New Engineer JOURNAL

Servicing Manufacturing, Industrial Engineering and Engineering Societies

Business Intelligence

Technology-centric, engineering-oriented

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integrate
transform
clean
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monitor
communicate
analyze
explore

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In this Issue

ENGINEERS AUSTRALIA

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Vol. 14 No. 2 October 2011

Upcoming Conferences & Exhibitions

Australasian Association for Engineering Education Conference 2011

5th December 2011
Esplanade Hotel, Perth WA

Engineering is an ever evolving profession.

New technological breakthroughs, a wider reliance on complicated engineering systems to maintain 'our quality of life', the inevitable impact these operations have on the environment, in addition to the nature of transnational job mobility, all contribute to a renewed emphasis on sustainability and the global responsibilities of the Australasian Engineer.

There will be four sub-themes to support the overarching theme:

- Humanitarian Engineering
- Inclusivity
- Ongoing Graduate Professional Development
- Pathways into Engineering

The exciting and diverse program will include high profile international, interstate and local speakers and will feature plenary and concurrent sessions, poster displays, workshops, social functions and numerous networking opportunities. For further information contact Lexie Duncan Ph: (08) 9389 1488; E: info@eecw.com.au

Eighth International Conference on Technology, Knowledge and Society

16-18 January 2012
University of California, Los Angeles USA
http://www.Technology-Conference.com

This conference will focus on a range of critically important themes in the various fields that address the complex and subtle relationships between technology, knowledge an society. The conference is cross-disciplinary in scope, a meeting point for technologist with a concern for the social and social scientists with a concern for the technological. The focus is primarily, but not exclusively, on information and communications technologies.

The conference includes plenary presentations by accomplished researchers, scholars and practitioners, as well as numerous paper, workshop and colloquium presentations. Presenters may choose to submit written papers for publication in the fully refereed International Journal of Technology, Knowledge and Society. If you are unable to attend the conference in person, virtual registrations are also available which allow you to submit a paper for refereeing and possible publication in this fully refereed academic Journal.

Whether you are a virtual or in-person at this conference, we also encourage you to present on the Conference YouTube Channel. Please select the Online Sessions link on the conference website for further details. We also invite you to subscribe to our monthly email newsletter, and subscribe to our Facebook, RSS, or Twitter feeds at http://www.Technology-Conference.com.

The deadline for the next round in the call for papers (a title and short abstract) is 14 June 2011. Future deadlines will be announced on the conference website after this date. Proposals are reviewed within two weeks of submission. Full details of the conference, including online proposal submission form, are to be found at the conference website http://www.Technology-Conference.com.

ENGINEERS
AUSTRALIA

International Conference on Mechanical Engineering Technology (icomet '12)

20-21st January 2012
Kottayam, Pala, Kerala, India

The objective of the conference is to

1. Expand the knowledge horizon of Engineers in the concerned field;
2. Develop sustainable academic and industrial relationship with premier engineering institutes and industries;
3. Establish a quality defining event for the institution.

The theme of the conference is 'Design, Manufacturing and Management'. Visit http://sjcetpalai.ac.in/main/B-Tech/MechanicalEngg/icomet.asp for more details

ICEI 2012: 'Green Technology for Sustainable Development'

4th-6th April 2012
Mahkota Hotel Melaka, Malaysia

The increasing demand for innovative research ideas, design, architecture and solutions in handling intriguing engineering and ICT problems advocates the provision of rigorous study among various distinct communities. The aim of ICEI 2012 is to foster a broad range of sustainable collaboration among leading researchers, experts, educators, practitioners and developers seeking knowledge sharing in addressing various issues to advance the state of the art of these evergreen engineering and ICT fields. It is hoped that ICEI 2012 will promote new opportunities for enhanced partnership between academics and industry.

For further details visit http://www.utem.edu.my/icei2012/

Supply Chain 2020

26-27 June 2012
Melbourne Exhibition and Convention Centre
www.supplychain2020.com.au.

Supply Chain 2020 is an exhibition accompanied by an interactive and educational conference program for supply chain & logistics managers to source new products and solutions in line with best practice in supply chain management. Due to its success in 2010, Interpoint Events, EEAA award-winners of Best Australian Show in 2010, will bring Supply Chain 2020 to Melbourne in June 2012 and is proudly supported by our Educational Partner, Swinburne University and Media Partners MHD and TandLNews. Supply Chain 2020 will address the future of supply & logistics with a focus on key competitive issues and best practices.

TAILORED EDUCATIONAL PROGRAM

Supply Chain 2020 Conference Program is based on extensive industry research, international trends and feedback from our database and key supply chain leaders who are faced with critical issues such as sustainability, safety management, human resources and emerging new technologies within their business every day. Conference sessions will be presented by industry experts who have the insight of business obstacles the logistics and supply chain sector typically face.

INTERACTIVE SESSIONS AND WORKSHOPS

Through round table discussions and small workshops, delegates are able to share best practices, discuss key issues and suggestions from business associates. Supply Chain 2020 Conference will provide the latest tools and strategies to help you become a more effective executive and open your mind to new perspectives and focuses in the future of Supply Chain.

For exhibition and sponsorship opportunities please contact Allison Miller on 02 8586 6193 or email amiller@intermedia.com.au

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Contents

Front Cover: Illustrated highlights of diagrams from this edition's feature article by Robert Ades.

FORMAL PAPER REVIEWS
Leading papers published in this Journal are 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.

IE, a work (still) in progress…

This edition of **New Engineer** covers a diverse range of topics: some well established and some new.

The well established topics (plant layout, work measurement, operations research, supply chain) speak for themselves, but the new topics of *business intelligence* and *performance theory* may challenge the reader… All topics, however, add to the ever-growing rich tapestry of that we all call 'industrial engineering'.

However, first things first…Federal President, Daniel Kulawiec, in his address speaks of IIE's latest AGM and the election of the Institute's newest Directors: Dr. John Blakemore and Mr. Mohammad Barghash. Both John and 'Mo' bring valuable knowledge and skills to the Board in the respective areas of manufacturing and new, internet-based technologies. We all welcome them.

Following Daniel's address, is an article on business intelligence by special guest author Robert Ades. As noted in the last (May, 2011) edition of **New Engineer**, Robert was the very first graduate of the IEEM Monash University program that started way back there at the Caulfield campus in the early 1980's. His topic is new for **New Engineer** and will no doubt stir up considerable interest in this fledgling field. The article draws upon not only Robert's initial expertise in IE but also upon the many years of experience he has accumulated in senior management positions both within manufacturing and service industries.

The next four articles add further discussion to more established topics within industrial engineering. 'Radha" provides a capsule piece on layout planning, W.C. Wong continues his series on work measurement – with an explanatory piece on the MOST system, Nnanna Innocent makes a contribution to the supply chain optimisation problem, and John Blakemore follows up on his most recent article ("Velocity…, NE; May, 2011) with a discussion centred on sustainable manufacturing.

Finally, I present the fourth article in the series on 'performance theory'. The paper titled "On Performance Theory and Trust' attempts to link what social scientists, evolutionary biologists, etc. have learned with our own body of knowledge in IE. The paper reflects on how the concept of trust has always played such an important role in expediting the productivity of the (business) transaction process, and attempts to formulate the build up of trust with the performance measures associated with successful business transactions. I trust you find this and all the articles in this edition of **New Engineer** both informative and a joy to read…

Dr. Damian Kennedy
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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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Institute of Industrial Engineers Federal President's Report

www.iie.com.au

In recent years it has become more critical than ever for the Industrial Engineering profession to position itself in a way that modern businesses can recognise the value-add it offers. It is not that the need for the skills has diminished, but the exact opposite! There are numerous specialist disciplines and practitioners in the traditional Industrial Engineering domain that many businesses forget that Industrial Engineers provide a 'one-stop-shop' for operations management, resource utilisation and productivity improvement.

To meet this challenge, the Institute of Industrial Engineers continued a program during the 2010/11 year to update its approach for this new Generation. This has included the introduction of three new Directors on the IIE Board to provide improved representation of Young Engineers and Graduate Engineers (Sam Ghaith and Scott Fairburn) and of the Manufacturing sector (Bill Ferme). IIE also established a Social Media presence on a number of popular platforms to leverage these as a mechanism for improving communication across the industry.

Through the year I had the opportunity as Federal President to visit a number of national and international Divisions, and listen to our members, which assists in defining our future programs. I have also been in communication with the Institution of Professional Engineers New Zealand (IPENZ) regarding the potential of a NZ IE Institute. This option remains viable and may be worth pursuing if sufficient local interest can be generated.

IIE also continued to produce a number of quality editions of 'New Engineer' magazine to cover both Industrial and Manufacturing Engineering in Australia.

During the 2010/11 years, a number of our members have retired. We have many members that have been a part of the Institute for 30, 40 or more years, and they hold an incredible amount of knowledge regarding Industrial Engineering and its application. When they move out of the workforce we don't want to lose this knowledge from the Institute. If you are close to retirement, please remember the IIE does have a special membership rate for Retirees. If you are approaching retirement in the next couple of years, please contact us for details.

Despite these retirements, I am pleased to advise that the number of Financial members of the Institute continues to rise, and we have had a solid growth of new members through 2010/11.

The challenge over the next 12 months in Australia will be to position Australian industry for the introduction of the new 'Carbon Pricing' policy. Industrial Engineers can assist industry to prepare for this new regime through improved efficiency in operations and utilisation of resource.

The role of Manufacturing in Australian Society has again been in the news recently, and IIE can contribute to the debate. I encourage members to take up the debate within their local division, while the Council takes up the discussion at the national level.

The 2011 AGM was held at the Park Royal Hotel at Melbourne Airport. In addition to the Institute of Industrial Engineers (IIE) Federal Council, I am pleased to advise that there was a strong representation from our members on the day. I thank everyone that was able to join us – the more members that are able to attend the Institute's meetings, the more ideas and opinions that are tabled and discussed. This allows the Institute to take advantage of the knowledge and experience represented by our diverse membership-base.

I am pleased to advise that, in addition to the re-appointment of Directors retiring and eligible for re-election, two new Directors were elected to council. Dr John Blakemore and Mohammad Barghash have joined the Federal Council. The two new Directors provide representation of a wider cross-section of members, especially in the Manufacturing sector, and bring new views and skills to the Council. And for the first time in many years NSW Division is represented on Federal Council. As one of our largest divisions, its omission has been a cause of concern.

In summary the full results of election of Directors and Office holders at the AGM are:

- Federal President: ***Daniel Kulawiec***
- Senior Vice President: ***Robert Watson***
- Immediate Past President and Journal Editor: ***Dr Damian Kennedy***
- Federal Secretary: ***Sam Ghaith***
- Federal Treasurer: ***Selvarajah Radhakrishnan***
- Chairman Membership Committee: ***Lex Clark***
- Membership Secretary: ***Scott Fairburn***
- Webmaster: ***Mohammad Barghash***

- Promotion and Development Director: ***Bill Ferme***
- Director: ***Dr John Blakemore***
- Director: ***Mr Chin Hak Wong***

The formal elements of the AGM covered reports from the President, Secretary, Treasurer and Membership Chairman. The Audited Financial Reports were also presented and accepted by the AGM and show that the Institute remains financially healthy.

I look forward to continuing to work with members on these and other challenges facing Australian society, and look forward to continuing to grow the role of IIE into the future.

