Meeting the educational demands of the South Australian automotive industry

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Abstract: *The largest employer in South Australia is the automotive engineering sector. This thriving industry, which is now going through a rapid period of expansion, produces billions of dollars worth of exports. This healthy situation has developed an immediate need for skilled workers that cannot be met by the state's tertiary education institutions. While in the distant future there may be a reduced demand for the overall numbers of employees, because of the need for more efficient working practices workers will need to be smarter and more qualified to implement these practices, thus continuing to place higher demands upon tertiary institutions.*

The School of Mechanical Engineering at the University of Adelaide has also seen a steady increase in the number of students who favour a mechanical or mechatronic engineering vocation. However, engineering is a vast discipline and the knowledge and expertise that students are expected to develop during the course of their degree, so that they are prepared for a multitude of possible career choices, is extremely wide ranging.

This paper presents a discussion for the need and proposed structure of a more specialised degree program, in which the increasing demand for a smarter workforce from the automotive engineering industry can be met by specialised Australian graduates.

Keywords*: Automotive, Vocational, Career.*

Introduction

Background

Two years ago the author commenced work as a lecturer at the University of Adelaide. Supervising a final year project in which sixteen students raised finance to design and build a race car quickly exposed him to the automotive industry in South Australia. It was very surprising to see that with such a vibrant and significant engineering sector, none of the South Australian universities offered a formalised degree program that enabled students to specialise in this area. Numerous meetings with industry (refer to acknowledgements) followed to establish whether there was indeed a need for such a course or a means in which engineers could graduate with a more specialised understanding of the industry. More recently (presumably because of drawing similar conclusions) the Department of Further Education, Employment, Science and Technology of the South Australian government have established a skills initiative to address the shortfall of appropriately qualified and skilled

automotive labour on a broader scale, looking at school leavers, trades people, engineers and management. The author is also a task force member of this initiative and draws some of his observations and conclusions from this forum.

The South Australian Automotive Sector

South Australia has a booming automotive engineering sector, fuelled by the recent successes of its two major automotive manufacturers (Holden and Mitsubishi) and the subsequent knock-on effect to their local subcontractors and suppliers (too numerous to mention in the context of this paper). Many of these suppliers are also independently successful, contributing towards an automotive export market worth billions of dollars annually.

In the Advertiser last year, Kelton & Duffy (2002) published a front page article detailing Mitsubishi Motors Australia Limited's (MMAL) acceptance of a State and Federal government investment incentive of $85 million, sealing a total investment commitment (from Mitsubishi, Japan) of nearly one billion dollars in total. This ensures the design and development of two new vehicles for 2005 and will establish an Adelaide based R&D centre.

In January of this year Holden announced, in various press articles and on their media release web site (Laird, 2003), one thousand new jobs for its Elizabeth manufacturing plant (in Adelaide) and the introduction of a third shift to satisfy its massive expansion program that will increase the number of models they now produce from 28 to 35. Holden Chairman Peter Hanenberger, stated that "Holden was on track to becoming a global car company driven by Australian know-how and expertise".

Many more continuing and emerging success stories of South Australian automotive industries can be quoted, such as Castalloy's production of wheels for Harley Davidson, or Schefenacker's lions share of the world rear view vision market, but the list would be far too long for the context of this paper. In short, the local industry is booming.

A joint State and Federal government press release (Vaile & Minchin, 2000) reported that in 1999 Australian automotive exports amounted $3.8 billion, which was a 36% increase on the previous year. This rose to $4.2 billion in 2000 (Vaile, 2001) and $4.9 billion in 2001 (Vaile, 2002). Automotive exports now rank ahead of beef, wheat and wool, and are just behind gold and iron ore in terms of export value. The largest export markets include Saudi Arabia, the United States, New Zealand, the United Arab Emirates and Kuwait. It was also estimated that the figure would rise to $6 billion in 2002 but figures to confirm whether this became so, were not available at time of writing this paper. It can however be seen from Figure 1 (extracted from the FAPM 2002 Industry Products Directory) that there is a strong trend to indicate that the industry will continue to grow from strength to strength.

