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AUSTRALIAN MANUFACTURING INDUSTRY REGENERATION THROUGH INNOVATION

Manufacturing has had a chequered history in Australia, in 1960 it accounted for approximately 25% of the GDP now it amounts to approximately 10%.

Manufacturing has generally received bad press: the rustbelt, tariff battles, trade-union power etc... Most governments do not know how to successfully boost manufacturing. The Australian government has commissioned 40 major reports on manufacturing since the early 1970s. These reports have resulted in little improvement and further decline. The reports reflect Australian governments' concern about the industry.

Manufacturing can be defined as: The full cycle of activities from research, design & development, production, logistics and service provision to end-of-life-management.

Let us look at the impact of manufacturing in Australia:

- 34% of all exports in 2008
- employs approximately one million Australians
- largest user of R&D
- trains engineers and managers

However, Australian manufacturing has traditionally focussed on process engineering rather than R&D, product innovation and design.

Overseas Manufacturing

George W Bush's administration introduced the "Manufacturing Council" in 2004 which has 15 private-sector individuals from a balanced cross-section of industry sectors they are appointed by the Secretary of Commerce. Don Wainwright, the council's chairman stated that manufacturing remains the bedrock of the economy[1]:

- Manufacturing has retained its share of the overall economy remains (16 -19%) since the 1940s;
- Each $1 of manufactured goods sold generates $1.43 of economic activity;
- The USA supports about 15 million manufacturing jobs;
- Manufacturing's share of employment has been reduced, but that is primarily the result of productivity improvement. While manufacturing constituted 17% of the US economy from 1992 to 2000, it accounted for one third of all productivity growth;
- Manufacturing accounts for about 62% of US exports;
- Manufacturing undertakes 62% of the nation's R & D and is the primary source of innovation;
- On its own, US manufacturing is equivalent to the world's fifth largest economy.

With regard to the UK manufacturing

ON THE INSIDE

industry which is the world's sixth largest. Manufacturing accounts for 50% of Britain's exports. Productivity has increased by 50% since 1997, more than twice as fast as the rest of the economy. Also, 75% of commercial R&D in the UK derives from manufacturing. A recent EEF survey showed that 75% of companies increased their expenditure on innovation in the past three years.

Automotive Industry

The World's automotive industry has the capacity to increase output by 50% above current demand [3]. Although 2009 was a bleak year for the industry, the future is very bright as an immense global market is expected to emerge in the next 10 years. The automotive industry is becoming much more intense and the markets are far more diverse and complex than ever before.

Some Vehicle Manufacturers (VM) are already building the requisite culture of innovation. They see that "moving people" does not necessarily mean selling petroleum-powered, four door sedans around the world. Daimler & Volkswagen have defined three car categories that require the support of distinct products and services:

1. Cars for city travel, moving people short distances, not at high speeds and possibly in combination with other forms of public transportation. These cars possibly will be electric vehicles (EV).

2. Cars for regional travel, such as going to and from work in relatively suburban or semi-rural areas. The distances are longer, the speeds are higher and the desire for a permanent family car is greater. A different type of car with a non-electric drive train, perhaps a hybrid is optimal;

3. Cars for use in long-distance travel at higher speeds and carrying more people or cargo. Advanced diesel-fuelled vehicles are well suited to this kind of driving because of their low operating cost per mile and their efficiency in an emissions-constrained environment.

Let us return to the Australian industry, currently we are producing about 200,000 units a year from three motor vehicle producers (Ford, GM Holden, Toyota). These volumes indicate that Australia only needs one plant. What should happen is the three companies get together and produce the cars in one plant and re-badge them. The C21 project revealed tier 2 and 3 suppliers with expensive equipment and running at about 40% capacity. They did not have their own design capability/ IP and thus found it very difficult to sell their components to overseas companies. This is exacerbated by the strong Australian dollar and low labour costs in neighbouring developing countries. The MVPs will have to find new products and markets to survive. Having one plant would enable the retention of economic sustainability.

India is now moving into the automotive industry along with China, where labour rates are significantly less than western countries and Indian industrial giant Tata introducing the Nano at about $3,000 [4]. India and China are expected to become major sources of components.

Overall, the prospects for the Australian automotive industry do not look good in the long term.

Innovation

Innovation is extremely complex and multi-faceted and requires integrative thinking. There are many definitions of innovation. Industry Canada defines it as: "innovation is the process whereby ideas for new (or improved) products or services are developed and commercialised in the marketplace. The process of innovation affects the whole business – not just specific products, services or technologies."

There are four types of innovation: technology, process, product & service and business model innovation. The smallest return is from the process innovation and this is where much of Australian manufacturing is involved.

About two thirds of all manufacturing companies are defined by the ABS as non-innovators. Businesses in this category have not introduced any new products, services, operational or organisational processes in the past two years. The OECD state that only 7% of SMEs and 12% of large companies in Australia are introducing new-to-market product innovations. Another report, the Global Innovation Index, based on research by INSEAD business school, rates Australia at 22nd place in innovation in its 2008/09 survey. The report listed the USA as the world's top innovator, followed by Germany, Sweden, Britain & Singapore.

Design is increasingly being recognised as important for national competitiveness. David Kester, CEO of the UK Design Council (DC) got an email from a stockbroker friend in late 2008 which had the DC's FTSE design index showing PLCs that used design integrally outperformed their competitors by 200% through bull & bear markets [5].

Prosperity comes from turning real ideas into commercial realities. There are four categories of design spending:

- Technical design is used to solve technical issues (about 81% of the total design spend)
- User design considers the user interaction and aesthetics of products and services
- Promotional design of advertising and promotional activities for specific products and services
- Identity design on company identity, including branding.

Cambridge University's Institute for Manufacturing (IfM) have introduced the International Design Scoreboard. The initial ranking for the first 12 countries has the USA at number one followed by South Korea, Japan, UK and Canada[6]. Australia must apply to the IfM to be ranked as this initiative is very important for Australia's manufacturing future. We must encourage the development of more new product design companies like the highly awarded "Invetech" with 200 professional engineers and the "Bayly Design Group".

There is undoubtedly a demand for new products and markets for the above suppliers, for the many job shops with no products and SMEs with declining products. To create a new product requires disciplined market research, idea creation effort followed by product design plus the need to produce prototypes. The future of innovation will be based on internet collaboration, an existing website "IdeaConnection" buys and sells inventions, innovations, patents and ideas.

