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Servicing Manufacturing, Industrial Engineering and Engineering Societies

In this Issue

- Leadership in IE
- Innovation in Manufacturing
- MOST® Work measurement
- Inventory Control and Lean
- Car Industry and Culture

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Contents

Front Cover: Photo is the assembly and inspection of high quality tap-ware at Enware Australia in Sydney. Enware, a progressive Australian company, continues to provide new plumbing solutions and excels at the innovation of both process and product.

FORMAL PAPER REVIEWS
Leading papers published in this Journal are usually fully refereed. This service is available through the **New Engineer JOURNAL**. Papers which are to be fully refereed for formal publication may be submitted at any time.

Good Leadership: key to society's success

This addition of **New Engineer** features the traditional opening address of the Federal President of the IIE in the first of its pages but, in this instance, also serves as a lead-in article on a major theme tending to run through many of this edition's follow-on pieces: leadership, and in particular, the importance of effective and efficient actions taken by leaders of some of society's most significant organisations in times of organisational crises.

Daniel Kulawiec in his opening address states that traditional IEs are often too reserved in their current leadership roles but, at the same time, are probably best qualified to play a much more significant leadership role within society. Natural leaders within the ranks of the IIE he cautions, however, must first be recognised, encouraged and then developed. He sees the IIE having a real on-going responsibility in this area.

Bill Ferme addresses the importance of product innovation in his article on Australian Manufacturing and how support at a National level appears to be a key in achieving superior national results. He proposes a TAFE-based approach to the nurturing of the innovation spirit among new graduate engineers.

Chin Wong makes another contribution to *New Engineer* by providing an informative look inside the work measurement system: MOST. This system is reported to enjoy wide acceptance within the Japan, China Asia Pacific region.

John Blakemore presents the essence of a case study involving an ABC approach to final product classification and the use of appropriate strategies to significantly reduce inventory costs within a traditional ERP manufacturing environment. He also contributes a piece on the Honda manufacturing company and its unfailing adherence to quality control and the subsequent benefits Honda and its customers continue to enjoy.

Brian Jenney presents a timely review of the recent Toyota crisis. His historical perspective (as always) provides for interesting reading on the background development of Toyota, and how a better focus on reliability engineering could possibly see the return of the pre-eminence of the Toyota brand.

Dr Patrick Moriarty's article on 'changing the car culture' also provides a timely reminder of how embedded the automobile is in our society. In an informative and a well evidenced article, 'Paddy' cautions that economic growth may not be able to continue without serious curtailment of our 'love of car travel'.

Finally, we return to the issue of leadership, and Lex Clark takes a military Vs. civilian look at the issue. He highlights the fundamental differences in approach to the nurture, and development of leadership in both spheres and summarises with some common sense 'do' and 'don't' dot points that are a useful and timely reminder to us all.

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YOUR CONTRIBUTIONS ARE WELCOME

Some Suggestions are:

- Ask the speaker at your regular member meeting for a copy or notes of his or her talk and send the draft to us to provide wider readership.
- Ask your colleagues for a written statement – long or short – which will inform or interest your fellow readers. Send some of your publicly available brochures and information kits to our editor for the information of your fellow members and to increase interest in your firm's products and services. Pictures are welcome: personalities, processes, plant and offices to show you are a positive developing unit within your industry
- Dash off an Email to us about your view of areas you would like us to include in **New Engineer** to stimulate industry improvement and innovation.
- See that someone is delegated at each plant visit to report on the visit for the benefit of fellow members in other states.
- Tell of success stories and policy statements of wider implication for our readership.
- Provide your personal observations from overseas visits and conferences, apart of course from your organisation's confidential data, to help readers keep up with the global economy

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Industrial Engineering in the year of Engineering Leadership

The year 2010 has been declared the Year of Engineering Leadership by Engineers Australia. It is a time to recognise our leaders and reflect on the role our members can take in both their local and global communities. In this way it is valuable to spend some time considering how Industrial Engineering fulfils the leadership ideals of the engineering profession.

Engineers Australia lists three key areas in which engineer's leadership abilities should be evident. Let's review each in turn (I have taken the liberty of inserting 'industrial' into the wording to make it more relevant)

1. *The industrial engineering team are leaders in providing sustainable solutions to society's challenges.*

This statement challenges us to examine the role our profession plays within the societies that we operate. Do Industrial Engineers take on leadership roles in the general community? My observation is that we tend not to be community leaders, even if many of our colleagues are leaders within their own organisation. Why is this? Industrial Engineers focus on the mechanics of organisations and processes. We look at the utilisation and efficiency in the way processes work to achieve a given outcome. We tend to be more focused on the how, rather than the what. As professionals we achieve a sense of satisfaction when the environment we are working on, and the resources employed, have been tuned to achieve optimal results and minimal wastage.

As such the Industrial Engineering professional does not typically take the role of proclaiming future visions in the public domain, or erecting public facilities. Our sphere of operation is normally behind the scenes delivering on a specific outcome.

Should this be a matter of concern? Should we, as professionals, seek a broader role in society? There is a good argument to say that the skills we possess and have developed can assist a civilised society operate more efficiently. And at the present time, efficient utilisation of resources is recognised as an important issue on a global scale. On this basis it could be argued that the time is right for the principles that underpin our practices can be applied to guide the thinking of our government and community at large. This would be the time for the natural leaders from our profession to emerge and have this discussion on the public stage. We may not call it Industrial Engineering, but for our members we would recognise it as such.

2. *Industrial Engineering is identified as the career for people who want to become leaders of the future*

In contrast to the first item, I would like to consider this statement in the context of the immediate organisations and environments in which we operate. Does Industrial Engineering equip it's practitioners with the skills required to be a future leader? I would fully support this statement. I consider that one of the strengths of our education and approach is that it trains our graduates to gain the best outcome from a given set of resources. This is a standard management dilemma. Other skills gained include cognitive thinking, problem solving, organisational design, communication and implementing change. The scope of study covers everything from technical to financial, logistics to quality. These are all skills that are valued by today's modern manager.

Another way to approach this is to ask the question - for a young graduate seeking to make their way to senior management, what course of study should they pursue? The typical option would be to go down the economics or commerce path. But this results in a very limited style of management. So which course is best adapted for a broader experience while still providing the opportunity to foster and develop managerial skills? Disciplines such as law, accounting, HR and marketing are all extremely focussed and don't permit the student to experience all aspects of an organisation. On the other hand Industrial Engineering's very core is to harness all the elements of an organisation to delivering a defined outcome.

The key obstacle for most Industrial Engineers is that they apply their profession at a micro level. The focus is on a specific production line / operating team / business process etc. It is important to realise that organisational leadership requires the thinking to occur at the organisational level. The organisation must be considered as the ecosystem that we are trying to optimise for the shareholders. This allows us to start to identify the way cash and financial flows represent the information and physical resources used in reality. If we can manage the financial dynamics to achieve the stated objectives of the company then we will be seen as leaders of the organisation.

3. *The Institute of Industrial Engineers is an organisation that fosters and develops engineering leaders through out all stages of their careers.*

Lets take this statement to refer to the life-long association the Industrial Engineer has to their professional body (IIE) and their peers. Do Industrial Engineering leaders emerge in this environment? Absolutely! For an example one only needs to refer to the list of Honorary members of our institute. This list reflects members that have provided years of service and leadership to the Institute, it's members, and the profession of Industrial Engineering. We have a proud history as presented in the recent 50th Anniversary edition of New Engineer.

Are the next generation of Industrial Leaders being identified and taking on these roles? Unfortunately if they are, we are not seeing or benefiting from this within our own organisation. This is unfortunate as I have the opportunity to work with recent graduate Industrial Engineers and they have a lot of skills, enthusiasm and new ideas to offer. And this is the time that our profession needs these members to take on a more active role. We are at a point in which Industrial Engineering no longer is being offered as a course at our Universities under it's own title. The term is becoming less relevant to industry in general (even if the disciple is being called on more and more often).

If we look inward into our own Institute we also see an unsustainable situation emerging in which the same loyal, yet limited, group of members are doing their best to support the organisation. Without the next generation of leaders taking a more active role, the ability for the Institute to have a positive influence for it's members and the industry-at-large is limited.

I am keen to be challenged on any of the views I have presented in this article. Please write to me with alternative perspectives to any of these items – we could publish these (with permission of the author) in future editions. It would also be good to provide biographies of any current or past members that have demonstrated examples of strong leadership in their careers for future editions of New Engineers. These can be sent to either myself or the Journal Editor.

