Research White Paper

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UNDERSTANDING THE MOTIVATIONAL DRIVERS OF CHILDRENS' CAREER DECISION CHOICES

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1 - ABSTRACT

Over the past 30 years both Governments and industry have attempted, to put in place numerous programs and career intervention activities focused on making the career decision process easier for students, with mixed results. This research was targeted at examining one specific school based career intervention program which set itself the goal of influencing student career decisions toward Engineering.

In 1998, in response to this now widely accepted perception that few young Australians viewed Engineering as a preferred career path, the Re-Engineering Australia Foundation Ltd (REA) began development and implementation of a number of career intervention programs with the goal of encouraging students to take up careers in Engineering. The most well recognised of these is an implementation of the F1inSchools (F1iS) Technology Challenge which was created in the UK in 2002 and first implemented in Australia in 2003. It now runs in 300 schools across Australian and in 33 countries around the world.

F1iS has been designed specifically through its association with F1 racing to attract the intrinsic interests of students. F1iS is based on the fundamentals of Action Learning and utilises role models and industry involvement as motivation modifiers. Anecdotally it has been very successful at influencing the career decisions choices of the students who participate.

With the aim of determining the impact that the F1iS program had on the motivation of the participants towards a career in Engineering, Doctoral research was carried out at the University of South Australia. This white paper is a summation of that research.

The motivational factors which were studied come from two groups. The first of these is the group of general factors which are known to potentially impact on children's career motivation which include factors related to intrinsic motivation and self-efficacy and the influence of others in the environment of the students. The second groups of factors were the designed elements of the program itself - namely the use of a project-based Action Learning Engineering activity designed to be "cool" through the use of the latest technology and interaction with industry role models and heroes.

The research also sought to examine whether there were any relationships between the motivational factors and specific elements of the program and if there were differences in the relationships between these factors and the outcomes for Boys as compared to Girls. It concludes with a comparison of intrinsic motivation towards the profession of Engineering as a general career against the activities of Engineering involved within the F1 in Schools Program.

The desired outcome of this research is to offer advice to the Engineering profession and industry to aid the development of strategies for attracting students in its direction.

The results of the research confirmed that the F1iS program was able to have a significant impact on the career motivations of the children who participated with 64% of Boys and 35% of Girls indicating that Fi1S had influenced a change in their career motivations toward Engineering. It also provides a foundation for rethinking the way in which we develop interest in Engineering for Boys and Girls.

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3 - SOCIAL AND ECONOMIC ENVIRONMENT DRIVING THIS RESEARCH

3.1 - SKILL SHORTAGES IN ENGINEERING

It has become widely accepted across industry and politics that Australia has been through severe shortages of skilled people. While shortages are not currently perceived to be politically sensitive as a result of the global economic downturn of 2009, it is accepted that as the mining industry comes back on stream to full production the shortage of engineers and scientists will again be magnified.

While these shortages can, to some extent, be related to specific economic booms which generate low levels of unemployment, there has been a universal acceptance by industry and government alike that there is a severe shortage of students completing Engineering at University. Consequentially a need exists for more students to take up the prerequisite subjects at high schools which facilitate participation in Science, Technology, Engineering and Maths (STEM) pathways.

The response by successive Federal Governments to the shortage of Engineers and, for that matter Scientists, has been based on a rhetoric focused on the development of a skilled nation. Within this rhetoric industry was granted a significant leadership role by Government, yet it failed to understand its responsibility, nor take the opportunity to use its leadership position to attract students to professions critical for success. What little that has been done by way of industry developed career intervention programs[1] aimed at attracting students to appropriate professions has been, in the vast majority of cases, ad-hoc and ill structured in terms of the design, implementation or measurement of outcomes. In addition, few if any of these programs have had their design or construction based on fundamental social science research which could add significant validity to the processes being called upon to achieve the required intervention outcomes.

Adding further to this environment, during the 1980's, an educational policy convergence between the major political parties toward economic rationalism had both sides of politics becoming particularly responsive to industry spokespersons and economic analysts who advocated that education be restructured according to market principles (Pusey, 1991, Marginson, 1993, Seddon, 1999). As a result of this economic rationalism, the ideological imperatives for the development of a skilled nation become way-laid by a big business focus on short term solutions that have shown little, if any, interest in engaging students, teachers or administrators in developing the attractiveness of professions such as Engineering (AIG, 2006). As a result, "Over the past three decades Engineering has suffered a poor profile leading to less interest from high school and university students" (Heydt, Jan/Feb 2003).

Within the development of a skilled nation lay an ill-defined description of the skills required to achieve this national aim. The industry definition of required skills (employability skills) places an emphasis on the role, definition and measurement of a range of soft skills which are somewhat ambiguous and imprecise. The responsibility for the construction of learning environments to develop these

[1] Career intervention programs are activities developed specifically to raise the awareness of specific careers, disciplines or subjects with the goal of attracting students to undertake those activities and the prerequisites needed to participate in those careers, disciplines or subjects.

employability skills landed in the lap of the VET systems (Billett, 2004), a system driven by people ill prepared for the task at hand.

3.2 - INDUSTRY RESPONSE TO SKILLING – AN AUSTRALIAN PERSPECTIVE

While there has been significant energy within the Australian context to attempt to understand the drivers and influencers impacting the attraction of students to Engineering (Lewis and Vella, 1885, Australian Committee on Technical and Further Education. and Kangan, 1974, Government, 2006, AIG, 2006, Raison, 2005, Initative, 2001, Govenment, 2001, DEST, 2005, Engineers-Australia, 2004, Maquarie-University, 2005, Australian-Government, 2001, Australia, 2011b, Australia, 2011a) few of the organisations involved in these studies have had a direct involvement in designing or developing intervention programs to meet the goals they have identified. More recent research (King et al., 2011), (Watson and McIntyre, 2011) and (Wise et al., 2011) continues to highlight the need for a clear definition of the pathways and activities which lead students into careers in Engineering.

Most of the student-focused career intervention programs which are currently in place in Australia have historically been developed by individuals, teachers or organisations driven either by personal passion aimed at helping children or alternatively as an activity focused purely on achieving financial reward. Only more recently have programs begun to specifically address the skills shortage issue. In most cases the outcomes, whether intentional or not, have all had an impact on increasing awareness of Engineering for those who participate in the activities but are having very little impact outside the environment surrounding the participants.

More recent activities designed specifically to address the shortage of students taking up STEM subjects which include, for example, the Science and Engineering Challenge by Engineers Australia, the activities of Re-Engineering Australia Foundation's F1inSchools challenge and the Formulae SAE challenge by the Society of Automotive Engineers have had a much broader focus on increasing the level of awareness of specific professions and prerequisites. Further intervention programs and activities with similar broad goals are currently under development by The Australian Academy of Technological Sciences and Engineering (STELR Project), The Warren Centre for Advanced Engineering and a number of the State Governments (Hay, 2009).

Within the United Kingdom this historical passion-driven development of intervention programs has also given rise to a plethora of programs, each with its own set of goals and key performance indicators (KPI's) but with little common focus. Recently, within the UK there has been an attempt to bring together and recognise the programs that exist under a single banner of a "Technology Learning Grid (TLG)" which unfortunately is little more than a catalogue of programs. The recognition provided by this process has not taken the next step of aligning the goals and KPI's of each of these programs to those of the national goal of educational development.

In Australia, programs such as the F1inSchools (F1iS) are attempting to bring structure to the process of developing effective career intervention programs which are aligned to more than passion or reward alone. In this regard, the F1iS program has proven to be highly successful and is now seen by many companies and government bodies as a critical component of industry/student engagement strategies[2].

[2] Federal Government's Defence Materiel Organisation has chosen F1iS as one of its 14 key strategies to attract students to defence industries.

The primary goal of this research was thus to determine if participation in the F1inSchools program was able to influence the career decision choices of the High School students who participated and in particular has participation changed their propensity to choose careers in Engineering?

3.3 - RE-ENGINEERING AUSTRALIA FOUNDATION LTD

In 1998, in response to this now widely accepted perception that few young Australians view Engineering as a preferred career path, a group of like-minded people and organisations from industry and government came together to establish the Re-Engineering Australia Foundation Ltd (REA). This not-for-profit public company has the single objective of putting in place a series of stepping stone activities, starting at the earliest ages, that form a pathway of encouragement, along which school students can progress, with each step adding to their interest and understanding of Science, Technology, Engineering and Maths (STEM).

The outcomes achieved by REA to date have far surpassed the initial expectations of the founders, with incredible stories of success around many schools and individual students. The programs of REA provide a unique research platform in that they bring together Action Learning, industry involvement, "cool[3]" projects and industry role models/heroes in an educational environment which has proven, anecdotally, to be very successful in influencing children's career choices. In support of this, many schools involved in the program are reporting enrolment demand in STEM related subjects increasing by 300-400%.

The aim of this research was to develop an understanding of the reasons behind the success of the F1inSchools program, in particular an understanding of the key motivators influencing change in the career decision choices of High School Students who participated in this program.

3.3.1 - Background to REA

Re-Engineering Australia's (REA) programs are aimed specifically at school-age students and providing technology, motivation and opportunities through a series of structured Action Learning programs. These programs develop employability skills and build interest and understanding of Engineering and manufacturing professions.

One of the most recognised stepping stone programs REA has initiated is the F1inSchools Technology Challenge (F1iS). F1iS is a competition which was first implemented in the UK in 2002 and commenced in Australia in 2003. It is offered to all high schools across Australia; initially aimed at students in years 7 through 10 but often being extended to years 11 and 12. The program focuses on developing the creativity and innovation of high school students through a structured Engineering design project based on the design and development of a model Formula One racing car. The program is linked with the international F1-in-Schools challenge which now runs in 33 countries and has over nine million participants worldwide.

The F1iS project links Schools, Industry, TAFE, Universities and parents in a collaborative and experiential environment focused on changing the metaphor of the education process. In 2008 over 280 secondary schools across Australia, together with numerous Universities and TAFE colleges participated in the

[3] The term "Cool" is used as the younger generations' equivalent to the baby-boomers term "Sexy" and refers to items, activities or people who have earned their intrinsic interest and thus promote a desire to be interested, participate or get involved.

program providing a platform for over 30,000 students to actively undertake the challenges each year - with another 300,000 students being exposed to the activities and the outcomes.

The following are some of the awards and recognition REA has achieved thus far:

- Engineers Australia, Engineering Excellence Award NSW 2004 and 2006
- Peter Doherty Smart State Science Award 2005
- Engineers Australia, National Presidents Award 2006
- Warren Centre Medal for Outstanding Contribution to Engineering 2006
- Association of Consulting Engineers (ACEA), Presidents Award for Outstanding Contribution to Consulting Engineering 2006
- Prime Minister's Award for Skills Excellence 2006
- Dassault Systems Global Education Award 2006
- Prime Ministers Award for Excellence in Primary Teaching 2009

3.3.2 - F1inSchools Program

F1 in Schools, the Formula One Technology Challenge, is an engineering and design action-learning project for students[4], implemented in high schools around the world (Wynarczyk, 2009, Marshall, 2007). With more than 33 countries participating from Europe, North and South America, Africa, the Middle East and Australasia, the international competition has very local and practical implications for all students involved.

Each year, student teams progress through a series of regional, state and national finals, with the best teams from each country competing for the F1 in Schools World Champions title. Australia is a world-leader in the F1 in Schools program, with an enviable history of success.

Teams of 3-5 students from grades 5-12 use industry level, 3-dimensional CAD/CAM and simulation technologies to design, analyse, test, manufacture and race miniature CO2 powered, balsa wood Formula 1 cars.

The challenge is multi-faceted and multidisciplinary. It inspires students to collaborate with industry partners within the context of their projects to learn about engineering principles such as physics, aerodynamics, design, manufacture, leadership/teamwork, media skills and project management, and apply them in a practical, imaginative, competitive and exciting way. Just like real enterprise projects, they must also incorporate marketing and team presentation activities.