The IMechE recently conducted a study of Scotland's manufacturing industry and one of the report's major recommendations was the creation of a "Prototyping Centre of Excellence" which would support the commercialisation of R&D and design for Scottish manufacturing companies. Prototyping is a one-off manufacturing exercise and is unlikely to be commercially attractive in its own right[7].

The writer sees that Australia could follow this approach by using suitable TAFEs for prototyping new products in each state where the TAFE workshops could be manned by both recent engineering graduates from the TAFE institutes as the writer believes engineering graduates need the practical experience to make them better engineers. The graduates could spend a year in the "Prototyping Centres" and this experience would allow them to gain experience and practical application of knowledge. However, there must be a mechanism/program to coordinate the various services from the market research, ideas/concepts and design for the new products plus prototyping that Australian manufacturing companies require.

The creation of a more innovative Australian manufacturing industry will require significant government funding at both federal and state levels. The funding would include funds for market research, new product design, the employment of engineering graduates in the TAFEs, the utilisation of TAFE workshops and the supply of materials for the prototypes. Manufacturing companies should cover 50% of the costs for their new products. This could amount to about $100m but it is small when considering the support the automobile industry gets in Australia. The mechanism to do this must have innovation in it.

Future for Manufacturing

Manufacturing in Australia has gone from about 25% of GDP to about 10%. Also, manufacturing has criticised. However, the industry still performs a major role in the economy. It has major weaknesses, like the major industry automotive, manufacturing is running uneconomic volumes, and that the overall manufacturing industry is lacking in innovation. The loss of the automotive industry would create a large hole in the Australian manufacturing industry. Consequently, the manufacturing industry must reorganise itself with government help to make it more innovative.

Finally, as "The Economist" said: that innovation is "the single most important ingredient in any modern economy." ■

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Mentor with Glen Eira and Kingston City Councils

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2. Manufacturing's "Make or Break" Moment, K. Grichnik & C. Winkler, Strategy + Business 8/5/08.

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4. The Best Years of the Auto Industry Are still to come, R. Haddock & J. Juliens, strategy + Business, 25/6/09

5. Company Spending on Design, Design Council, London, 2009.

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EDITORIAL

Following several emails and comments of approval of my first issue, I shall endeavour to meet the high standards I set. One issue I did notice was that my email address was printed incorrectly, it should be: m.j.springer.03@aberdeen.ac.uk – I hope I haven't missed too many communications.

As with all publications, they can only be produced with the help and submission of articles. If there is something you want to see published or an issue you want highlighted, please send them in. Similarly, anything you want to say to your local panel or committee is appreciated. Check out the nearyou pages on imeche.org for contact details.

I hope to retain the high standards that Roshan and previous editors have set, and live up to the promises I made in my nomination form.

I always welcome more correspondence from readers. Please feel free to submit any articles, letters, notes from an interesting seminar or site visit that you would like to share. Length of the article is unimportant and photos or images are appreciated. ■

Matthew Springer

LEAVE ME ALONE, I KNOW WHAT I AM DOING!
(OR WHY SAFETY INTERVENTIONS CAN BE DIFFICULT)

A safety intervention is an action taken to stop unsafe behaviour or to remove an unsafe condition; it is a common practice in organisations with the best safety cultures.

Stopping unsafe behaviours is the more challenging of the aforementioned scenarios, as this involves challenging the way others work. Learning the correct approach helps overcome the barriers faced by someone intervening to stop an unsafe act, barriers can include:

- They are my boss so they should know better, shouldn't they?
- I don't know how to approach them
- I can't say anything; I've done the same before.
- I don't know them
- Is it worth the hassle?
- They're not going to like this

You should consider how you can best approach the person to get a positive reaction. Once they have stopped what they were doing, start the conversation with 'I' statements and open questions "I see you weren't wearing your safety goggles when you were drilling those holes. Don't they fit properly?"

Their response should be listened to and validated; this will help you understand why they are demonstrating unsafe behaviour. This step is important to build a rapport and trust with your colleague. You can then go on to explain your concerns about what they are doing "I am worried that you may get something in your eye" (once again, 'I' statements are helpful), and discuss consequences of continuing the unsafe behaviour. You should then be able to agree on a way forward that is safe. This process is sometimes known as the SAVED approach.

Stop the Action
Ask questions to understand the situation
Validate the response
Explain your concern
Decide what to do next

If you are faced by a negative response, find out why they are reacting by asking more questions "Why is doing it that way important to you?" and acknowledge any associated emotion "It sounds very stressful for you having to complete that in such a short time". The emotions must be managed to allow you to address the task, it is vital that you make it clear you are challenging the behaviour, not the person.

You should also check your own reactions, how well are you managing your own emotions? The 'heroic rule of relationship' says we are all responsible for 50% of every interaction. When we have a difficulty, we usually try to change the 50% over which we have no control – the other persons. If you want to change the outcome, change the 50% over which you have full control and responsibility and this will change the whole exchange. This self-awareness is key in improving the success of interventions.

Finally, though it is hard, do not give up if you receive a negative response. When it comes to safety, no amount of injuries should be tolerated. To put it in context, if we were to agree to 99.9% success we would have to accept for example:

- The Oxford English Dictionary containing 228 misspelled words
- Getting food poisoning once every year
- 12 newborn babies being given to the wrong parents every day

No-one would think these are acceptable, why should we think any differently regarding safety. To close I will leave with the words of the immortal Jerry Springer, "Until next time, take care of yourselves and each other". ■

Andrew Gagg
Project Engineer at KBR

ETHANOL – WHAT YOU MAY OF MAY NOT KNOW

Robin Firth goes on an exploration into the energy uses of Ethanol, through contemporary engineering history.

Ethanol is the distilled alcohol product from the fermentation of starch derived from vegetable sources such as corn, wheat, potatoes and barley etc. The well known reason for its adoption as a fuel is that it comes from renewable sources and not from fossil fuels.