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Australian Manufacturing Industry Regeneration through Innovation

W.D.Ferme, MBA. M.Sc. C.Eng., FIMechE

1. Manufacturing in OZ

Manufacturing has had a chequered career in Australia as in 1960 it accounted for about 25% of the GDP now it amounts to about 10%. Manufacturing has generally had a bad press: the rustbelt, tariff battles, trade-union power etc. Generally, most governments do not know what to do with manufacturing and this produced about 40 major reports on manufacturing since the early 1970's with little improvement and continual decline! The many 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: contributes to exporting (2008 about 34%) of all exports, employs about a million Australians; biggest user of R & D (31% of all R & D); a manufacturer of automobiles which is important for generating technology (23% of all manufacturing R & D), training sophisticated engineers and managers. However, Australian manufacturing has traditionally focussed on processes rather than R & D, Product Innovation and Design!

2. Overseas Manufacturing

George W Bush's government introduced the "Manufacturing Council" in 2004 which has 15 private-sector individuals from a balanced cross-section of industry sectors and who are appointed by the Secretary of Commerce. Don Wainwright, the council's chairman stated that manufacturing remains the bedrock of the economy; and manufacturing remains the most vigorous in the world:

- Manufacturing's share of the overall economy remains where it has been – in the 16-9% range – since the 1940s;
- Each $1 of manufactured goods generates $1.43 of economic activity;
- We support about 15 m manufacturing jobs and another 8m jobs in other sectors;

- Manufacturing's share of employment has been reduced, for sure, but that's primarily the result of productivity increases. While manufacturing constituted 17% of the US economy from 1992 to 2000, we accounted for one third of all productivity growth;
- Manufacturing accounts for about 62% of US exports;
- We undertake 62% of the nation's R & D and are the primary source of innovation;
- On its own, US manufacturing is equivalent to the world's- fifth biggest economy.

French President Nicholas Sarkozy, upon being elected, vowed to protect his nation's industrial base.

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

3. Automotive Industry

Currently, the World's automotive industry has about 30m vehicles capacity in excess of the 60m vehicles demand in a good year. Although 2009 was a bleak year for the industry, the future is very bright as there will be an immense global market which will emerge in the next 10 years. The world 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 intracity 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). Already there are 12 EVs on the market;
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 companies instead of about 400,000 in good times. These volumes indicate that Australia only needs one plant. What should happen is that the three companies get together and produce the cars in one plant and re-badge them to their marques. 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. They will have to find new products and markets to survive. Having one plant would keep some of them in business. India is now moving into the automotive industry with China where labour rates are significantly less than western countries and with India introducing the Tata Nano at about $3,000. Also, India and China will be major sources of components. Overall, the prospects for the Australian automotive industry do not look good in the long term as large VMs are noting the introduction of inexpensive cars into new markets.

4. Innovation

Innovation is extremely complex and multi-faceted and requires integrative thinking. There are many definitions of Innovation. Industry Canada provides a good one: "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 and Service and Business Model innovation. The smallest return is from the Process innovation and this is where much of Australian manufacturing is involved.

Terry Cutler who was responsible for the recent" National Innovation Review" said he was shocked at the poor state of innovation in Australia. About 2/3rds 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 @ 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 e-mail from a stockbroker friend in late 2008 which had the DC's FTSE design index showing that PLCs' that used design integrally outperformed their competitors by 200% through bull & bear markets. 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: considers the user interaction and aesthetics of products and services;

Promotional design: design of advertising and promotional activities for specific products and services and Identity design: design on company identity, including branding.

Cambridge University's IfM (Institute for Manufacturing) have introduced the International Design Scoreboard, a framework for ranking nations that consider design at a national level as a system comprising enabling conditions, inputs, outputs and outcomes. The initial ranking for the first 12 countries has the USA at number one followed by South Korea, Japan, UK and Canada. Australia must apply to the IfM to be ranked as this initiative is very important for Australia's manufacturing future. This means that we must encourage the development of more New Product Design companies like the highly awarded "Invetech" and the "Bayly Design Group".

There is undoubtedly a demand for new products and markets for the above C21 suppliers and for the many job shops with no products and SMEs' with declining products. To create a new product requires a disciplined market research, ideation effort followed by product design plus the need to produce prototypes. The future of innovation will be based on internet collaboration which has been described as an Ideagora which is creating an eBay for innovation. An existing web-site is "IdeaConnection" which buys and sells inventions, innovations, patents and ideas.

The Institution of Mechanical Engineers (IMechE) (UK) recently did 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.

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 universities as the writer believes engineering graduates need the practical experience to make them better engineers, and staff and students from the TAFE colleges. The graduates could spend a year in the "Prototyping Centres" and this experience would make them better engineers. 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 take 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 beer when considering the support the automobile industry gets in Australia. The mechanism to do this must have Innovation in it. The poorly named "Enterprise Connect" program should be renamed to "Manufacturing Innovation" and the program reorganised to be more focussed on new product generation instead of manufacturing processes. This means that there should be a new adviser in the program, a "Design Associate/ Mentor", who will be a cross between a business consultant and a designer (engineering/industrial) who will advise a company how design can be used to create new products. Unfortunately, we have a glut of manufacturing Lean consultants but not Design Associate/Members.

5. Future for Manufacturing

Manufacturing in Australia has gone from about 25% of GDP to about 10%. Also, manufacturing has had a bad press where it has been called the rustbelt. However, the industry still performs a major role in the economy. It has major weaknesses like the major industry, the automotive, is running uneconomic volumes, and that the overall manufacturing industry is very weak in innovation. The loss of the automotive industry would create a large hole in 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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MOST® Work measurement

System For Lean Applications – by Chin Hak, Wong
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Introduction

The MOST® Work measurement System is one of the most efficient and economical work measurement tools available today. It was developed by Kjell B. Zandin of H.B Maynard Inc, now becoming a part of Accenture LLP.

Today, MOST® is used widely in almost all the multi-national manufacturing operation throughout the world. MOST®'s widespread use began in 1988 when H.B Maynard launched the product in Europe, North America, Japan and the Asia Pacific region. Today, the total number of certified MOST® users is increasing rapidly, especially in the Japan-China-Asia Pacific regions.

Difference between MOST® and MTM

What essentially is the difference between MTM-based systems and the MOST® System? First of all, I must acknowledge that MTM-1 and MTM-2 systems are indeed the database foundation of the MOST® System. From MTM-1, the MOST® System derives the Basic Construction Pattern of a natural task unit of work, which is

Natural Task Unit of Work Performed By A Worker = Reach + Grasp + Move + Position + Release

The MOST® System, however, advances the above motion pattern into a work sequence called the General Move Sequence as :

ABG ABP A

A	=	Action Distance of fingers, hand reach and walking step
B	=	Body Displacement, as measured by referencing to the knee-level
G	=	Get to obtain complete control of the object by the hands
P	=	Placement of objects to a specified position/location
A (last)	=	Return action of the hands or to walk back to original position

The General Move Sequence – ABG ABP A

The above General Move Sequence is one of the many Activity Sequences that are being applied in the MOST® System structure. In order to convert the above Activity Sequence into measurement, each of the Activity Parameters,

ABG ABP A

are indexed according to the actions required. For instance,

A_3	B_0	G_3	A_6	B_6	P_3	A_{10}
Walk 2 Steps	No Body Displacement	Get Heavy Object of 10 kg	Walk 4 Steps	Bend Down And Arise	Place With Several Adjustments	Return to original position with 5 Steps

When all the index numbers are added up (31 in the above example) and multiplied by 10, the above activity sequence provides 310 TMU (Time Measurement Unit, 100 TMU = 3.6 seconds). The above activity sequence analysis would normally take an experienced MOST practitioner less than 1 minute to develop the standard time of 11.20 seconds with a defined performance level of about 82 BSI (100 BSI being equivalent to a walking speed of about 4 MPH or 6.4 KPH)

Kjell B. Zandin – The Inventor of the MOST® System

According to the inventor, Kjell B. Zandin, whom I met in 1988 at the Pittsburgh office, the parameters of the MOST® System were modeled close to the MTM-1 system, while the MOST® System of Index Value was constructed on a statistical basis based on the nature of human work using the MTM-2 System. In order to prove the point, I validated the MOST® System time, using MTM-2 for the same activity as described above. This of course, takes into considerations, the allowance for some variation of work and the definition for both MOST® parameter index values and those of MTM-2 elements.

Sample MTM-2 Analysis

1. Walk 2 Steps	S X 2	=	36 TMU
2. Get Heavy Weight 10 Kg with 2 Hands	GB30 + GW5	=	14 TMU
3. Lift Heavy	PA30 + PW5	=	12 TMU
4. Walk 4 Steps	S X 4	=	72 TMU
5. Bend Down And Aside	BD + AB	=	61 TMU
6. Put Adjustment Heavy Weight	PC30 + PW5	=	31 TMU
7. Walk Back 5 Steps	S x 5	=	90 TMU

The time Variation Is Small

From the comparison above, it can be observed that the difference in time (6 TMU) for the same activity, when verified with MTM-2 is small. Allowing, for some slight variation in the human work methods, over a system balancing time period, of about 2.0 minutes for the MOST® System and about 1 minute for the MTM-2 System, it can be verified that the MOST® System's accuracy vs that of the MTM database is close to within ±5% or better. From my 20 years' experience in applying MOST® in diverse situations, the MOST® System achieves ±5% accuracy when there are variations in the method for short cycle operation; or when an operation cycle approaches 2 minutes and more.