The F1 in Schools Technology Challenge addresses several key learning areas, while at the same time getting even the most uninitiated students interested and involved in engineering, design, science and math related classroom activity.

Particular key learning areas include science, maths, design and technology, business and economics. The program has been successfully integrated into design and technology, industrial arts, science, maths, business and enterprise curriculum areas - sometimes through cross curricula approaches. The F1 in

[4] The importance of the Action Learning structure which underlies the F1inSchools project should not be underestimated. While Action Learning theory and its effectiveness are not a direct focus of this research, it does form a key underlying foundation stone in this environment upon which the program is based. The importance and potential of Action Learning environments is discuss in the literature review (see section 2.1.5)

Schools Challenge is not just an engineering program - it relies on public speaking, project planning, development and management, resource procurement, industry links, graphic design and manufacturing engineering. Students of all traits and interests are having loads of fun in the challenge.

In addition to the more obvious outcomes, students develop many personal and employability skills, learning about working in a team, working towards a common goal, time and resources management, seeking industry support and mentors. The project was established to generate excitement and raise awareness of careers, trades and professions related to science, math, design, engineering and manufacturing, as well as teaching students valuable social, employability and technical skills enabling them to 'take on the world'.

The implementation of the F1-in-Schools program in Australia by REA is now recognised as being the fastest growing and global-best-practice example of the program. The incorporation of skills shortages objectives, collaboration and industry links are unique and are now being adopted in many other countries around the world. Annual participation rates by schools in Australia surpass those in any of the 33 other countries involved, including the UK and USA. All of these facts are testimony to the high standard, school suitability and sustainable nature of REA's program implementation methodology. REA has now been involved in the implementation of this program in Canada, France, New Zealand, China and Singapore.

Since the program's inception, tens of thousands of Australian school students have been involved, with dozens of Australian school students sent on world study tours, sponsored by REA. Australian students are revered internationally, having previously won the world championships, placing regularly in the top three teams and winning Best Engineered design every year!

3.3.2 - Outcomes, Goals and KPI's

The forces and agendas which influence the career choice decisions of students are many, with complex linkages between the stake holders. The benefits for each of the stake holders can be very different. For the student, the outcomes and benefits being "sold" to them by the differing influencers may not be particularly evident in their eyes due to their stage of social and physiological development.

The competition between industries within the market to attract new entrants into specific career directions is also very intense. Given that Engineering, Science and Mathematics are professions not known for their excellence in self marketing they have to some extent lost their "MoJo"[5] in terms of being cool careers in the eyes of the students. The task at hand of generating interest in these careers has become even more difficult.

To be considered effective REA has set itself the goal of achieving the following Key Performance Indicators (KPI's):

1. The programs should be such that they attract students to participate.
2. The programs must improve the employability skills of the students taking part.
3. The program must increase the attractiveness of STEM subjects.

[5] MoJo is the essence of being cool. A term bought to significance in the Austin Powers movies.

4. The programs must increase the acceptance of Engineering as a profession of choice.

While there is anecdotal evidence that the F1iS projects have increased the numbers of students electing learning pathways aligned to manufacturing and Engineering, a key outcome of this research is to validate the extent to which these activities are actually meeting the KPI's for attraction to the profession.

In addition to the target KPI's, REA has internal long term goals which are:

1. Forming sustainable partnerships between industries and schools;
2. Promoting collaboration between our cities and country regions in support of innovation;
3. Developing the skills of our children to assure their opportunities for the future;
4. Raising the level of Engineering and manufacturing skills development in regional areas;
5. Increasing acceptance of regional communities and regional industry to the level of technology that they can implement in their local environments; and providing a supply of students direct to industry who are able to understand and work with this technology.
6. Creating an understanding in our students of Australia's potential to take a world leadership role in Engineering and manufacturing.
7. Creating new skills training opportunities for young Australians in the field of Engineering technology.

3.3.3 - Program Differentiation

A fundamental and key differentiator of the REA programs has been the requirement for students to work directly with industry partners in the context of their projects. This results in students seeing a direct relevance between classroom activity they enjoy and the world of work. Another point of difference is the provision of the latest technologies which enable teachers, students and industry to collaborate easily in "smart" classrooms.

Students from schools all over Australia, in both city and regional communities, participate in the program. The Schools are linked through technology into hubs, focusing on the development of collaboration skills. Over the course of the school year, both in their own time and in class with the supervision of dedicated teaching staff, these students follow the Design, Appraise, Make and Test learning steps. This curriculum tests their problem solving skills and encourages innovative and imaginative thinking to create a model vehicle that fits the competition design constraints. The curriculum also encourages an environment of team competition which is aimed at preparing them for participation in a competitive global working environment.

To further facilitate the development of collaboration skills, sets of 5-6 schools are joined together in technology hubs in a wheel and spoke format. These technology hubs are provided with current industry technology including a Computer Numerically Controlled (CNC) Router, a Smoke Tunnel, a Wind Tunnel, and world's best Computer Aided Engineering (CAE) software tools including Computational Fluid Dynamics (CFD) and Finite Element Analysis (FEA) as used by BOEING, Toyota, Mitsubishi, Ford and many of the world's leading organisations for product design and development. The intent of providing industry based technology is to give the students experience with tools that will lead directly to development of skills and capabilities immediately useable in the work environment. The students have shown, anecdotally, a very positive response to the fact that they are using the same tools as industry ... It is not uncommon to hear students boast "We use the same tools as BOEING". This is an acknowledgement that the students are attaching importance to using industry technology. All of these technologies are provided to schools and are available 24/7 for use by students on any projects.

Both metropolitan and rural schools are linked to encourage ongoing collaboration between country and urban students. The students develop a confidence that they have skills and understanding of technology to allow them to continue to live where they like (city or country), following their chosen careers. This also provides capabilities which allow both city and country students to collaborate over distance as is done in business, empowering them to deal with people anywhere in the world.

The "hub" approach to implementing the technology provides a practical, flexible and an integrated approach that addresses the key drivers of skills development by:

- Utilising a mix of schools in hubs selected by industry and geography (including disadvantaged schools, students and parents) thus alleviates issues relating to limited access to training and education programs.
- Promoting collaboration between regions so that rural access issues can be overcome preventing internal migration of young adults from rural to metropolitan areas:
- Providing appropriate school participation and training so that low levels of education and employment among Indigenous Australians can be improved:
- Encouraging support from both large and smaller local businesses. Business and marketing skills are integrated into the school support base.

The technology implemented in the schools remains available for use on any type of learning, such as industrial design, interior design, science and the arts. The partnerships that are established between the schools and industry facilitate development of additional new projects at a school level utilising the implemented technologies and partnerships that have been put in place.

One of the key outcomes for the students is the development of project portfolios which can form a key deliverable in the students' job seeking activities. The student portfolios produced as deliverables in the F1IS program are a testament to the high standards of work produced by the students. They also provide a clearer understanding of the complexity of the project and the quality of the outcomes.

F1iS is fundamentally a structured experiential learning[6] program based on Action Learning concepts aimed at developing and building interest in, and understanding of, Engineering and manufacturing professions. Within these programs there has been a stated focus by REA on the use of the concept of industry heroes[7]/role models combined with the use of industry technology as catalysts to influence the career decision process.

[6] "Experiential Learning" and "Action Learning" are often referred to in learning research literature as different names of the same fundamental process of learning by doing: a learning philosophy used within NSW Education Department in Design and Technology curriculum which equates to a process of design-make-test-appraise.

[7] The reference to heroes is specifically in terms of the people students think are their heroes. A detailed description is included later in this document.

3.4 - RESEARCH RATIONALE, OPPORTUNITY AND SIGNIFICANCE

With the goal of improving the way in which career intervention programs are designed and delivered, there was an opportunity to carry out focused research on the Re-Engineering Australia Foundation's implementation of the F1inSchools Technology Challenge.

The aim of the research was to measure the impact of the F1iS program on the motivation of school children towards a career in Engineering and to investigate the relationships with a range of potential factors which impact career motivation. More specifically what influence does the F1iS program have on the motivation of its participants towards a career in Engineering.

With the goal of uncovering pre-existing research which would shed light on the factors which influence student career choice motivation, the initial literature search sought to find linkages between pre-existing theories of learning, choice, social peer environments and interaction with heroes as it relates to the career decision making process. Also for consideration was the impact of the hierarchy which may exist in the process of making career decision choices, e.g. moving from being unaware of Engineering to having some awareness, to having some interest, to higher levels of commitment such as undertaking prerequisite studies of science and maths and to further study in Engineering.

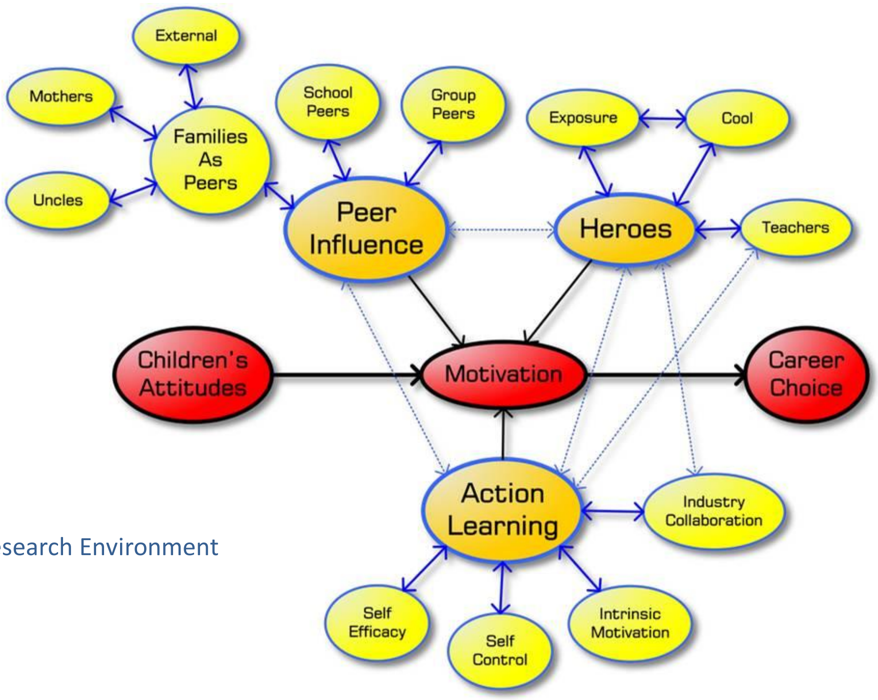

Figure 1 – Initial Research Environment

Figure 1 – Initial Research Environment, highlights diagrammatically the framework used for the initial literature review. What became evident from this review was that key career motivational drivers appear to emanate from a combination of the following:

- the learning environment's ability to promote self-efficacy and intrinsic interest in a particular direction,
- the level of career decision making self efficacy which exists in the students,

- environmental peer pressure both internal and external to the school environment, in particular the influence parents have over the career decision process,
- a student's perceptions of the images Engineering professions offer of themselves and how the delivery of that image fits with the hierarchy of the process of career choice,
- the role industry and other heroes/role models play in the promotion of intrinsic interest and hence their ability to influence career decision choice,
- differences in the responses of Boys and Girls.

The detailed literature review sought to firstly examine research related to the broad general factors which are known to potentially impact on children's career motivation. These include forms of motivation such as intrinsic and extrinsic, self-efficacy and the influence of others in the environment of the students. The second part of the literature review considers research applicable to elements of the program itself and the development and construction of intervention activities which are focused on bringing about change in motivation in a particular direction. This includes the use of active learning environments, the role of heroes and the contribution of industry. A further aspect to consider is the difference between the way in which Boys and Girls respond to these interventions and the general motivation factors.

This research will have a significant outcome if by studying the activities of F1iS we are able to assist Government(s) and industry in the construction of further intervention programs built on this knowledge which can become catalysts for an increase in the number of students choosing STEM educational pathways as a preferred option. It is also hoped that the knowledge developed will provide industry with guidance on how they can influence children to be attracted to their particular industry.