There are many claims made in relation to this product, some of which are very extravagant, some ambiguous. Searching the internet for substantiation or amplification of these claims does not provide much satisfaction, this is what I found: -

The World War 2 German V2 rocket was powered by 3.8 tonnes or 4,800 litres of ethanol [1]. The ethanol used to power these rockets was derived from the fermentation of potatoes [1]. The production of this ethanol took the entire annual growth of potatoes in Germany 30,000 tonnes, equal to 38,000,000 litres of ethanol and the entire German production of oxygen. This powered 8000 V2 rockets.Hitler demanded 2000 V2 rockets a month [1].

Ethanol comprises generally 4.5% beer, 10-14% wine and 37-43% spirits. Ethanol comprises two gases of extremely low boiling point accounting for 48% ethanol's mass, and a solid, accounting for the remaining 52%, which when combined together form a liquid at standard ambient temperature and pressure [2].

35% of ethanol is oxygen, which has no energy content at all. When we buy ethanol we are paying for something which is freely available in the air.

Look at a litre of ethanol and try convincing yourself that 1/3 of that is oxygen and you're paying good money for it.

The combustion of one litre of petrol yields 2.16 kg CO2. (Or 2165 tonnes per 1 million litres petrol) [2]

The combustion of one litre ethanol yields 1.51kg CO2, (or 1509 tonnes per 1 million litres ethanol) [2].

Based on the lower calorific value of each fuel, 1 litre petrol is the equivalent of 1.59 litres ethanol. Or one litre of ethanol has 63% of the energy in petrol; Bearing this in mind, substituting ethanol for petrol results in an output of 2.4kg CO2, for the same energy [2]. Starch from a vegetable source requires modification to glucose before it can be fermented to create alcohol.

The fermentation of this glucose creates 0.75kg CO2 for every litre of ethanol produced. (754 tonnes CO2 for every one million litres of ethanol) [2].

The fuel equivalent equation now stands as follows

- Petrol creates 2165.24 tonnes CO2 per one million litres petrol.
- Ethanol creates a total of 3599.744 tonnes CO2 for the ethanol equivalent every one million litres of petrol [2]

If gas were used for the mashing of starch products and distillation of subsequent ethanol the CO2 output from the plant would be 283 tonnes CO2 per million litres ethanol produced.

The equivalent output of CO2 for ethanol replacement of 1,000,000 litres petrol would be 451 tonnes [2].

The overall end product of using ethanol produced by gas and consumed as a motor fuel results in an reduction of 1885 tonnes of CO2 compared to petrol [2].

Using ethanol to fire the plant would require the production of 2.15 litres of ethanol to for every one litre of petrol it replaces [2]. The result now is that while we have a plant that does not consume any fossil fuel in its production, the CO2 output is now 5,707 tonnes for the equivalent energy value of every one million litres of petrol

The excess CO2 produced by ethanol is 3541.76 tonnes more than one million litres of petrol in energy equivalent. We can however say that all the CO2 produced in manufacturing and combustion of ethanol is recycled back to the replacement starch sources in time. Petrol is not.

When using a 10% mix of ethanol with petrol, the power of the vehicle is reduced by 3.1%.

Ethanol Fantasies

A standard loaf of bread comprises 650g of flour starch, which after enzyme activity can be converted to glucose and from there to Ethanol. Thus it can be shown that in carbon content, one loaf of bread could theoretically be the equivalent of 0.42107 litres Ethanol

Based on 10% ethanol mix in a 60 litre tank, the proportion of energy supplied by Ethanol is 0.065. Assuming the car obtains an overall fuel consumption of 60 litres for 600 kilometres. The number of kilometres, which can be attributed to Ethanol, is 39.154 kilometres.

Thus our car does 39.154 kilometres on 6 litres Ethanol. But the starch used to make Ethanol could also have been used to make 14.25 loaves of bread.

We can therefore now say that our car will travel 39.154 kilometres on 14.25 loaves of bread. (Or 36 loaves of bread per 100 kilometres).

At A$2.50 a loaf that represents A$90 per 100 km!

Considering that, here in Australia, the driest continent; the land available for agriculture is very limited, and bearing in mind that our present drought is reducing crop output, do we convert all our arable land over to producing ethanol to put in our tanks, or do we use it for growing crops for food? ■

Robin.V.Firth

Robin has had 45 years experience in the production of Ethanol on a small scale

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2 www.users.on.net/~engineering and other web based sources

HORIZONTALLY SPLIT CENTRIFUGAL COMPRESSOR CONFIGURATION AND DRIVER SELECTION

The centrifugal compressor does not exhibit the internally induced shaking forces and complex pulsation problems of the reciprocating compressors, and therefore does not need the same massive foundation, valve (or unloader) repairs.

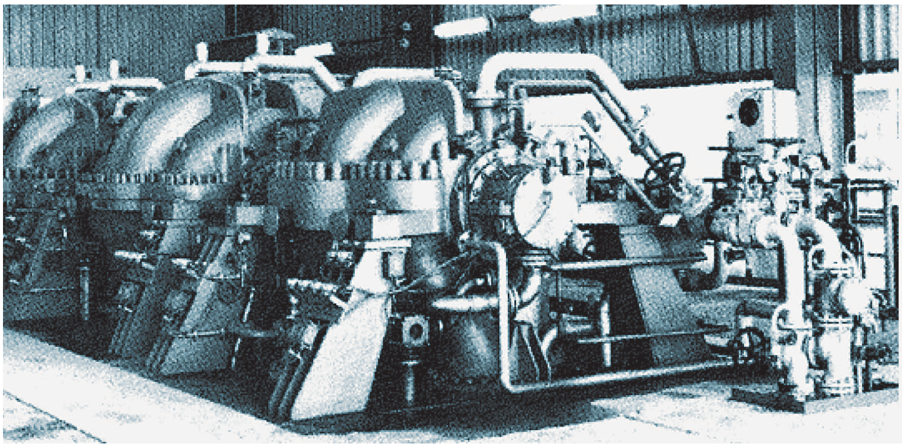
As plant size increased, the pressure to improve reliability is very high because of the large economic impact of a non-scheduled shutdown. In many modern and large size process plants, non-scheduled shutdown impact is much larger compared to the long term impact of a small decrease in efficiency. Run time between centrifugal compressor overhauls currently is around four years or more. Centrifugal compressors, because of its simplicity, reliability, light-weight, and compact design, become much more popular for use in process plants. The centrifugal compressor has been applied in an approximate range of 2000 m^3/h to 400,000 m^3/h.