Daniel Kulawiec, Federal President, IIE
daniel.kulawiec@bigpond.com

L to R: Daniel KULAWIEC, Mohammad BARGHASH, Dr. John BLAKEMORE, Scott FAIRBURN, Bill FERME, Dr. Damian KENNEDY, Robert WATSON, Selvarajah RADHAKRISHNAN, Craig SUTTON, Lex CLARK, Denis VENGUST, Sam GHAITH (aka 'dirty dozen')

INTRODUCING MX Start

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

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

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

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

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

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

The fee is modest + travel expenses. Contact Bill Ferme FIMechE for more information bferme@bigpond.net.au. Currently, this service is only available to Victoria.

Business Intelligence – are we there yet?

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Business Intelligence (BI) as a concept is not new, but businesses leaders have yet to fully recognise BI or appreciated its significance as an integral part of company strategy, and as a powerful way to deliver outcomes. Australia is not unique in missing the point, but we may pay a higher price in losing the race to a 'knowledge economy'.

Background

Twenty-five years ago, I recall the cutting edge in Management Information systems was typified by MRP2, with supporters lauding how great a breakthrough this was from the original closed-loop MRP. The more advanced pundits were already advocating DRP, whilst the next step of ERP was yet to be popularly coined. This was a time just before computing became widespread inside companies, and often only existed on mainframe systems under the direct control of the Finance function.

Amongst the main issues debated within prevailing MRP2 user groups and APICS society meetings (online communities were still 15 years in the future) were user education, system trust and technology resistance. This was a time when computers were still seen as 'taking people's jobs', and the legions of old-school inventory and production planners, purchasing officers, and production control managers strongly believed that their years of judgement and experience could not be replicated by a machine. Every wrong answer or unexpected result from these early systems confirmed their beliefs, and the blight of 'garbage in / garbage out' was discussed by engineers and IT managers with resigned agitation.

These problems of linear system thinking, mistrust of technology, disparate systems and clinging to old ways are surely symptoms of a past time. We've all moved on so much since then, haven't we? In the mid 1980's an IBM PC still cost nearly $10,000 (1985 dollars) and networking was something mainframes did with dumb monochrome ascii terminals. Card index systems still existed, and a spreadsheet was an A3 page with lots of lines ruled on it. Today we think in terms of cloud computing and Business Intelligence, and the inherent connectedness of all information is so obvious that it's rarely spoken about as anything novel. However, I'm not convinced that companies, those who lead them and who work in the day-to-day details, yet understand the profound assets we now have, and the potential for BI to transform companies from the inside.

What is Business Intelligence?

Using good old MRP2 as a point of reference, let's first talk about Management Information. As the term implies, it's data collected across a business and fed upwards to controlling managers who then make wise decisions about stuff. MRP2 as a MI system relied upon people 'on the floor' diligently collecting and entering accurate data about their activities; purchase orders, receipts, usage, output/production, waste, conversion, invoicing/returns and other supply chain or production activities. Upstream, MPR2 also relied on accurate sales forecasts, correct bills of materials, rigorously scrubbed item masters, agreed operations sequences and standard times, and a plethora of other static data with specified owners. Managers emphasised staff responsibilities to feed the system correctly (the stick) with little promotion of the personal benefits of getting it right (the carrot).

I'm going to go out on a limb here, but I'd like to suggest that these early days of MI were very much like the early days of standardised manufacturing. There were strong echoes of Taylorism in attitudes to information systems. It was the responsibility of 'people on the floor' to maintain information in the same way as production output, with a command and control structure demanding both (information and product) whilst feeding very little back. Information is for Management; hence MI.

Whilst process measurement in Kaizen had long been understood as one of the pillars of TQM, few had thought to apply that thinking to a whole company as a combined system. However, I'm getting in front of myself.

MI systems like MRP2 collected historic information about production requirements, usages and product movements within a business, which was fed to management for them to provision for tomorrow's requirements. An implicit assumption was that the company's business model would not change, that the BOMs, products, operations, clients, materials, etc., were stable and acceptable. In other words, that the world would largely continue on as before. MI systems are about looking at the past to support the current day and very near future. If profound changes needed to be addressed, or the outside world examined, that surely was the role of far sighted senior managers and directors perched atop an efficient command and control structure, sagely steering the ship.

Through the lens of today's insight, let's consider the journey from Management Information to Business Intelligence systems. As illustrated in Figure 1, Business Intelligence begins when company systems (predominantly but not exclusively IT based) start to assemble and return predictive data that can show a business not only how it's travelling but where it's travelling to in the wider environment (at least on the current course).

It will reflect the entire business, not just key support

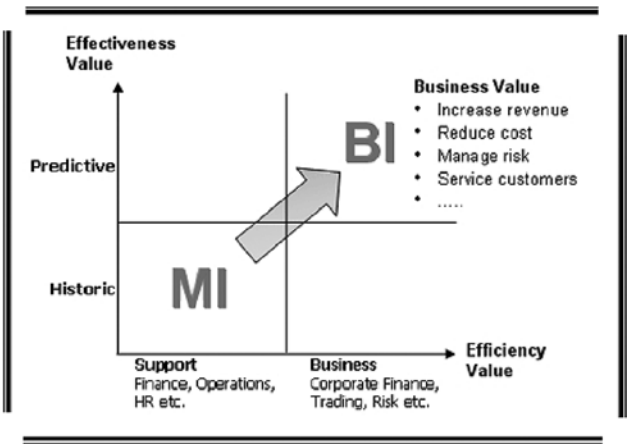

Figure 1 – Evolution from MI to BI
[MI is narrow in terms of time horizons and functional relevance compared to BI.]

functions, and increasingly the wider market. Most importantly, it provides information to the whole business, not just to management perched atop, and unlocks wider contributions from the team. Information flows become circular, interwoven and ultimately fuzzy. Everyone adds and views information, making linear ideas about data meaningless.

Consider Terry Gilliam's classic 1985 film, Brazil. In a world of bureaucracy, two monolithic government departments prevail; the Ministry of Information Storage, and the Ministry of Information Retrieval. Minions in Information Storage spend their lives in demeaning cubicles, endlessly keying infinite details about public activity but never knowing what use the data may be put to. The self-important denizens of Information Retrieval live in relative comfort, piecing together the ever expanding sea of information to exert further control over the world, all the time deriding the hapless IS staff as unreliable lesser beings. It wasn't Gilliam's intention to caricature a classic MI system of that time, but he did it quite well.

So what is Business Intelligence and how can it save us from such a terrible fate? BI can be defined in many ways, and the key tenets may include:

- analysing large amounts of corporate information without functional boundaries;
- assimilating otherwise disparate sources and flows of information, sometimes into agreed KPI's;
- sharing information flows in a collaborative sense;
- detecting patterns, trends, thus better informing the team of the past, the present and predicting the future;
- tracking business and market performance, and predicting future outcomes;
- help enterprise/business users make better decisions at all levels;
- provide a common language for everyone to speak.

Many articles have been written about BI, and an almost equal number of database systems, query tools, dashboard GUI's , and assorted middleware purport to be or support BI. However, in 2011 I think we have a much better example to describe the ideal…

Is Social Networking just BI outside the workplace?

Think of an information system that isn't populated by users and managers, but by members who interact with enthusiasm. Members happily, if not constantly, inform the system of various matters from the profound to the trivial, leaving no subject or detail unreported. The same members are searching, reading, absorbing, editing, correcting and enhancing the data as they go, making it largely self-scrubbed. Connections between members and matters of interest aren't linear or fixed, but rather are fuzzy and constantly changing. Information is collected, harvested, combined, built on and placed back in the cloud for further use. Sure, some inaccuracies occur, but these are weeded out or labelled as such by members.

Most amazingly considering the huge human effort required to keep this all going, the members do so with enthusiasm, dedication and intelligence (mostly). Consider also that (with very few exceptions) no one is paying them to do this, no one ordered them to do it, they just do it. Amazing! But why? It's going on all around us with search engines, portals and 'social media'.

Then consider the processes sitting over the top of these fuzzy data rivers. Google state their mission as organising the world's information to make it universally accessible and useful. This includes making information accessible in contexts other than a web browser and accessible to services outside of Google. The Google Data Protocol provides a means for external developers to write applications that let end users access and update the data stored by many Google products, which in turn summarise the interests, activities and (worryingly) personal details of millions of internet users. Google Analytics provides built-in reports for subscribing companies to understand their audience, advertising impact, traffic sources, conversions, content, and more, displayed through a dashboard or even via Google Maps.

Whilst the largest example, Google is just one of many companies at the forefront of internet-based BI. Human nature and our relationships to complex systems haven't changed in 25 years. We have mostly overcome our fear of technology, which is helpful in removing an inhibitor, but that's not the engine that drives all this. The fundamental motivator is what members get back for all their efforts, immediately, constantly, and in almost direct proportion to their actions. Retrieval. Actually, it's better than that, it's reciprocity of information, connections and other intangible benefits that make the Storage stage of the process so obviously worthwhile. If Gilliam had foreseen this, Brazil might have had a different ending.

The term Business Intelligence remains prejudiced by its MI roots, unless we unlock who can benefit from the information, interact with it, and how quickly they can feel the benefit.

Analysing information, and closing the loop

The turning point for many MRP2 projects came when people working with the system, particularly those crusty old-school planners and managers, started to see it work to their benefit. It wasn't that it saved them huge amounts of time or allowed them to reduce clerical staff (that came later), but it gave them information that they didn't previously have. MRP2 was also quick, so 'visibility' became more immediate. On better systems, managers could fiddle with key parameters such as batch sizes, lead times, minimum stocks, yields, etc. and see their proposed material orders, production schedules and projected inventory adjust instantly. They received immediate feedback to small adjustments, and so were rewarded for their efforts. Decision making became quicker and easier. Once we'd got past the inevitable 'garbage in / garbage out' stage, the benefits to managers of this MI system was obvious.

But what about the ordinary corporate citizens? Slowly we've raised the level of trust and allowed more staff to see more data, and some of it directly related to their own work. Falling hardware costs lead to the expectation that everyone must have a PC on their desk, networked to a central database. We continued to close the loops, which (as any control systems engineer will tell you) is essential for a system to become balanced. Like steering a car, it's difficult to do quality work of any kind if you can't quickly see the results of your actions.

BI philosophy began to gather steam when MI systems were expanded to give people throughout the company an ability to withdraw information as well as deposit, to receive timely, clear and relevant feedback related to their actions.

The next quantum step was when we could see information about those around us, or on the company as a whole. Knowing that many people can see what you're seeing can be very motivating.

Notes for Engineers

Rule #1 – People are not machines. This is particularly important for engineers to remember. We tend towards technology centric solutions, based on cold hard logic. Back in the MRP2 days we complained about the lack of support in collecting, cleaning, transforming, storing, etc., the data vital to our systems' successes. As illustrated in Figure 2, today we can recognise that systems must be human-centric, allowing all participants to explore, analyse, communicate, monitor and predict. Our understanding has moved from MI to BI.

Rule #2 – Refer to Rule #1.