Advantages of using the MOST® System

The advantage of applying the MOST® System will be considerable when it is necessary to determine the workload in standard man-hours required in completing a given defined work task. For example, what is the average standard hours that would be required to pick up parts of varying weight from a warehouse where walking, pulling, pushing, selection and inspection activities are involved.

Although, MTM-2 can be used to analyze the defined motion patterns, it would be too time consuming to apply. With the MOST® System, the speed of application is 10 times faster than MTM-2; the advantage is quite obvious. The other advantage is the analysis could be completed with only a few sequences to manage the picking activities, while MTM-2 practitioners will have to laboriously go through the motion of analyzing the picking of the parts with weight, distance and size variations. In situations of short and repetitive cycles, with minute finger motions (as in detailed assembly work), MTM-1 and MTM-2 applications are useful. For this short cycle repetitive work, Accenture offers the Mini-MOST® as the MTM-1 equivalent alternative.

Application To Value Stream Process Improvement

Today, with the emphasis on making Value Stream Improvements, the MOST® System can be efficiently used to enable an industrial engineer to analyze the operational sequence of a machine and process for multi-machine operations for workload balancing on a production line. MOST® System applications can be extended upstream to configure the design of machine or workstation to achieve the optimal man-machine time for productive work design.

The downstream application of the MOST® System includes conducting Kaizen Production Studies during which a new improvement method is applied against an existing inefficient method. The time saving from the Kaizen Production Study can be estimated quite accurately even though the existing method is undergoing re-design.

Lean Machine Design is becoming increasingly popular when the Right Size Design for a machine is put to the drawing board. With the MOST® Technique, engineers can quickly determine the following elements of machine / processing operation:

1. Unload
2. Load
3. Set Switches
4. Close The Machine
5. Run The Machine

The machine designer can then determine the number of workstations or the number of fixtures to be worked upon during the machine cycle time. With MOST® Analysis it is possible to develop a number of improvement designs for the activities mentioned above with the main objective of achieving a short machine operation cycle time.

Make-To-Order Product And Services

The quality principle of "Do It Right The First Time" can be attributed to all of the industrial engineering work measurement tools, such as MTM, MODAPTS, MOST® etc. In many manufacturing organizations, having an ability to closely estimate the process production cost is an important factor of the New Product Management process. This is where MOST® has a key advantage here. It is fast to apply, systematic in analysis, easily adaptable to all kinds of variation in processes without getting bogged down in analyzing the mountain of variations. And most important of all, all activity parameters' indexes are traceable and can be verified quite easily even with variations in method change.

The other good news about MOST® is that people using the system will not only enjoy the 10X speed advantage over MTM, but will find MOST® indispensable in coping with the many minor changes inherent in method variation.

Conclusion

The MOST® System is indeed the work measurement tool for today's high-mix and low volume production strategies. It does away with the over dependency on motion analysis to focus on activity sequences that manage the motions in the sequence itself.

In this respect, MOST® System analysis has a high system reliability and cycle time development consistency. This is mainly due to system simplicity and reduced applicators' errors which are quite prevalent with other measurement systems.

Besides the General Move Sequence, ABG ABP A, the MOST® System includes the Controlled Move Sequence, ABG MXI A, for the analysis of machine operations and the Tool Use Sequence ABG ABP U ABP A, for analysis of work with all types of tools. Additionally, for heavy machine work, the Manual Crane Sequence, the Power Crane Sequence and the Truck Sequence are available in the Maxi- MOST® System.

Within the MOST® System of work measurement – Mini-MOST®, Basic-MOST®, and the Maxi-MOST® and the Admin-MOST® almost all conceivable service, administration, engineering, warehousing, and manufacturing operations are measurable for analysis and improvement.

Inventory Control and Lean Manufacturing

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Introduction

The ultimate solution to the issues of matching orders with production and converting this to cash, at the same time as reducing overproduction, waste, errors and high working capital has been demonstrated by the Japanese car makers like Honda and Japanese electronics manufacturers such as Panasonic and Canon. These lean thinking principles were first developed by Leonardo Da Vinci, Dr Walter Shewhart, Dr W.E. Deming, Mr Soichiro Honda, and later by Dr Taiichi Ohno. Honda and others added Kaizen to this and later still, Canon have added new training systems, and environmental friendly processes. (see www.blakemore.com.au).

The first part of the solution is to define and implement a strategy where the rules can be demonstrated internally so that maximum support of the staff can be obtained. Later this can be extended to the whole of the supply chain. At all times the "Voice of the Customer" must be paramount. This strategy can be introduced without inconveniencing customers during the change process and initially would fit in and improve the culture of the organisation. These techniques can then be further extended to all functions of the business.

This is not a step function change. It means however that the focus of the whole of the company will need to gradually change. Herein is the major challenge.

There has to be a continuous focus on making each batch to order or making with a batch size of one, with integrated non wasteful processes. This means that excess inventory, preparation time, set-up time, clean-up time must be considered to be a waste and therefore continually reduced. The value added time as a percentage of the total time must be continuously increased. To do this the workforce must understand the principles and work at the correct skill level and be innovative in all ways.

Waste takes several forms and includes potential waste in planning, the finance department, supply, and in fact all operations.

Inventory Control

Success in manufacturing operationally relies on three basic performance metrics:

Quality (Q)
Cost (C)
Delivery (D)

The quality level should aim for zero defects, in process and product.

The cost should be as low as possible consistent with market expectations.

Delivery should be to the customers promised date 100% of the time.

It is a very simple matter to reduce inventory at the expense of on-time deliveries. This can be fatal for a business. Also, cost should not be driven down to the extent that quality is compromised. The quality level should express the desire to continuously innovate processes which reduce the cost of production and improve quality at the same time.

All products should be delivered seamlessly from the bottleneck in production and the bottleneck removed as soon as possible. Since the total production lead time tends be much greater than the desired delivery lead time

expected by the customer, unless stock is held at the point of sale (POS), either the customer waits or we supply from stock. Since freight delivery times can vary from 1 day to 5 days within Australia then a more clever option is to have all subcomponents in stock and assemble to order. This model is similar to the Dell production system. The issue now is how much buffer stock we need. We can estimate this from the following relationship:

$$B = \sqrt{(Rbar*Rbar(\sigma S*\sigma S) + Sbar*Sbar(\sigma R*\sigma R)} \quad (1)$$

Where:

B = Buffer stock

Rbar = average replenishment cycle

Sbar = average sales in the period

σS = standard deviation of the sales in the period

σR = standard deviation in the lead time for replenishment

For a lean manufacturing overlay on ERP, this translates to:

Replenishment level =

$$\text{If } (Sbar \leq 0, 0(Sbar*L)+normsinV(Fill\%)*\sqrt{L}*\sigma*\sigma+((Sbar*Sbar*(\sigma R*\sigma R)) \quad (2)$$

Where:

Normsinv(Fill%) = the normal distribution for the expected fill% for the order

L = lead time from supplier

Equation 2 has a high degree of flexibility in determining the correct level of inventory to deliver 100% fill rate (customer on time delivery).

Lean Manufacturing Algorithms for ERP

Late in 1999, Shaw Carpets USA engaged Blakemore Consulting to introduce Lean into their two plants. They specified that $40M needed to be reduced from the working capital. They believed that the way forward was to apply Lean manufacturing methods to the shop floor processes. A business audit by Blakemore Consulting revealed that while that approach would eventually lead to the desired objective, the complexity of the manufacturing processes and the large range of products made the task relatively slow. There was a faster way. This involved the application of the 25 Lean guidelines to the planning system as a first step. The results were spectacular as shown in Figure 1. Immediately the correct lean parameters were fed into the ERP system, the on-time deliveries improved as the inventory was reduced.

The guidelines that were applied were chosen from the following list of ***25 Guidelines for Easy Lean*** (The United States Air Force is using these for training with permission). Not all of these can be applied immediately but as far as

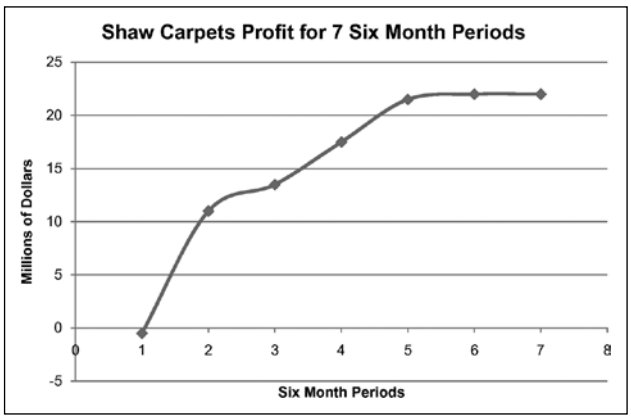

Figure 1

the ERP system is concerned we can start with sending the planned order to production when the calculated buffer stock (B) (where B = Buffer = Replenishment Level) in inventory is reached.

