Future [2], noted a future project to model interventions at all levels of the education system to ensure a better supply of high-quality Australian graduates and technicians.

Most recently, a report[3] prepared by Universities Australia for the Office of the Chief Scientist (http://www.universitiesaustralia.edu.au/resources/680/1319) provides a comprehensive review of the factors influencing the choice of First Year STEM and non-STEM University courses, including a review of similar issues in four other countries. Relevant extracts, including their conclusion concerning relevant factors affecting choice of a STEM course, are provided in Attachment 2.

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[1] Addressing the Supply & Quality of Engineering Graduates for the New Century. Recommendation 1: the public perception of engineering.

[2] Scoping Our Future Addressing Australia's Engineering Skills Shortage, ANET October, 2010

[3] "STEM and non-STEM First Year Students", Universities Australia, January 2012.

We Need to Start Earlier

A review of literature[4] commissioned by DEEWR in 2008 found

"considerable evidence that, for the majority of students, their life aspirations are formed before the age of 14, with the implication that engaging students in STEM pathways becomes increasingly difficult after the early secondary school years. Interventions and resources aimed at encouraging student engagement in STEM thus need to be prioritized to engage and capture the imagination of students in the upper primary and early secondary school years. Student aspirations are significantly mediated through the secondary school years and transformed into career choices later by a range of factors including interest and self-efficacy in relation to mathematics and science, parental expectations and encouragement, teacher support and inspiration, career expectations and exposure to career guidance, exposure to role models and successful adults, and perceptions of the usefulness of the subject. These factors differ in importance and aspect for mathematics compared to science, and for developmental level and gender."

Recent Australian research by Dr. Michael Myers, the founder and Chairman of the Re-engineering Australia Foundation, indicates that children are most receptive to motivation and direction about choosing a trade or career around the age of 12, at the beginning of secondary schooling. Dr Myers' research confirms the value of an action learning approach to the teaching of design and technology and, contrary to established belief, shows that girls are more likely than boys to choose an engineering career if engineering and its associated complex processes are clearly explained. Fuller detail of Dr. Myers' work in this field can be found in his individual submission to this Inquiry.

The middle school years - when children make decisions to study subjects relevant to their particular work and career aspirations - are the time when the benefits and worth of an engineering career must be promoted to the people capable of influencing these decisions, including teachers, parents and guardians, and peers.

Overseas Experience and STEM Programmes

Similar problems with a declining market share of the total undergraduate population year-on-year have been experienced throughout the developed world. Across the globe, governments are taking an active role, funding programmes and setting KPIs to increase both STEM participation and the supply of suitably qualified teachers.

United Kingdom

The 2006 STEM Programme Report, published jointly by the Department for Education and Skills and the Department of Trade and Industry, called for better coordination of the organisations involved in STEM education. The STEM Cohesion Programme was created to bring together the many stakeholders who support the teaching of STEM subjects.

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[4] Opening up pathways: Engagement in STEM across the Primary-Secondary school transition, June 2008

A further report by the Department of Education in 2009 identified four key areas of responsibility for solving the STEM shortage, all of which can be translated into the Australian context. These four key areas are reproduced in Attachment 3.

The STEM Cohesion programme resulted in the creation of eleven Action Programmes which have resulted in a number of significant, professionally managed initiatives drawing on public and private funding. Details of these can be found in Attachment 4, and include the following.

- A **National STEM Centre**, (www.nationalstemcentre.org.uk).
- **STEM Directories** (www.stemdirectories.org.uk).
- A **STEMNET** network (www.stemnet.org.uk).
- A **STEM Ambassador** programme (managed through STEMNET).
- A mobile **STEM Module** (www.stemmodule.org.uk).

Two major non-profit contributors to the UK STEM encouragement effort are:

- **The James Dyson Foundation** (www.jamesdysonfoundation.com); and
- **EngineeringUK** (www.engineerinuk.com), which is also the lead organiser of **The Big Bang UK Young Scientists and Engineers Fair** (www.thebigbangfair.co.uk).

United States of America

The **America COMPETES Act** of 2007 created new federal funding for STEM education. The Act included a new federal initiative to train 70,000 new teachers in Advanced Placement and International Baccalaureate courses, as well as initiatives designed to provide STEM training for teachers, and to encourage university students pursuing STEM degrees to concurrently obtain teaching certifications.

The **America COMPETES Reauthorization Act** of 2010 established a **National Science and Technology Committee on STEM Education (CoSTEM)** and charged it with developing a five-year strategic plan to advance the state of American STEM education by early 2012. A report on the first mapping stage of this plan can be found in Attachment 5.