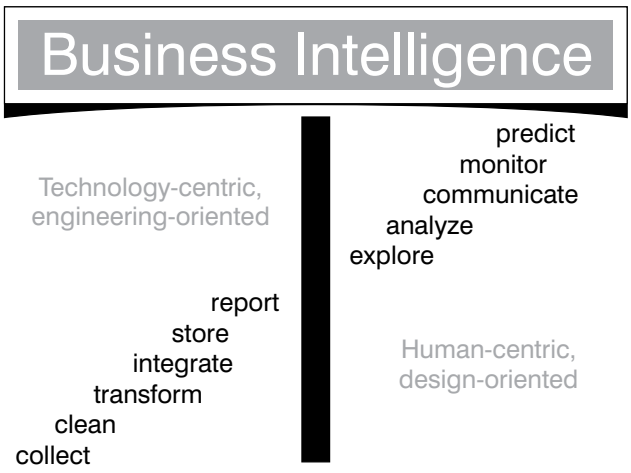

Figure 2 – The BI "event horizon"
[Systems transcend narrow MI definitions and become empowering BI environments when human-centric designs enable fuzzy thinking as well as management control.]

Good to Great

One of my favourite business references is Jim Collins' 'Good to Great' (2001). This is a well researched sequel to his prior best seller, 'Built to Last', and discusses BI in the form of critical ratios, unique denominators and flywheel momentum. The underlying proposition is simple … each company will have a critical few, possibly unique, ratios that describe its health or competiveness. Often these are '$ per something', but could be any related output versus input (labour, capital, energy, material, etc.) or a change in value over time. Collins presents case histories on successful companies that have a clear understanding of their critical ratios and have built company systems to maximise (or minimise) these measures. Once this momentum is established, it quickly becomes self-sustaining.

The concept is simple enough, and 'ratio analysis' has long been extolled by the accountants. After all, gross margin and EBIT/TA are just ratios. But this is not BI in itself. Most companies still only conduct ratio analysis in hindsight and at a very high level. The notion of live systems that harvest the flows of data and make comparisons in real-time, that all interested participants can see, is still pretty rare. Many companies see this as either beyond them or just plain unnecessary.

Of course there are exceptions. Call centres engage in BI. It's common in these environments to see large screens above the work floor, summarising the flow of calls in terms of pick-up, duration, lost calls, satisfactory resolutions, etc. Hopefully these screens are not just digital taskmasters, but are giving the team real-time feedback on critical success factors. Listed securities brokers and traders likewise see the effects of their work in real-time on company systems, which also aggregate and compare multiple data flows to senior managers. The information not only gives constant spot positions on complex portfolios, it looks backwards to calculate gains (hopefully) and forwards to

predict cash-flow, liabilities and predicted future returns. Everyone in the business can see information relevant to their responsibilities, plus those around them for a bit of healthy teamwork, competition and risk management. Such companies have an abundance of information flows to tap into, and have taken the time to collect and compare the flows that really matter.

But what about the rest of us? How can the rest of us be great companies if we haven't got rivers of information to tap into, to easily create and sustain such KPI's?

How do you stitch your quilt?

It's an unfortunate fact that business systems are often developed around a single corporate function, then expanded outwards into related functions. Accounting systems (general ledger, reporting, tax) now often include Payroll, but didn't for a long time. HR systems are still largely separate. Inventory control (MRP2/DRP) may interface with Accounting to a point but otherwise stand separate. Client Relationship Management (CRM) systems are specified and owned by Sales & Marketing and often don't interface with anything other than the Call Centre (client services). And so on. Imagine this IT landscape as a patchwork quilt. How do we harvest and compare data flows when many are disconnected?

Sadly there's no easy answer to that. All-encompassing ERP systems that integrate every aspect of a business are pretty rare, and can easily be obsolete by the time every last bit is implemented. Once implemented, managers can find they're steering the Titanic, so rigid and cumbersome the monolithic system has become. Or the system doesn't really suit all parts of the business, so bespoke modifications or standalone systems are demanded by some functions.

Some companies have found success by having a well-structured, open architecture, central data warehouse that can be fed from disparate sources. These companies can more nimbly develop and change systems in different parts of the business whilst maintaining protocols on feeds to the central database. This bolt-on / bolt-off approach can work well, but the central data will only remain healthy if it's fed in real-time and is used properly. The strategy will likely fail if it's infrequently fed, or presented as a Management Information hub. The strategy will more likely succeed as a cloud-like Business Intelligence 'wrap', feeding back to members in a prompt and indispensible way.

The key is in the stitching of the quilt. There are very few companies today who don't have large flows of real-time data coursing through their digital veins. If the stitching between the different pieces is clever enough, and a standard (protocol) can be maintained around a central database, then a BI system is possible. The more timely the reporting and feedback that can be provided to 'members', the more the data will be used, maintained and grow. As long as maintenance is not arduous (avoid hand stitching at all costs), it's surprising how quickly momentum is established.

Alternatively if you prefer hierarchies to quilts, Figure 3 illustrates layers of tools and plumbing that allow us to mine, connect, aggregate and then operate on the data from disparate functional silos. Off-the-shelf ETL solutions are the beginning, upon which bespoke or published reporting and analysis tools can be mounted.

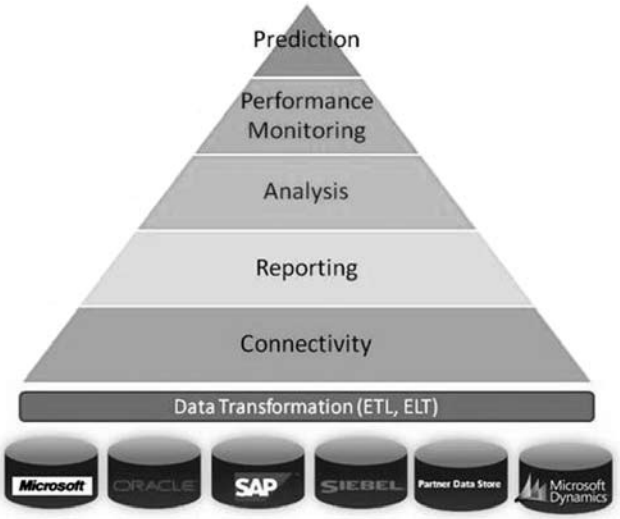

Figure 3 – Classic information systems hierarchy [Information business system architecture is based upon layers of databases, middleware, data mining, aggregation, query and analytic applications.]

You will know when momentum is being achieved when the company language beings to change.

The language that we speak here…

I know it's not a management reference, but Jack Vance's 1958 novel, 'The Languages of Pao', contains a great business truth. The central tenet is that beliefs and behaviour are shaped by language. You can introduce new concepts by inventing new words; we do that all the time with jargon and acronyms. Further, you can alter attitudes and understandings by adopting new phrases and grammar. Ultimately you can shape culture itself if you can change the way people talk, alter the language that they use.

Any BI strategy is just a dry and academic IT system if it's not talked about. If you get your ratios right, plus timing and accessibility, then we can talk about the business in the terms expressed on the BI dashboard. The language when used becomes alive. If not used as a living language then it becomes Latin.

Language adds to the environment, creating a framework within which people can exchange ideas and discuss issues that matters. Language provides a framework through which new ideas and beliefs can emerge. Language can be a direct contributor to the productivity of a company, through the beliefs carried by staff. Examples of negative language that undermine productivity and company health are easy enough to recall. Examples of positive, formative language should be more common with an informed and involved population.

What senior management pays attention to

An unsurprising fact of business life is that people pay attention to what their manager pays attention to. For BI, this attention must come from the top. If the CEO talks in terms of the key ratios, uses the language of what she/he is seeing on the dashboard, guess what happens. Everyone talks the language pretty soon. If the CEO is not that interested, well … you know the rest.

There's another whole thesis to be written on CEO relationships with technology. Sadly some CEO's and company directors still regard IT as a necessary evil. They know it's important and agree that systems must be maintained and developed to 'keep pace', but often their approach is one of risk minimisation. Some CEO's see their IT capabilities as key business assets, and will challenge their CTO/CIO to meet their expectations around BI as an integrated part of their plans for the company as whole. If you don't have such a CEO, find one and hang on to him/her.

A journey of steps and stages

Like TQM as a way of thinking and acting, which took decades to imbed in business culture (still not completely), BI ideals also suggest a journey on many fronts.

The points in each cell in Table 1 may not fit each company exactly; if not, feel free to tailor them. The proposition is that BI isn't just an IT project, nor a system/package you can buy off the self. Like TQM, BI is a way of thinking that if thoroughly applied will transform not just company technology, but its people, processes, systems and ultimately strategies. The strategic application will generally lag the technology, processes and systems, and their adoption by the people.

Sadly I suspect that many of us might rate our companies as somewhere between 'elementary' and 'basic' on the above scale when measured at the strategic level, if not below that.

Table 1 – Strategic Evolution

[BI as a whole-of-business strategy ultimately encompasses/supports all developments across a company. Technology will tend to lead as an enabler, but the full potential is not realised until it percolates up to strategy setting.]

	Elementary	Basic	Advanced	Sophisticated
Strategy	• Ad hoc • Accidental • Reactive	• Current & Future States defined • Technology roadmaps established	• Active business management • BI reflected in all IT plans	• Business and Technology strategies aligned • Key ratios drive Innovation which supports business strategies
People	• Functional Structure • Ad hoc innovation & project teams	• Early cross-functional structures • Communities of knowledge and practice emerging • New acronyms	• Established cross-functional communities • Collaborative partnerships established. • New jargon • New language	• Innovation & strategy teams established • Culture of innovation • Highly engaged and motivated team
Processes & systems	• Ad hoc • Unstructured • Isolated	• Stage gate processes • Selective integration • Basic collaboration	• Integrated processes • Efficient data flows • Established collaboration	• Fuzzy information flows. • Knowledge sharing across enterprise
Technology	• Excel • PowerPoint • Word • Email	• SharePoint, early stage gate (workflow) process • Some central database • Basic dashboard tools • Instant Messaging	• Integrated idea and data management • Stage Gate monitoring • Enhanced collaboration • Enhanced dashboard & reporting	• Integrated cloud computing approach to information sharing • Technology inseparable from company strategy

How to start?

There's no 'one size fits all', but you may consider…

1. Get the CEO engaged. If you are the CEO, even better.
2. Identify the core components that will make up your Business Intelligence strategy. Leverage existing information gathered from internal and external sources as far as possible.
3. Start analysing large amounts of corporate data as it flows. Start with flows easily reached.
4. If it looks wrong then go to the source, don't adjust at the report level. Provide drilldowns from aggregates to raw detailed data for further investigations.
5. Define KPI's and detect patterns in key business metrics. Share patterns and trends, informing team members of the past and the present.
6. Start tracking business performance. Consider low hanging fruit such as;
   a. Gross Margin reporting (revenue vs direct costs by product line)
   b. Administration costs vs number of transactions
   c. Supplier delivery data vs ship-on-time vs back-orders
   d. Deliveries to clients vs client enquiries
   e. Incident tracking, analysis and time series reporting (tabular, charts)
   f. Add more complex, higher level measures progressively.
7. Build the measures into regular company reports, meetings, and discussions. React to the numbers, good and bad.
8. Promote access to the information. Give as many staff as possible access to the system. Treat them as members. Allow fuzzy connections and flows to develop. Accept new requests and ideas.
9. Talk about it more. Bring the KPI's and BI concepts into the corporate language.
10. Get the CEO engaged.