To achieve this end the 5500 products were separated into 3 groups depending on demand, A, B, C. The A group were high demand and low risk and were to be made to stock (MTS), since the production lead time far exceeded the acceptable lead time to customers. These were to be made at the Economic Production Run or greater if the demand was high. The C group were high risk and would only be made to order (MTO). The intermediate group, B, were to be made at the Economic Production Run and the divisions between the groups were to be continuously assessed and readjusted.

When these rules were applied there was an immediate improvement in on-time deliveries, a reduction in manufacturing cost and a reduction in inventory. Finished goods inventory fell from $20M to $9M and the company withstood a 6 week strike by the TCF trade union. On-time deliveries improved from 34.7% to 99% for the top 20 customers, and 95% overall in the same period. The Infors Visual system operates similarly through a ROBS (Resource Operating Buffer Status).

25 Guidelines for Easy Lean

People	1	Customer	Optimise Customer Response. Listen to his voice
	2	Teams	Form Teams at Interface and Free up Communication
	3	Culture	Continuously Improve the Culture
Integration	4	Demand	Demand = Supply
	5	Pull	Pull not Push
	6	Supply Chain	Apply to whole of Supply Chain
	7	Variation	Minimise Variation
	8	Cycle	Shorten Financial and Total Cycle

	9	6S	Apply 6S to all activities and work stations
	10	Constraint	Send demand to Bottleneck
	11	Mix	Aim for Even Mix at Bottleneck
	12	FIFO	First in First Out
	13	Supply	Optimise Supply
	14	Load	Level the Load as much as possible
	15	EB at EPR	Equal Batches at Economic Production Run
	16	Sequencing	Optimise Sequencing for Max Value added
Operations	17	Waste	Minimise
	18	Continuous Flow	Minimise Interruptions
	19	Value Added	Maximise
	20	Link	Link Processes
	21	Hold Points	Minimise
	23	Prevention	Prevention not Rework
	24	SPC	Apply Statistical process Control
	25	SMED	Apply Principles of SMED

The Major Variables influencing Inventory Levels

When we start with a rapid supply inventory model (such as that used by Dell), where the total lead time will be the assembly time from the sub component buffer stock, and we allow say 2 to 3 days for assembly, then it is clear that the following principles must be obeyed:

- There must be sufficient stock of components for assembly and finished goods.
- To satisfy the above requirement, stock levels must be high enough to allow for variations in supplier lead times, and variations in demand and any variations in available labour for assembly.
- For outside suppliers on short lead times say local suppliers, the requirement no 2 above should not be a problem. For overseas suppliers this could be an issue.

Sensitivity of Inventory to Usage Variation and Lead Time Variation

For the work done at Shaw carpets, a limited study of these two major variables and their influence on inventory stock turns has been done. For this study the inventory turns is defined using the more popular definition as given:

Inventory Turns = (Yearly Sales at COGS)/(Average Inventory at COGS) (3)

Using this equation, the number of inventory turns can be calculated and is plotted in Figure 2.

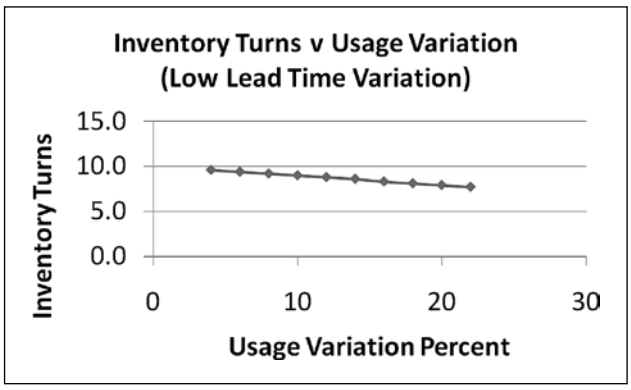

Figure 2

As can be seen from the above graph, the relationship between inventory turns and usage variability (for a minimal variation in lead time of 10% and for a fill rate of 99%) shows inventory turns of the order of 9.6 to 7.7. Provided that lead time for supplies are predicable and reliable then reasonably high usage variations can be absorbed and inventory turns can be good.

If we now turn to the sensitivity of the inventory turns to lead time variation at low usage variance, we end up with a relationship as shown in Figure 3 below.

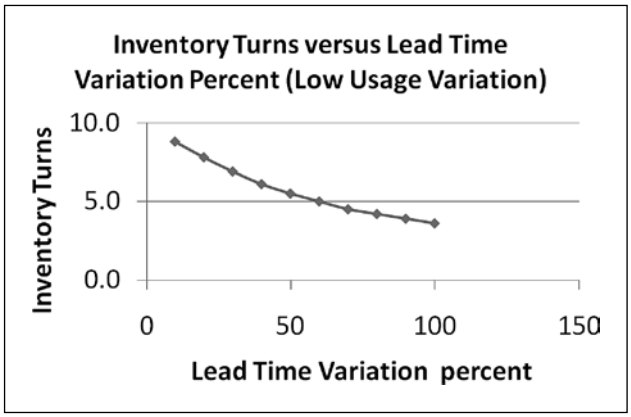

Figure 3

The above graph illustrates that even with a plot of lead time variation, provided that the usage variance is not great, then stock turns can vary from 8.8 to 3.5. Supplier lead time variation is a major determinant of inventory turns, but no more so than a 20% variation in useage. The values of the variances are critical to good control. Models have been developed to assist in setting the parameters. For the case of a high usage variation combined with a high lead time variation we see the relationship as plotted in Figure 4.

The above table summarises the results published in the three figures. In all cases the variations in lead time and usage are believed to be reasonable based on past experience. The fill rate is set at 99% for each set.

From Figure 2, it is clear that if the lead time is not greatly variable, then inventory turns of up to 9.6 are possible and even 7.7 when the usage variation increases to

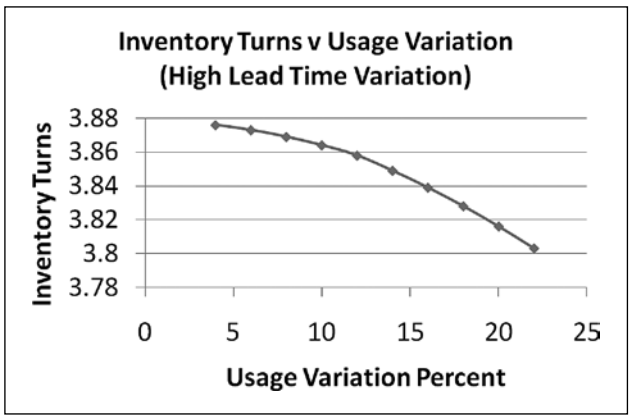

Figure 4

22%. Remember these models are allowing for delivery in say 2 days plus freight time to the POS, and for a complex system with hundreds or thousands of product variations where stocking of the finished product is not a viable option. For the case of low product complexity and a small number of suppliers, T can approach infinity since JIT can be implemented. In real complex systems in Australia with many components from overseas suppliers and the uncertainties of freight deliveries by sea in particular, JIT is not an option.

For Figure 3, a large increase in inventory is seen if the supplier is not offering a reliable and predictable lead time, then the inventory turns will decrease to approx 4 turns. In real terms this is taken as a benchmark in Australia because of our isolation and dependence on overseas suppliers. Inventory turns of 4 correspond to 3 months stock at the cost of sales and this erodes profitability by as much as 2% of profit on sales depending upon finance and gross margin. For businesses operating at a gross margin of 50% or more this is not so bad but if the gross margin is less than 25% this could be the difference in the company remaining viable or not.

Figure 4 illustrates that the value of T will collapse to approx 3.8 which as mentioned is the benchmark value for many Australian companies. Hence improvement is needed, and reliability of supply is paramount.

Conclusions

1. Simple mathematical algorithms can be added to ERP systems to enable Lean thinking to be applied into normal ERP systems.
2. Numerous models have been developed to aid in achieving improvements in Quality, Cost and Delivery using the Honda based supplier system.
3. The results in Australia where these methods have been developed have been spectacular and can be applied almost universally.
4. The models developed provide valuable guidance on the resetting of the major parameters controlling production and the inventory level needed to deliver on time and maintain a competitive advantage of fast delivery.
5. The model uses all the basic algorithms used to set the replenishment level (trigger point), ie usage, lead time, lead time variance, and demand variance.