Compressor Configuration

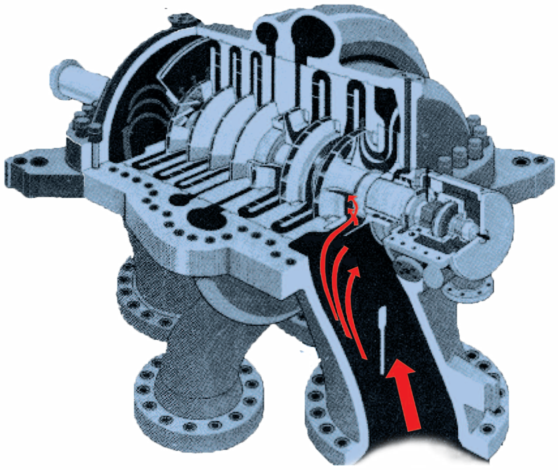
For low and medium pressure applications, horizontally split casing is common. Large numbers of horizontally split centrifugal compressors are installed in ethylene plants, lube oil plants, refrigeration, LNG units, etc. Maintenance of the horizontally split compressor is very simple and straightforward as the rotor is removed without disturbing the impellers.

Horizontally split casing major maintenance is simpler with downward piping connections, because there is no need to disturb the pipe-work when opening the casing. Inter and after coolers, as well as other auxiliaries (such as vacuum condenser for steam turbine drivers) can be conveniently located below the operating floor allowing downward piping branches.

Horizontally split compressor is typically applied below 40 Barg. However, this limit also depends on flow and gas compositions. For high capacity machines, horizontally split compressor is used for below 25 Barg.



Multi-casing horizontally-split centrifugal compressor in a modern process plant.



Cutaway view of horizontally split centrifugal compressor with downward nozzles. This machine has side streams.

The pipe loads imposed on a casing should be limited. API 617 specifies load limits around 1.85 times NEAM SM23. However, some purchasers ask higher loads even as high as four times NEAM SM23 to make piping design easier. This is not recommended and API values are usually optimum selection.

When applications are more complex than can be accommodated by single case compressor, multiple cases can be used. A popular configuration is the tandem-driven series arrangement using a common driver. Gear units may be included in the compressor train, either between cases or between the driver and the compressors.

The maximum number of compressor casings is usually limited to three. Longer, tandem-driven series connected compressor trains tend to encounter specific speed problems. At the inlet, where flow is highest, the gas stream is divided into parallel steams and the volume is reduced to a value within the specific speed capability of a single flow compressor. The alternative is the use of a speed increasing gear unit between compressor bodies to permit the flow matching of down-stream stages.

Driver

Historically, the most popular driver for the centrifugal compressor has been the steam turbine. A steam turbine, with its ability to operate over a relatively wide speed range and speed match with compressor, was ideal for the centrifugal machine.

A steam turbine is still the common driver of centrifugal compressor in some process plants (petrochemical, refinery, etc). Electric motor drives require, with the exception of very large units with high inlet flows, that a step-up gear is used. Because fossil fuel can be more efficiently converted to electricity in large central generating stations, the costs of electrical energy for motors become low enough to displace the more convenient steam turbines.

Large electric drivers using variable frequency conversion are very popular. Initial cost may be preventing universal acceptance of the variable frequency. However it is common solution for medium and large machines. Electric motors, whether speed controlled or not, are either induction or synchronous in design. Size and plant electric system requirements set parameters for motor selection. Synchronous motors normally receive consideration only for the large drivers, with the individual plant setting the minimum size at which the synchronous machine is used.

A gas turbine is selected as a compressor driver based on available fuel and plant specific requirements. It should be understood that gas turbines are relatively standardized even though they cover a wide range of power and speed. They are not custom engineered to the specific application for a power and speed match. The speeds of gas turbines are standard for a given frame. Sometimes the output speed of the gas turbine can be considered to design an efficient compressor. If not an intermediate gear will be needed. It adds the complication of another piece of equipment, subsequently higher capital cost, and potential decreased reliability. If exhaust heat recovery or regeneration is used, the efficiency of the gas turbine is quite attractive. Drivers generally shall be sized to deliver continuously not less than 110% of the maximum power required by centrifugal compressor.

Conclusion

The advance technologies have been used to provide maintainable, flexible and compact process horizontally split centrifugal compressors. Worldwide installed capacity and horsepower of centrifugal compressors in process industries (oil, gas, petrochemical, etc) are more than other compressor types. ■

Amin Almasi

Amin is a regular contributer to the News Bulletin, he is a lead rotating equipment engineer for WorleyParsons, Brisbane

FROM THE CHAIR

Greetings all. I sit writing this in the departure lounge at Perth Airport. Last night I took the opportunity of a visit to the West to deliver a paper to the WA Mechanical Branch. It is very pleasing to see across the breadth of this country, that the IMechE and IEAust (and other institutions) continue to collaborate and provide a broad spectrum of opportunities to our collective members – including the learned society activities and professional interviews.

Both Institutions face similar challenges – I recently learned IEAust have undertaken some analysis and have concluded that they have a conversion rate of only 3% from the free student memberships into fee paying membership. I have yet to ask (and perhaps should not) what that metric would be for our Institution. That said, I think it pertinent we keep a focus on the members we have, rather than ones we might have in the future.

With that theme in mind, I would seek direct feedback from our members in Tasmania. What more can we be doing to support you? Should we be allocating budget during 2012 to take forward some Tasmanian activities – and if so what and by whom? Is there a member in Tasmania who wants to lead some activities?

Similarly, in the ACT, can we envision holding a Speak Out for Engineering competition in 2012? With the ANU and the ADFA in town, there can be no shortage of young, bright engineering minds who might relish the challenge of competing for the monetary prize and honour of being the Champion.

You will read elsewhere in this bulletin of the ongoing success of the Speak Out for Engineering competition which rightly recognizes some very capable young engineers. I always reflect (somewhat tongue in cheek) that for a young engineer – the prize money on offer for a 20 minute presentation is the best hourly rate you will likely get for a while! With that thought in mind, when entries open for the competition in your Panel in 2012 – why not try your hand if you are eligible? It would be fantastic to see the champions of WA, SA, VIC, Tassie, NSW, ACT, and QLD battle it out for the nation champion title in 2013 – and why not?

I say 2013 as the 2012 competition will be held at the AGM, in Sydney on 18 February 2012. I hope this will be well attended by the membership.