4 - DISCUSSION OF RESEARCH OUTCOMES

The career decision processes of students are influenced by a complex range of factors which involves them moving beyond the boundaries of the education system into the usually unfamiliar world of work. In addition to the many individual characteristics which act to shape their perceptions, students are subject to the influence of their peers and the aspirations of their parents and many others who exist within their environment. They are also at the age when they are under the influence of numerous genetically initiated changes in their physiologies which impacts their physical and mental capacity and their self-confidence.

When called upon to make career decisions students often find themselves with little preparation for the complex, unstructured and ad-hoc environments in which they can be placed. Cohen's (2003) examination of Existential Theory of Career Choice highlighted that students start to look outside their peer groups and spheres of influence to establish their position in a new adult life and the career decision process becomes a pivot point as they attempt to interpret direction from the many intrinsic and extrinsic signals they are receiving.

This research was focused on examining the effectiveness of one anecdotally successful career intervention program, F1inSchools, which has as its goal, to influence student career choice toward the profession of Engineering. The research goal was to not only measure the success of the program and the reasons behind its success, but also to gather data on the general factors which have been shown to influence career choice in students. An important goal of the understanding developed from the research is to provide advice to those wishing to design further intervention activities and to assist STEM based industries to attract students in their direction.

The students who were selected to participate in the research were drawn from a wide range of socioeconomic and multicultural backgrounds from across Australia. It included students from private and public schools, city and country regions, and from every state in the nation. Given this diversity it is reasonable to assume that the group of students who participated were a broad representation of the Australia high school student population.

The goals of the research were to examine the following:

1. What are the levels of intrinsic motivation which exist in the students who participate and does participation in the program change the levels of intrinsic motivation toward careers in Engineering?
2. What level of career decision making self efficacy exist in the participants i.e. are the students confident in the career decision process?
3. What is the influence on the career decision making process of others who exist within the participants peer environments?
4. What impact does participation in the F1iS program have on the motivation of its participants towards choosing a career in Engineering and does a relationship exist between any specific elements the program and a change in motivation of students towards a career in Engineering?

5. Is the program sufficiently "cool" to gain the intrinsic interest of the students and are there elements of the program which have greater impact on increasing intrinsic interest in Engineering careers than others?
6. What is the impact of industry involvement in the program on influencing student career choice?
7. Are there any differences in the conclusions drawn from the questions above for Boys as compared to Girls?

In the simplest of terms, participation in the F1iS program has had a very positive influence on student career decision choices, with 64% of Boys and 35% of Girls indicating that Fi1S had influenced a change in their career motivations toward Engineering. This research, however, provides a much deeper insight into the underlying environment of the students and their perceptions on a range of issues related to career choice.

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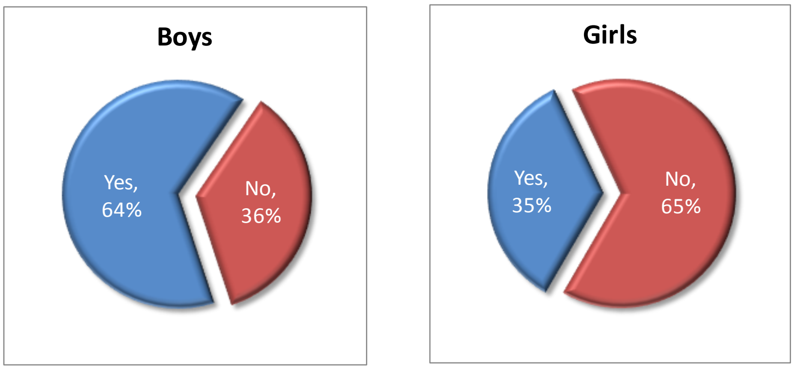

Figure 2 - Did F1inSchools Change your motivation toward a career in Engineering?

We begin by looking at the three general factors studied in this research before looking at the elements of the program and their influence on student motivation.

4.1 - **INTRINSIC** MOTIVATION

Ryan and Deci (2000) highlight that high levels of intrinsic motivation in students translates to a preference and propensity to participate in activities for no other reason than the intrinsic interest it has for them. Intrinsic motivation in students has also shown a clear association with positive decision choice (Lent et al., 2003, Linnenbrink, 2003). The goal of Section 1 of the research was to gain an understanding of these general levels of intrinsic motivation toward Engineering careers and if the F1iS program in any way impacted on this.

Randolf Watt (2004) proposed that intrinsic motivation is more highly visible in the actions of younger children with extrinsic motivation generally more prevalent in older children, yet this research recorded high levels of general intrinsic motivation across all students age groups. The responses to the Situational Intrinsic Motivation Scale (SIMS) used in Section 1 highlighted that Boys recorded scores above 4.9 and the Girls above 4.3 for intrinsic motivation within both the before and after samples and across all age groups. Scale scores of 3.5 or above are considered to be very positive. In their response to the fundamental question (1-1) 'I would be interested in a career in Engineering because I think this Engineering is interesting' 85% of all respondents responded positively to this statement with a value of 4 or more on the 7 point scale.

The high levels of intrinsically driven motivation towards Engineering as a career amongst the group of students who were surveyed before they participated in the program is an interesting and somewhat surprising outcome. There are, of course, many potential reasons for this high level of intrinsic motivation. One possible explanation is that the presence of the program in the School has stimulated an interest in Engineering and attracts students with this interest to the program. Each school approaches selection of students into the program in different ways. Some schools have the program as a core component in the curriculum so all students will participate. Others initially choose students that they feel would benefit from the program but once a school has been involved for at least 1 year the anecdotal feedback from the teachers is that the students self select based on the intrinsic interest the program generates within the school community. Once it is accepted by the students as being cool the program's growth feeds upon itself. This effect has been seen in many schools where participation in the program has grown from very small beginnings into quite large numbers of students being involved. Some evidence for this is also seen in the students' response to question 6-1 which asked them why they decided to engage in the F1inSchools program to which a similarly high proportion of 85% agreed with the statement that it was because of their interest in the activity.

While the levels of intrinsic motivation toward Engineering careers as measured in Section 1 did not significantly change due to participation in the program this was not the case in Section 6 which looked at levels of intrinsic motivation toward the F1iS program. Once the students had experienced the program their intrinsic motivation toward the program showed a statistical significant increase for both Boys and Girls. The Boys scores lifted from 4.9 to 5.5 and Girls from 4.7 to 5.1.

The analysis showed a strong connection between the levels of intrinsic motivation in careers as measured in section 1-1 and the extent to which students reported that they were more interested in careers in Engineering as a result of their participation in the program (correlation =0.65). This is evidence to support the view that if the students show high levels of intrinsic motivation and their interest is fuelled by activities which are of interest then there is a propensity to influence their career decisions. Once students are lead to experience Engineering activities their intrinsic interest in those activities was also shown to increase.

The analysis of the qualitative data gathered in question 5-17 provided further evidence of the connection between intrinsic motivation towards a career in Engineering and the activities of the program. Students recorded "learning about Engineering careers" and "learning that Engineering was fun and exciting" as their two highest responses to those aspects of the F1iS program which changed their perception of Engineering as a career path.

While there was obviously some level of intrinsic motivation which drew the students to participate in the program, it is clear that the program itself was able to increase their general level of interest in a career in Engineering. In latter sections we will examine in more detail the impact specific elements of the program had on developing this interest.

4.2 - CAREER DECISION SELF-EFFICACY

Self-efficacy makes a difference in how people feel, think and act. There is much within the literature which highlights the interaction between learning and self-efficacy. In particular Nauta (2002) found that the relationship between career interests and self-efficacy is bidirectional or reciprocal and concurred with Lent's (1994) suggestion that interests may influence self-efficacy development in a motivational capacity.

Within the scope of this research it was important to determine if the students who participated had an underlying strength or weakness in terms of their perceived ability to make career decisions. If the students are confident about the career decision process then we can be more confident that any observed positive impact of the program on their career motivations may flow through into a decision to pursue a career in Engineering. A lack of perceived ability to make career decisions would call into question the assumption that any intervention program can infact influence career decision choice.

The CDMSE-SF Scale (Betz and Hackett, 1986) used In Section 2 measures an individual's degree of belief that he/she can successfully complete tasks necessary to making career decisions. The CDMSE-SF Scale is based on work originally postulated by Bandura (Bandura, 1977), that self-efficacy is a major mediator of behaviour and behavioural change. Low self-efficacy expectations regarding a behaviour or behavioural domain lead to avoidance of those behaviours, where as increases in self-efficacy expectations should increase the frequency of approach versus avoidance behaviour. Hackett and Betz (1981) in extensions to this research found that an understanding of self-efficacy had considerable utility for the understanding and treatment of career development programs.

The CDMSE-SF Scale uses as a basis for its construction the five Career Choice Competencies developed by Crites (Crites, 1978).

1. Accurate self-appraisal
2. Gathering occupational information
3. Goal selection
4. Making plans for the future
5. Problem solving

Both Boys and Girls groups recorded scales scores above 3.5 on a 7 unit scale for both before and after results of the CDMSE-SF scale which suggests that we are dealing with a group of students with a high underlying self-efficacy toward the career decision process and a belief in their own abilities to go about choosing a career.

Participation in the F1iS program did not appear to change this underlying confidence to be able to make career choices.

4.3 - INFLUENCE OF OTHERS – PEERS AND ROLE MODELS

As part of the program the students were required to work outside their home and homogeneous peer environments, interacting with role models in a complex business process. It appears that participation in the program may have facilitated different changes in Boys as compared to Girls in terms of their belief in the role others play in the career decision process.

Section 3 of the questionaire sought to understand the general impact of others on career choice while Section 4 sought to examine in much more detail the specific influence of others who exist in the environments which suround the students i.e. parents, mates and peers.

Overwien (2000) highlights that the skills and competencies needed for working life can be acquired in a variety of ways outside the framework of formal education and can actually comprise 70% of all learning in this area. This high level of informal sources of development of our occupational competencies emphasizes the critical role likely to be played by mentors and role models outside of the education process and, consequently, their significant influence on career motivation.

Social persuasion, the encouragement and support of others, forms part of Bandura's (1977) Theory of Perceived Self-Efficacy. Ackalof (1983), Erikson (1977), Taylor (2005) and others also highlight that the influence of role models and heroes, particularly in the early development years, can be profound and this has again been confirmed by this research.

The IOACDS scale, which was used in Section 3 of the questionnaire, measures two dimensions of the impact of role models on academic and career decisions ie. inspiration/modelling and support/guidance. The results of Section 3 suggest that we are dealing with a group of students who respond to the influence of others. The sub-scale score for inspiration/modelling for both boy and girl groups both before and after were above 5 and the sub-scale score for Support/Guidance for both Boys and Girls both before and after above 4.2. These could be considered to be moderate to high responses to those influences.

There was, however, some evidence that that the Boys and Girls responded differently as a result of their involvement in the F1iS program in terms of the inspiration/modelling sub-scale. Boys showed an almost statistically significant (p=0.07) increase between before and after in the sub-scale response as compared to no change in the Girls between before and after. There was further, statistically significant evidence of a difference in the impact of the program on the responses of the Boys and Girls to specific peer influences in Section 4 of the questionnaire, particularly in relation to the influence of parents. While Section 4 examined the influence of parents, mates, people they met during the program and people who they considered role models, the greatest significant differences between the Boys and the Girls were recorded against the impact of parents and role models on career choice.