Table 1. Summary of Figures 2, 3 and 4

Figure	Graph	Fill %	L	U	T	Notes
2	T v U	99	10%	4 to 22%	9.6 to 7.7	10% achievable
3	T v L	99	4% to 100%	4%	8.8 to 3.6	Large increase in inventory
4	T v U	99	4 to 22%	4 to 22%	3.8 const	If L is high, usage variation less significant

Upcoming Conferences & Exhibitions

Australian Institute of Packaging National Conference
16-17 June 2010
Melbourne Cricket Ground, Melbourne
www.aipack.com.au

The biennial Australian Institute of Packaging (AIP) National Conference brings together leading international and national experts in a variety of fields to cater for everyone in the food, beverage, manufacturing and packaging industries. Keynote speakers are world-renowned experts in their fields and the program provides an extensive array of educational and technical opportunities for everyone in the industry.

The AIP National Conference is open to both Members and non-members and is the largest educational conference of its kind in the industry. A not-to-be-missed event on the Packaging calendar.

The Safety Show and Sydney Materials Handling
26-28 October 2010
Sydney Showground, Sydney Olympic Park, Sydney
www.thesafetyshow.com.au

Keep up to date with new developments in OHS across a broad range of specialist exhibitors at The Safety Show – a unique opportunity to find the latest OHS products under one roof, along with hundreds of new and innovative ways to improve your workplace performance.

See the latest in safety and materials handling solutions at the Live Demonstration Stage, including case studies, hands-on demonstrations and practical workshops.

A schedule of events for The Safety Show Sydney & Sydney Materials Handling will be available closer to the Show.

Quality back on the agenda at Toyota but never off the agenda at Honda

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It is truly disturbing that Toyota, once the celebrated benchmark on high quality automobiles, especially for the more expensive Lexus brand, has now had to recall worldwide 8.5 million vehicles for quality problems. Honda, the largest motor manufacturer in the world by a large margin, maker of cars, motor cycles, outboard motors, lawn mowers, edge trimmers, generators, jet engines etc. … in fact anything with a motor (Internal Combustion Engine), more often than not, has edged out Toyota in most quality measurements even when Toyota was at its peak.

Toyota has now announced that it will boost its technology centres in the USA from one to seven, to enable more scientists and engineers to interface with customers and enable greater checking of quality problems. What has happened to the voice of the customer?

Soichiro Honda was renowned for his detailed approach to manufacture. Even tolerances on drawings were not encouraged. Everything in the Honda factory had to be made to a target. No six sigma for him. Six sigma first made popular by Motorola in the mid 90's is really 4.5 sigma since it allows for a 1.5 Sigma shift in the target. This would be anathema to Soichiro Honda.

Toyota's brand image is tarnished so much that it may never be able to return to its pre recall level. Tatsuya Mizuno notes that the cost of this will be huge in image and dollars. It seems that many of the basic Deming's 14 points have been lost.

A senior executive of a dedicated Toyota supplier, who does not wish to be named, has said that when many of the senior managers in Toyota were replaced with younger ones over the last few years these new managers did not know who Dr Deming was. The old system of centralisation of quality control at Toyota has not worked.

Toyota is currently suspending production at its plants in France and Britain for at least 12 days because of much weaker demand in the wake of the global recalls.

The simple proven Honda approach is called the BP system. Best Position, Best Productivity, Best Product, Best Price, Best Partners. BP experts are taught at the shop floor to observe and measure and evaluate every activity first hand using the scientific method.

At Honda, at least 80% of the vehicle comes from first, second third and four tier suppliers. Honda built a supply base of partners who consistently deliver almost zero ppm defect quality. They do this through the execution of a well thought out corporate strategy. This is done through a single driver, the purchasing function. Honda always work assiduously with suppliers, developing them, not forcing them to drive down prices. There is a total understanding of Company mission and the Honda Philosophy. These are:

1. Be customer driven
2. Show respect for the individual
3. Teamwork with open space offices
4. Excellence in process and product
5. Focus on the long term
6. Assiduous attention to detail
7. Link process and product innovation.

The strategy for continued global success in the future is as follows:

1. Stay close to customers. They are the most important part of the process
2. Understand the needs and wants of the customer
3. Exceed the customer's expectations.

I have experienced the Honda experience from 1989 to the present since over that period I have owned and my company has owned eleven Hondas. This represents 1.1 Million km of trouble free use. The only potential fault was when I was advised by Honda, that after my Honda Legend had reached 120,000km and out of warranty, it needed the control unit to be replaced. Having owned a Rover 3.5Litre V8 which at 90,000km had the control unit fail and I lost power steering, and power brakes around Victoria pass at 11 pm whilst returning from a client I was concerned. The Rover control unit cost $2500 to replace in 1985. The Honda control unit was replaced free of charge. It is no wonder to me that Top Gear readers rank the Honda S2000 as the world's best car and the Honda Jazz as the second best. Of all the clients I have consulted to, only Panasonic and Canon approach this level of excellence.

Changing the car culture

Patrick Moriarty
Department of Design, Monash University

Someone famous—I forget who—once said that 'People can be relied upon to do the right thing –after all other avenues have been explored.' Keep this thought firmly in mind as we look at the feasibility or otherwise of 'changing the car culture' in Melbourne and other Australian cities.

Car travel in Australia: some statistics

Car ownership in Australia is about 550 per 1000 population. If LCVs are added in, it's over 650—two vehicles for every three persons. About 86 % of the eligible age population have vehicle licences, and only among the oldest age groups is female licence-holding significantly lower than males. In the youngest age groups, a higher percentage of females hold licences, so the car culture in future could be a largely female one. In Australia overall, an average of about 9200 veh-km are done for each person per year. In the 8 capitals, the corresponding figure falls to about 8200, but of course public transport travel is greater. Petrol consumption rose from 525 litre/capita in 1960 to reach 1000 litres/capita in 1977, and since then has fluctuated around this value. Auto LPG, also almost entirely used by light vehicles, rose from near zero in 1980 to a peak of around 125 litre/capita in 2001, but has since fallen to 90 in 2006. It might be thought that work travel was declining in importance in Australia. But successive surveys have shown that work-*related* travel and journey to work travel once again together account for the majority of veh-km done by light vehicles, and are increasing their share.

Success in changing the car culture can only be measured by large drops in equivalent petrol consumption per capita, and drops in veh-km per capita. Changing people's 'attitudes' is not enough.

Why so much car travel?

As one sardonic biologist said, based on his experiences of micro-organisms in a petrie dish: 'when organisms are unhappy, they tend to move around a lot'. You're unhappy with that explanation? Let's look a bit deeper.

Non-instrumental reasons

Researchers have long hypothesised that car travel, particularly driving, produces psychological benefits, and that these are important in explaining the high popularity of car travel. An earlier argument for such psychological benefits was put forward in 1986 by Marsh and Collett in their book *Driving Passion*. They saw the thrill of driving as involving the mastery of speed and acceleration, and its associated controlled risks, and acceleration as producing psysiological changes in the human body. They further argued that cars provide their owners with a powerful means of self-expression, as witnessed by the popularity of personalised number plates and the customisation of cars. Their analysis was, however, short on empirical evidence for the psychological benefits of car travel, as distinct from car ownership.

More recently, empirical evidence for such non-instrumental motives for car travel has been published, including a special double issue of the journal *Transportation Research Part A*. In one study in this issue, Steg surveyed several hundred holders of driver's licences in the Dutch cities of Groningen and Rotterdam. Her studies found that several motives for car use can be distinguished. 'Symbolic or social motives refer to the fact that people can express themselves and their social position by means of (the use of) their car, they can compare their (use of the) car with others and to social norms. Affective motives refer to emotions evoked by driving a car, i.e. driving may potentially affect people's mood and they may anticipate these feelings when making travel choices'. In this paper I will group symbolic and affective motives together as non-instrumental motives.

In the US, Mokhtarian and Salomon explored the concept of travel for its own sake, or travel affinity, as they termed it, in a 1900-strong sample of San Franscisco residents. All modes of travel were found by at least some of these urban travellers to provide a positive experience, but as expected, the proportion liking car travel (nearly 60%) was far greater than for rail (30%), or bus (less than 10%). (I know, it's hard to believe, but some people actually prefer cruising down a lightly-trafficked highway to waiting at an unsheltered bus stop in the rain.) More generally, their survey found that nearly half of their sample agreed with the statement that 'getting there is half the fun'—so for many, it truly is better to travel than to arrive. In the U.K., a recent study found that the relative importance of instrumental and affective (non-instrumental) factors varied by purpose of trip. Specifically, instrumental aspects were found to be much more important for work trips as compared with leisure trips.