Further afield, our colleagues in PNG continue to actively participate in the Institution, despite the IMechE member fees remaining prohibitively high for countries like PNG (in real terms). Professor John Pumwa has recently suggested members can assist PNG through:

- An active member who could go and present a seminar to the students and staff about IMechE activities including benefits of being a member of IMechE
- Any member who can assist in recruiting teaching staff for short-term appointment (for one year)

The University of Lae continues to work on those items identified as conditions precedent to enabling IEAust to accredit the University of Lae course. However, the process has slowed down because of staff shortage.

In other news, the structure and membership of the Australian Branch Committee for the coming years has been resolved as the closing date for nominations passed on the 30 November. I am pleased to say that the Branch will benefit from the continuity enabled by the incumbents all being re-elected unopposed. Whilst I welcome this, I do encourage those members with some time to spare (actually scratch that – few people have time to spare – more appropriately can make time) to put their hands up and actively participate in the institutions activities and driving the Institution forward here in our region.

In terms of active participation, my personal thanks to both Clive Waters and Robin Firth for their efforts in developing the applications that led to the award of the 3 Engineering Heritage Awards in Australia – and indeed, the first outside of Europe! Congratulations both for a job well done.

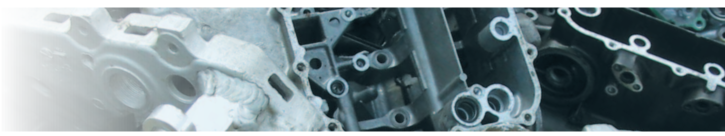
I nearly completed the Chairman's address without mentioning money – but thought the membership might be pleased to know that the Australian Branch continues to be funded at the levels we budgeted for to do our activities. Having just received my subscription reminder – I am pleased to be able to write that.

I trust you will have had a joyous festive period. But on reflection - where did 2011 go?

Cheers all. ■

Ian Marsh

HEAT TREATMENTS FOR ALUMINIUM DIE-CAST PARTS



Heat treatment has traditionally not been possible for aluminium high pressure diecastings (HPDC's) because they contain substantial amounts of entrapped gases that arise during the casting process. High pressure diecasting is a highly efficient casting process whereby molten metal is injected at high pressure into a mould cavity. When diecastings are heated to elevated temperature for heat treatment, these gases expand causing blistering and dimensional instability. The inability to heat treat high pressure diecastings has been a limitation on their further utilisation. A process has recently been developed in Australia that overcomes these problems and provides the opportunity to gain large increases in mechanical properties.

The patented process, developed in the period from 2005-2010 by the Commonwealth Scientific and Industrial Research Organisation (CSIRO), overcomes these problems and provides significant improvements to tensile mechanical properties, fatigue resistance, fracture resistance and thermal heat transfer.

The process has been evaluated with a wide range of commercially produced components. All were independently assessed as having significantly increased strength and mechanical properties after treatment. The evaluations included trials on large HPDC parts (engine blocks) of up to 40 kg weight.

The process is particularly effective in commonly used HPDC alloys, including CA313, CA605, A380, C380, A360, A383, ADC10, ADC12, and AlSi9Cu3Fe, as well as in a number of experimental alloy compositions.

Improved mechanical properties

HPDC aluminium alloy components treated with the process typically demonstrate the following improvements in properties.

Strength and Hardness is increased significantly. The yield stress of components may be doubled for little change in tensile ductility. The tensile strength also undergoes large improvements. Increasing the hardness improves both wear resistance and machinability.

Fatigue resistance is often as high as for some wrought aluminium products. This has major implications for many components, especially those used in automotive applications, which are often fatigue limited.

Thermal conductivity is increased up to 60% above the as-cast condition, meaning that for engine or transmission applications heat can be transferred or removed more efficiently and quickly. Enhancing the thermal efficiency of the metal used in housings has special consequences for electric vehicles, where the thermal management of both the motor and inverter systems is crucial to their operation, robustness and life expectancy.

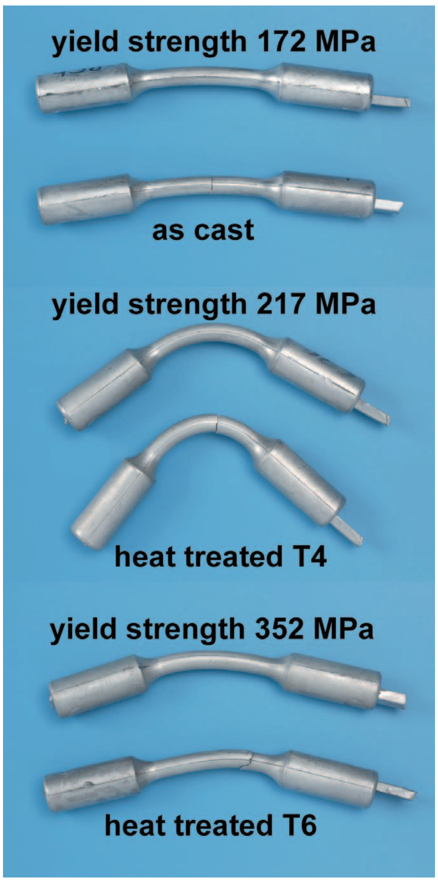
The ***high temperature strength and stability*** of the heat treated high pressure die-castings is excellent, typically showing mechanical properties at 200°C similar to those at ambient temperature. Extended testing has also shown excellent stability of properties over long term tests at 150°C. This result has particular importance for turbocharged engine applications, where the strength at temperature needs to be higher than the levels current achieved in HPDC engine blocks.

The procedure can be tailored to raise ***energy absorption during fracture***. Energy absorption has been found to almost double for some alloys heat treated specifically for this purpose. This has significant implications for crash sensitive structural components made by high pressure die-casting. A range of new alloy compositions has since been developed and patented.

Heat treatment has been shown to make high pressure diecastings able to be anodised for decorative and protective (marine) finishes. This is expected to facilitate significant improvements in corrosion resistance.

How the process works

Heat treatment of aluminium involves three steps, being 1) solution treatment at elevated temperature to dissolve elements into solid solution; 2), quenching to retain the elements in a supersaturated solid solution, and 3) age hardening at a lower temperature to develop mechanical properties. Conventional solution treatments for permanent mould or sand castings are for longer periods at high temperatures; for example, 6–12 hours at 540°C. In the new process, HPDC components are heated to relatively low temperatures for short periods of time for solution treatment; for example, 10–15 minutes at 430–480°C.



