A BETTER AND SMARTER ECONOMY

Editorial

Given the challenges in front of us, we do indeed need a better and smarter economy. I list just three:

- How to continue to improve our own living standards, and to support the developing countries who have every right to enjoy at least the same standards as our own, but in ways which reduce all our carbon footprints.
- How to restore productivity gains so that we can afford the imperatives of social inclusion but with an aging workforce and as we recover from the global recession.
- How to foster the necessary innovation and entrepreneurship by investment in research and development and by increasing the broader education and skill levels of all.

A more highly skilled workforce, a better educated population and increased and targeted research and development are essential ingredients in making a difference to these and other challenges. In addition to a resurgence of government investment in tertiary education, a similar increased commitment is necessary from industry. This reinvestment will have much more effective economic and social impact globally and for enterprises and institutions, with a stronger platform of collaboration between industry and tertiary education institutions. I mention just two examples for which this collaboration is vital.

- All agree that today’s students and learners need more than a narrow focus on their selected discipline.
- Businesses and enterprises, public and private need to develop a stronger individual and organisational culture of learning and innovation.

Effective and sustained conversation between business and tertiary educators and between both and government, is key to imagining what can and should be done and to developing and implementing motivation, direction and content.

The fundamental role of B-HERT is to foster this collaboration at the strategic level and to develop partnerships aimed at more specific issues. This role has not changed in the 19 years of our existence, but the ways in which we work with our members and support our members in working with their stakeholders, is under constant and necessary change. We must be effective and relevant and our members must see the benefit.

My term as B-HERT President comes to an end at this year’s annual general meeting. It is probably appropriate to make a few (brief!) comments on the past, but perhaps more importantly, on the future. B-HERT is ideally placed to perform its role. Our membership has the unique combination of the majority of Australia’s universities, increasing membership from VET, and a range of large and small business enterprises. Our credibility comes from 19 years of sharing perspectives from leaders in industry, education and government and from the insights and outcomes which have come from the resulting discussions and collaboration. Much sought after are our annual national awards for collaboration in research and development, education and training, entrepreneurial education, philanthropic support of tertiary education and the Ashley Goldsworthy award for sustained collaboration. It has been an honour for me to have had a range of B-HERT roles (member, board member and President) for over ten years.

Our members’ world is changing at an accelerating pace. More is expected of them and they expect more of themselves. The better and smarter they are, the more they will deliver to their stakeholders and the more they will be able to contribute to society at large. More will be expected of B-HERT and in ways which are relevant to today and tomorrow. I want to thank all of our contributors and supporters, some of whom have contributed to this issue of B-HERT News.

There is much yet to be done!
In keeping with its mission, B-HERT has always been focused on contributing to a Better and Smarter Economy. However, the experiences of the last 12-18 months have generated renewed attention within the community. Government has conveyed a sense of urgency in implementing its policies for a new education/innovation landscape in order to position Australia as a leader in the global community of the 21st century. B-HERT has been working closely with our members, partners and government in identifying how to tackle the challenges to support the achievement of key critical outcomes.

The education policy debate within the tertiary sector was alive and well during the Australian Government (Bradley) review as was demonstrated in the B-HERT/VTA/RMIT Vocational Education & Training (VET) Round Table held in March. In the course of the debate about where VET was best positioned in the evolving tertiary education sector, industry and educators reiterated some of the contentious issues affecting the delivery of training needs. Issues arising from Bradley also dominated discussion at the Regional Universities Higher Education Engagement Forum in April. Again, models were presented that demonstrated the value of collaboration between institutions and with business. The 2010 Regional Universities Higher Education Engagement Forum no doubt will detail the strategies adopted by regional tertiary institutions in implementing the government’s education priorities.

That innovation is the core ingredient in achieving a smarter economy was emphasized by both Minister Carr and Dr Terry Cutler at Innovation 2008. The Medical Innovation Conference in June and Innovation 2009 in September offered practical perspectives and featured new directions and examples of effective collaboration. Pfizer, a global pharmaceutical company presented a case study outlining how it intended to be ‘smarter’ through a global organisational restructure and alignment of strategic intent with its culture. Pfizer deemed these changes as fundamental to its ability to achieve innovative outcomes in product development and business performance.

Another significant ingredient is the National Broadband Network infrastructure initiative that is now underway. Because ICT represents the gateway to virtually all future activities, B-HERT organized the ICT Summit in April for business, universities and government to follow up on members’ concerns of a current labour shortage on the one hand and limited student demand on the other.

B-HERT was very pleased to be approached by DEEWR to work with them on a one day conference to discuss the future developments and requirements of Australia’s workforce. The Workforce Australia program will be targeting employers to reinforce the importance of graduate recruitment, with good examples of how to manage even in difficult times in order to avoid the looming skill shortage once the recovery takes hold.

There are numerous examples of effective collaboration and to showcase just a few, B-HERT has published Partnerships @ Work, a series outlining effective partnerships and successful case studies (see www.B-HERT.com for more information).

As we move out of the GFC into a new phase of economic recovery and consolidation, B-HERT will continue our commitment to better business/education outcomes through collaboration.

Australia depends heavily on natural, not human, resources for economic wealth. In the long term, natural resource dependency is a formula for relative poverty. The problem is that our short term default option to leverage natural resources helps us endure economic challenges whilst it slows our drive to develop world-class human resources for the global knowledge economy. This 21st Century economy is one in which almost unimaginable wealth and prosperity comes not from training the workforce to mine coal or liquefied natural gas, but from educating the workforce to mine ideas and develop new intellectual properties.