Declining Interest in Design and Technology

"From an early age we are asked to choose: Art or Science? Creativity or Analysis? But it doesn't have to be one or the other. Design and Technology is a middle ground, where both disciplines are equally crucial[5]".

Design and Technology is where we are taught about innovation, how to apply science and maths to solve real-world problems and to manufacture things.

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[5] From The James Dyson Foundation's website

There is increasing concern in both Australia and the UK about the declining proportion of students choosing Design and Technology (D&T) in middle school and beyond. Reasons for this vary but in Australia are thought to include the following:

- The attractiveness of the social sciences in terms of ATAR points rankings, which is influenced by a number of factors. "Visual learners", who tend to choose practical subjects, often do not do well in written exams, dragging down the "quality of candidature" of these subjects. Subjects with low raw means are generally avoided by brighter students. The lower overall mean for the candidature therefore leads to the subject being less "cognate" in the ATAR process.
- The outdated view of D&T as a “trade” subject associated with woodwork, home sciences and metalwork, which reflects a lack of understanding of the modern trade skills required to operate sophisticated robotic devices and computerised diagnostic equipment.
- A lack of awareness among the predominately female (>80%) primary and middle school teacher population of the rapid technological advances that are making engineering careers “cool”.
- The relatively expensive nature of the necessary resources and extra-curricular support activities.
- Preparation and classroom time that might better be applied to a NAPLAN-tested subject.

The Design and Technology Teachers Association (DATTA), under Peter Thompson’s leadership, is addressing some of these concerns by developing a national engineering course for Years 8 to 10 which includes testing. It is currently running in NSW and is scheduled to be introduced into the national curriculum in 2016. DATTA members have committed to writing the course content but, as a voluntary organisation, it lacks funding for Secretariat assistance.

A particular concern identified by DATTA is a likely upcoming shortage of D&T teachers given the lack of support for their recruitment and training and the lack of appeal resulting from its lingering 19th Century image as a manual skills learning area.

The Warren Centre’s Skills and Education Project

The Warren Centre’s aim is to foster engineering excellence around Australia to create wealth. We seek to achieve this by stimulating new technology; encouraging engineering innovation; and providing independent advice to government and industry. The Warren Centre collaborates with our extensive networks in academia, industry and government to find solutions to the issues created in an increasingly complex world.

By bringing together leading experts in a selected engineering field to work as a project team, The Warren Centre has initiated important breakthroughs in technology and advances in engineering practice.

We recently turned our attention to the subject of this Senate Inquiry, following a three year campaign to persuade State and Commonwealth Departments of Education to adopt a more outcome and business oriented IT implementation model in their classrooms.

We are establishing a Skills and Education Project which will seek to identify, link, and coordinate effective initiatives across the whole of the education pipeline, with a particular emphasis on the middle school years. All existing Australian providers will be invited to participate. We intend to review overseas best practice, identify any gaps or improvements in existing programmes, and develop cost-effective processes to address them.

Given the importance of teachers in influencing young people's career choices, it is worth examining whether the current generation of teacher education students is adequately equipped to teach skills relevant to the 21st century. The Warren Centre has sponsored a pilot survey from Professor Ian Gibson, Vincent Fairfax Family Foundation Chair in Education, Macquarie University, to gather state-wide data from this previously under-researched education sector. Such data is vital to help develop initiatives to increase the number of students studying STEM subjects.

Results from this survey are expected in the second quarter of 2012.

Conclusion

In researching this submission, The Warren Centre has been particularly impressed by the UK Government's recognition not only of the need for a National Strategic Plan to promote STEM studies, but also the support they have provided for the mapping of current initiatives (a necessary first step in any strategic plan) and follow-through on Action Plans that, five years later, have resulted in a number of professionally managed initiatives.

We have also noted that the USA, although some three years behind the UK, is following the same course of action.

Australia currently has no strategic plan for promoting STEM subjects, a task The Warren Centre is seeking to influence through the creation of its Skills and Education Project and through lobbying the Government using submissions such as this.

We have also been impressed by the overwhelming weight of evidence indicating the need for:

- support of primary and secondary teachers, an area to which the majority of early overseas effort and funding has been directed; and
- a more experiential or action learning approach to the teaching of technology, mathematics, and engineering subjects, which addresses the need to make them more interesting; relevant to real life; and "cool" (as advocated most eloquently in Dr. Myers' submission).

What The Warren Centre would like to see from this Inquiry

The Warren Centre would like the Inquiry to **RECOGNISE** the following.