The time that components are held within a specified temperature range is critical since the solution treatment procedure can be entirely non-isothermal. This step is sufficient to cause at least a partial solid solution of soluble alloying elements such as Si, Cu and Mg.

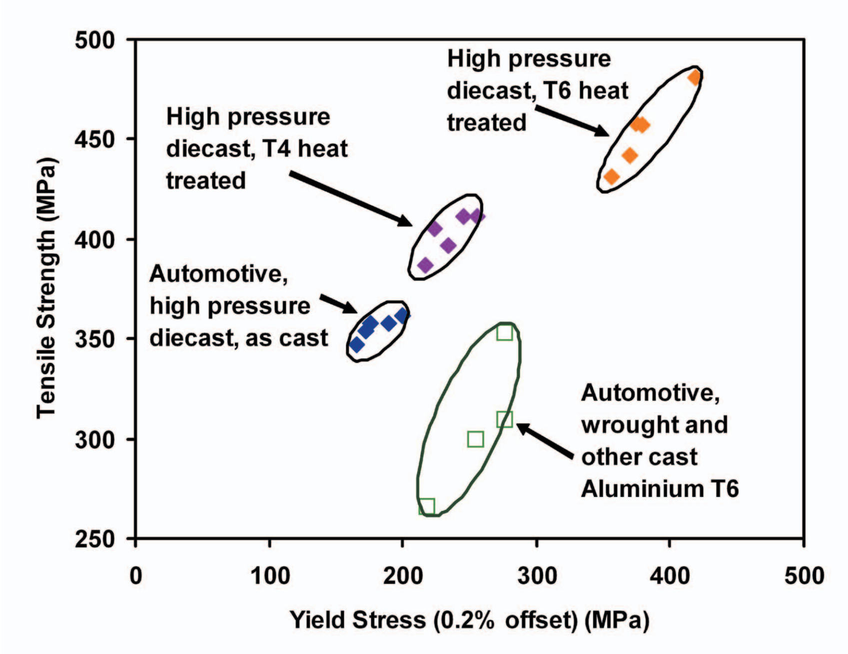
Following quenching, the HPDC component is aged to a tempered condition, such as T4 (natural ageing at 22°C), T6 (artificial ageing at 150°C) or T7 (artificial over-ageing at 200°C).

Improved material properties

In common with other age-hardening processes, the new heat treatment process depends on a precipitation hardening mechanism. Production of fine nanoscale particles within the aluminium grains provides additional strength by impeding the movement of dislocations.

Similarly, the new process improves thermal conductivity through its effects on alloy micro-structure and the distribution of alloying elements. The treatment causes silicon particles to become spheroidized, and also re-distributes the copper present in the alloy as fine precipitates within the aluminium matrix, resulting in improved thermal conductivity. In heavily overaged T7 conditions, the thermal conductivity may be increased by as much as 60% above the as-cast condition.

The process can be tailored to optimise yield strength, or to optimise fracture resistance. In general, as yield strength increases, fracture resistance goes down. T4 tempers or underaged T6 tempers produce optimum

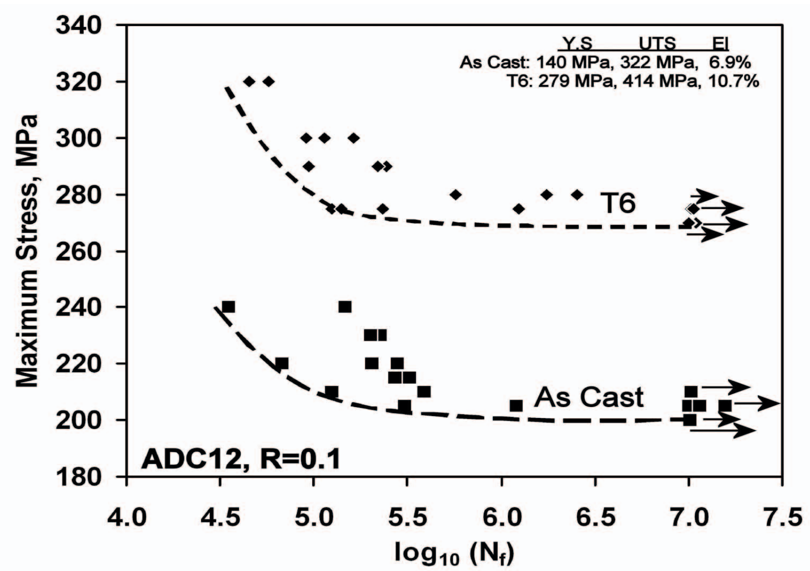


combinations of tensile properties and fracture resistance. T4 tempers for common A360 or A380 alloys (Australian Designations 605 and CA313 respectively) exhibit energy absorption during crack propagation (unit propagation energy) that is approximately doubled compared with the as-cast conditions. Underaged T6 tempers display the best combination of properties, with high strength and reasonable fracture resistance. Importantly, T4 tempers for HPDC components typically display superior fracture resistance to permanent mould cast 356 alloy (used in wheels and other safety critical applications), for similar levels of tensile properties.

A range of alloy compositions that display extraordinarily rapid strengthening behaviour has also been identified. These high pressure die-casting alloys can be treated with a complete heat treatment cycle time of only 30 minutes and develop properties superior to conventional heat treated aluminium alloys requiring thermal cycles of up to 24 hours. This has major cost and particularly energy usage implications in manufacturing processes.

Overcoming blistering and distortion

The silicon particles present in the microstructure of HPDC components are critical in preventing blistering and dimensional instability. During heating to the temperature of solution treatment they change rapidly, undergoing fragmentation and Ostwald ripening. The silicon fragments appear to pin the gas pores, preventing them from expanding into blisters until longer times.



Significance of the new process for HPDC component applications

This new process significantly expands the range of applications in which HPDC's can be used, and allows them to be re-designed using lower amounts of metal to support the same levels of load. Heat-treated HPDC components (made from recycled metal) often have superior properties to sand cast and most permanent mould-cast aluminium alloys (made from primary metal), so substitution of these castings with a lower cost, heat-treated HPDC is also possible. The process also makes possible replacement of some wrought components, particularly when loaded in compression.