Making some early deliveries is essential. Getting some BI scores on the board, even low level ones, helps the buy-in and adds to the momentum. Long waits for big builds can have the opposite effect. Like a living language, BI should evolve and grow with the business. If the CEO and senior management pay attention to the measures early then this will happen naturally.

When the CEO believes that company objectives can be achieved through the language of BI and the selected KPI's, the advanced and sophisticated stages will become within reach.

Observations and conclusions

Australian industry in 2011 is under great pressure on many fronts, with many companies outside the Resource Sector struggling for relevance. Those that survive need to be clever and nimble to remain differentiated. If we are to become a true 'knowledge economy' as government tells us, we need to make much better use of our information flows.

In support of BI as a philosophy and roadmap to becoming a knowledge economy, we may consider the following.

A. Information is an asset and should be treated and used as such.
B. The value of BI investments depends upon the ability of members to access and interpret the results and take action.
C. A defined BI strategy is key (roles, funding, architecture, priorities, sponsorship, and objectives). Avoid monolithic projects, but build progressively within the strategy.
D. More users collaborating with information increases the value through economies of scale and network effect. Consider the social networking example.
E. There is little point in improving the quality of information if people can't reach it, don't know how to use it effectively, or can't relate it to their daily work.
F. More information is not always more valuable. However, more combinations of information (particularly ratios) often are. Experiment with the data.
G. Unused information can be a liability. No value is extracted from it, but storage and management costs are incurred. Be parsimonious.
H. Information gives birth to language, and language shapes beliefs, behaviours and ultimately outcomes. Use BI to talk about your business world. Make it part of your language.

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Nomenclature

APICS: Australian Production & Inventory Control Society, the local Operations Management organisation.

BOM: Bills Of Material.

CI: Continuous Improvement, Six Sigma.

DRP: Distribution Resource Planning.

EBIT: Earnings Before Interest & Tax / Total Assets.

ERP: Enterprise Resource Planning.

ETL: Extract Transform Load. Data warehousing consolidates data from different source systems; each a separate system.

GM: The usual definition of GM% is (Sales Revenue – Cost of Sales) / Sales Revenue.

GUI: Graphic User Interface.

MRP: Material Requirement Planning.

MRP11: Manufacturing Resource Planning.

KPI: Key Performance Indicators, sometimes defined as measurements of Critical Success Factor.

Layout Planning: based on Industrial Engineering techniques

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In brief

The prime objectives for Layout planning as summarised as:

- Reducing costs
- Improving Service/Operations
- Increasing Output
- Improving work place safety
- Improving working conditions
- Improving Maintenance
- Streamline process work flow

Where this improvement method is applicable

- Manufacturing shop floor
- Warehouses
- Inspection and Quality Control areas
- Laboratories
- Offices
- Service industries

Fundamental considerations for an effective layout planning Project

- Integration
- Utilization
- Expansion
- Flexibility
- Closeness
- Orderliness
- Convenience
- Safety

Types of layout

- Layout by Fixed Position / Material Location
- Layout by Process / Function
- Layout by Product

Methods of approaching a layout

- Instinct and Intuition
- Find one ready-made
- Full participation of Everyone
- Flow of Material
- Organized Systematic Methodology

Main stages of layout planning

- **Selection of Location**.Various aspects such as financial implications concerning logistics capital deployment and various overhead costs to be worked out.
- **General Overall layout**. Traditional Industrial Engineering techniques such as Operations flow charts, Flow process charts, Flow diagrams and String diagrams can be performed by a trained practitioner.
- **Detailed layout**. This has to be formalised after consultation with personnel and associated cost benefits of the proposed Layout project
- **Installation**. Once the above is approved by the corporate management then the process of Installation will take place under the guidance of an Industrial Engineer.

Basis for layout planning

The following key aspects have to be considered prior to a Layout planning study:

- **P** Product or Material
- **Q** Quantity or Volume
- **R** Routing or Process
- **S** Services or support
- **T** Time or Timing

Process

1. Improving the Process as a Precondition for Layout Planning
2. Where applicable work simplification program has to be carried out.
3. Apply Methods Engineering techniques i.e.: Motion & Time Studies / MTM, Work sampling / Value Engineering

Material flow

To streamline the material flow the following Industrial Engineering strategies are to be adhered to for optimum efficiency

Effective Material flow

- Progressively
- Without detours
- Without back tracking

Material Flow Analysis

- Operations Process/Multi Product Charting/Process Mapping
- Grouping
- Flow diagrams

Relationships

Activity relationship being determined by the following process scenario.

Range A Heavy products or materials in large quantities – High Importance

Range B Job shop Layouts (Tool Making)

Range C Service Shops (Maintenance, Laboratories)

Range D General Office and Administration Areas

Space

The following five major methods to determine space requirements are:

- Numerical analysis and calculation
- Converting
- Space standards
- Roughed – out Layout
- Ratio Trend and Projection

The Practitioner has to balance or compromise what is determined as space required with what can logically be made available.

Material handling

When planning for an effective layout, Material handling aspects have to be considered

A simple definition for Material Handling…

- Is handling of material
- Is not confined to the movement of items.

The practitioner has to target material handling by defining handling systems and methods

So the Material handling Equation would be:

Material + Move = Method

Considerations while planning for a layout design

The following aspects have to be taken into consideration when at the problem definition stage of the proposed project.

- ❖ Maintenance/Tool room
- ❖ Personal Requirements (locker rooms, canteen etc)
- ❖ Production Planning and Control
- ❖ Rework and Scrap Handling
- ❖ Site Conditions//Environment/Building features (Windows ,Floor load, Ceiling height)
- ❖ Information Processing and Technology (Computer Centre)
- ❖ Occupational Health and Safety
- ❖ Legislation and codes of practice

Approval and selection criteria

a. Selection Criteria

- Balancing advantages against disadvantages
- Simulation/Weighted factor Analysis
- Decision Analysis
- Cost Benefit Analysis

b. Approval process

- Corporate Management
- Installation / Maintenance personnel
- Occupational Health & Safety personnel

Installation procedure

- Who should make the move
- What to Move/Sequence of Move(s)
- New Equipment
- Phase in/Phase out of production

Problems associated with layout planning projects

- Product might change/Quantity might change – Unpredictable
- Scope of layout not clearly defined at Problem definition stage
- In most cases there was no participation by the top management
- Too many assumptions and no actual data
- Danger of getting too specific
- Schedule wrong

MOST® work measurement system

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Introduction

MOST® is a Registered Trademark of H B Maynard & Co – ACCENTURE LLP. MOST® stands for the Maynard Operation Sequence Technique. It is more than just another pre-determined motion time system and does not make the well known MTM system obsolete. In fact MOST® is an efficient way to develop time standards that are too time consuming with the traditional approaches – time study or MTM. Besides an enhanced speed of application of 10 to 20 times the speed of MTM-2, and 30 to 40 times the speed of MTM-1 (Source: HB Maynard), MOST® is accurate to within +-5% at 95% confidence limits at a Balance Time of about 2 minutes. However, extensive studies have shown that where variation in methods abound, MOST® can achieve the same degree of accuracy at a much shorter balance time that has been validated by many industrial engineering studies in the USA.

The use of MOST® as a work measurement tool provides great scope to industrial applications in most manufacturing as well as service industries. MOST's fast track motion sequences enable the analyst to develop more consistent and accurate standards that could only be achieved after a long period of practice with other measurement systems. While MOST® does not render Time Study and MTM obsolete, it certainly, in many cases, is a better way to make use of the data derived from these more traditional methods. Once time study data or a MTM standard is available, the MOST® system will transform this data into information (based on statistical analysis) for easy use on the MOST® system and the MOST® standard motion sequences. These standard motion sequences are the key to MOST®'s success over other systems. There are six standard motion sequences that MOST® employs to provide a fast track approach to work measurement. Of these, three are for general industrial use, (see Figure 1) while another three are designed for heavy industrial applications where weight lifting – either manual or with truck or powered cranes, is required.

The development of the MOST® work measurement system is centered around three key motion sequences from which 100% of all industrial and administrative work can be identified. The motion sequences are as follows:

1) General Move Sequence ABG ABP A
2) Controlled Move Sequence AGB MXI A
3) Tool Use Sequence AG ABP U ABP A

Almost 100% of all manufacturing and assembly work can be analyzed through use of the above three motion sequences. Because motion sequences are identified easily, errors brought about by an applicator's errors and lack of analysis skill are reduced to almost zero.

MANUAL HANDLING		
Activity	**Sequence Motion**	**Sub-activity**
General Move	ABD ABP A	A – Action Distance B – Body Motion G – Gain Control P – Place
Controlled Move	ABG MXI A	M – Move Controlled X – Process Time
Tool Use	ABG ABP U ABP A	F – Fasten L – Loosen C – Cut S – Surface Treat T – Think M – Measure U – Tool Use Time

Figure 1 – sequence models comprising the basic MOST® techniques
Source: MOST® Work Measurement – Kjell B. Zandin

Unlike traditional methods of analysis, MOST® does not require the analyst to make a detailed analysis of the motions made in each operation. All that is necessary is to be able to describe the methods of work. Next, the analyst needs to index a value to each of the actions as shown on the standard motion sequence. Each index applied describes the actions made and these are available from the MOST® data card.

For example, a typical pick up and assembly of a screw on a bench-top would be analyzed using the General Move Sequence as follows:

Explanation

GET ← A_1 = Within Reach Distance To Screw; B_0 = No Body Motion Involved; G_1 = Easily Grasp/Light Object

PLACE ← A_1 = Within Reach Distance To Place Screw; B_0 = No Body Motion Involved; P_3 = Place of Screw Requiring Simple Adjustment

RETURN ← A_0 = Return Action Distance

The time value is obtained by adding all the indices as follows:

1 + 0 + 1 + 1 + 0 + 3 + 0 = 6

6 x 10 (Multiplier) = 60 TMU

If the screw-driver is used to fasten the screw on an assembly, the MOST® indexes would be made on the TOOL-USE SEQUENCE (ABG ABP U ABP A) which is as follows:

$A_1 B_0 G_1$ $A_1 B_0 P_3$ F_{16} $A_1 B_0 P_1$ A_0

24 x 10 = 240 TMU

where $A_1 B_0 G_1$ = Pick Up Sequence

$A_1 B_0 P_3$ = Place Sequence

F_{16} = Tool Use Process Time (6 to 9 hand turns)

$A_1 B_0 P_1$ = Aside Tool Sequence

A_0 = Return Action

If the foot is placed on a pedal to operate a riveting machine, the analysis involves the use of the controlled-move sequence, which is analyzed as follows:

$A_0 B_0 G_0$ $M_1 X_3 I_0$ A_0

0 + 0 + 0 + 1 + 3 + 0 = 4

4 x 10 = 40 TMU

where $A_0 B_0 G_0$ = Foot Already on Pedal

$M_1 X_3 I_0$ = Foot Action & Machine Process Time Sequence

A_0 = Return Action

Almost 100% of all manufacturing and service-related industry processing methods can be analyzed with the above three MOST® standard sequences. Because they are easy to use and fast to apply, engineers using MOST® will learn to appreciate the system for its uniqueness in simplifying documentation and paperwork.

In addition to the general assembly and manufacturing operations, there are occasions for MOST® to be applied to heavy engineering work, warehousing operations, cargo handling and trucking operations. MOST® takes care of these areas by employing three additional standard operation sequences as described below.