1. THAT any quantum increase in the number of engineering graduates is likely to require significant initiatives targeted at the middle school years (ie 12 to 15years old).
2. In particular, the need to:
   a. arrest the slow decline in Year 12 students studying physics; and
   b. increase the number of students studying STEM subjects at school.
3. THAT such initiatives should also increase the number of STEM literate students leaving school at Year 10 to enter a trade.
4. THAT business has to be the primary driver of STEM initiatives.
5. THAT key constraints (eg lack of support to primary teachers) in the teaching of STEM subjects must be alleviated.
6. THAT more flexibility has to be introduced in the provision of STEM education (eg specific support for STEM teachers).
7. THAT the Government has to play a major role in supporting STEM initiatives

The Warren Centre would like the Inquiry to **NOTE** the following.

1. THAT many OECD Governments are experiencing a similar decline in the STEM segment of overall undergraduate numbers year-on-year.
2. THAT the UK Government in particular has a clear Five Year Strategic Plan , with many fully funded initiatives, studies and programmes already in place to address this decline.
3. THAT the development of a national engineering high school curriculum by the Design and Technology Teachers Association (DATTA) is a largely voluntary effort with a significant delay before it is introduced nationally.
4. THAT The Warren Centre stands ready to assist in any Industry/Government studies in this field.

The Warren Centre would like the Inquiry to **RECOMMEND** the following.

1. THAT the Federal Government and the various States, through COAG, investigate and validate overseas STEM initiatives and programmes with a view to initiating a similar approach by government and industry in Australia.
2. THAT Federal support is provided to DATTA to complete the development and accreditation of a national engineering high school curriculum.

Attachment 1: Education Pipeline Statistics

Relevant statistics for the last five years of the education pipeline.

- In 2009, the potential tertiary education pool of domestically educated children in Year 12 numbered approximately 200,000 [6]. This number has increased slightly over the last three years due to increasing high school retention rates.
- The percentage of Year 12 children studying advanced mathematics (10%) intermediate mathematics (20%) and chemistry (18%) is stable, whilst the proportion of those taking physics (15%) continues to decline[7]. As university engineering courses generally require applicants to have studied both mathematics and/or physics, this suggests a maximum of around 30,000 Year 12 students (using the 15% physics participation rate) who could potentially study engineering at university.
- The number of university domestic commencements for the four-year engineering Bachelor degrees was relatively constant until about four years ago. It has increased from around 10,000in 2005 to just over 12,000 in 2009[8]..
- However, recent research[9] by the Australian Council of Engineering Deans, working with engineering graduates at a number of universities, indicate that the DEEWR figures for commencements may be around 10 to15% too high, due to double counting for different degree phases and inter-university transfers. This suggests that the actual number of commencements in 2009 was likely to have been nearer to 10,500 and the graduation rate correspondingly higher at around 65 to 70%. This has remained relatively constant over the last decade.
- Whilst the number of domestic engineering degrees has been relatively constant at around 6,000 over the last decade (reflecting the relatively flat commencement and drop-out rates), the recent lift in commencements could increase this number to 7,200 in 2013 (a 20% increase) if the drop-out rate remains constant.

Taking all of the above statistics together we can observe the following.

- Only 15% of Year 12 Students are studying the combination of STEM subjects that would give them the opportunity to study engineering at university.
- Only 35% of those that DO study the necessary STEM subjects choose to study for an engineering Bachelor degree.
- 30% of those that commence this degree do NOT complete it.

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[6] "Updated Year 12 Mathematics figures". Frank Barrington for AMSI August 2010
[7] Fig 4.1 and Table 4.2 of THE ENGINEERING PROFESSION: A Statistical Overview, Eighth Edition, 2011.
[8] Fig 4.3 of THE ENGINEERING PROFESSION: A Statistical Overview, Eighth Edition, 2011
[9] Godfrey, E. & King, R. (2011) "*Curriculum specification and support for engineering education: under-standing attrition, academic support, revised competencies, pathways and access*"

Attachment 2: Extracts from STEM and non-STEM First Year Students Report by Universities Australia for the Office of the Chief Scientist (January 2012)

"Introduction

Previous research has identified declines in mathematics, physics, and chemistry studied at the undergraduate level over the period 1989-2005 (Dobson, 2007). Furthermore, despite successive government attempts over the last decade to increase student participation in science, technology, engineering and mathematics (STEM), the proportion of students commencing in STEM has stabilised around 10 per cent or less. Consequently, despite the current generation being voracious consumers of all things technological it appears that they are not increasing their ambitions to be the creators and innovators of tomorrow.