The results of Question 4.1 & 4.2 clearly show a difference in the Girls group after participation in the program which was the opposite of the Boys. As a result of their participation in the F1iS program a high proportion of the Girls (35%) were quite strong in their views that they are less willing to accept their parent's career recommendation just because their parents thought it was a good idea. In contrast, the Boys trended towards a more positive response in terms of their willingness to listen to their parents on issues of career choice. Again while a trend was visible in the plot of the means, the overall statistical test of the means was not significant. Question 4.8, however, highlighted a statistically significant difference between the Boys and Girls in terms of their willingness to accept the career advice of role models. The Girls showed a decline in their willingness to take the advice of role model between before and after groups and this negative change in attitude was nearly statistically significant in its own right with a p=0.11. This data appears to support the argument that Girls respond less to the influence of role models than do Boys with the difference between Boys and Girls increasing the more the Girls were exposed to the processes involved in Engineering.

The best subset regression analysis for Section 5 highlighted a difference between the predictors of influence in terms of others between the Boys and Girls. This analysis showed for the Boys that the best predictors of the overall response to the program were the following three items:

1. I have met people who have inspired me to take a career in Engineering
2. I would consider the engineers I have met a role models
3. I have a much clearer understanding of Engineering as a career

The similar analysis for the Girls as a group however showed quite a different pattern with the best predictors of the response to the program being:

1. I liked the fact that I used technology used by industry
2. I thought the project was cool
3. I have a much clearer understanding of Engineering as a career

For the Boys there was an overt focus on the influence of role models they had met as part of their involvement in F1iS and an increased understanding of Engineering while for the Girls there was an overt focus on the technology, an improved understanding of the career and an acceptance that that Engineering was "cool" i.e. socially acceptable for them.

For the Girls the first two of these predictors are associated much more with the project itself whereas for the Boys the first two predictors were related to the interaction they had with people they considered to be role models. This appears to contradict the generally held concepts that Girls are attracted to the people issues while the Boys are attracted to the technology. The responses to the qualitative data also supported this hypothesis with a surprisingly larger proportion of the Girls (40%) compared to the Boys (29%) acknowledging that they liked designing and making cars. Anecdotally car design has been considered a boy thing.

One point that should be understood is that this research did not measure the numbers of role models the students felt that they interacted with during their involvement in the program and more specifically if those role models were male or female. With Engineering being a male dominated profession the Girls may have interacted with less female role models than male role models. Any discussion about the role gender plays in the importance or influence of a role model will be fraught with complexity. In many of the articles examined in the literature review, the definition students have for role models is one of people who do good things yet at no time was there any indication that Girls equate more so to females role models nor Boys more so to male role models. In terms of this research the decline in the response of the Girls to their mother's recommendation of career choice as a result of participation was the same as their decline in response to their father's recommendation on career choice. Given this fact it would be reasonable to assume that the numbers of male and female role models that the students interacted with during the program had little impact on their overall attitude to the influence of role models no matter the gender. The key point which should be highlighted is the divergence in attitude of the Boys compared to the Girls in terms of their willingness to respond to role models as a result of their participation.

In terms of Neo-Darwinian Rational Choice Theory as it applies to Academic Engagement Norms (Bishop and Bishop, 2007), the response of the Boys might be explained as them responding to an innate capability and desire to learn by experience and by apprenticeship. This result links with the findings of Taylor (Taylor, 2005) who found that employability skills in male youths in Western Australia were found to have been honed by interactions with grandparents, uncles and other role models. It follows that an increased movement of Boys, more so that Girls, into Engineering careers will be achieved by facilitating an increase in interaction between students and adult Engineering role models and by increasing opportunities to learn by apprenticeship from older adults.

Girls, in contrast to the Boys, and prior to their involvement in the program, may have looked to their parents for advice on important issues like career choice. What we may be seeing is that the F1iS experience has provided the Girls with a significantly improved understanding of the processes involved in Engineering careers, thus giving them a clearer understanding of Engineering and their abilities to handle the complexity of Engineering roles. This new knowledge about Engineering careers may now be sufficient for them to feel they have the confidence to make their own career decisions and thus they feel less compelled to take their parents' advice. They now understand the processes of Engineering to the extent that they feel that they are able to make clear career decisions for, or against an Engineering career direction. In support of this the qualitative data highlighted that the greatest outcome from participation in F1iS for the Girls revolved around those items which added to their developed understanding of the activities and complexity involved in Engineering and that Engineering is fun and exciting.

The differences in response between the Boys and the Girls on their propensity to accept their parent's advice was not expected when the research started and thus the research tools did not provide a direct method of determining, in more detail, the reasons behind the difference in perspective between Boys and Girls. This is a significant finding and an area worthy of much further research.

Given that this research was looking to detect the impact of heroes and role models within the activities of the F1iS program, the fact that the students are open to influence by others in terms of career choice adds to the validity of the outcomes of the research. If the students were showing low levels of response to influence by others the possibility of influencing their career choices with the use of role models would be limited. What has become evident is the difference in the extent to which the Boys and Girls respond to the influence of role models and to a developed understanding of the processes involved in an Engineering career. This was not a topic perceived as having relevance when the research began yet has become a key finding of this research.

The Boys clearly seek out human interaction particularly with mentors and role models, whereas the Girls appear to seek out an innate understanding of the complexity of the environment and how that environment fits with their vision for their future direction. For industry to be successful at influencing the career decision of students it will require the development of a different set of selling messages if they are to attract Boys as compared to Girls in their direction.

4.4 - **F1IS** PROGRAM IMPACT - OVERVIEW

The foundation of the F1iS program includes a focus on the use of industry heroes as mentors and role models, the use of industry technology to create career relevance and on just being "cool" to attract their interest. Each of these fit with the general factors which drive the development of intrinsic interest as highlighted by Bandura (1977) and others.

In terms of what the students felt they learnt as a result of their involvement in the F1iS program, there were a number of key points of note which were highlighted, particularly in the qualitative responses. The majority of students readily highlighted how much they had learnt about Engineering as a result of the program. In particular what had been learnt about what engineers do, the complexity involved and that Engineering is fun and exciting

By far the biggest response to changing Engineering career perceptions was learning about Engineering careers with 47% of Boys and 67% of Girls recording it as their highest response. Example resposes include: "Engineering is interesting", " there is so much more to Engineering", "leaning about the heaps of types of Engineering", "it's even better than I imagined", & "I now like Engineering". Of particular interest 19% of Boys and 22% of Girls highlighting that learning that Engineering is fun and exciting had the greatest influence on changing their perception of Engineering as a career.

Learning about Engineering and developing an understanding that Engineering is fun and exciting, dominated the overall response of the students and may give some support to the context that prior to particiation in F1iS few students truly understand the profession of Engineering and certainly do not associate the concept of fun and excitement to the profession.

There was also significant interest in using the technology and in particular technology used by industry. 33% of Girls and 34% of Boys highlighted the opportunity to use Industry standard technology as the most important learning outcome from the program. They saw learning technology as both interesting and bringing career relevance to the program. An interest in aerodynamics also rated highly in the qualitative responses of the students. Aerodynamics could be considered a science rather than a technology yet it appeared to attract the interest of many students and would indicate that if given the appropriate relevance, specific sciences are of keen interest to students.

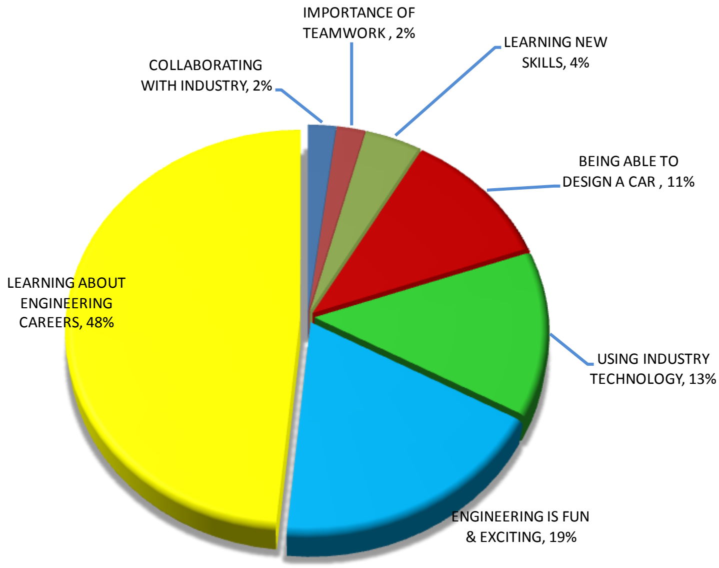

Figure 3 - What was it about F1inSchools that changed your perception of Engineering as a career path?

The concepts of learned teamwork, management, communications skills and collaboration with industry were also highlighted by the students as key learning outcomes. Teamwork was highlighted as a key outcome in 11% of responses and in most instances this reference was to the students either enjoying teamwork or recognising the need for teamwork to achieve a result.

One of the clear outcomes for the students is the emotional link they now have with the opportunities which exist for them within Engineering careers. The program brings context, alignment and relevance to their understanding of Engineering and brings the profession within their perceptions of what exists in the real world.

Being able to work on real world projects provides a catalyst to magnify the impact role models and interactions with industry can have in the influencing and changing career decision choice by placing the information the students seek in front of them at a critical point when their emotional willingness to accept information is highly attuned to the subject and when they are most susceptible to accepting and absorbing that input.

In terms of Neo-Darwinian Rational Choice as it applies to Academic Engagement Norms, the program, through its ability to have the students leaning senses on high alert, is able to change the accepted norms of the students toward engineering and it is this ability to change normative understanding that has the greatest potential to impact long term change in student attitudes toward career choice.

4.5 - BEING COOL

Being "cool" is all about being of interest. Bandura's (Bandura, 1977) Theory of Perceived Self-Efficacy includes emotional arousal (arousal of interest and lack of anxiety in connection with the behaviour) as one of the key elements in the development of self-efficacy and being "cool" fits with this concept. Within a world of Wii's, Twitter, Facebook and Playstation, being sufficiently "cool" is a battle in itself which cannot be fought by those who do not understand the distractive influence of this new technology.

Certainly modern day mythology (Sheahan, 2005) has the Y generation associated with the "I do it because it's there" intrinsically driven attitude to life. There is much popular conjecture as to why the Y generation and those generations which follow are more this way inclined than previous generations. Some argue (Sheahan, 2005) that the Y generation has just been over nurtured and to some extent spoilt, growing up in an environment which allows them to stay socially younger longer and thus, perhaps driven more by intrinsic motivation. It may simply be a result of growing up in an encouraging environment which promotes development of intrinsic motivation. Whatever the reason, attracting the intrinsic interest of students with the goal of modifying their motivations toward a specific career or career intervention program has become much more difficult given the success of our society in creating a plethora of "cool" technological distractions.

In Section 5 of this research, 83% of the students felt that the F1iS program was "Cool" which confirms that the program was able to break through to the students and place itself clearly in the target range of the students' intrinsic interest. In the regression analysis the Girls placed the fact that they felt the F1iS program was cool as the second highest predictor of their response to the program.

The analysis of the relationship between the measure of intrinsic motivation and the impact of the program showed that the students with higher levels of intrinsic motivation were more likely to be further influenced by activities which can attract their intrinsic interest.

Being cool appears to be a key to the doorway of intrinsic interest. The F1iS program has a number of elements which the students find "cool". These vary from its association with the F1 program, being able to meet heroes such as Michael Schumacher, Jenson Button or Mark Webber[8], being able to use the same tools used by Airbus to design the A380 through to interacting with people from industry who they feel build "cool stuff".

If industry is to develop intervention programs to attract students of this age, those intervention programs need to be sufficiently "cool" to gain the intrinsic interest of the students. Without this "cool" status it becomes difficult for any activity to break through to students and hence provide the access to a diverse range of mentors, role models and heroes who are able to provide guidance and assistance in resolving the priority of the many signals the students are receiving.

4.6 - USING INDUSTRY TECHNOLOGY

As already highlighted there was significant student interest in using the technology and in particular technology used by industry. The use of industry technology adds to the relevance and vicarious learning (Bandura, 1977) provided by the F1iS program helping to bringing target behaviours that the students associate with a career within realistic boundaries.