These three other motion sequences for common use in medium to heavy industrial operations are identified as follows:

1) Manual Crane Sequence A T F V L V P T A
2) Powered Crane Sequence A T K T P T A
3) Truck Sequence A S T L T L T A

These motion sequences are designed to help identify material handling – object movements with equipment, cranes and trucks. They are commonly used in metal working industries where heavy components must be moved by crane – manual or automatic. These motion sequences are also commonly used to analyze cargo-handling, operations in storage, packaging, shipment and trucking operations.

EQUIPMENT		
Activity	**Sequence Model**	**Sub-activity**
Move with manual distance (JIB Type Empty)	A T K F V L V P T A	A – Action Distance T – Transport K – Hook Up & Unhook F – Free Object
Controlled Move	ABG MXI A	V – Vertical Move L – Loaded Move
Tool Use	ABG ABP U ABP A	P – Place A – Action
Move With Powered Crane (Bridge Type)	A T K T P T A	T – Transport K – Hook Up & Unhook P – Place A – Action
Move With Truck (Forklift Type)	A S T L T L T A	S – Start & Park T – Transport L – Load or Unload

Figure 2. Most sequence models for equipment handling objects
Source: MOST® Work Measurement – Kjell B. Zandin

For example, the Crane Sequence for lifting a heavy object manually with overhead crane can be described by the following sequence:

A T K F V L V P T A

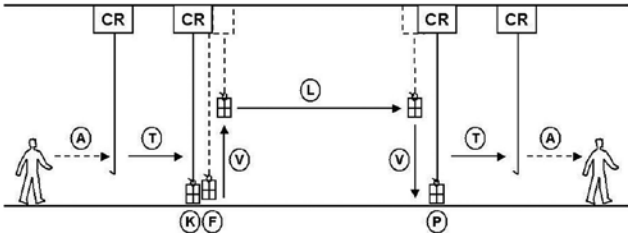

Figure 3. Manual crane sequence
(Diagram adapted from "MOST® Work Measurement" by Kjell B. Zandin)

A – Action distance to the crane
T – Transport the crane empty to the object to be moved
K – Hook-up and unhook the object
F – Free the object from its surroundings
V – Vertical move 'Up'
L – Loaded move of the crane
V – Vertical move 'Down'
P – Place the object
T – Transport the crane empty 'Aside the crane'
A – Action distance to return

The truck Operation Sequence for cargo handling, warehousing operations and general trucking activities can be described with the following sequence:

A S T L T L T A

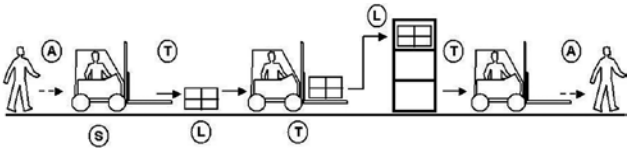

Figure 4. Truck operation sequence (Diagram adapted from "MOST® Work Measurement" by Kjell B. Zandin)

A – Action distance to the truck
S – Start and park the truck
T – Transport truck empty
T – Transport truck loaded
L – Unload truck
T – Transport truck empty
A – Action distance from the truck

The Powered Crane Sequence is for lifting heavy goods with an overhead crane can be described as follows:

A S T L T L T A

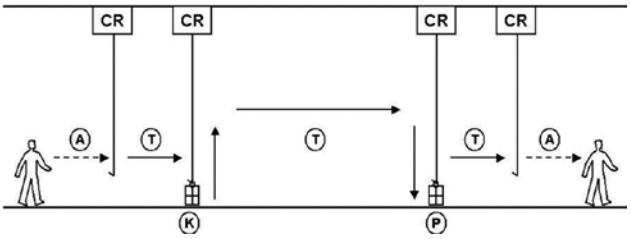

Figure 5. Powered crane sequence (Diagram adapted from "MOST® Work Measurement" by Kjell B. Zandin)

A – Action distance to the object
T – Transport crane to the object
K – Hook-up & unhook object
T – Lift object & transport it
P – Lower & place the object
T – Transport the crane aside
A – Action distance to return

As can be seen from the above, the MOST® standard motion sequence provides a great aid to establishing methods and time easily and with less effort. The MOST® system of work measurement manages data that are derived from MTM analysis and time study. Time Standards that are developed by traditional methods can be converted into special MOST® index values through a simple graphical comparison process. Special time data from unique processes from any industry can be similarly converted to MOST® indexes values. Once this is achieved, the use of MOST® standard sequences will analyze the reliable methods and work time to obtain the standardized work.

MOST® Training

MOST® training will equip the analyst to become a more productive member in the organization to undertake:

- Value-adding analysis
- Production job standards
- Methods improvements
- Set-up time reduction
- Cycle time reduction
- Manpower analysis & planning
- Job cost & estimating
- Capacity management, and
- Contribution & profit analysis

Where Can MOST® Be Applied?

Generally, MOST® can be applied with good results in the following areas:

- Common medium sized batch and medium cycle time manufacturing operations in machining, fabrication and assembly;
- Repetitive, short-cycle, identical activities as in manual assembly;
- Non-repetitive, long cycle, heavy engineering operations;
- Repetitive or non-repetitive highly variable material handling, warehousing activities;
- A variety of short or long cycle maintenance job tasks.

And since MOST® is so universal, it can be used in a wide variety of industries. Here are some of the many industries where MOST® has already been successfully applied:

- Toy assembly
- Computer industry
- Metalworking
- Electronics manufacturing
- Machine automation
- Material handling
- Maintenance operation
- Repair work
- Shipbuilding
- Cargo-handling
- General inspection activities
- Apparel manufacturing
- Food processing
- Agricultural operations
- Construction equipment
- Furniture manufacturing
- Steel production
- Shoes manufacturing
- Hospital management
- Automotive assembly
- Warehousing
- Administrative work

The MOST® Work measurement System caters to the different needs of industry groups to provide the right measurement solution. This is done by offering 3 unique measurement systems, namely,

1. Mini-MOST®
2. Basic-MOST®
3. Maxi-MOST®

– to provide the required precision and accuracy to accord with the variability and the length of the activity cycle time.

The MOST® System is the world's most user-friendly work measurement system in terms of ease of application, wide-industry applicability, good accuracy and simplicity in design and analysis. However, it still requires an experienced instructor to turn it into a powerful tool in the hands of industrial engineers.

The supply chain management optimization problem

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Abstract

Supply chain management (SCM) has becoming a topic of critical importance for both companies and researchers today. In this paper, a Linear Programming model is used for optimization of the costs of transporting a truckload of a product from the plant under transporting cost constraints that will minimize the transportation cost. Sensitivity Analysis (SA) presents a post optimality investigation of how a change in the model data changes the optimal solution. SA allows decision makers to determine how "sensitive" the optimal solution is to changes in data values.

Keywords: ***Supply chain management, transportation model, linear programming and sensitivity analysis.***

Introduction

Supply chain management is a field of growing interest for both companies and researchers. As nicely told in the recent book by Tayur, Ganeshan, and Magazine (1999) every field has a golden age: This is the time of supply chain management. The term supply chain management (SCM) has been around for more than twenty years and its definition varies from one enterprise to another. We define a supply chain (SC) as an integrated process where different business entities such as suppliers, manufacturers, distributors, and retailers work together to plan, coordinate, and control the flow of materials, parts, and finished goods from suppliers to customers. This chain is concerned with two distinct flows: a forward flow of materials and a backward flow of information. Geunes, Pardalos, and Romeijn (2002) have edited a book that provides a recent review on SCM models and applications.

As mentioned above, a supply chain is an integrated manufacturing process wherein raw materials are converted into final products, then delivered to customers. At its highest level, a supply chain is comprised of two basic, integrated processes: (1) the Production Planning and Inventory Control Process, and (2) the Distribution and Logistics Process.

These Processes, illustrated below in Figure 1, provide the basic framework for the conversion and movement of raw materials into final products.

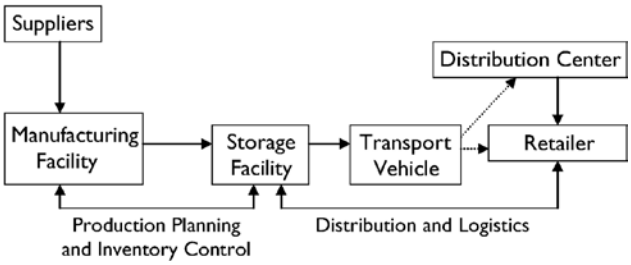

Figure 1. The Supply Chain Process

The Production Planning and Inventory Control Process encompasses the manufacturing and storage sub-processes, and their interface(s). More specifically, production planning describes the design and management of the entire manufacturing process (including raw material scheduling and acquisition, manufacturing process design and scheduling, and material handling design and control). Inventory control describes the design and management of the storage policies and procedures for raw materials, work-in-process inventories, and usually, final products.

The Distribution and Logistics Process determines how products are retrieved and transported from the warehouse to retailers. These products may be transported to retailers directly, or may first be moved to distribution facilities, which, in turn, transport products to retailers. This process includes the management of inventory retrieval, transportation, and final product delivery.

These processes interact with one another to produce an integrated supply chain. The design and management of these processes determine the extent to which the supply chain works as a unit to meet required performance objectives.

Transportation Model

In 1941 Hitchcock first developed the transportation model. Dantzig (1963) then uses the simplex method on the transportation problem as the primal simplex transportation method. The modified distribution method is useful in finding the optimal solution for the transportation problem.

Transportation models are primarily concerned with the optimal way in which a product produced at different plants can be transported to number of depots or warehouses. The objective in a transportation model is to fully satisfy the destination requirements within the operating production

at capacity constraints at minimum possible cost. Whenever there is a physical movement of goods from the point of manufacture to the final consumers through a variety of channels of distribution (wholesalers, retailers, distributors etc.), there is need to minimize the cost of transportation (such as maintenance cost, personnel cost, fuel cost, and loading/offloading cost) so as to increase the profit on sales.

Transportation problems arise in all such cases. It aims at providing assistance to top management in ascertaining how many units of a particular product should be transported from plant to each depot to that the total prevailing demand for the company's product is satisfied, while at the same time the total transportation costs are minimized.

Transportation model generally deal with get the minimum cost plan to transport a product from a source (Plant) (m), to number of destination (Depot) (n).

Research methodology data collection

The model provides a systematic tool to identify the relevant information required to answer the question: how can transportation cost be minimized?

The data was acquired after an extensive search that involved personal and

telephone interviews with experts in the area and internet search.

In the model it is possible to specify many depots and years in business as required transporting the products. For the purpose of this research, eight depots and six years (2003 to 2008) in business were selected to give a diverse range of characteristics. Table 1 shows the yearly transportation costs per truckload from the plant to the depots. These costs are based on mileage, maintenance, fuel, driver's welfare, and loading/Offloading rates.

Transportation problem illustrative example

A coca cola plant (Onitsha Road) in Nigeria has resources to transport its products from the plant to their various depots for six years with the average costs as summarized in Table1.

As can be seen from Table 1, there is some differences in transportation costs based on the yearly difference in the number of trucks available per depot. From the data the total cost of transportation for the six years was found

to be N0.0484m per truckload. This suggests that the realized sample may be considered acceptable representation of the transportation problem in Supply Chain Management.

Analysis of the survey data

The data obtained from the survey were analyzed using one approach Operation Research (OR). The OR approach involves the use of the tools of linear programming to model the problem.