Instrumental reasons

In contrast to psychologists, transport modellers, often engineers or economists, usually assume that travel motivation is almost entirely instrumental, or in economist terms, a derived demand. Travellers, in other words, are viewed as only being prepared to outlay time and money to access desired destinations. This view is incomplete, given the importance of psychological motives in car use discussed above, but such a simplification may be needed

to make the problem mathematically tractable. Steg again: 'Instrumental motives may be defined as the convenience or inconvenience caused by car use, which is related to, among other things, its speed, flexibility and safety.'

The replacement of public transport and non-motorised modes by car travel has greatly increased door-to-door travel speeds. Hence a possible reason for car travel growth is that people can participate in extra activities, since they now have available a higher speed mode. For example, with public transport or walking, many trips—those too long for walking, or those requiring a modal change—simply cannot be made during a restricted time frame such as an employee's lunch hour, but they can be done by car. These extra activities made possible may well be regarded as worth an increase in travel, even if total time (and money) outlays for travel also rise.

How did ever-rising car travel manage to maintain its speed advantage over public transport? In contrast to the radially oriented fixed rail public transport network, the ever-expanding road network made non-radial travel easy. The progressive suburbanisation of activities meant that most trips were less and less oriented to the centre than was the case in the public transport era. Such a dispersion of destinations meant that car travel speeds could be kept high even as car ownership rose to about one vehicle for every two residents. Only for work trips to the CBD could public transport, especially rail, compete with car travel on speed. Again, only for CBD journey-to-work trips will instrumental and non-instrumental travel motivations conflict, rather than reinforce, each other.

An analysis of data from Newman and Kenworthy showed that, for 37 cities in Europe, North America, Asia, and Australia in 1990, average annual car travel rose with average car speeds. It is likely that non-instrumental benefits of car travel also rise as average car speeds rise and traffic congestion is reduced. Travel distance and speed data from a 1985/86 national Australian survey support this argument, since, again, higher daily travel levels are correlated with higher average speeds. For example, female pensioners averaged only 15 km daily travel by all modes—motorised and non-motorised—at an average speed of 23 km/hr, whereas males working full-time averaged 52 km of travel at 35 km/hr. Interestingly, higher average speeds resulted in more, not less, travel time: female pensioners spent only 40 minutes per day travelling, compared with nearly 90 minutes for males in full-time work.

Car travel is not only faster than alternatives, but is regarded as having a number of other instrumental advantages. These additional perceived advantages include greater security and privacy, all-weather protection, and ease of transporting young children or goods. These advantages vary little from city to city. Along with car air-conditioning and stereo systems, they both increased the attractiveness of car travel over public transport, and encouraged increased trip making. Another change that has increased car travel is the rise of chauffering of both children and the elderly. Consider the case of a parent chauffering a child to school, (replacing the child's former walking or cycling trip) and then returning home. In terms of passenger-km, three vehicular trips have replaced the former non-motorised trip—one for the child and two for the parent driver.

Some approaches to changing travel behaviour

Many people see car-oriented cities as the ultimate historical endpoint for urban transport; no further change is necessary—or possible. Business corporations, governments, and the majority of the urban population are seemingly happy with this solution to urban travel. So why even consider change? One reason is that a number of researchers who are far from hostile to the car have done so. Various approaches to how our apparent obsession with cars might change (or be changed) have been proposed by others, including:

1. Information technology will make the problem go away. (Years ago, we engineers were obsessed with slide rules. IT cured our addiction.)
2. The need to shift to rapid transport because of time budget constraints will greatly reduce car passenger travel.
3. Changing land-use, particularly increasing urban density, will greatly reduce car travel.
4. Advances in social/environmental psychology can be used to shift individual travel behaviour toward environmentally friendly modes.

1. This view has been argued at length by MIT planner William Mitchell (originally from rural Victoria) in a series of books, one with the intriguing title: *e-topia: "Urban Life, Jim, But Not as We Know It"*. He argues that advances in the new Information Technology (IT) will make much travel, including urban travel, redundant, and uses the term 'demobilization' as a general term for the substitution of work, shopping, and other trips by networked computers. Pelton, also from the US, has a similar view, but sees security as an additional driving force for radical changes to urban form and hence transport.

But arguments to the effect that IT will radically reduce urban travel needs have now been made for three decades. Actual results so far have been disappointing. As one commentator pointed out, if teleworking is so good for productivity, why aren't more employers encouraging it? Teleshopping, or e-commerce, similarly has not fulfilled its early predictions: e-commerce still only accounts for a tiny share of retail sales. And even if (say) 10% or even 20% of retail sales were done over the Internet, it doesn't follow that shopping travel itself would be much affected, since a large variety of purchases are usually made on each shopping trip—there are few single-purpose shopping trips. Household shopping trip frequency may remain unchanged. And given the child-minding functions of school education, tele-education is even less probable. Even for tertiary education, initial enthusiasm for IT-based 'virtual universities' has waned. As virtual university critic Noble points out, they are really just a fancy term for the old correspondence colleges.

Nevertheless, recent developments in IT could have some indirect impact on future urban travel, by reducing the perceived psychological benefits of the car. The development of 'intelligent' air bags has in turn led to the development of an Electronic Data Recorder, similar to an aircraft's 'black box'. This device can continuously record data on steering wheel angle, engine speed, acceleration/deceleration etc, and will consequently be of great value in both accident reconstructions and the design of safer vehicles. The data for the last five seconds of a crash have also been used in court cases. Further, a simplified black box, now on sale, will allow parents to monitor the driving behaviour of their teenage children, or car-rental companies to monitor their customers' use of their vehicles. Should such devices become widespread, the surveillance they enable could profoundly affect the psychological benefits that adolescents, particularly, obtain from driving. In other words, for urban residents, it is at least possible that car travel could lose much of its non-instrumental value.

2. An interesting variant on painless solutions comes from Schafer and Victor. In a series of papers, they argue that in all countries people have a fixed travel time budget. They argue that the shift from slower modes—public transport and non-motorised modes—to car travel has allowed people to travel further for a given time outlay. In order to accommodate their projected large rises in personal travel levels out to 2020 and 2050, they foresee absolute declines in the level of car travel for present car-oriented countries, and huge increases in high-speed travel (air and very fast train travel). Car travel—particularly in cities—will in future be too slow for a fixed time budget of an hour or so per day, they argue. A variant of this approach foresees maglev trains travelling at high speeds in evacuated tunnels displacing car travel for both urban and longer-distance trips.

Air travel within urban areas is not an option. It is also unlikely that short or even medium length urban trips can ever be made at high speeds, even by rail, given the physiological limits to acceleration/deceleration of the human body. It is, possible, but unlikely, that long-distance rapid travel, either inter-urban or overseas, could *displace* urban travel. But my own research has found that it is doubtful that people do in fact have constant travel time budgets, even when aggregated at the city-wide or even national level. Further, different sub-groups have very different average travel time outlays, as shown above by the more than two-fold travel time difference between female pensioners and full-time working males. Further, as Lyons and Urry stress, the increasing ability to use travel time for other activities argues against individuals having fixed travel time budgets.

3. The idea is that high density of residents (and workplaces) can increase the relative attractiveness and economic viability of public transport, and by increasing car congestion, reduce car travel. Further, vehicular travel levels are reduced by the closer proximity of origins and destinations-workplaces, shops, schools etc. Yet it is one thing to have the historically very high densities of many Asian cities—up to 10 times Australian levels—but another to try to convert historically low density cities to high density. Our major cities vary by roughly a factor of two in urban density. Yet the two densest cities (Sydney and Melbourne) had the same average level of LV veh-km per capita as the three lower density smaller mainland state capitals (Brisbane, Perth, Adelaide).

So even doubling their urban density would achieve little in the way of travel reductions and would take many decades. It would also be enormously unpopular, and would in effect replace the resistance to policies that directly reduce car travel with equally unpopular policies that might indirectly reduce travel. And not only is it unnecessary (we can easily reduce the convenience of car travel, given the political will, by taking away the privileges we have granted the car, such as speeding through residential areas), but an environmentally sustainable city might need somewhat lower density living, to allow for own-provision of water, and at least some food and energy. Sustainable transport is only one aspect of a sustainable city—if indeed the latter is not an oxymoron.

4. In Australia, particularly Perth, this has taken the form of Travelsmart interventions. The main idea is to target the less-committed motorists, to recognise that while some trips have to be made by car, for many others

environmentally-friendly modes (EFMs) are a real option. By providing information on these EFMs, Travelsmart programs try to shift some trips to these modes. Let's look at the experience of Perth, where such programs have now been in operation for a decade. The result? Perth has higher levels of light vehicle veh-km per capita than any other Australian city. Not promising. But governments are willing to try these programs because it puts the responsibility on individuals to make the changes, rather than on politicians facing re-election.