The previous paragraphs illustrate that the Australian automotive industry is clearly successful in terms of its domination of the domestic market and its export figures, but is still small by world standards. Its ability to survive and prosper in the world market place is largely due to a "boutique car manufacturer" attitude that addresses the customer desire to own an apparently unique car. Because the cars are manufactured to order, an extensive range of colours, trim options and accessories ensures that few cars are identical. This in itself requires a dynamic approach to keep one step ahead of competition and the need to demonstrate flexibility and innovation in terms of design and manufacture. In order for this success to continue, more efficient working practices will need to be introduced that, while ultimately leading towards a reduction in overall staff numbers, will substantially increase the

need for skilled and qualified personnel. The Australian automotive workforce needs to become leaner yet smarter. This is not only the case for the prime manufactures, but also for the subcontractors who are being forced to accept more and more responsibility for the cost, design and quality of their deliverables.

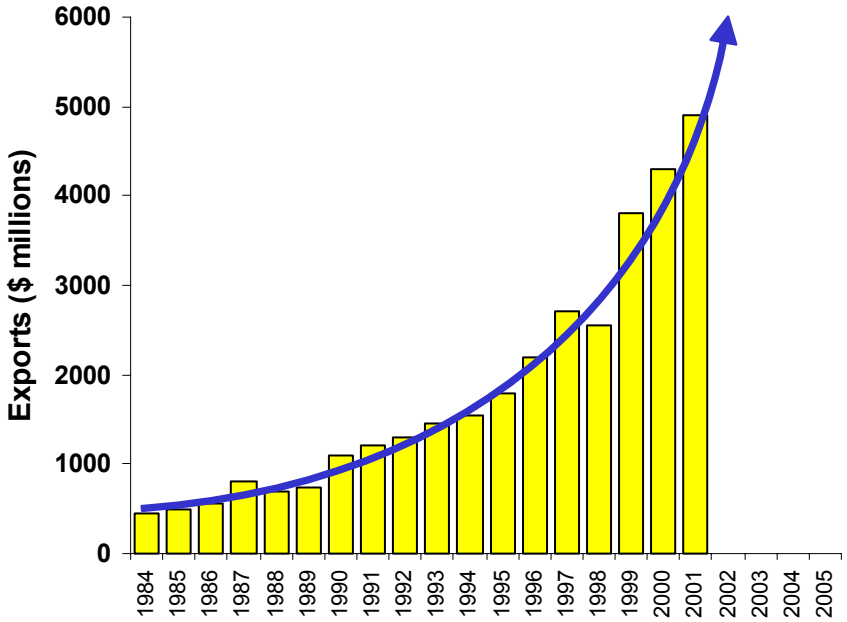

Figure 1: Australian export figures and trends

This need, amidst a national shortfall of specialised and qualified automotive engineers and tradesman, has increased the incestuous practice of companies poaching skilled labour from closely related industries, at a scale that is producing some angst and ill feeling. These industries are not necessarily competitors, but often from a common chain of contracting and subcontracting partnerships, and so the problem often shifts up and down the same supply chain.

The Australian skilled and qualified employee resource pool needs to grow. Importing skilled labour is costly (although often resorted to in desperation), time consuming and risky. It is also counterproductive for those who may seek a career in the automotive industry, but do not have the opportunity to specialise.

Australian engineering graduates are regularly recruited by automotive employers, but it is generally believed that they do not have sufficient specialised knowledge to become productive in a sufficiently short enough time frame. The following sections therefore detail some of the steps and propositions that the author is making in an attempt to address this.

The first steps towards producing specialised engineers

Formula SAE

Obviously most Australian universities that offer mechanical engineering courses show some interest in automotive applications. To complement the theoretical content, students often participate in practical laboratory sessions, or choose to be involved in design or research projects with an automotive application focus.

However, to place the vocational value of these projects and lab classes in perspective, it must be remembered that engineering is a vast discipline and that students must develop a broad range of engineering attributes to prepare them for a multitude of possible career choices. Consequently, while these methods may encourage student interest, the automotive engineering exposure is minimal and does little to prepare them for the specific engineering practices of an automotive engineering company.