The general problem of IP is the search for the optimal minimum of a linear function of variables constrained by linear relations (equations or inequalities).

General LP formation for transportation problem

The general of LP is the search for the optimal (minimum or maximum) of a linear function of variables constrained by linear relations (equations or inequalities). The IP optimize a linear objective function subject to a set of linear equalities or inequalities.

The general transportation problem minimization model is:

Table 1: Yearly Cost of Transportation per Truck load (N m)

	Depot								Number of truck available per year
Location	D1	D2	D3	D4	D5	D6	D7	D8	
Year	Ikotekp	Umuahia	Mbaesi	Calabar	Aba	Orlu	Eket	Uyo	
2003	0.0020	0.0009	0.0008	0.0011	0.0006	0.0004	0.0008	0.001	49
2004	0.0021	0.0010	0.0009	0.0012	0.0006	0.0004	0.0008	0.0011	57
2005	0.0022	0.0010	0.0009	0.0013	0.0007	0.0004	0.0009	0.0011	63
2006	0.0026	0.0012	0.0011	0.0015	0.0007	0.0005	0.001	0.0013	65
2007	0.0017	0.0008	0.0006	0.001	0.0005	0.0003	0.0007	0.0008	73
2008	0.0020	0.0010	0.0009	0.0012	0.0006	0.0004	0.0008	0.0010	73
Yearly Number of truck per depot	23	41	35	58	71	53	53	46	

Objective Function

Minimize $Z = c_1 x_1 + c_2 x_2 + \ldots\ldots + c_n x_n$

Subject to

$a_{11}x_1 + a_{12}x_2 + \ldots\ldots\ldots\ldots + a_{1n}x_n \geq S_1$,

$a_{21} x_1 + a_{22} x_2 + \ldots\ldots\ldots + a_{2n} x_n \geq S_2$

$a_{m1} x_1 + a_{m2} x_2 + \ldots\ldots\ldots + a_{mn} x_n \geq S_m$

$x_j \leq 0$

$j = 1, 2, 3 \ldots. n; i = 1, 2 \ldots m$

Where

Z = objective function that minimized transportation cost (Nm)

x_j = choice variable (trucks) for which the problem solved

c_j = coefficient measuring the contribution of the jth choice variable to the objective function.

S_i = constraint or restrictions placed upon the problem

a_{ij} = coefficient measuring the effect of the ith constraint on the jth choice variable.

The above problem can be solved using Software packages such as TORA and MS-Excel SOLVER which provide following LP information:

1. Information about the objective function:
   a. objective function optimal value
   b. coefficient ranges (ranges of optimality). The range of optimality for each coefficient provides the range of values over which the current solution will remain optimal. Managers should focus on those objective coefficients that have a narrow range of optimality and coefficients near the endpoints of the range.
2. Information about the decision variables:
   a. their optimal values
   b. their reduced costs
3. Information about the constraints:
   a. the amount of slack or surplus
   b. the dual prices that represent the **improvement** in the value of the optimal solution per truck **increase** in the right-hand side.
   c. Right-hand side ranges (ranges of feasibility) that represent the range over which the dual price is applicable. As the RHS increases, other constraints will become binding and limit the change in the value of the objective function.

Sensitivity Analysis Rules

- For the objective function coefficients):

  If $\sum_j \delta C_j / \Delta C_j \geq 1$, the optimal solution will not change

Where:

δC_j is the actual increase (decrease) in the coefficient,

ΔC_j is the minimum allowable increase (decrease) from the sensitivity analysis.

* For the RHS Constraints

If $\sum_j \delta b_j / \Delta b_j \geq 1$, the optimal basis and number of trucks yearly will not change

Formulation of transportation problem as a linear programming model

The LP model and analysis exploit the structural advantages that accompany deterministic data and avoid representing potentially costly errors. In reality, the decisions occur sequentially over time. This manufacturing problem is straight forward.

From the Survey data Table 1

In the following, let

x_1 to x_8 = yearly number of truck per depot

The objective function can be represented as:

Minimize $Z = 0.0020X_{11} + 0.0009X_{12} + 0.0008X_{13} + 0.0011X_{14} + 0.0006X_{15} + 0.0004X_{16} + 0.0008X_{17} + 0.0010X_{18} + 0.0021X_{21} + 0.0010X_{22} + 0.0009X_{23} + 0.0012X_{24} + 0.0006X_{25} + 0.0004X_{26} + 0.0008X_{27} + 0.0011X_{28} + 0.0022X_{31} + 0.0010X_{32} + 0.0009X_{33} + 0.0013X_{34} + 0.0007X_{35} + 0.0004X_{36} + 0.0009X_{37} + 0.0011X_{38} + 0.0026X_{41} + 0.0012X_{42} + 0.0011X_{43} + 0.0015X_{44} + 0.0007X_{45} + 0.0005X_{46} + 0.0010X_{47} + 0.0013X_{48} + 0.0017X_{51} + 0.0008X_{52} + 0.0006X_{53} + 0.0010X_{54} + 0.0005X_{55} + 0.0003X_{56} + 0.0007X_{57} + 0.0008X_{58} + 0.0020X_{61} + 0.0010X_{62} + 0.0009X_{63} + 0.0012X_{64} + 0.0006X_{65} + 0.0004X_{66} + 0.0008X_{67} + 0.0010X_{68}$ {i.e. Total cost of transporting a truckload of the products from coca cola plant (Onitsha Road) annually for six years}

Subject to:

$X_{11} + X_{12} + X_{13} + X_{14} + X_{15} + X_{16} + X_{17} + X_{18} = 49$

$X_{21} + X_{22} + X_{23} + X_{24} + X_{25} + X_{26} + X_{27} + X_{28} = 57$

$X_{31} + X_{32} + X_{33} + X_{34} + X_{35} + X_{36} + X_{37} + X_{38} = 63$

$X_{41} + X_{42} + X_{43} + X_{44} + X_{45} + X_{46} + X_{47} + X_{48} = 65$

$X_{51} + X_{52} + X_{53} + X_{54} + X_{55} + X_{56} + X_{57} + X_{58} = 73$

$X_{61} + X_{62} + X_{63} + X_{64} + X_{65} + X_{66} + X_{67} + X_{68} = 73$

$X_{11} + X_{21} + X_{31} + X_{41} + X_{51} + X_{61} = 23$

$X_{12} + X_{22} + X_{32} + X_{42} + X_{52} + X_{62} = 41$

$X_{13} + X_{23} + X_{33} + X_{43} + X_{53} + X_{63} = 35$

$X_{14} + X_{24} + X_{34} + X_{44} + X_{54} + X_{64} = 58$

$X_{15} + X_{25} + X_{35} + X_{45} + X_{55} + X_{65} = 71$

$X_{16} + X_{26} + X_{36} + X_{46} + X_{56} + X_{66} = 53$

$X_{17} + X_{27} + X_{37} + X_{47} + X_{57} + X_{67} = 53$

$X_{18} + X_{28} + X_{38} + X_{48} + X_{58} + X_{68} = 46$

$x_1, x_2, x_3, x_4, x_5, x_6, x_7, x_8 \geq 0$

Constraint (1) says that the total product supply at depots in 2003 is 49 truckloads. Constraints (2) to (6) similarly express the supplies at depots in 2004 to 2008 respectively.

Results and discussions

The results of the data obtained are discussed, summarized and present in simplex tableaus formats as well as in charts.

Solving this problem using TORA software package will result:

Minimum transportation cost Z = N0.02920m per truckload

X6 = 73, while other variables have zero values respectively.

The solution recommends the reduction cost of N0.01920m per truckload compared with the initial cost of N0.04840m.

The results conclude that the optimal decision is not to increase the number of trucks needed at depot number 6 (Orlu) from 53 to 73, slightly increase number of trucks at other depots.

Sensitivity analysis of the input data

In linear programming input data of the model can change within certain limits without causing the optimal solution to change. This is referred to as sensitivity analysis, (Taha 2008).

However, exactness of our LP model was confirmed by running sensitivity analysis. Through this the impact of uncertainty on the quality of the optimal solution was ascertained.

Through SA, it is possible to change the corresponding coefficient in the objective function and resolve the IP problem once more.

These observations give rise to the investigation of the SA.

Knowing that the structure of the problem does not change, it is possible to investigate how changes in individual data elements change the optimal solution as follows:

- If nothing else changes except the objective function value when slightly change the number of truckload, transporting cost and the nature of the solution changes considerably.
- On the other hand, if the transportation cost is kept fixed, and the number of truckload needed increase or drop by e.g. 10% and there would be no major impact on the solution, Firm would still transport their products and take the initial IP problem solution into consideration.

This result shows that maintenance, fuel, driver's welfare, mileage, and loading/offloading costs have significant effect on transportation costs. Given these constrains due consideration, transportation costs will be minimized.

Figure 2 represents the yearly costs of transportation cost constraints for the period of 6years.

This shows that 49.20% of the Company total expenditure under transportation sector for six years was on maintenance alone. While 27.98%, 17.79% and 5.03% was on fuel, driver's welfare and loading/offloading respectively. Figure 3 represents the yearly transportation cost per depot as from 2003 to 2008.

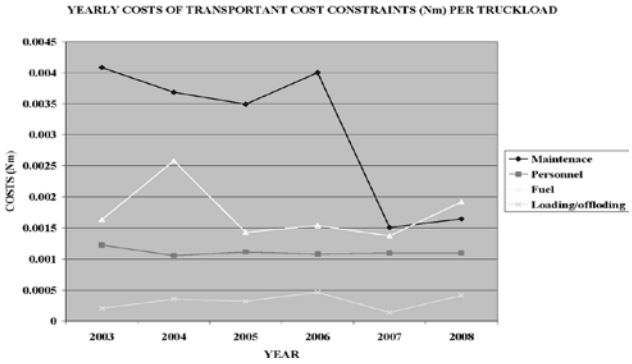

Figure 2

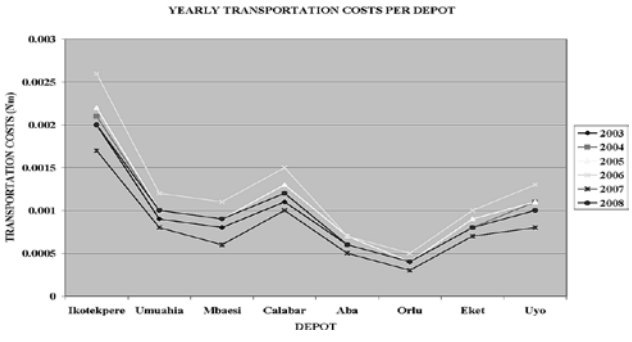

Figure 3

Conclusion

Managing data when constructing IP models can be challenging.

The data used in IP models is often clouded with uncertainty.

Sensitivity Analysis SA (or post-optimality analysis) is used to determine how the optimal solution is affected by changes, within specified ranges, in the objective function coefficients and the right-hand side (RHS) values. Sensitivity analysis is important to the manager who must operate in a dynamic environment with imprecise estimates of the coefficients. SA allows asking certain what-if questions about the problem. SA is appropriate when the basic structure of the model is not altered by the presence of uncertainty, for example, when all uncertainties will be resolved before any decisions are made.