A different approach to how change occurs

Both Australian and world transport face the twin problems of global climate change and oil depletion. Climate change can be denied/avoided for a while longer—indeed this is the present, grown-up, response—but this is not an option for global and Australian oil depletion. In climate science, the relevant term is 'external forcing'. I believe that the car culture will only change in a major way under 'external forcing' in our transport systems. People might undergo profound religious or political conversion, but still don't give up their cars. ('I converted on the road to Damascus—but still used my car to finish the trip'.)

The only time when the (fledgling) car culture was seriously challenged in Australia was in 1929. Car ownership rose rapidly in the 1920s, but the Great Depression, followed by World War II and petrol rationing, stalled the rise of the car for two decades. And the recent high petrol prices did at least temporarily lower car use. National petrol sales rose 1.5 % in 2004, but fell 3 % in 2005, and 2 % in 2006, which is unprecedented in an era of strong economic growth. (True, diesel and ethanol for light vehicle use rose, but were offset by falling LPG use.) On the other hand, Melbourne's public transport patronage is growing rapidly. Average weekday trips grew 5 % in 2005/6 and 8 % in 2006/7. Are we seeing glimpses of Melbourne's future travel? Both examples show the importance of externally imposed constraints on reducing car travel.

How crises, such as global climate change or oil depletion, get interpreted is important for policy responses. Fortunately, when the level of Melbourne's water reservoirs started their sharp decline, we didn't have 'Melbourne reservoir water level sceptics' to tell us that there really was plenty of water in the reservoirs, nor boosters who assured us that in any case there were plenty of great substitutes for water—if only the price was right. So we were able to act fast and introduce policies to cut water use. We did this in part by banning certain categories of water use—not by bringing in a 'water-use trading scheme'. But for what most of here recognise as the severe challenges posed by oil depletion and global climate change, there are many who don't see a problem, or if they do, think that one or more of a variety of tech fixes will make the problems go away, without the need for any change in our lifestyles.

So the government response to what is a global crisis for car manufacturers is to promise taxpayer's money for a 'green car', rather than to use the crisis to wind down an industry that has no future in this country—or probably any other. This brings us to another important question: whether incremental change (such as a green car) will really help in moving to an environmentally sustainable society. An analogy: to get a couple of metres closer to the moon, leaning a ladder against the back shed will suffice, but it is a dead-end approach for closer approaches to our moon. For that we must build a rocket. However, other incremental approaches are a very good fit to deeper change, including efforts to move people onto public transport, or to make our suburbs more accessible by active modes.

Another thing that doesn't help achieving change is inconsistent government responses to the various problems facing car travel. An example: for 51 weeks of the year, our state government lectures us about driving carefully: 'speed kills', they scold us. But for the Grand Prix week, 'speed thrills'. Then back to 'speed kills'. When individuals behave this way, we call it schizophrenia.

More and more we are coming to realise our commitment to continued economic growth is an obstacle to ecological sustainability, just as the practice of literal interpretation of the bible was for scientific advance. At present, any proposal that would hurt economic growth can be dismissed out of hand. However, with the present intense focus on the economy, global climate change may well move off the front pages. (Of course, when the global economy enters a bad patch, atmospheric CO_2 molecules think: 'O my god! The economy's in trouble; we'd better stop absorbing and re-emitting infrared radiation!' Don't they?)

Changing the car culture, I believe, is first and foremost about changing our economic growth culture, and our magical view on technology. Let us be frank: the car culture provides an excellent fit to growth-oriented capitalism. The demand for high-speed travel modes is part of our obsession with endless economic growth, which seems to require ever-rising labour hours from households. Time becomes a premium. If we all worked part-time, and eased off consuming things, we could all slow down and work far fewer hours. I'll be provocative and leave you with the following idea: if we are really serious about stopping urban transport's contribution to global climate change, then we'll have to turn our backs on continued economic growth.

A perspective on the 'Toyota Troubles'

Dr Brian Jenney, CPEng., FIIE, FIEAust

The first half of last century saw two World Wars and those involved in the second one thought that the 19 years gap needed to have something done about it. From 1919, the 'Reparations Game' was played by the victors, particularly France, and this eventually led to the collapse of the Weimar Republic and rise and rise of Hitler. So what was his answer? Crippling the losers had proved a counter-productive exercise and so the Marshall Plan was evolved to help restore the economies of both sides of the conflict.

The Americans provided most of the funds and almost all of the experts in the various recovery programs. The value of Quality Control was recognized as a key factor and three experts were sent to Europe and two to Japan. The original expert sent out to Japan was the 75 year old actuary, W Edwards Deming, but when Joseph M Juran published the first edition of his Quality Control Handbook he was invited out shortly afterwards. They both toured and lectured – and managements of manufacturing firms listened. Deming refused recompense from the Japanese so the funds were used to set up the highly valued and most prestigious top prize in Japan for quality – the Deming Prize.

The Germans listened to the experts – and the Japanese even more closely. In Japan this was translated into high value small instruments, such as cameras and optical goods, at the beginning and then motor bikes before motor cars. One of the earliest incidents with motor cars was the purchase of a whole factory's equipment from the USA for US$5 million by the Nissan Company. Old fashioned and not very reliable, the Japanese could not do much about the looks and fuel economy of the product but, by the strictest application of quality control, they made the machinery perform to a higher standard than ever achieved by the original owners. From this they managed to achieve this lasting reputation for reliability – and soon did something about looks and performance with newer models and other companies entering the automobile market.

There were, and are, many factors that determined the rise of Japan as a dominant manufacturing country after WW2. The Mitsubishi Company was founded in 1887 as a bank and most of the world's largest banks are still in Japan, so longer-term finance was never a problem. The evolution of the Ministry of International Trade and Industry, headed by the senior bureaucrat of the public service who later became prime minister, also helped in master planning for long-term profitability. Quarterly returns on capital were on a five-year basis and only a strong government could ensure the manipulation of the value of the yen and a standards policy that restricted foreign competition.

Unfortunately in 1945 it was a 'sellers' market in Europe and any old rubbish was scooped up by populations starved of goods. This, for instance, was a major factor in the shrinking of the British automobile industry by comparison with the rise of the German one. It did not take too long to affect industry on the other side of the Atlantic as well, and one of the most famous American popular commentators made the remark, "Those friendly guys that gave us Pearl Harbor are now stealing the jobs from our people in many factories, and have named their top prize for achievement after an American".

We now flash forward nearly sixty years. Today the whole automotive industry is internationalised so that any particular model may have been made in several places and most likely away from the country of the recognized brand name. The Germans are still very good at making cars such as the impeccable Golf. Even when most, then all, of the original 'Beetles' were made in San Paulo, they still chugged along with many faults but few recalls. When Volkswagen took over Maserati they shut it down for a whole year before they got the quality control up to VW standard.

Amongst the Japanese cars the brand name of Toyota rose to the fore in volume of world wide sales with models made in many countries. This included Australia with many of the medium sized Camry models being made here. The principal claim to fame, of course, was the Toyota manufacturing system with many well-known aspects such as Just-in-Time and Lean Production. The whole world caught the idea that profits benefited by having linked chains of supply and minimum holdings of stock. The Toyota system went much deeper with its training of suppliers and the idea of continuous improvement on all aspects of the business.

Vehicle recalls go on constantly and so one would expect some would go to the firm that made the most cars world-wide. However, the ones to hit Toyota in the three months from November 2009 to January 2010 included over five million vehicles with an unsecured heavy duty rubber mat that could entrap the accelerator pedal. This was followed by over 2 million with the possible mechanical sticking of the same accelerator pedal causing unintended acceleration. These numbers added up to two thirds of the total Toyota sales last year, but of course related to the sales of cars and trucks made in previous years as well. It also highlighted the fact that reliability engineering is more important than quality control. Here, relentless design review, careful development testing and exhaustive life testing is the order of the day. The latter two used to be called environmental engineering, and the Society of Environmental Engineering still exists, but that name has been stolen by the 'greens'.

The general area of product recall is always an emotive one. Sometimes it is hidden from public view via a 'technical services bulletin' aimed at dealers who can quietly make

checks and any adjustments at service breaks. The main point is that history shows the incidence of a tiny proportion of defects invariably leads to a mountain of recalls that cost time, money and reputation. One can recall the hiatus caused by the 'elk test' threat to the mighty name of Mercedes when their A series models were launched in 1977. One can be fairly sure there were very few 'elks' running loose on the city roads for which the model was developed, but it made hilarious fun to the masses who could never afford a 'Merc' in the first place.