A very positive response was shown by the students in both the qualitative and qualitative data to the use of industry technology. Within the quantitative data 86% of the Boys and 71% of the Girls responded positively to the use of industry technology. Of this 60% of the Boys responded in band 6 or 7 where as only 35% of Girls responded in band 6 or 7. While the Girls did not record as high percentage of responses in band 6 or 7 in question 5.8 the regression analysis highlighted that for the Girls, the use of technology was the highest predictor of their response to the program. This means that whilst the response from the Girls overall towards the technology was not as strong as it was for the Boys, this factor is one of the key separators for whether Girls are likely to be interested in a career in Engineering or not.

It should be highlighted that the CAD/CAM technology the students were using was the same technology as use by BOEING, Toyota, Ford and many other leading industry organisations. What was also evident as an outcome of the F1iS program is that students as young as 12 have no problems handling industry level technology such as this. Industry needs to be cognisant of the technological level at which students can operate at a very young age. The school system, historically, has a reputation of providing technology to schools which is at a very low level when compared to what is used by industry. It is common knowledge amongst teachers that students are able to learn this low-level technology very quickly, soon becoming bored. Being able to use the same tools as used by industry in the way that has been achieved by F1iS, has provided a platform which has no inherrant limits to the students' scope for learning.

The level of work produced by the students, as highlighted in their portfolios is a clear indication the students understand how to research projects and careers and are willing to accept and absorb high levels of information. These students are confident and are keen to learn about the benefits and processes involved in specific careers.

[8] Current F1 Drivers

This is critical information for industry in terms of the development of resources needed to attract students to careers in Engineering. It is essential that industry treats students with a great deal of respect when offering career options and providing students with information about careers. It should not underestimate the level of knowledge students are seeking to help them make career decisions.

Overly simplistic intervention programs which do not understand the importance of this will struggle to attract the intrinsic interest of students and will fail to provide the motivational fuel to promote career selection toward complex professions like Engineering. The need for relevance in the activities undertaken by students appears critical in the process of targeting their interest and the F1iS program is seen by the students as providing career relevance and recognising their capacity to learn.

5 - CONCLUSION

Developmental career theorists such as Super (1996), Ginzberg (1984), Gottfredson (1981), and Vondkracek (Vondracek et al., 1986), have noted the importance of the adolescent years in laying the foundation for future career and educational pursuits. Each of these theorists acknowledges adolescence as an important time in the development of interests, perceptions of abilities, and knowledge of the world of work.

The key elements which we learnt from the different sections of the questionnaire are the following:

1. The students surveyed displayed high levels of intrinsic motivation and a propensity to respond to those activities which attract their interest.
2. Student career decision making self efficacy is high which translates to the students feeling very confident in their abilities choose a career path.
3. While students are influenced by those in their surrounding environment, particularly their parents, they are not pre disposed to respond to the influence of their mates beyond the influence their mates have over establishing a status of Cool for a particular process or activity.
4. Within their immediate peer environment students respond to the influence of parents and key individuals but this level of response changes as a result of the people they interact with, the knowledge they gain and the experiences they encounter within an intervention program and this change is different for Boys as compared to girls.
5. The greatest positive response of the students to their involvement in F1iS was toward how much they had learnt about the profession of Engineering and how much fun and how exciting they found Engineering to be.
6. The students rated their intrinsic interest toward the activities of Engineering higher than their intrinsic interest toward the profession of Engineering.

What has become very evident from this research is that, for those students who display high levels of intrinsic motivation toward a career, interventions which are able to further increase their interest in that direction are able to have a significant impact on motivating their career choice. The high levels of intrinsic motivation toward Engineering recorded in the students, combined with an activity which rated very highly on their "Cool" stakes and a project based learning environment, has resulted in a significant impact on the students with 64% of Boys and 35% of Girls indicating that Fi1S had influenced a change in their career motivations toward Engineering.

While the F1iS program was able to attract the intrinsic interest of the students, the Boys responded to a different set of motivators compared to the Girls. The overt use of Industry involvement within the scope of the project and the subseiquent link to mentors provided a platform for encouragement and support by others (social persuasion). It provided an environment for vicarious learning facilitated by a developed understanding of the processes involved within Engineering tasks which helped bring Engineering careers within realistic achievable boundaries for the students.

The focus on promoting interaction between the students and the Engineering role models had a particularly important impact on the Boys and a lesser impact on the Girls. For the Girls, development of a clear understanding of the processes involved in the profession, particularly in a way that they can relate to, and can make critical career decisions about, appears to have a greater impact on their propensity to include Engineering as a viable career option.

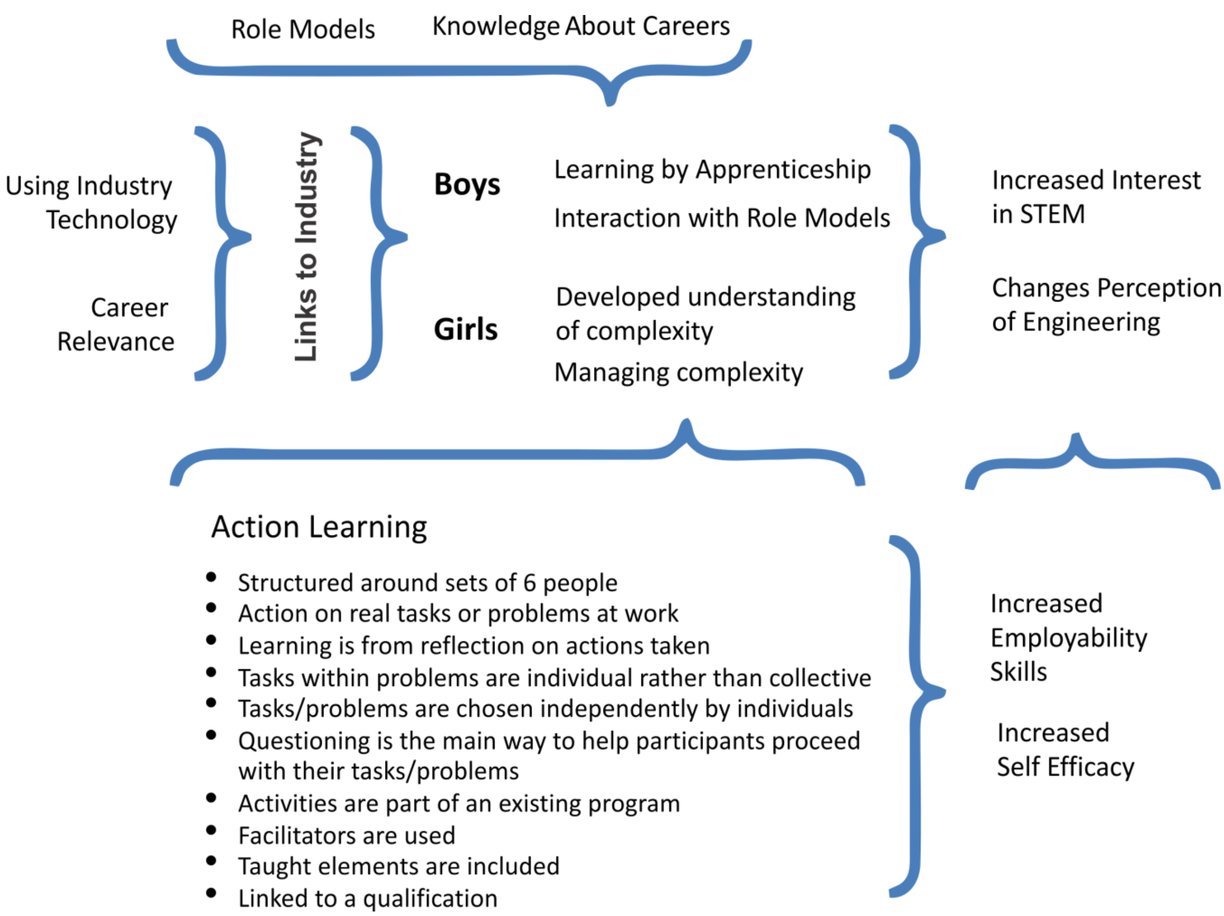

Figure 4 - Summary of Outcomes

Given a clearer understanding of the motivational drivers of Boys and Girls, there exists significant scope for industry to recreate the way it sells itself to students and also the level of intrinsic interest it is able to generate in the profession itself. The current image of the profession of Engineering has historically been developed based on appeasing a set of motivational drivers which work for Boys rather than Girls. The longer term challenge for the profession, if it is to develop intrinsic interest in Girls toward Engineering, will be to develop an image of the profession that both Boys and Girls can relate to, an image that fits with their different motivators.

The success of the F1iS program in bringing about motivating change in career choice has highlighted that it is possible to develop intervention programs in Schools which can significantly enhance student employability skills and assist industry to attract students to STEM based careers. One only has to look at examples of student portfolios produced as part of their participation in the program to see the outstanding world class work that is produced in the program. The project based learning approach, long learning trajectories, rich interaction with industry through mentoring and the use of high technology provides useful guidance to the school system on the types of learning tasks that will inspire students to achieve their best.

This research also provides ideas for teachers on how to develop the way in which STEM subjects are taught as a part of the normal school curriculum. In support of this, industry has a key role to play in providing support and staff development opportunities for teachers. Industry should take an active role in collaborating with schools to provide a connected range of activities across the primary and secondary years which help facilitate an increased understanding of STEM based careers. Direct collaboration will also assist students to develop and sustain an intrinsic interest in STEM.

F1iS is as much about bringing career relevance to Engineering as it is about creating an image of fun and excitement around the profession. F1iS has been able to lead participating students by the hand to increase their interests in Engineering career paths and they have also come to understand that Engineering is "Cool".

To quote the students ..."This stuff is Cool"...
and so we should make all of Engineering "Cool".

5.1 - **LIMITATIONS** AND AREAS FOR FURTHER RESEARCH

There are a number of limitations when researching the attitudes and behaviours of secondary school children which are important to note. Many of these revolve around the limitations on being able to conduct long term longitudinal research on students and the level of control you as a researched have over the environment.

Students are generally difficult to track over extended time periods due to their movements in and out of classes, teams and schools. Ethical limitations also required detailed parental approval prior to undertaking longitudinally tracking of individual students. From past experiences of the author, gaining the buy-in of the parents of the students from low socioeconomic areas has proven to be extremely problematic, and from a research perspective very restrictive. In this instance, limiting the research to students who were able to provide parental approval would have had the potential to constrain the diversity and socioeconomic spread of the students who participated in this research. It was felt important for this research to include low socioeconomic schools within the mix being studied and thus parental consent was not sought.

While there was limited control over many elements of the research environment e.g. the quality and number of industry interactions, the performance of the teachers etc. this was not considered a limitation. Students grow up and operate in real world uncontrolled environments and for any career intervention program to be considered successful it must be effective within these uncontrolled environments. We are fortunate that Action Learning environments, by their design, create a level of control over many of the elements we seek to measure (Bourner, 2011, Chenhall and Chermack, 2010, Congdon and Congdon, 2011, Donnenberg and De Loo, 2004, George, 2004, Leonard and Marquardt, 2010, O'Hara et al., 2004, Wilson and Fowler, 2005). Much of this control comes about as a result of the rules of engagement in the activity and the requirement for the participants to take over the decision making responsibility during the activity. Passing decision making to the students facilitates a self managed learning environment where the students must choose to follow the rules of participation e.g. the requirement to interact with industry, or they will not succeed.

An important issue, shared by other intervention programs, is how to sustain student interest in a career in Engineering beyond the life of the intervention, through to enrolment in courses of study at the tertiary level and progression into the work force. To date, the majority of industry focused career intervention activities have been built on what could be called a hit-or-miss strategy built around career days or short interactions with students. The basis for this approach by industry has come as a result of the responsibility for implementation of these programs often being passed to marketing departments. With little knowledge of the complexity of the career motivation process, the modus operandi of marketing departments often falls foul of issues of economic rationalism where the less spent the better and thus simplistic 101 marketing techniques based on "host a number of events, post a number of adverts and they will come" are employed. Given that industry accepts that 50% of marketing is waisted, but they don't know which 50%, when combined with a poor understanding of what is required to attract the intrinsic interest of students, the chance of these programs developing any long term sustainable outcome is thus very slim at best.