HPDC is considered the most cost-effective casting process for mass production. The cost of T6 heat treatment for a HPDC component has been quoted as being approximately half the cost of T6 heat treatment for a permanent mould or sand cast product. Heat-treated HPDC components are thus substantially cheaper to produce than a heat-treated permanent mould casting or sand casting.

Reducing the amount of metal used per casting also has obvious cost benefits. If the tensile yield strength of a HPDC part is increased around 100%, then approximately 30% of the mass could be removed from the part, (taking into account design considerations, stiffness, castability etc). This means more (re-designed) components can be made per tonne of metal than was possible for the original design. Designing a component with lower mass also has a substantial effect on productivity, die design and usage of consumables. As a result, the cost per part may be substantially reduced. ■

Roger Lumley

Stream Leader: Light Weighting, CSIRO Future Manufacturing Flagship

PANEL NEWS

NSW NEWS

The NSW Mechanical Chapter have had some recent popular technical presentations in conjunction with EA and ASME.

In August, Rosie Hicks, CEO of the Australian National Fabrication Facility and A/Prof. Michael Withford, Director for the MQ Photonics Research Centre presented on "The Australian National Fabrication Facility – What can it do for me?" Rosie opened this presentation by overviewing the flagship facilities and capabilities spanning the east to west coast of Australia. In the second part of this presentation A/Prof Withford reviewed activities within the ANFF-Optofab Node with an emphasis on local (Sydney based) microfabrication highlights and industry success stories.

In September Chris Turner, the State Coordinator for Engineering Advice with WorkCover NSW. Presented on the topic "The new Work Health & Safety legislation for 2012: What does it mean for you?"

There are currently nine different work health and safety (WHS) laws across Australia. In NSW, the new Work Health and Safety legislation will become effective on 1 January 2012 and affects engineers as employers, employees and how engineers perform their work day to day. In this presentation, Chris Turner discussed the major changes in the work health and safety law and regulations and their practical effects in engineers' workplaces, as well as the specifics for pressure vessels.

In October the NSW Speak Out for Engineering competition was held in Chatswood. Two excellent papers were given. Firstly Nathan Boland, who is just completing a Mechanical Engineering Degree at the University of Wollongong, gave a lecture entitled "Engineering the Perfect Brew", which described the whole process from the coffee "bean" growing to being delivered in a cup as part of our morning ritual. Nathan explored the trends in coffee types, the processes involved, and the tips for that perfect brew. The result of the paper was the Chairman of the Australian Branch desperate for a cup, and a plethora of questions from members asking for advice in improving their own home coffee machines, and also the processes behind decaffeinated coffee making.

Secondly Rupam Bandopadhyay, a student in the final year of an MEng at the University of Sydney, provided a paper entitled "Application of EMI Sensing Technique in Aircraft and Civil Engineering Structures". Rupam first described some of the problems with existing sensing and measuring techniques and highlighted the commercial limitations of such techniques. Rupam also looked at the advantages and disadvantages of both traditional testing and Piezo-Electric (PZT) sensing. Rupam then went on to describe PZT sensing, before looking at applications where this can be used.

Following the papers, Ian Mash gave a short presentation including some fine educational photographs of the misfortunes of people who don't think like engineers…

I am pleased to announce that Nathan won the competition with a score that just crept in above Rupam. Both are to be congratulated on their tremendous efforts. Nathan will now go on to compete in the Australian National Finals being held in Sydney at the IMechE AGM.

Monika Sud
NSW Panel Chair

QUEENSLAND NEWS

During the weekend of 27th and 28th August, the Queensland Panel was pleased to host the Australian Branch Executive Committee in Brisbane. Ian Mash led the committee on discussions surrounding many topics. It was a good chance to catch up with the committee since our last meeting in Perth in February.

The Queensland Panel organised a Student Evening at the University of Queensland in October to introduce the IMechE to 4th year students and provide an idea of what life was like after graduation. Our Panel Secretary, Roger Buckley gave a presentation on his experiences and provided an introduction to the IMechE. His presentation entitled "Engineering - a Personal Journey by Plane, Rocket, Building, Car and Train" was well received; many students staying back after the presentation, keen to ask about the benefits of membership.

The Queensland members of the IMechE were fortunate to be able to join Engineers Australia on the 12th October at its annual dinner, and to listen to Ms Dianne Boddy speak of her Engineering experiences. Not formally educated in engineering in the traditional sense, she described her experiences in the "school of hard knocks" and impressed the audience with her numerous designs and patents in what were quite complex process machinery. She even brought and demonstrated a model of her design for 4WD vehicles.

Two interviews were completed for Associate Members wishing to transfer to Corporate Members. The Panel wishes them success in their application.

The Christmas Function for the Queensland Membership was held at the Dick Johnson raceway on 10th December. Many enjoyed the day at the raceway. As 2011 draws to a close, the Queensland Panel would like to wish all its members good fortune and good engineering for 2012.

Leslie Yeow
QLD Panel Chair

VIC NEWS

The Victorian Panel Speak out for Engineering was held on 21st October. Three students made presentations to an with a panel of four Judges - Patrick Russell-Young, Bill Swinson and Brian Carter from the IMechE, and Paul Walker from the personnel area of the CSIRO.

The first speaker was Mr Vignesh Arunachalam from the Swinburne University of Technology his presentation was entitled "Analysis of Automotive side intrusion beam and possibility of using composites".

Victorian Panel SofE contestants (L to R) Tian Xue Ting (Jacquelynn), David Kong and Vignesh Arunachalam.

He outlined a series investigations aimed at replacing the steel side intrusion protection reinforcement in motor vehicle doors with a lighter alternative made from carbon fibre composites which could help improve the performance of the beam during high speed impact. The investigation was done using LSDyna a transient finite element program used to model behaviour in high speed crashes.

The second speaker Mr David Kong from the University of Melbourne spoke of work he has done in connection with the formation of titanium components with a presentation entitled "Titanium Powder forging-an inexpensive approach to titanium manufacturing". Titanium is widely used in aerospace industry due to its light density but incredible strength and corrosion resistance. The downside of using titanium is the high cost associated with its extraction and forming. Mr Kong described how he investigated the likelihood of forming titanium components directly from titanium powder with similar mechanical property but reduced cost compare to cast and wrought bulk titanium made from current processes.