Several accidents and some deaths were attributable to the current Toyota defects, though most would have been caused by other reasons such as driver error. One of the veterans in the field, Leonard Evans, who worked for General Motors for three decades wrote a book called *Traffic Safety and the Driver*. In this he claimed that design faults were outweighed by driver-contributed faults at around a staggering fifty to one. However, a major case was made by the USA Government and Toyota was agreed to pay US$16 million for knowingly concealing the accelerator pedal defects. With the recent world monetary meltdown, one could claim the litigants are now the major owners of the major American competitors, all of whom have themselves a long history of spectacular product recalls. It could also hopefully be claimed that, subsequently, Toyota has recognized the hidden dangers of delayed reaction in a rigid system of 'Command and Control' from HQ Tokyo.

Compounding the problems, a separate recall came in the next month, February, concerning the hybrid anti-lock brake software. This was of a more contentious nature and extended the canvas of recall campaigns. In the aviation industry, software problems are very familiar since the 'fly-by-wire' phenomenon became an aerospace industry standard. So a greater reliance in automobiles was sure to bring new headaches. This had caused much grief even in models such as the 700 series BMWs where, in Queensland, one entrepreneur had bought a number of the latest models as hire cars and found the plethora of minor electronic monitors and controls was causing much grief and annoyance to his erstwhile customers. Part of this was bound to happen as automotive manufacturers moved from a century of improving mechanical systems to one that included electronic ones as well, and where a whole new environment takes over with electromagnetic interference being the villain on the side and in the shadows. Even the love of gadgetry that requires a myriad of tiny electric motors does not help the requirements of reliability.

Toyota entered the twenty first century with the plan to become the world's largest automobile company in the world and achieved this within the first decade. The monolith that is Toyota will stay at the top for some years before being overtaken by India and China, but the recognition of changing technologies and strict adherence to the principles of reliability engineering is the way by which it will continue its pre-eminence for some time in the future.

Brian Jenney (CEng, CStat and CQP) made the academic input to the first university degree course in the world in the general area of quality and reliability. This was the MSc in Quality and Reliability Engineering at Birmingham University UK in 1964 and which he supervised for 16 years before emigrating to Australia. He actually flew Spitfires in WW2, and did a few other things too.

Military and Civilian Leadership

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The following excerpt on "Flexible, pragmatic leadership" is from a Department of Defence 2009 publication "Focus on Human Performance in Land Operations". The original publication by US Army Colonel Carl Castro, Major Jeffrey L Thomas and Dr Amy B Adler was selected and edited by Colonel Peter Murphy of the Australian Army Psychology Corps.

One of the trademarks of a strong organisation is an emphasis on identifying and developing its leaders. This is especially true in the military, where all senior leaders arise from the ranks within the military. Unlike civilian businesses, in which proven managers and leaders at all levels can be hired from outside the organisation, the military can only hire managers and leaders at the entry-level, before their abilities have been demonstrated.

Thus, the military has the tremendous responsibility of identifying and developing its junior leaders for advancement within the organisation. This commitment to developing leaders from within is reflected in the immense resources militaries around the world dedicate to developing their leaders.

The following is a list of leadership Do's and Don'ts based on practical experience. In developing this list of recommendations, the authors borrowed from numerous sources, in particular from scientific surveys and interviews conducted with US military personnel during and following combat duty in Iraq:

- **Do be fair and just –** leaders should never issue an order they cannot enforce. They should promise nothing they cannot deliver. They should be as good as their word at all times and in any circumstance. It is the leader's responsibility to make sure that all members of the unit assume equal risks and make equal sacrifices in pursuit of the unit's mission.
- **Do admit mistakes –** the best thing leaders can do when they are wrong is to admit it, publicly. Naturally, no one likes being contradicted and refuted, so this is best done by the leaders themselves. Contrary to what many leaders may think, when leaders admit their mistakes in the presence of their subordinates, their credibility and authority is enhanced. Pragmatic flexible leaders accept personal blame when things go wrong, even if it wasn't their fault, yet they credit all successes to their subordinates.
- **Do underwrite honest mistakes –** organisations only improve when members of the organisation are allowed to make mistakes. When subordinates make mistakes, but not from any lack of goodwill or effort, it is best for the leaders to take the rap for them or to "fly high cover" for them as it is sometimes called in the military. The last thing a leader wants to do is disaffect an honest, hard-working subordinate needlessly. Not underwriting honest mistakes is a very quick way to squander any capital that leadership has brokered in the eyes of subordinates.
- **Do protect subordinates –** it is the duty of leaders to intervene and protect their subordinates against any manifest injustice, whatever its source. This includes abuse or harassment from other members of the unit. In fact, this trust is so implicit between leaders and subordinates that all leaders should be willing to risk their professional reputation on it, when they are convinced that their subordinate is being unfairly assailed, or that due process is not being followed. This protection does not extend to cheating or deliberate misconduct.
- **Do communicate –** tell subordinates what is going on. Every individual in military service is entitled to the why and wherefore of what he or she is expected to do. The individual's efficiency, confidence and enthusiasm will wax strong in response to the leader's communication about the mission or task. Leaders who believe in the importance of giving full information in a straightforward manner, and who continue to act on that principle, will benefit over the long-term by their subordinates' efforts. The skill of flexible, pragmatic communication requires both sending and receiving. If subordinates can talk naturally to their leaders, the product of their resourcefulness becomes available to all.
- **Do visit the troops –** meaningful contact with subordinates goes beyond merely sending information down the chain of command for dissemination. It is absolutely critical for leaders to be with their subordinates when enduring hardship (e.g. long hours on task, rigorous training, being in remote sites). The subordinates will become discouraged and will lose their sense of direction unless the leader has face-to-face contact with them, looking in on them periodically. Another benefit of this type of contact is that the leader demonstrates by example that he or she is not above experiencing hardship and will personally sacrifice time, comfort, convenience and energy to support the troops.
- **Do encourage involvement –** leaders must encourage their subordinates to become involved in recognising and solving problems. A universally disliked attribute

of leaders is a dictatorial style. Making subordinates a part of the solution instead of a victim of the problem is a way to instil confidence, innovation and adaptability in a unit. If the problem is such that the subordinates cannot solve it, then the problems needs to be brought to the attention of the leader. Leaders should decentralise information and imagination.

- **Do team build –** team building is the sole responsibility of the leader. The unity that develops from recognising one's dependence on others is the mainspring of every movement by which society and the military moves forward. One set of key leader attributes and behaviours valued across cultures is for a leader to be a team builder. Team building by its very nature must be inclusive to be effective. Therefore it should never be undertaken at the expense of excluding other unit members or other units. However, the leader who builds teams must be vigilant against possessive individualism and splinter factions within the unit. Both are counter-productive to group goals.
- **Do instill discipline –** the level of discipline should at all times be according to what is needed to get the best results from the majority of subordinates. There is no practical reason for any sterner requirement than that required. There is no moral justification for countenancing anything less. Discipline within the military should not be viewed as a ritual or form, but simply as the best course of conduct most likely to lead to the efficient performance of an assigned responsibility. Subordinates are able to recognise right and reasonable discipline as such, even though it causes them personal inconvenience. But if the discipline is unduly harsh or unnecessarily lax, subordinates' morale will fall.
- **Do use punishment judiciously –** before meting out punishment, it is necessary to judge the subordinate, and judgment means to think over, to compare, to weigh probable effects on the subordinate and on the command, and to give the offender the benefit of any reasonable doubt. Before any punishment is given, the question must be asked "what good will it achieve?". If the answer is none, then punishment is not in order. Punishment of a vindictive nature is a crime of leadership. Whether it is given uselessly or handed out in a strictly routine matter, it is an immoral act. To punish a body of subordinates for offences committed by two or three of their members, even though the offence is obnoxious and is impossible to point the finger at the culprits, is no more excusable within a military organisation than in civilian society. Any leader who resorts in this practice of "mass punishment" is likely to forfeit the loyalty of the best in his or her team.
- **Don't embarrass subordinates –** in general, leaders should not embarrass or humiliate their subordinates in front of others. One of the strongest passions individuals are subject to is their aversion to being criticised, contradicted, and exposed as a fool before an onlooking crowd. Making clever remarks that casually denigrate the worth of subordinates only serves to lower their self-esteem as a member of the unit, while at the same time eroding respect other subordinates may have in the leader.
- **Don't hide behind rules and regulations –** rules and regulations constrain individuals for the good of the group, but the excuse that one was only following rules or regulations is never an acceptable answer when committing an injustice towards other human beings. Receiving orders or instruction does not relieve the leader from the obligation to exercise commonsense. Rules only exist for the good of the service and the good of the country. Rules that do not achieve at least these objectives should be at least questioned and considered carefully in terms of their guidance.
- **Don't abuse privileges –** in the military, rank has its privileges. However, it is out of the abuse of privileges that much of the friction between leaders and subordinates arise. With increased rank also comes increased responsibility. In fact, rank only exists to facilitate leaders in fulfilling their responsibilities. What puts most of the grit in the machinery is not that privileges exist but that they are exercised by those leaders who are not motivated by a passion and sense of duty and responsibility towards their subordinates.