When the decisions are to be made, a deterministic

model will be appropriate. In this situation, SA can help us to appreciate the impact of uncertainty. In all other cases, we cannot count on it to do so.

When information is obtained during a decision sequence, we have the opportunity to adapt to it. Whether the adaptation is imposed, as when costs are constrained by demand, or advantageous, as when supply chain decisions can be delayed until after demand is known, adaptation causes changes in the IP model. The constraint matrix changes considerably, affecting both the number of constraints and the number of variables.

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Sustainable Manufacturing

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Sustainable manufacturing can be defined as the creation and development of innovative new products and processes and services with the use of minimum energy and the creation of minimum waste using ecofriendly safe and non-toxic biodegradable materials with cradle to grave systems.

Background

The great stabilizing influences on the world helping us through the global economic crisis, which is still unfolding, are the manufacturing giants, particularly Germany.

The US would be able to pay its debt if it can use its people to add more value through its manufacturing industries. The value creating industry is manufacturing, not derivative trading.

The US has learnt nothing from the Asian crisis of 1997.

It was some considerable time after the global financial crisis that the Ayn Rand disciple, Alan Greenspan, came out with "Mea Culpa". However, US Wall street financiers still control the US congress and senate.

World debt and the global financial crisis and the high value of the Australian dollar are destroying Australia's manufacturing industry.

Where to from here for Australian manufacturing?

How then can we at least preserve what we have and then grow? How can we have a sustainable and competitive manufacturing industry?

Sustainability is not just about the environment. It is about jobs.

Sustainability is a complex mix of economic, social and environmental factors. Foremost amongst these are:

- Energy consumption
- Non renewable resource and material usage
- Poverty and population growth
- Nutrition and sanitation
- Health and wellbeing
- Hazardous waste production, and storage
- Soil degradation
- Forest depletion
- Use of toxic chemicals
- Air quality
- Climate change
- Desertification
- Toxic emissions and the ozone layer
- Marine life destruction
- Animal and plant destruction
- Water resources availability for an increased world population
- Overall contamination of all aspects of nature

Manufacturing will play an increasingly important role in solving all of the above problems.

There are many other good reasons to maintain a strong manufacturing sector. Some of the most important ones are:

- Security
- Defence
- The employment multiplying effect
- Creativity
- Manufacturing is the real basis of tangible wealth
- Manufacturing creates useful products we all use
- Manufacturing is the real basis of our high standard of living
- Manufacturing will enhance the prospects of developing new sources of energy and food for the future.
- Manufacturing is essential for long term sustainability and social well being

Where to from here for World manufacturing?

Manufacturing uses vast quantities of raw materials and energy. As the world population increases, the current rate of usage of raw materials and the waste that is created is unsustainable. It has been estimated that the total reserves of coal, oil, gas, shale and uranium and thorium will be exhausted in 400 years.

How then do we create a better and more sustainable and balanced future? What is sustainable manufacturing and how do we create it?

Firstly, we must design sustainability into the whole value creation system as well as each individual process.

In the future it will be more about reduce, reuse, recycle, repair and refuse. It will be about cradle to the grave use of renewable materials where possible using renewable energy with little waste and minimum harm to the ecology of the planet, climate, plants and animals.

Sustainable manufacturing is about reducing the use of energy and materials, reusing as much as possible and recycling as much as possible…waste less, consume less, interfere with nature less and share more.

Examples of sustainable manufacturing

Some of the companies the author has worked with have made startling progress already.

At Canon in Toride in Japan, where they practice Kyosei, all employees wear clothing made from "Coke bottles". PET coca-cola bottles are melted and turned into thread and woven into very attractive work-wear.

At Honda the new hybrid Insight uses far less fuel than conventional internal combustion engine cars, while the Clarity fuel cell car exhausts only water vapor as it uses only hydrogen as the fuel

At Panasonic in Osaka in Japan, old televisions are completely stripped and the various materials like glass and plastic and other metals are separated and reused or converted into useful materials.

A way forward?

This latter system is an example of the sustainable control manufacturers can implement by not selling the product outright to the consumer but instead leasing it and recovering it at the end of its economic use. We could introduce this system by legislation to all consumer items. The benefits to all would be considerable and less electronic waste like mobile phones would find their way into solid waste sites. This also opens up new avenues of business for struggling retailers.

These are all steps in the right direction but not enough.

The possibilities are endless but all this requires creative input. Innovative work practices by well educated scientists and engineers with the latest tools and techniques exploring new materials, less corrosive and lighter materials, and more innovative and integrated processes are needed. It also means less transport and more usage at the source with more efficient supply chains.

None of these can be exploited without a strong manufacturing base. This highlights the poor priorities that western society sets on educating professionals. Akito Morita of Sony once famously said that the trouble with the USA is that it trains too many lawyers and too few engineers. Australia is similar to the USA here.

As we move to a more sustainable future the air will be cleaner, conservation goals will become more rational, the forests and the general ecology will improve and greater self-sufficiency will result.

So how do we fit manufacturing into this picture?

New products can be created but policies and priorities have to be set, in the first instance by an enlightened government.

Back to Australian manufacturing

This paper considers only what is necessary for current Australian manufacturing plants to do immediately if they are to become sustainable using the current state of play of government policies on innovation and employment. Clearly the current system is not good enough when the world's second largest economy, China, controls its currency at a level which gives it an extraordinary competitive advantage - especially when combined with lower labour rates. China very successfully, therefore, is able to ramp up its value adding industries, manufacturing, to export large quantities of manufactured goods to the West, but mainly the USA and then buy up US treasury bonds. This will continue as along as it suits China since the West is not prepared to take hard decisions to ensure that the playing field is level.

From a broader visionary standpoint, with a strongly supported strategic plan aligned with strong leadership, new industries can be developed in Australia with the correct

incentives. These will be needed as the new economy takes hold and many conventional energy intensive industries collapse unless given some form of protection.

Employment must be seen as of greater priority than short term gains for investors. New industries need to be developed and those with a strong comparative advantage supported with a higher priority and policy decisions made so that they compete on a level playing field.

Broadly speaking, we can stratify manufacturing in Australia into primary manufacturing conversion, secondary manufacturing conversion, and elaborately transformed manufacturing. Examples of primary manufacturing are the alumina refineries, and aluminium smelters. An example of what is defined as elaborately transformed manufacturing is Cochlear, whilst those in between these two extremes could be termed secondary manufacturing like aluminium die-casters. The closer the processes are to simple conversion then generally the greater the energy consumption, so Australia suffers here.

Australia is strongest in primary manufacturing, but much of this is overseas owned and controlled. Rio Tinto is already restructuring to sell off its secondary processing alumina plants and aluminium smelters as the fear of the carbon tax starts to take hold.

In most cases the Australian population is too small for truly competitive and efficient global manufacturing facilities to be built here if they are only going to service the small domestic population. They must export. With Australia's isolation and very high currency, such ventures are doomed unless they are truly innovative and new and, even then, the window of opportunity is only a few years until it is more economic to move the factory overseas. Clearly to be globally competitive, we must export. To export successfully from Australia we must produce goods and services which have a competitive advantage. Aligned with this for survival, we must adopt the priority that employment and worker satisfaction should have a higher priority than short term profits and the next dividend to shareholders. This requires a change in culture which so far Australia and particularly overseas owned enterprises are not prepared to make.

To become more sustainable all manufacturing plants must continuously lift their performance by continuous innovation and research and development using the following principles:

- Reduce
- Recycle
- Reuse
- Repair
- Refuse

Reduce

- Energy
- Raw Materials
- Water
- Waste
- Idle time

Recycle

- Materials
- Waste
- Water
- Product
- Cradle to the grave control

Reuse

- Alternative Use
- Extend Life

Repair

- Preventive Maintenance
- Isolate and remove the limits

Refuse

- Refuse the use of toxic materials

Reduce

There are numerous ways we can improve efficiency and reduce energy and material consumption. The process and system must improve continuously.

Japan: Still showing the way?

The Japanese not only innovate continuously but they practice a concept called Kaizen, small incremental steps for continuous improvement. It is traditionally claimed that the Samurai warrior's sword is never sharp enough. This concept led to the phrase "six sigma" first coined by Motorola to define the very low defect rates in Japanese manufacturing plants. Australian plants, particularly small to medium sized manufacturers. are typically running at 3% defective in process and product. Top globally competitive plants like those at Honda, Panasonic, Canon and Toyota operate at defect levels measured at 3 parts per million. 3% defective translates into 30,000 ppm. If we can reduce defects and operate processes at six sigma and deliver on time we can reduce costs and working capital and hence also release capital for further technological improvements, research and development.

In fact, the improvements in cash flow will be enormous. It is only with an improvement in quality of both process and product that inventory can be confidently reduced. There are further improvements as waste material is reduced and this will also add to the profit.

The implementation of improved, high-quality processes has led to the use of the word "lean" to describe Japanese plants…they are lean in inventory, and space, both as a result of high quality processes and systems. To control these systems new management systems need also to be introduced.

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On performance theory and trust

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Abstract

This paper addresses the general issue of trust in human transactions from a performance theory point of view. The paper shows how the evolution of mankind's efforts to create efficient and effective schemes of transaction can be mapped onto utility and productivity experience curves, and how the role of trust has impacted the efficiency of such transactions over the eons. The paper then develops an expression for trust in terms of both goal and overall transactional performance measures. Finally, further use is made of performance theory in formulating an expression for an inventory of trust and how it is governed by an evaluation of the conditions of trust.

Keywords: ***trust, inventory of trust, performance theory, utility of resource, productivity of process, performance equation.***

Background

Evolutionary biologists tell us that early man invariably sought to minimise his energy investments in the meeting of basic survival needs (goals) (1) and, by today's evidence, nothing has changed! (2). Modern man still pursues the exact same basic objective of minimising his energy expenditure per transaction ($\mu_g = \frac{E_g}{t}$) as we continuously seek ever more efficent ways to effectively meet all kinds of goals (survival included).

Figure 1 is the utility of input resource (energy) experience curve $\mu_g(\chi)$ (3), andshows that initial (family-based) transaction (energy) costs in hunting and gathering were very high. Man soon learned to initiate more efficient (mutually satisfying) arrangements with other outside-of-family groups. These early interactions were still 'grunt'-based but, more importantly, reciprocated.

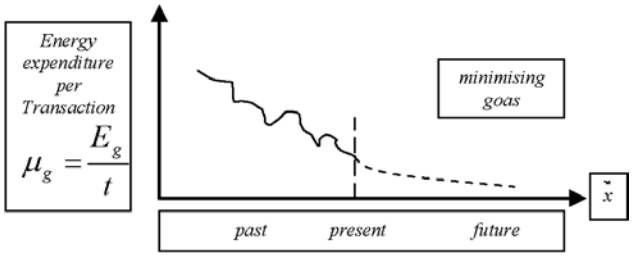

Figure 1: Man's quest to minimise the energy cost per transaction continues...

Grunts evolved into more efficient words which, in turn, evolved into more efficient albeit simple language to further facilitate and expedite man's growing list of mutual-survival interdependencies.

Social scientists believe these group networks then evolved and further developed into societies with their customary norms and customs. These evolved societies also offer the societal advantage of a broader range of lower energy cost exchangable goods and services, with many offering (importantly) a more competitive multiple choice of supplier. This range of ever-decreasing energy cost transactions continues to expand in the form of today's internet based commerce and social networking phenomena. Thus, man's continuing quest to further realise the transactional potential of energy (embeded in Figure 1) is reflected in the loci of minimising goal points marking the path from present to future in Figure 1.