One student project is, however, proving to be an invaluable exception and has won immense support and praise from the top four Australian car manufactures (Mitsubishi, Holden, Toyota and Ford). The Formula SAE (Society of Automotive Engineers) project (now regularly patronised by over sixteen Australian universities and invited overseas universities) exposes students to the realities of automotive engineering. In this project a team of students are required to raise funds, design, build and compete in a Formula style vehicle amidst strict design regulations and time constraints (
Figure 2). Students gain first hand experience in:

- working to design constraints and specifications,
- working to a budget,
- working to strict and real deadlines,
- team management,
- methods of manufacture,
- the value of modelling and prototype testing and
- the assessment of product performance against stiff competition.

Representatives from the event sponsors (Mitsubishi, Holden, Toyota and Ford) regularly tell participating students that involvement in Formula SAE is valued as highly as an initial year of on-the-job training.

While this is an encouraging step in the right direction, few universities nationwide offer a formal recognised structured program that is geared towards the specifics of an automotive engineering vocation. To the author's knowledge, and at the time of writing this paper, only RMIT offer a Bachelors Degree in Automotive Engineering. Nothing along these lines (or towards similar goals) exists in South Australia, a state rich in automotive interests.

Figure 2: The University of Adelaide 2002 Formula SAE car

A New Automotive Engineering Elective

In pursuit of the goal to improve the preparation of undergraduate students for a career in automotive engineering, the University of Adelaide has now added a final year elective subject to its fourth year curriculum – Automotive Engineering. This subject, with a strong vocational focus, is not intended to theorise, but to expose the students to specific design areas and the working practices of this engineering sector. Towards this end, industry experts (in most cases senior managers) present a series of lectures to the students. This has a number of advantages over the use of an academic lecturer, in as much as it:

- ensures an up to date perspective of current practices and relevant issues,
- allows students to empathise with experienced qualified automotive engineers,
- exposes students to their potential employers from the sector, and
- enforces that what is said, is what actually takes place.

This optional subject addresses company missions, design objectives, design philosophies, engineering practices, work-place practices, safety, environmental issues and quality assurance practices. On-going discussions with industry have, however, shown that while this subject has been extremely well received as an interim measure, their ultimate desire is for a fully recognised local automotive engineering degree program that allows proactive industry involvement. The following section therefore details the plans and proposal that the author has towards realising this requirement.

A proposed Bachelors degree program

For a university to accept a proposal for a new degree program, it must not only have a perceived value for the university, but must also be cost and time efficient as well as straightforward to implement. A totally new course structure and course content for each level would most probably be unacceptable, but also unnecessary.

As already discussed, automotive engineering has a strong synergy with mechanical engineering, and is probably best described as a specialised stream that incorporates disciplines from other schools of engineering (electrical, production, manufacturing and industrial design for example). However, the combination of these ingredients when blended, form a special brand of engineer who, while encumbered by a bureaucracy of procedures, standards and quality assurance systems (second in depth only to aerospace and military applications), will be expected to develop a high level of niche expertise while remaining creative, innovative and versatile throughout their career.

The fact that there is so much in common with a mainstream mechanical engineer and a dependence on many of the theoretical concepts that are taught in a mechanical engineering program, implies that an automotive engineering degree would not have to be too dissimilar to a mechanical engineering degree. It would however need to be tuned to address the peculiarities of automotive engineering practices and to address the directly relevant theories in more detail.

The first two (foundation) years can in fact be common to both automotive and mechanical streams. The third and fourth year would then require customisation to address specific automotive engineering requirements. To include the additional material, some mechanical engineering subjects must be sacrificed. While it may be argued that all third and fourth year mechanical engineering subjects have some relevance to the requirements of an automotive

engineer, there simply won't be sufficient time to include it all. A five-year program would not be an attractive proposition for students and as a consequence, would be poorly patronised. This apparent problem may however be alleviated with a careful choice of subjects, so that all of the required attributes of a graduating automotive student are adequately addressed.

Table 1 shows a proposed course structure for an automotive engineering degree and draws comparisons with the mechanical engineering program. Its merits include sufficient similarity with the mechanical engineering degree to permit efficient and relatively easy implementation with minimal effect on staffing and timetable disruption. It is estimated that only one additional lecturer is required. It can also be seen that a necessity to remove pertinent subjects is significantly minimised by reducing the choice that students may normally exercise for fourth year elective subjects.