Influencing career motivation of students is a complex process and career intervention programs based on a short term interactions have the potential to lose their impact on student motivations very quickly. While industry career days and even two day events like the Newcastle University's Engineering Challenge offer a degree of intense interaction with industry and can lift the short term intrinsic interest of students (if the students' motivation for participation is more than just a reason to have a day off school), they do not provide an opportunity for the students to reassess and reflect on their involvement in the activity. Formal assessment of the influence these activities have on changing career motivations is rarely if ever carried out. Without the students undertaking a formal personal assessment process the opportunity to achieve sustainability of career change is further weakened.

The F1iS program by comparison, requires the students to clearly document their understanding of Engineering in the 20 page portfolio and the students are also required to make a verbal presentation to industry executives on their engagement with the science and Engineering behind their project and their involvement with industry during the project. This provides a platform for the students to reaffirm their understanding of Engineering and provides an opportunity to further develop an understanding of how they see themselves fitting within an Engineering career environment.

Measurement of the sustainability of the outcomes achieved by career intervention programs based on Action Learning can be compounded by the fact that the outcomes of Action Learning programs can often be tacit knowledge which will only become evident in the student in light of subsequent experience, a point highlighted in many articles on this topic (Checkland, 2000, Clark, 2004, Kolb, 1984, Lizzio and Wilson, 2004, McCarthy and Riner, 1996). This makes the measurement of the effectiveness of this form of learning difficult and any evaluation of the effectiveness and sustainability needs to be structured in such a way as to account for more extended trajectories of learning.

Given that the F1iS program is based on very long learning trajectory of well over 6 months and in many instances the students live and breathe the F1iS program over many years, the opportunity for sustained motivational change is obviously much greater for F1iS than for short term one or two day intervention activities.

As a point of caution, while there is anecdotal evidence in the positive, this research was not able to validate the sustainability of the F1iS's ability to implant a change in career motivation which will survive the test of time. Here again the limitations on undertaking detailed longitudinally tracking of individual students limited the ability of this research to validate long term sustainability. Areas of further research which would add to our understanding of the sustainability of the F1iS program and aid our understanding of the motivational drivers of children's career decision choices would include the following:

- A longitudinal study which measures the sustainability of the program's ability to influence long term career choice (Anecdotal feedback provides some evidence of continuing interest by the students in Engineering careers some time after completing their participation in the program).
- The ability of specific elements of the program to increase the sustainability of a change in career choice. In particular the interaction with industry and the use of industry based design tools.
- Examination into the sustainability of the program to fit within the education system(s) which exist in each of the States.
- The impact interaction with varying numbers of role models has on influencing career choice decisions of students,
- The impact of male vs female role models on influencing career decision choices of Boys and Girls,
- The influence parents have on the effectiveness of career interventions and if this influence can be a positive or negative in the process of career choice,
- The attributes which students consider make an activity "Cool" vs. "Un-cool" and thus the ability of the program to remain "Cool" and continue to attract the interest of the students.
- The role of teachers in the program and how they might be better supported to incorporate some of the successful aspects of this program in their classroom practice.

5.2 - **ADVICE** TO INDUSTRY

If we examine the relationship the general public has with professions such as medicine, law and accounting it is certainly well accepted by the community that they can have a personal relationship with their Doctor, with their Accountant and quite possibly even with their Lawyer. Given a general willingness for the public to accept the development of relationships with professions critical to their involvement in society it is paradoxical that few people would consider having a formal relationship with an Engineer. While society trusts the bridges and structures that the engineers build, this does not appear to be sufficient to generate a relationship with the engineers who build these structures.

In addition to the general lack of attachment society appears to have with Engineering, there appears an even greater level of detachment by the female gender. Girls have little issue with professions such as accounting, law or medicine where the participation by Girls can be higher than 50% yet for Engineering it can be as low as 2%. This research has shown that correctly targeted interventions can bring about a dramatically change in the number of Girls who have an interest in an Engineering career.

Students currently need significant support to discover just how interesting and exciting the activities of Engineering can be. F1iS is playing a leadership role in making this happen. Learning environments which facilitate an increased understanding of the profession in a way which fits with the different motivational drivers of Boys and Girls will go a long way to providing the guidance and understanding the students are looking for as they make critical career choices. F1iS is considered by the students as "Cool" and it uses this status to attract the intrinsic interest of students. Once the door of intrinsic interest is open it uses motivators which the students can relate to, in order to change their career choice norms.

The story about Engineering needs to be told in a different way to Boys than it is to Girls. Boys need continuous human interaction particularly with role models and mentors to perform at their peak. Boys learn by apprenticeship and respond to the influence of role models. They need to touch jobs prior to making an emotional decision about career engagement. Movement of Boys into Engineering careers will be increased by facilitating interaction between students and adults in Engineering roles. Part of this message is that during their career journey there will always be engineers around them who will help them to learn and grow. Engineering should be sold to Boys as a continual learning process.

The selling pitch to attract Boys to Engineering could be the following:

- *Engineering will allow you to design many really Cool things ... and throughout your career you will have the opportunity to work in great teams and learn continuously from the very experienced engineers you will work with... your career will be one of continuous discovery.*

Girls respond to managing complexity in environments. Highlighting the processes and complexity involved in Engineering will attract them to the profession. Girls will respond to the project management aspects of Engineering careers and need to understand the processes involved in Engineering projects. The selling pitch to attract Girls to Engineering could be the following:

- *Engineering is a profession which requires a great deal of management to bring together all the different skills and processes needed to achieve an outcome ... throughout your career you will be required to manage and coordinate complex sets of tasks to bring a project to a successful conclusion.*

It is possible for Industry to effectively sell the value of Engineering as a career path to students. It is also possible to sell the Engineering profession as an important part of our Australian society to the community at large. The story behind how the Snowy Mountains Scheme (SMS) became part of the psyche of the Australia public is an example of how the broad community can develop an emotional buy-in for Engineering and Engineering projects.

Snowy Mountains Scheme

> *The Snowy Mountains Scheme has achieved a status of "Cool" in Australian society. Australians have an emotional attachment to the Snowy Mountains Scheme (SMS), the people who worked on the project and the role the project played in the development of our nation. It was this emotional attachment, which drove the community's rebellion against the public sale of the Snowy Mountains Authority in 2006.*

> *What facilitated the SMS becoming so embedded in the Australian psyche was the way it was sold to the community, over time, which fitted with the different motivational drivers of both Men and Women. i.e. the processes involved in design and Engineering of the project were clear explained, how people came together from across the world to work together in teams, and how the project mentored and developed the skills in the people who participated. These messages trigger the same motivational response which we have found to exist in Boys and Girls.*
>
> *While Australians understand that the output of the SMS is electricity, their attachment to the project has nothing to do with the amount of electricity being generated but rather acceptance and emotional ownership of the project because they understand, from different male and female perspectives the way this Engineering project fits within their lives and their involvement in society.*

Industry needs to create a similar emotional buy-in by students toward Engineering careers and if it is to use career intervention activities as a motivational tool it must consider the following as key points which have been shown by this research to have an influence in focusing career decisions:

- Interventions should be focused on building on the existing intrinsic interest students have in careers such as Engineering,
- Intervention activities must be "Cool" and the level of "Coolness" must be as defined by the students and not by the adults who look to create the intervention activities.
- The selling messages used to attract students to participate should match the different motivations of Boys and Girls as highlighted above,
- It is highly recommended that interventions should be based around the 10 fundamentals of Action (Experiential) Learning,

    1. Structured around sets of 6 people
    2. Action on real tasks or problems at work
    3. Learning is from reflection on actions taken
    4. Tasks within problems are individual rather than collective
    5. Tasks/problems are chosen independently by individuals
    6. Questioning is the main way to help participants proceed with their tasks/problems
    7. Activities are part of an existing program
    8. Facilitators are used
    9. Taught elements are included
    10. Linked to a qualification

- When engaging students, those engagements need to take students on a journey to the core of the complexity of Engineering and NOT focus on giving a guided tour around the final outcome of the Engineering effort,
- Interventions should be such that they are directly relevant to Engineering careers and this relevance should be in the eyes of the students,

- Industry should NOT underestimate the level of knowledge students are seeking to help make their career decisions and thus careers information supplied to students must respect their highly evolved capacity to absorb information.
- The opportunity exists for industry to be the catalyst for a sustainable change in career choice. Industry should become directly involved in the formation of sustainable partnerships with schools in a way which increases the interaction between industry role models, knowledge about career opportunities and the students. Industry can facilitate the links to career role models which the boys seek and also access to the knowledge about careers which girls seek. While teachers play an interface role between students and careers they do not have the experience or knowledge sufficient to facilitate the messaging which will bring about sustainable career decision choices in students.
- Intervention programs need to be provided with the knowledge and skills needed to increase collaboration with Industry and help facilitate interaction between Industry and the education system.
- Industry and the educations system must work together to provide the ongoing guidance and support which will encourage teachers to implement career interventions which are proving clearly effective in producing the outcomes industry is seeking. An issue which was regularly raised when dealing with teachers during the research process, but not specifically addressed within the scope of this research, was the support given to teachers to implement STEM based career interventions such as F1iS. Many teachers lack the confidence and competence to explore experiential learning programs within the STEM area and don't understand the Engineering profession and how it contributes to societal needs. While this research looked to examine the motivational drivers of the students much must also be done to support the teachers. They play a pivotal role and, in many instances, operate as the only heroes and role models the students have to encourage them to take on activities which are outside the scope of their experience and knowledge.
- Sustainability of career interventions programs would be enhanced if education departments and industry come together to develop an accreditation system for STEM intervention programs which maps against National Curriculum outcomes and employability outcomes as defined by industry. Most of the career intervention programs focused on attracting students to STEM struggle to attract the support and funding they need because of their inability to be recognised by the broader community as being accredited to achieve the appropriate outcomes. An accreditations system would provide programs with a common set of task oriented outcomes aimed at unifying the outcomes and guiding principles used to develop and manage intervention programs.

Industry has a critical role in the development of student career choices and there is much that industry has to do to encourage students to take up careers in Engineering. The major issue for industry will be: to not only adopt and implement these concepts, but to maintain focus on the problem and to make the appropriate changes to the normative behaviours of the culture within the organisation so as to ensure continued support and hence sustainability of programs such as F1iS.

Influencing the career motivation of children is not an issue that will respond to a short term 'shoot from the hip' reaction to the problem. Industry needs to be measured in their actions and those actions must be sustained over a long period of time if there is going to be a long term benefit from an improvement in student attitudes toward careers in STEM. Industry for both good and bad reasons has a tendency to allow strategic focus to be overtaken by issues of economic rationalism, driven by issues which appear to have shorter term economic benefits for the share holders. Solving the issues of skills shortages is an issue which requires long term focus and should remain out of reach of the economic rationalists.

Changing the messages being delivered to students by both industry and society is critical to the success of any career intervention and the profession as a whole. The finding from this research that students relate to the activities of Engineering more than they do to the profession of Engineering is a disturbing outcome from an industry perspective. The marketing of the profession which has taken place to date by both the profession and industry in general appears to have had little impact on the way in which participating students relate to the profession. Without a change in the way the profession is tuned and marketed to attract the interest of students the sustainability of any intervention program aimed at attracting students to the profession could be questionable. Long term sustainability of career choice toward Engineering will be influenced by the level of societal reaffirmation the students receive about the profession. This will be magnified if the messaging is in sync with what they experience while undertaking an Engineering focused career intervention activity.

The term "Cool" has been mentioned many times throughout this document. From an Engineering perspective it is should be considered a state of mind rather than the outcome of a differential equation. For the profession to grow the number of students taking up Engineering, it needs to make a leap in the way it is sold to the next generation and this will only happen with a focus on marketing the profession, an activity which does not require a calculator.