Figure 2 shows man's corresponding productivity of process (transacting) experience curve $\eta_a(\chi)$ (3). It illustrates a continuous and upwardardly trending improvement in the desirable productivity of process ($\eta_a = \frac{t}{E_a}$, number of (inter-group) transactions per unit of energy). It also shows what began with the earliest of man, continues today.

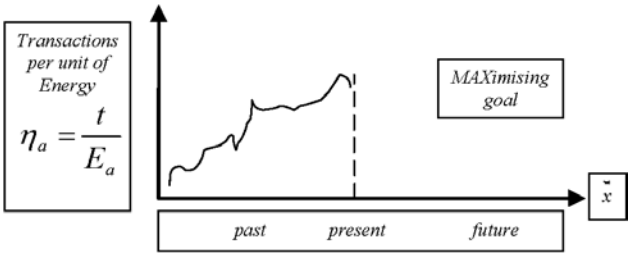

Figure 2: Continuous technological change has continued to boost the productivity of process (transacting) into today's world.

That is, what began with man's earliest attempts to seek and reciprocate goods and services for survival from/to groups outside of immediate family, has continued to progress over the millenia. Transaction productivity has become ever more efficient with the advent of technological change in the form of language development, the establishment and continuous development of various forms of instruments of law (contracts, consumer-protection legislation, etc.) and evolving expected societal norms of behaviour (local, national and increasingly global).

Finally, from a performance theory point of view, mankind has been very successful. Figure 3 illustrates the general overall performance of mankind in developing and maintaining his ability to survive via inter- group transactions of all forms of goods and services (commerce).

As expected, Figure 3 is the product of Figures 1 and 2 as governed by the utility [of input resource (energy)] – productivity [of process (transacting)] performance equation (3):

$$P_{P=\eta_a} = \mu_g \cdot \eta_a = \frac{E_g}{t}\,\frac{t}{E_a} = = \frac{E_g}{E_a}$$

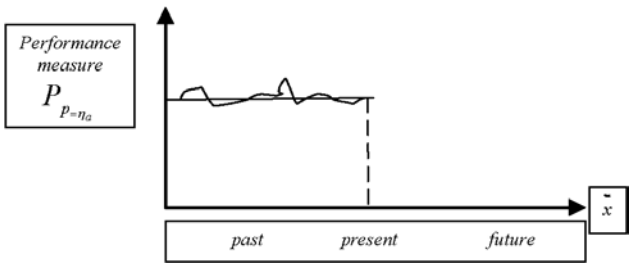

Figure 3: Man's nominal transactional performance over the millenia.

It shows that performance has probably been fairly nominal (at 100%) over the millenia, as man's efforts to drive down the actual energy expenditure per transaction to match the ever decreasing minimising set goal, has largely been successful.

The role of trust

"Trust" is a concept central to all human relationships of value. It can be expressed as the interaction between two players: A and B (4):

"A asks B to do X so long as B takes A's interests (goals) into account". That is, A – in asking B to do X, is *trusting* B to undertake some action(s) so that A's desires are met. As we shall soon see, this last condition is most important. From a performance theory point of view, if B does perform to A's expectations, then A's placement of trust in B is well founded.

This can be expressed by the fact that such a transaction results in a nominal 100% performance measure: A's goal(s) have been met.

For example, if A has n-number of goals to be met in a single transaction with B, then each met goal scores 100% and the overall performance measure of the transaction is also 100%. That is, in general for the j^{th} transaction (involving n-number of goals in any of the *j*-transactions), between A and B:

$$P_{transaction_j} = \prod_{i=1}^{n} P_i$$

where P_i is the performance measure associated with the i^{th} goal.

$$P_{transaction_j} = P_1.P_2....P_i.....P_n$$

ie

$$P_{transaction_j} = 100\%..100\%..100\%..100\% = 100\%$$

where $P_{transaction_j} = 100\%$ is defined to be nominal 'paid-for' performance (3).

Thus, from the above formulation, one can conclude that if the P_i^{th} goal performance measure is weak (<<100%), then overall performance is also weakened since $P_{transaction_j} = \prod_{i=1}^{n} P_i$ is as only as good as the last P_i^{h} goal performance measure.

With such a result ($P_{transaction_j} = 100\%$), A should be well pleased with the outcome and would most likely have confidence in trusting B to again perform on A's behalf – if and whenever requested to do so. That is, A's trust in B has built upward as B has done well in meeting A's initial (j =1) transaction interests (goals).

Trust builds as each experience (transaction) is successfully completed. A can place more and more trust in B to perform each successive action. This also progressively lowers the energy cost A has to invest in transacting business with B and so highlights the central importance of trust in making business transactions more and more productive.

Thus, trust is a valuable resource whose inventory tends to build up with each successful transactional experience (χ_j).

This can be expressed as:

$$T_j = \int_0^j \left(P_{transaction_j}\right) d\chi$$

where j is the total number of transactions to date,

and T_j is the build up of trust from the initial (j=1) transaction through to and including the j^{th} transaction.

Thus, for each successful transaction experience (χ_j), $T_j = \int_0^j \left(P_{transaction_j}\right) d\chi$ builds up by amount $P_{transaction_j}$.

However, experience also shows that trust T_j *can also be quickly destroyed.* So a multiplicative delta function $\delta(\chi_j)$ of value range: $0 \le \delta(\chi_j) \le 1$ is introduced into a formulation for the available inventory of trust stored $T(j)$ after j transactions, and is given by:

$$T(j) = \delta(\chi_j) T_j$$

An explanation of this multiplicative delta function and its purpose and effect will be presented in the section titled '***Fatal and non-fatal transactions***'.

Thick and Thin Trust

Because man's earliest successful interactions with close "neighbours" resulted from increasingly trust-based cooperative efforts (to satisfactorily meet mutual, co-survival objectives) these interactions were strongly *person-to-person* (ie "personal"- experience based) transactions. And, as historical (and evolutionary) evidence shows, these early transactions were also, overall, successful. One can thus conclude that commerce between parties, that continued on a 'as needed' basis, overall became based on even increasing levels of (mutual) trust to lubricate the smooth flow of business between parties. Thus, trust is beneficial to all transacting parties involved in commerce and is a valuable resource inventory to have in expediting the very basic business of survival.

Survival in today's world, however, is not as dire and problematic as in early man's world. In modern developed societies, we are pretty much assured of the basics to survive.

However, the *type* of trust we rely on today is very different to that our early ancestors relied upon. Early man developed personal-experience based trust (so called 'THICK' trust) whereas, in our modern, technologically advanced, world we have become more and more reliant on groups (often very far physically removed from us) to supply the goods and services we so desire (5). This "thinning" of trust arguably has occurred simultaneously with each

advance in man's communications technologies.

Thus, over the millenia, man has relied more and more on increasing expert-designed "systems" to facilitate commerce and meet today's individual needs and wants. In contemporary society we rely more and more on these 'thin-trust'-based systems in order to "survive". Such systems are said to be "reputation-based" trust systems rather than personal-experience based systems. In performance theory jargon, THICK-based trust systems are "personal knowledge based" wheras thin-based trust systems are "transferred knowledge based" systems.

Fatal and non-fatal transactions

Internet-based commercial transaction systems are thin-trust based expert systems. They are often reputation (transferred-knowledge) driven. However, initial personal interaction is always apprehensive. One often 'dips their toes in' by initiating first transactions only of a low economic risk due to the zero or low level of built-up trust inventory one has in such systems. However, as experience may be rewarding (all goals being met), the overall performance measure for such systems can assure our confidence in continuing to expend our own (personal-knowledge based) trust in such systems- albeit in an apparently increasingly, thin-trust based operating environment.

Failure to perform in thin-trust environments can have devistating effects on both consumers and suppliers of goods and services. The severity of the consequences of complete failure… ($P_{transaction\ j} = P_1.P_2....P_i.....P_n = 0$) is, however, directly related to the conditional statement associated with trust: ["A asks B to do X] ***so long as B takes A's interests (goals) into account***".

In situations where failure in the latest transaction ($P_{transaction\ j} = P_1.P_2....P_i.....P_n$) can be identified as being caused by B having (absolutely) ***no regard for A's interests***, then the failure will be fatal. That is, A's inventory of trust in B will have been destroyed and no further business will occur between A and B. From a formulation point of view, this sets the value of the delta function to 0 and $T(j) = 0$. This was the classic situation encounted with the Bernie Madoff' Ponzi scheme report of 2009 (6). Investors (the As) had complete system failure in their last transaction with the trustee, Madoff (the B). No further transactions between As and B occurred once the complete *betrayal of trust* had been uncovered. Betrayal of trust (THICK, thin, or whatever) is always guaranteed to be (to use an Australian colloqualism) the proverbial "BBQ Stopper"!!!

In situations where failure in the latest transaction ($P_{transaction\ j} = P_1.P_2....P_i.....P_n$) can be identified as being caused by B having (only) ***calculated regard for A's interests***, then the failure may not prove to be fatal, but will prove to be costly in terms of time, money, energy and effort to recover business confidence and re-establish trust.

From a formulation point of view, this sets the value of the delta function to 1. That is, although the performance of the last transaction was zero (aircraft did not fly), and hence added nothing to the previous value of trust inventory $T(j)$, $T(j)$ itself did not collapse to zero but, (at best) retained its *apriori to the last failed event* value $T(j-1)$. This is typical of the recent event in which the CEO of Qantas completely failed in "doing X" (flying aircraft) (7). Performance associated with this event was , by definition, zero (ie $P_{transaction\ j} = \prod_{i=1}^{n} P_i = 0$ as the P_j^{th} transactional performance measure = 0), but for some customers, directly affected by the grounding, the event may not prove to be fatal. They may fly again with Qantas, but then again, they may not. It all depends on how the affected passangers view the CEO's motivation – did he do what he did in their (As') interests? and what interests of customers were affected?

If the answer to the first question is 'yes' (to legally engage a third party independent of both Qantas and the unions) to get the airline again doing "X" (ie reliably, safely, flying aircraft on time – as the personal-trust based reputation of Qantas goes), then the event may prove non-fatal. However, the final decision of any customer will *then* depend on their interests and how the grounding event affected such interests. If the perceived (nee potential performance measure) economic cost recovery to passangers is not fully realised from Qantas, then the fatality in relationship between the customer and Qantas is probably assured. However, if the promised economic cost recovery promised by Qantas is assessed as adequate, then the grounding event may not prove fatal. Qantas has indeed taken a *calculated regard for A's interests,* but is to pay a high price in doing so –reportedly AUD$100M!!!(8). Such is the price of "system failure" in today's modern world of thin-trust based, commercial enterprise systems.

How an assessment of the economic cost to customer of supplier failure affects the willingness of the customer to again engage the supplier for goods and services is also an interesting question. The answer, however, will have to wait for another paper on "On Performance Theory and <.trade>.." as this paper has already said enough.

Conclusion

This paper has addressed the difficult issue of "trust" from a performance theory point of view. The theory has shown to be rigorous enough to formulate a preliminary expression of trust in terms of experienced based performance measures. These measures, in turn, have relied on the use of the utility of resource, productivity of process performance equation that forms the basis of performance theory.

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