Year	Subject		Points
Level 1	All subjects are the same as BEng (Mechanical)		**24**
Level 2	All subjects are the same as BEng (Mechanical)		**24**
Level 3	Thermo-fluids 2	(same as Mechanical)	3
	Engineering and the Environment	(same as Mechanical)	2
	Heat transfer	(same as Mechanical)	2
	Dynamics and control 2	(same as Mechanical)	3
	Solid Mechanics	(same as Mechanical)	3
	Design and communication	(same as Mechanical)	3
	Manufacturing engineering,	(same as Mechanical)	2
	Power train Design	(Mechanical has Eng Maths III)	2
	Vehicle Electronics	(Replaces Elec. Energy Systems)	2
	Ergonomics for Industrial Engineers	(Replaces Aeronautics)	2
		Subtotal (level 3)	**24**
Level 4 Core	Engineering management and professional practice	(same as Mechanical)	2
	Automotive Design Project (part 2)	(same as Mechanical)	8
	Vehicle Dynamics	(Additional core)	3
	Vehicle Safety	(Additional core)	3
	Advanced Design Methodology	(Additional core)	2
		Subtotal (level 4 core)	**18**
Level 4 Electives	Choose 6 units from any other elective	***Subtotal (level 4 electives)***	**6**
		Total Units	**96**

Table 1: Proposed Automotive Engineering Degree Program

Choosing these newly offered electives on behalf of the student immediately adds a distinctive automotive flavour to a mechanical degree program. Minor changes in the third year curriculum will necessitate replacing some of the existing courses, but the consequences of these will be minimal, while substantially strengthening an automotive engineering focus. Electrical Energy Systems would make way for a more specifically focused Vehicle Electronics subject. Aeronautical Engineering would be superfluous to an automotive engineer and could therefore make way for Ergonomics for Industrial Engineers. Mathematics at level III has value, but is perhaps better suited to a research focused student more so than one with an automotive vocation focus. This would therefore make way for a subject on power train design.

A significant component of the fourth year mechanical engineering curriculum is the final year project, worth one third of the final year mark. This will continue to be the case for the automotive engineering curriculum, but each project, whether research based or industry focused, must have an automotive focus. It is also planned to sub divide the third year design and communication subject (common to both streams) so that automotive engineering students consider an automotive assignment. This may be an opportunity for third years to conduct initial research for a large final year project, such as the Formula SAE (which would only be available to automotive engineering students).

The proposed structure is also intended to bring together the strengths of The University of Adelaide and the University of South Australia. Discussions with their School of Industrial Design have been initiated to explore the possibility of a joint university venture.

Student Interest in Automotive Engineering

Towards the end of 2002 and at the beginning of 2003 there was a significant amount of press coverage in South Australia regarding the successes of Holden and Mitsubishi. Coincidentally, this year's student intake in the school of Mechanical Engineering at the University of Adelaide has increased by 31% when compared to last year.

Participation in the University of Adelaide's Formula SAE project is always over-subscribed with many students disappointingly being turned away each year.

Engineering electives usually attract between thirty and forty final year students from a crop of about one hundred or so. Over one hundred enrolled in the Automotive Engineering subject.
It is clear that student interest exists. The employers' needs for specialised engineers also exist. Only the local tertiary educational programs are missing in South Australia at this moment.

Conclusion and Future Plans

The successes of the South Australian automotive industry have been briefly summarised and the problems associated with an insufficiently qualified work force highlighted. Local South Australian undergraduate students are demonstrating interests in automotive engineering, and should be an obvious target for employers. However, few opportunities exist for them to specialise and develop the appropriate skills and attributes that would enable them to become more immediately productive and hence more attractive to automotive industry employers.

The University of Adelaide has now demonstrated a commitment towards improving the relevant skills of mechanical engineering graduates with its involvement in the Formula SAE program and the introduction of a specialised final year elective. The author is now actively working towards implementing plans for a Bachelor's Degree in Automotive engineering. Discussions with interested parties will continue as will the exploration of methods and levels of funding.

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