Industry has to learn to become "Cool" and must make the effort to stay "Cool". Being "Cool", however, is only a symptom of a state of mind where students have at least placed careers in Engineering on their radar or within their scope of acceptability. It may come as a consequence of a changed set of marketing messages, increased exposure of the profession and its heroes or an increased understanding of the complexity of the profession. Whatever the drivers which facilitate Engineering becoming "Cool", it is only the start point for industry to begin its efforts to translate "Cool" into Engineers.

As has been shown, effective and well directed interaction with industry can have a clear impact on developing an emotional link with the participating students as they step out of the school environment. Providing students the opportunity to work on real world projects and standing beside them as they traverse these projects is the catalyst they seek to increase their ability to have an impact on the environment of work they are now entering.

The students who participated in F1iS are now able to easily make the linkage between industry, the role of engineering, the career opportunities which exist and the roles they can play within this profession but without the support of industry the final link in the transformation to becoming an Engineer will not happen. Career interventions like F1iS may be able to bring students to the doors of opportunity but without industry there to open the doors the final step in the process will not happen. Success will only come when industry engages with the students and commits effort to the process of feeding their intrinsic interest in Engineering beyond the intervention activity. It is about industry providing contact with role models and access to knowledge about the profession. Role models and knowledge are critical for students and industry is in the best place to provide both of these. It is about industry making a sustained effort which will have the greatest impact.

If nothing else, industry must take from this research the fact that that we are blessed by the capabilities and enthusiasm which exists within our children. Given the high levels of intrinsic motivation being displayed by these students, the strong linkage in the literature between intrinsic motivation, self-efficacy and innovation, it is reasonable to assume that this new generation of students will be highly innovative. This is a great position for industry, and our nation, moving forward in a competitive world. All that is left is for industry to take the appropriate actions to attract these students to the profession and to the jobs that build a nation.

5.3 - EPILOGUE – THE BLOG

Throughout this research there were a number of areas which were highlighted as potential opportunities for further research. In addition to these is a case for further research into the effects viral marketing has in generating intrinsic interest in Engineering.

In today's technological world viral marketing has anecdotally been very successful in delivering a message and influencing the younger generation way beyond the expectations of the marketing community.

The messages passed from one person to another or in this case from one student to another can have a greater impact as a marketing deliverable to attract, excite and to create a perception of "Cool", than has been achievable by traditional advertising based on print and media.

With viral marketing it is possible to create marketing pull without the need for any advertising expenditure. To some extent it is an off-shoot of marketing or a marketing event which relies on social networking facilitated by the web. As with traditional marketing techniques, however, measuring the outcomes and effectiveness of viral marketing is difficult as it may come into play long after the event is over.

While not a subject of this research, it is generally accepted that an effective viral marketing associated with an activity can have a great impact being additional source from which to create intrinsic interest and bringing the students to the program in the first place.

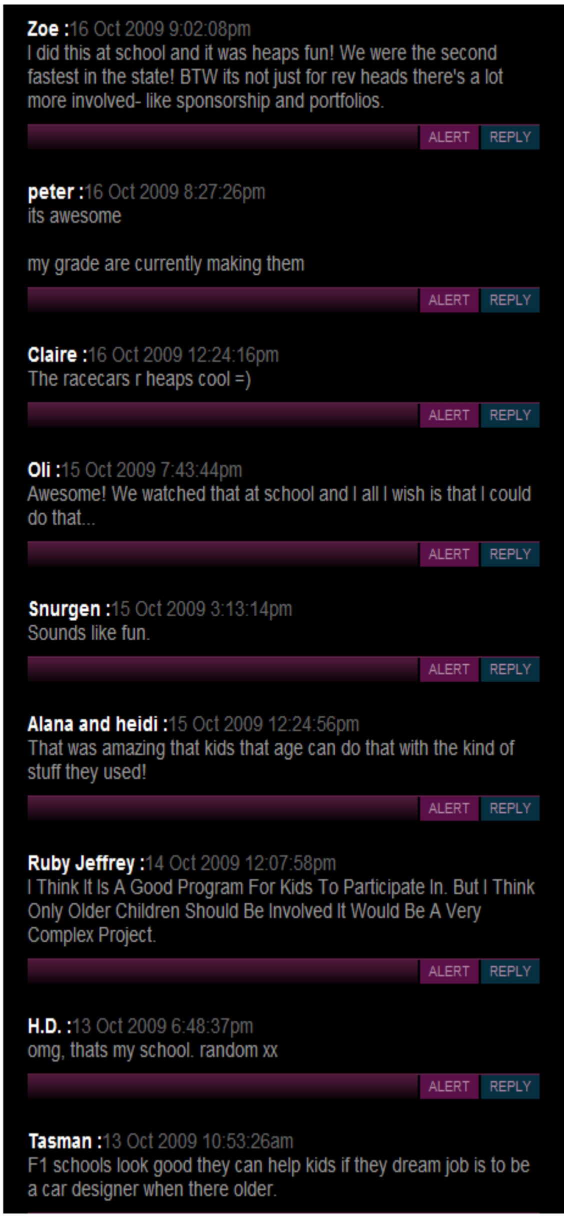

Figure 5 - ABC-BTN Blog October 2009

Once they are participating the opportunity exists to then change their peer norms about an Engineering careers which will lock and load them on the appropriate career path.

Figure 5 - ABC-BTN Blog October 2009 is an extract from the ABC-BTN blog site and refers to a video screened by ABC at the beginning of October on the 2009 F1iS South Australian State finals. While this research examined the "Influence of Others" on the career decision processes of the students who participated, it did not examine the influence on or by other students who are currently outside the program. While this research founds that students did not place a great deal of emphasis on the career advice of their mates, it did not prove that they would not virally market to their mates about what is Cool or respond to what was marketed to them as Cool.

It is obvious from the responses on the ABC-BTN Blog site that the F1iS program is able to generate intrinsic interest in students and to influence others to become interested in the program and Figure 5 is an example of how viral communication was playing out on a prominent Blog site.

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7 - APPENDIX - EXAMPLES OF PROGRAM SUCCESS

7.1 The Ultimate Dream Realised: From Student F1 Competition to the Real World of Formula One!

7.2 Five little kids have changed a whole school!

7.3 Aussies 2nd and 3rd at F1 in Schools World Final in Malaysia

7.4 Aussies 2nd, 3rd and 4th at F1 in Schools World Final in London

7.5 Aussies 2nd and 5th at F1 in Schools World Final in Singapore

7.6 Australia wins 2011 F1inSchools World Final in Malaysia

7.1 - MEDIA RELEASE - MAY 2011

THE ULTIMATE DREAM REALISED: FROM STUDENT F1 COMPETITION TO THE REAL WORLD OF FORMULA ONE!

RED BULL RACING RECRUITS ITS FIRST SYDNEY F1inSCHOOLS "GRADUATE".

Red Bull Racing - the Formula One team of Aussie driver Mark Webber - has employed its first young Australian to work in the engineering team with the appointment of former Barker College student Mat Cruickshank.

Like most of the 35,000-plus high school students engaged in the F1inSchools Technology Challenge in Australia, Matt dreamed of one day having a career that involved innovation, technology and engineering. Today, just a few years out of high school, he is a full-time aerodynamics engineer with Red Bull Racing. Thanks to the F1inSchools program.

Matt's journey began while he was at Barker College in Sydney. He was part of a student team which used space-age engineering software and industry-spec' manufacturing machines to design, make and race a miniature F1 car as part of the F1inSchools program ...the world's largest high school technology competition with 9,000,000 students competing.

The F1inSchools program is run by the not-for-profit organisation, Re-Engineering Australia Foundation, which has been inspiring and equipping young people to follow engineering and manufacturing careers for 14 years.

Matt and his peers excelled so much in the competition that they earned the right to represent Australia at the 2008 F1inSchools World Championships in Malaysia. There, his team finished third outright, beating students from more than 20 other nations.

"F1inSchools bought out the passion I had for motor sport and engineering. It also gave me a unique insight into F1 and taught me a lot about the industry which was vital when I applied for this job", says Matt from their Milton Keynes headquarters in the UK.

"F1 in Schools taught me general engineering skills, how to solve problems and showed me various ways to interpret rules and regulations and thinking outside the box. It also taught me a lot about how to work as a team to achieve goals which is important when working in industry. One of the most important areas F1inSchools helped me with was presentation skills. It gave me practical experience with presenting in public and having interviews, both of which are great skills to have when applying for jobs."

He adds, "When I was at school I always wanted to work in F1 but ultimately I saw it as a long term goal. I certainly never imagined working in F1 in my second year of university, let alone in one of the best teams in the paddock. It all came about in a very short period of time. If you had of told me a year ago that I would be working in the world championship Formula One team I probably wouldn't have believed you."

Matt is one of 550 people who work at Red Bull Racing and Red Bull Technology. He started off in an aerodynamic development team using wind tunnels and since then has moved on to using computational fluid dynamics to analyse the aerodynamics of the cars in a virtual environment. A typical day for Matt is spent simulating airflow over the race car using super computers, analysing the results and working with the aerodynamicists,

"Fundamentally this is the same as the work the students do in F1inSchools, but on a much bigger scale!"

"No day is ever the same. I work with a wide variety of people, mainly with aerodynamicists who design and scheme the part, and also the surfacing team and model designers who work with CAD to manufacture the parts. The work can be challenging but is also very rewarding. I have learned an amazing amount so far and continue to learn more each day. I thought I learnt a lot about engineering at university but the last six months have been unbelievable – from basic engineering skills to teamwork, everything I have learnt has been invaluable. I am very thankful to Red Bull Racing for giving me the opportunity to learn so much and get a unique view into Formula One and engineering."

"Re-Engineering Australia Foundation is all about preparing young people for their careers. Our F1 program, which is one of several REA initiatives, makes these innovators of the future very employable", says Foundation Chairman and Founder Michael Myers, "We have introduced tens of thousands of students to wonderful opportunities in design, engineering, innovation, problem solving and manufacturing and many have gone on to fruitful careers - although Matt is certainly a shining star and an example of the capabilities of young Australian given the opportunity to be their best. We are sure many more will soon follow in Matt's footsteps of success."

7.2 - MEDIA RELEASE - FEBRUARY 2010

"Five little kids have changed a whole school!"

Ashcroft High School is located in Sydney's southwest in a low socio-economic area. It is highly multi-cultural and a large number of the students' parents speak limited English or it is their second language. Quality teaching curriculum programs and Sport - predominantly rugby league - have been the school's claim to fame. But things are beginning to change.

Industrial Arts teacher Lee Miller is at the centre of a dramatic shift which is moving throughout the school and having a positive effect on teaching staff and students. It is a change which was initiated by the F1 in Schools Technology Challenge operated by not-for-profit organisation, Re-Engineering Australia Foundation.

"This year we have started something that has never been done before at our school. We have launched a Year 9 Engineering class. This is purely as a result of the interest that has been generated by the F1 program and we have 22 students in our first intake. Half of them are Girls. They are using the Computer Aided Design software, the same technology as used by Toyota, and our science teacher is teaching them about aerodynamics and Engineering formulas."

The students are very excited and are coming to class during their lunch and recess. We're already looking ahead to launching Year 11 and Year 12 Engineering classes in 2011."

Ashcroft High School is new to the F1 in Schools Technology Challenge but success has come quickly. Its Year 9 team, TRS, has made it through to the National Finals which are being held in conjunction with the Formula 1 Australian Grand Prix in Melbourne in March.

Lee says the five team members - Dennis Nguyen, Reece Williams, Nguyen Hoang, Sandy Le, Corrina Baars - have become "heroes" to their peers and triggered an amazing change in attitudes across the school.

"Talking to the teachers we are seeing a definite change in our students. Not only towards science and math's, but also toward all of their study habits. They have become keener in other subjects than before. Their results are improving as is their behaviour in the classroom.