It is not just Australia that is seeing students turn their backs on science or STEM (Science, Technology, Engineering and Mathematics) courses (Hamer, Frinking, & Horlings, 2005); the United States (Hira, 2010; Maltese & Tai, 2011) and the United Kingdom (Department of Education, 2009; The Royal Society, 2011) report similar declines in STEM enrolments. From Europe, the predominant view is that there is an increasing shortage of scientists in Europe, and surveys indicate that science and technology (S&T) as a career is steadily losing its attraction. As one specific example, the Netherlands is concerned about its low number of graduates in S&T, a weakness aggravated by low female participation (Hamer et al., 2005). Canada is proving to be the exception, with enrolments in STEM increasing as a proportion of total enrolments (Association of Universities and Colleges Canada, 2011)."

"Executive Summary – Conclusion

To sum up what is required to increase STEM participation is to make school mathematics and science more relevant to daily life, present it on a personal level and make it more relevant. Put simply, we need to stop textbook approaches such as including chemical formulas for "classic" reactions, or discussing the effects of sea-level rise on distant locales and start to focus the discussion on more real and personally relevant issues such as chemical processes in human digestion or an environmental analysis of a local stream (Maltese & Tai, 2011).

This approach shows students' how important science and mathematics are in their lives, and coupled with a more hands-on or learning-by-doing methodology has been shown to increase engagement (Maltese & Tai, 2011).

To do this well we need to invest more in our teaching resources and place a higher value on scientific subjects and how they are taught from kindergarten through to university and post graduate research programs. A child's mind is a raw resource, but unlike coal and iron ore it has an infinite potential. The difficulty is in nurturing that infinite potential towards scientific pursuits.

Lowering entry requirements and reducing HECS liabilities sends a psychological signal that science and mathematics are not valued despite the lowered opportunity cost in relation to competing courses. Education needs to send the right signals about the social and economic value of scientific fields of study.

Attachment 3: UK Department of Education – Possible Solutions to STEM Shortage -

A UK Department of Education, "The report of the STEM review: science, technology, engineering, maths (2009)", identified four key areas of responsibility for solving the STEM skills shortage.

1. Business must take the lead in promoting STEM

a. Establish a business-led STEM framework.
b. Develop a clear STEM careers path.
c. Introduce prestigious STEM scholarships.
d. Address gender bias.
e. Develop regional STEM links.

2. We must alleviate key constraints in the STEM artery

a. Address the disparity in STEM performance amongst schools.
b. As a matter of urgency, there needs to be a program of support for primary school teachers to ensure they develop the confidence and enthusiasm to teach science in ways which motivate and engage pupils.
c. Review developments in mathematics in relation to STEM provision.
d. Make STEM learning more enquiry based.
e. Post-primary schools and their feeder primary schools need to plan jointly to ensure that there is improved continuity and progression from primary to secondary school [and university], so that the teaching of STEM builds effectively upon the children's earlier learning.

3. There needs to be increased flexibility in the provision of STEM education

a. Increase the focus on the core sciences and mathematics subjects.
b. Facilitate easier two-way transfer between TAFE & higher education.
c. Reduce barriers to obtaining increased financial support in STEM.
d. There needs to be a clear professional development framework related specifically to STEM, which continues to update teachers, lecturers and support staff on STEM developments and issues globally, and to promote best practice in respect of curriculum, pedagogy and assessment.
e. More resources need to be allocated by business and government to careers education, nformation, advice and guidance (CEIAG) for STEM. Formal links should be created between the business framework and the Careers Advisory Service.

4. Government must better coordinate its support for STEM

a. DEEWR and DIISR, supported by other relevant departments, should develop a clear strategy for STEM, recognising the critical role of STEM and the skills required for sustained economic growth.
b. DEEWR and DIISR, supported by other relevant Government departments, should introduce cross-departmental structures to help develop appropriate STEM strategies and

policies. The structures should include a Chief STEM advisor who would carry the educational responsibilities of a Government Chief Scientist and a National STEM Director.

c. Develop a more proactive approach to managing STEM supply and demand.
d. DEEWR, in partnership with initial teacher education institutions, should continue to seek to increase the number of students entering initial teacher education courses in the physical sciences and mathematics. Further research is required into the issue of STEM subjects which are taught by teachers without appropriate specialist qualifications.
e. Expand the capacity to respond to critical skills shortages as they arise (Department of Education, 2009, pp. 11-15).