The third speaker Ms Tian Xue Ting (Jacquelynn) an undergraduate student at the Royal Melbourne Institute of Technology University, spoke on the "Mechanical Properties of a Slotted Log Spiral Conformal Load Bearing Antenna Structure". The slotted log spiral antenna is a special class of antenna which has the advantage of being frequency independent. Worldwide Research is investigating various concepts of conformal load bearing antenna structures to make them a reality on aircraft and unmanned vehicles due to the numerous advantages that these multi-purpose structures can bring. Some of these advantages include reductions in signal penalties, drag and improvements in structural efficiency and hence the range. Finite element analyses and experimental validation for various composite slotted log spiral configurations were described.

All presentations were professionally made, and the audience posed a series of searching questions which were confidently handled. In due course the results were announced Ms Tian Xue Ting being awarded first prize and Mr David Kong second prize. The judges congratulated all three contestants on the quality of the visual material used to support their presentations. Ms Tian Xue Ting will proceed to the Australian Competition in Sydney.

The Victorian Panel had their annual dinner at Coopers Inn, Melbourne with an after dinner presentation on the use of the Medical Beamline at the Australian Synchrotron which complimented the visit to the Synchrotron by our retired members group.

We also organized a return technical presentation by Mr Andrew Lezala CEO of Metro Trains, who reported on progress in improvements to the "Met" Melbourne's public rail network. The System comprises 15 lines with 212 stations and 3700 employees servicing more than 200 million customers per year This presentation attracted a large audience and there was an extended question time following.

A photograph appears below of all contestants on the night.)

J.W.Burt
VIC Panel Chair

SA NEWS

The year of 2011 is coming to a close and finishes with a successful Speak out for engineering competition in Adelaide. For the first time we had four speakers and all presentations were of a very high standard. Two speakers were students from both the University of Adelaide and UniSA. Jack Lowe, a first year mechanical engineering student from Uni SA, won the night with a very good presentation closely followed by Amelia Greig, a final year student from the University of Adelaide. Jack will now go on to represent South Australia in the national finals early next year.

Towards the end of this year the SA panel received news, that Engineers Australia would withdraw its participation in the SA Joint Technical Program with immediate effect. We are yet to interpret and evaluate what exact impact this will have on IMechE members in South Australia to undertake their CPD component, but I am delighted to report that the events that have already been organised by the IMechE for 2012 are still to go ahead and event flyers will be distributed closer to the dates. The SA Panel will also keep the local membership informed of any future collaboration with our sister organisations from EA, RAeS and IET.

Finally, it is my pleasure to report that the preparations for the traditional New Year's lunch are well underway and scheduled to be held on Sunday 5 February 2012.

Michael Riese
SAPanel Chair

YOUNG MEMBERS PANEL NOTICE

Free Cookies! Beer! Pizza!

Now that we have your attention, we at IMechE would like to let you all know about a fantastic opportunity. We are seeking some enthusiastic, young and driven people who have an interest in Mechanical Engineering (or are involved in it) to help fill positions within our Young Members Panel.

No real experience sitting on a panel is necessary! All that you needed is a positive attitude, a will to meet with other likeminded individuals on a semi-regular basis and a need to show how great Mechanical Engineering is.

How can you get involved? Simple! Just get in touch with a state rep via the contact details below and they'll be able to fill you in with what's going on in your area.

SA – Brian McAvaney
SausPublicity@imechenetwork.org

VIC – Matt Springer
m.j.springer.03@aberdeen.ac.uk

QLD – Belinda Herden
Belinda.herden@se1.bp.com

What are you waiting for?
Oh? The free stuff promised above?
Well, join up and we will see what we can do…

BRAIN POWER

The general public's personal awareness of engineering tends to be confined to transport matters – hardly at all surprising, given that motorcar ownership has increased from 30 people per car in the 1920's to not much more than one adult per car today. Similar data applies to trains – and their speeds – and to air travel.

All this did not exist a mere 200 years ago; we had only the horse-drawn vehicle on land, wooden sailing ships on sea and nothing except a few short-lived hot air balloons in the air.

Relate this to the existence several thousand years ago of civilisations that built large permanent masonry structures. These would have required a fair amount of geometric knowledge, and a managerial expertise not far short of many present day projects.

However, their transportation was no better than that noted above. Why? How did our explosive development occur?

The adjective explosive is most suitable. Explosives consist of macro- or molecular mixture of oxidising and oxidisable agents, plus some form of detonator. Now it was the latter that was missing to the ancients, since the raw materials and the energy sources were there to be dug up.

Let us be conceited. What they lacked for a detonator was the collective brain power of engineers and scientists.

There is a vital message for us in this story, relating to the quite certain future lack of the key to our civilisation – oil. Realistic alternatives must be found. The "Detonator" will still be brain power, at a level yet to be achieved. ■

MX START

This program has been designed to enable manufacturing companies to improve and increase their competitiveness by providing a process to:

- Enable companies to benchmark their current status;
- Identify the areas that are most important to their specific business;
- Identify priority areas for improvement;
- Provide feedback about what best practice would entail;
- Link to best practice resources.

This program is based on the best practices from the top British & German manufacturing companies and comes from the collaboration of IMechE MX (Manufacturing Excellence) program and the International Manufacturing Centre, University of Warwick (UK).

All businesses are different but they all have common core activities/processes which must be managed correctly:

1. Customer Focus
2. Business Development
3. Product Innovation
4. Logistics & Resource Efficiency
5. Process Innovation
6. People Effectiveness
7. Financial Management
8. e-Business

To assess a company requires an experienced business/engineering/manufacturing advisor to help companies do the assessment.

The fee is modest + travel expenses. Contact Bill Ferme FIMechE for more information bferme@bigpond.net.au.

Currently, this service is only available to Victoria.

WORD SEARCH

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aluminium australia branch centrifugal chairman compressor engineer manufacturing mechanical out panel safety speak start strain train volunteer vulcan young

COMMITTEE NOMINATIONS

Following the call for nominations for positions in the Australian Branch committee, no post went opposed. So there will be no vote required at the AGM.

Institution of MECHANICAL ENGINEERS

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Clive Waters
Ken Tushingham
Dayaratne Dharmasiri
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