Lee says the unique hands-on format of the F1 program is a huge attraction to kids of all ages,

"The students see something practical, they see how they can interact and solve a problem. They're not strong at reading from books but they are keen to get in front of a computer and have a go."

"We have kids lining up at the classroom door at lunch time wanting to see what is going on. They offer to help out. We just had a group of Year 12's stay back after school to set up the race track so that TRS could test their latest car design."

Lee says those in the F1 competition are not treated like geeks or brainiacs by their peers. Some of them have other interests like sport and dance, "They are your average well-rounded students but they have decided to 'have a go' and it has earned them a lot of respect."

"Something I have encouraged which is really great to see is students teaching students. TRS has taken the lead and are teaching other students how to use CAD/CAM, and they in turn will go on to teach the next group that come in. The students are fast learners when they work with their peers. They really take notice and listen. As a teaching style it is better than me standing at the front of the room talking about it or doing a demo. The kids are very much hands-on and they love being in teams. If someone is struggling the others get in and help them out. Even some with learning difficulties are really having a go and becoming pro-active...they're stepping out and making decisions."

Students arrive before school to work on their F1 cars and their work ethic and passion for learning is being noticed at home. More and more parents are contacting the school to say how thankful they are.

"I already have four new teams for the 2010 competition including an all-Girls team. And I've had Year 7 students asking me if they can join teams or form their own."

The effect is also spreading further afield to the Ashcroft community,

"We had a group of parents of primary school kids come to the school to check it out and the F1 team gave a speech on what they have learnt and their journey to the finals. The parents were astounded and came up to us afterwards and said they will be enrolling their children at our school because of seeing the TRS presentation. They were that impressed!"

Local businesses are sponsoring TRS to cover the costs of travel and accommodation in Melbourne but, more importantly, the team members have been provided an opportunity that has not been seen by any of the teachers at the school before.

TRS visited a local Engineering company to learn about what they do and some of the students sat down in front of their computers to try out an unfamiliar type of CAD software. Within minutes they were creating files and carrying out complex tasks. The engineers were stunned!

They told TRS that they were doing work not taught until the second year at university. The engineers couldn't believe how quickly these 13 and 14 year olds picked up new skills.

The Managing Director was very impressed and said if TRS continue their schooling through to Year 12 and focus on Engineering he will employ all of them and give them scholarships to university!

As Lee remarks,

"Five little kids have changed a whole school!"

7.3 - MEDIA RELEASE - OCTOBER 2008

Aussies 2nd and 3rd at F1 in Schools World Final in Malaysia

Team Goshawk, a group of year eight F1 designers-engineers sponsored by the Australian Defence Force Academy and Royal Australian Navy, has finished second outright at the World Championships of the F1 in Schools Challenge at Kuala Lumpur, Malaysia!

Standing alongside them on the winners dais was Impulse F1, the team from Barker College in Sydney. It was a stranger-than-fiction moment for the year eight students - Alistair Smith, Dan Boucher, Ed Larkin and Luke Abberton and their teacher Graeme Hutton from Trinity Christian College in Canberra - because they only became involved in the F1 in Schools program in late 2007! Not only did they come within mere points of becoming World Champions (that honour went to an English team), they were awarded Best Engineered Car. This is a major coup because it means that since Australian teams began competing in the World Championships four years ago we have won Best Engineered Car every time! Says something about our ingenuity and reinforces that having access to 'best in the world' design tools, like CATIA, provides for greater innovation capabilities.

Impulse F1 are "veterans" of the F1 in Schools competition having finished very close to becoming Australian National Champions for several years, until finally achieving that goal in November 2007. And, to prove their expertise, they managed to outscore 17 other nations! 25 teams flew to KL to compete in the annual international showdown which was staged in association with the Malaysian Grand Prix. They raced miniature 100 km/h F1 cars that they had designed, tested, made and raced themselves!

Despite only having joined the F1 in Schools competition in late 2007 the Goshawks were very quick to embrace the space-age 3D design and engineering analysis software (CATIA) they were provided with. They designed a clever, aerodynamic car capable of 100 km/h... machined it from a block of balsa... assessed it with Virtual Wind Tunnel software and physical wind and smoke tunnels, and completed the other tasks such as collaborating with industry, obtaining sponsors, preparing a detailed engineering portfolio of their ideas and reasoning, and marketing. ADFA, Navy and Neal Bates Motorsport (responsible for building the Australian Rally Championship winning Toyotas) got behind their project and also began their association with REA Foundation at both the ACT finals and National Finals in Noosa. Proud onlookers were two teams which were crowned 2006 Australian National Champions (senior and junior): 'DASHA The Eagle' from Melbourne and the 'Race-A-Roos' from Perth.

7.4 - MEDIA RELEASE - OCTOBER 2009

Aussies 2nd, 3rd and 4th at F1 in Schools World Final in London

Australia totally dominated the 2009 international showdown between 31 teams from 20 nations in London. To prove that last year's two podium spots were no coincidence, Team Australia again stood twice on the winner's dais as well as taking out 4th place.

Three schools made up Team Australia…Redline Racing (featuring two students from Team Goshawk which had gone to Malaysia in '08) again sponsored by the Australian Defence Force Academy and Royal Australian Navy, AC Racing from Noosa and Biohazard from Sydney. They won the lion's share of the category awards picking up Fastest Car, Best Technical Folio, Best Pit Area Display and the inaugural International Collaboration Award. The latter award was the result of a collaboration between students from Noosa in Queensland and Manitoba, Canada. Using Cisco Webex technology – online web conferencing, application sharing – they managed to design and build their car even though separated by many thousands of kilometres!

In addition, Team Australia managed to do what the national cricket team was unable to do…they brought home the Ashes. The Ashes is a small urn identical to that played for by the cricket sides, which contains the ashes of the cars of the 2006 Australian world champions and the best English team.

Defence Materiel Organisation not only sponsored Team Australia to the UK it also used its contacts to organise breakfast for the students and teachers at Australia House. They were hosted by Counsellor Defence Materiel, Nigel Morris…Kim Gillis, General Manager Systems, Defence Materiel Organisation…Adam McCarthy, Deputy High Commissioner of Australia to the United Kingdom…Air Commodore Steve Martin, Head of Australian Defence Staff London … Australian Government and DMO officials. Team Australia was also given VIP tours of Red Bull Racing's and McLaren Mercedes' F1 facilities.

This success at the world championships reinforced REA's position as the world leader in developing the next generation of engineers, manufacturers and technicians.

7.5 - MEDIA RELEASE - OCTOBER 2010

Aussies 2nd and 5th at F1 in Schools World Final in Singapore

When added to first place (2006), second and third (2008) and second-third-fourth (2009), Australia has the best track record of the 33 nations involved in this global high school competition.

The dominance is confirmed with Australia winning the coveted Best Engineering Award for the fifth time in six years, and claiming two other category awards (Best Portfolio and Best Collaboration).

Australian students have stood proudly on the winners' dais five times in just three years and taken home a total of 12 major awards since the initial Team Australia...far and away ahead of any other nation. Confirming that we have the smartest STEM students in the world.

Team Australia 2010 consists of:

(1) "Zer0.9", Pine Rivers State High School in Brisbane - Joshua McClennan, Alysha Limmer, Greg Mills, Megan Gaskell and teacher Corey Gieskens collaborating with The Indian School, Dubai - Prateek Mahindra, Saif Fazal Mahamood, Sidhant Shetty, Vivian Anthony Britto &
(2) "Basilisk Performance", Sebastopol College in Ballarat - Aidan Cowie, Brett Sizeland, Ben Kersten, Keira Schroeders and teacher Christoff Muller.

World Finals highlights:

- "Basilisk Performance" defeat the fastest team, Germany, in the knockout competition;
- "Zer0.9" make it through to the finals of the knockout competition with wins over China, Singapore and Germany-USA; finish second to Malaysia;
- "Basilisk Performance" defeat England to retain the Ashes for Australia (the urn is an exact replica of the one fought over by the Australian and English cricket teams. It contains the ashes of the fastest Australian and English cars at the 2007 world finals);
- "Zer0.9" Second in the world;
- "Zer0.9" Win Best Collaboration Award ;
- "Zer0.9" Finalist for Innovative Thinking Award;
- "Basilisk Performance" Fifth in world
- "Basilisk Performance" Win coveted Best Engineered Award;
- "Basilisk Performance" Win Best Portfolio Award;
- "Basilisk Performance" Finalist for Best Pit Display Award;-

The Defence Materiel Organisation was, again, a major sponsor of Team Australia and was joined in 2010 by the Victorian and Queensland Governments, ResMed, The Warren Centre, QMI Solutions, Engineers Australia, the City of Ballarat, The San Diego Foundation.

7.6 - MEDIA RELEASE - SEPTEMBER 2011

Australia Wins 2011 F1inschools World Finals in Malaysia!

2011 F1inSchools World Finals - Doubletree by Hilton Hotel - Kuala Lumpur, Malaysia

A team of teenagers from Brooks High School in Tasmania are the new world champions of the biggest science and technology competition on the planet, having received the Bernie Ecclestone Trophy at a glittering event in Malaysia tonight.

The F1 in Schools Technology Challenge involves 17,000 schools in 31 countries and tasks students with mastering space age engineering and manufacturing technologies to design and make miniature F1 cars capable of more than 80 KM/h. The program raises the awareness of innovation-type career paths and is run in Australia by not for profit organisation, Re-Engineering Australia Foundation.

Calling themselves the Pentagliders, the three boys and a girl have been presented with the solid glass trophy (during the playing of the Australian national anthem), scholarships to City University in London to study engineering, and tomorrow they will meet F1 supremo Bernie Ecclestone before being the guests of F1 teams at the Singapore Grand Prix.

Pentagliders scored maximum points across 11 criteria including car design, speed, innovation, technical portfolio, verbal presentation, pit display, marketing and collaboration with industry.

The Tasmanians had the fastest car of the three day finals event, with a track time of 1.084 seconds, and received the Fastest Car Award from the Petronas Mercedes GP Sporting Director. They won the Best Engineered Design Award, sponsored by the Vodafone McLaren Mercedes team, making it the sixth time in seven world finals that Australia has won this category.

The Pentagliders were finalists for the Research & Development Award and succeeded in beating the English team to win the Ashes - a replica of the urn from international cricket which is filled with the ashes of past Australian and English mini F1 cars. In the process, female team member Amy had a reaction time of just 0.010 seconds which is the fastest recorded at any world final! The reaction time is electronically measured when the "driver" presses a slot car-like hand controller to send their F1 car down the track.

Earlier this year the Pentagliders won the Australian national finals and some of the students were promised careers in industry well before their end of year exams.

Another Australian team, Trident Racing, from Sebastopol College in Ballarat won the Collaboration Award - sponsored by Team Lotus - and was a finalist for the Sportsmanship Award. They paired up with an all girls school from Singapore to develop their car. Last year the same school produced the Australian national champions who went on to finish fifth at the world finals.

The third team of young Aussies was Trans Tasman Racing – a collaboration between Mirani State High School in northern Queensland and New Zealand's first-ever F1 team, from Auckland Grammar School.

This was the sixth time in seven years that Australian students have stood on the podium at the F1 in Schools World Finals. At the inaugural event in 2005 Team Australia came third...in 2006 they were world champions...second and third in 2008...second, third and fourth in 2009...second and fifth in 2010...and now world champions again.

Which goes to show that Australian students are the smartest in the world.

F1 in Schools Technology Challenge is run in Australia by not for profit organisation Re-Engineering Australia Foundation Ltd. which was launched in 1998 to promote engineering and related career paths to young Australians. REA was responsible for introducing it to New Zealand. The program introduces students as young as 11 to industry standard 3D engineering design and testing software as well as computer controlled manufacturing technology. Its hands-on approach, mentoring format and accessibility to potential employers has resulted in many students taking up challenging careers.