Attachment 4: STEM Initiatives in the UK

United Kingdom Private/Public Funded STEM Initiatives

The STEM Cohesion Programme brings together the many stakeholders who support the teaching of STEM subjects. By organising existing activities it is hoped that:

- schools and colleges will have a better understanding of what is available to them and be more able to access appropriate provision; and
- stakeholders and funders should have a clearer picture of what is already being done and where gaps in provision remain.

Eleven Action Programmes were initiated which, to date; have resulted in a number of significant and professionally managed initiatives drawing on a combination of public and private funding.

- A **National STEM Centre**, which contains the UK's largest collection of STEM resources for teachers and lecturers, as well as offering a physical space for collaboration (www.nationalstemcentre.org.uk).
- Online maths, science and engineering **STEM Directories** comprising a collection of accredited schemes and activities provided by organisations from across the UK that aim to enhance and enrich the curriculum. These schemes are usually based around events or experiences that cannot be delivered with standard school contacts and resources. Each activity is linked to the curriculum so that the impact of the experiences and outcomes can be sustained (www.stemdirectories.org.uk).
- A fully staffed and professionally managed **STEMNET** network (www.stemnet.org.uk) whose purpose is to:

o ensure that all young people, regardless of background, are encouraged to understand the excitement and importance of science, technology, engineering and mathematics in their lives, and the career opportunities to which the STEM subjects can lead;

o help all schools and colleges across the UK understand the range of STEM enhancement and enrichment opportunities available to them and the benefits these can bring to everyone involved; and

o encourage business, organisations and individuals wanting to support young people in STEM to target their efforts and resources in a way that will deliver the best results for them and young people.

- A **STEM Ambassador** programme (managed through STEMNET) which taps into the willingness and enthusiasm of private individuals to help guide school children and support their teachers in STEM related activities.

- A mobile **STEM Module** which is a mobile laboratory and workshop, constantly on the move around the UK, and which is fully equipped to deliver a state of the art learning experience to schools (www.stemmodule.org.uk).

Two major non-profit contributors to the UK STEM encouragement effort are:

- **The James Dyson Foundation,** which was set up in 2002 by James Dyson (of Dyson Vacuum Cleaner fame) to support design and engineering education. This is specially aimed at inspiring young people to study engineering and become engineers by encouraging students to think differently and to make mistakes. (www.jamesdysonfoundation.com); and

- **EngineeringUK,** whose purpose is to promote the contribution that engineers, engineering and technology make to society. EngineeringUK aims to inspire people at all levels to pursue careers in engineering and technology (www.engineeringuk.com).

EngineeringUK works in partnership with UK professional engineering institutions, business and industry, government, the education sector and the wider science, technology, engineering and mathematics community, and partners with business and industry, Government and the wider STEM community to promote engineers and engineering.
It is the lead organiser of The Big Bang UK Young Scientists and Engineers Fair. This is the largest such event in the UK, bringing together over 80 partners and sponsors within the STEM sector to engage and inspire young people aged 9 to 19 (www.thebigbangfair.co.uk).

Attachment 5: STEM Initiatives in the USA

United States of America Private/Public Funded STEM Initiatives

The **America COMPETES Reauthorization Act** of 2010 established a **National Science and Technology Committee on STEM Education (CoSTEM)** and charged it with developing a five-year strategic plan by early 2012 to advance the state of American STEM education. The first stage of this plan is reported on in Attachment 2.

The first step in the development and implementation of the strategic plan was to inventory the current efforts of the agencies. That report, *The Federal Science, Technology, Engineering, and Mathematics (STEM) Education Portfolio,* published in December 2011, gives the clearest and most complete picture of the Federal investment in STEM education to date. The report also provides a detailed analysis of duplication, overlap, and fragmentation among the nation's STEM education programs. The report's essential findings include the following.

- The overall Federal investment in STEM education for fiscal year 2010 was $3.4 billion, or about 0.3 percent of the nation's total education budget of $1.1 trillion.
- About one-third of that $3.4 billion directly benefits students from groups currently underrepresented in STEM, addressing a major Obama administration goal to develop a STEM workforce that reflects the full diversity of the nation.
- About one-third of the $3.4 billion funds 113 investments focused on various agencies' specific workforce needs. Two-thirds is spent on 139 broader STEM education investments.
- Of the broader investments, 87 per cent of which are funded by the National Science Foundation and the Department of Education:
    - 104 involve STEM-related internship opportunities;
    - 35 have as their primary objective the provision of training and certification in preparation for entry into the STEM workforce;
    - 99 either require or encourage public-private partnerships and;
    - 24 support STEM teachers.