This view is widely communicated and well established. Yet, the idea itself appears forgotten in public policy. Of course, there are those who disagree with the view that dependency on natural resources is problematic. We can empathise with their cynicism. In early 2008 UNSW Associate Professor of Economics, Peter Kriesler told the ABC’s Inside Business that the...
resources boom might collapse if China and India experienced an economic slow-down. By late 2008, his predictions appeared to ring true as the Chinese economy showed warning signs of rapid cooling. Recent “green shoots,” to use United States Federal Reserve Bank Board Chairman Ben Bernanke’s phrase, cast doubt on Prof. Kriesler’s gloom. In late August 2009, the Gorgon LNG project on Barrow Island off the Pilbara coast in Western Australia was approved by the Federal Environment Minister, Peter Garrett leading the way to a $50 billion, 20-year project. However, the relatively short-term bulls and bears of global financial markets arguably are less important than the longer-term strategic direction of our nation. Instead of focussing on the immediacy of markets, we need to focus on the arc of economic history and establish our place in it. The clever country could be the brilliant country. The “soft” creative industries could be married to the “hard” engineering of intelligent networks. The arts and the sciences could converge and reward us in both social and economic terms in ways that finite natural resources simply cannot. Critically, we need science and the creative industries to make this happen and we need graduates who can work together to leverage their talents.

The American popular astronomer, the late Dr. Carl Sagan, wrote in his plea for science education, The Demon-Haunted World, Science as a Candle in the Dark (1997) “We have . . . arranged things so that almost no one understands science and technology. This is a prescription for disaster. We might get away with it for a while, but sooner or later this combustible mixture of ignorance and power is going to blow up in our faces.” Although dramatic, Sagan’s point was clear. Science and technology are the currency of our day, and literacy about and for them ought to be the lingua franca of multicultural nations like Australia. The medium of this language is the internet of course. It needs to be fast, ubiquitous and affordable. However, of more vital importance is online literacy. Internet literacy must be universal and at the level of meaningful production beyond (yet including) popular culture. To achieve this level of literacy, we must ensure that all Australians are encouraged to blog, post YouTube videos, and express themselves about politics, economics and social matters. This is the likely nexus of arts and sciences in practical terms.

Although information and communication technologies are not universally available to all Australians, they should be. Indeed, according to the Australian Bureau of Statistics, 81% of Australian households have a broadband connection. According to Nielsen Research, less than 60% of online Australians use social networks and blogs. Thus, less than half of Australians are producing content and contributing to the national knowledge and content store. The era of social networking allows interactivity and engagement that, at present, is not being mined for the national benefit.

Australian and overseas academics in the creative industries have argued that participatory culture can give rise to a level of democratisation that will drive innovation. Scholars like University of Southern California Professor Henry Jenkins, author of Convergence Culture: Where Old and New Media Collide, advise that people, not technology, are the basis of wealth in participatory culture. Sure, a digital networking infrastructure must be in place and it must be commoditised (at least domestically), but knowledge exchange occurs in minds, not technologies.

The crux of the argument here is that Australia is fortunate to have two types of resources: dumb and smart, natural, and human. Quite simply, we can do more with smart resources than we can with the dumb over the long term, and it’s time to choose which resource we want to be the focus of our public policy and national psyche.

Business and academe are not at odds in this choice. They both have more to gain from smart resource mining than they do from pulling dumb resources out of the earth. Guidance on this point comes from the compelling work of an American who has founded projects at the Harvard Business School, served as a fellow at Harvard’s Centre for International Affairs and is Chairman and CEO of a life science venture capital firm focussed on genomics research. Juan Enriquez is also author of the current affairs book, As the Future Catches You. In 225 light pages followed by 25 pages of detailed notes, Enriquez establishes the difference between wealth and poverty of nations. He demonstrates that ratio of wealth creation per person in the wealthiest countries compared with the poorest countries in 1900 was 5:1, but today that number is 427:1 and diverging rapidly toward 1000:1 with the emerging marriage between the Information Technology and Genomics industries. “Things change very quickly in a digital world” explains Enriquez and the digital world will operate increasingly with the use of biologically-based processors.

Just as the digital revolution created a new language that required a new literacy, so too will the genomics revolution introduce a new dominant language. The national population that speaks this language and writes its dictionary will generate much more wealth than LNG can generate with flow-on advantages that are not yet conceivable.

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3 According to the Australian Bureau of Statistics Internet Activity Survey for 2008, released in April 2009, 84% of the eight million active internet subscribers in Australia have broadband; of these 6.6 million were households. There are 8.1 million households in Australia according to the Yearbook Australia 2008 report. (Both reports available online: http://www.abs.gov.au/AUSSTATS)
Establishing intellectual property rights is paramount to wealth in the twenty-first century. As Enriquez points out, not all patents are good, but generating fewer patents than your competitors is worse. He cites the United States Patent and Trademark Office (USPTO) 2003 Technology Assessment Forecast (TAF) report that showed how many citizens of different countries were needed to produce one patent. Australia was NOT near the top. Indeed, only one U.S. patent was produced for every 22,090 Australians. This compares well to, say, Spain which produces one U.S. patent for every 133,013 Spaniards. However, the comparison with many of our key trading partners is less favourable. Canada shares many social and cultural similarities with Australia and manages to produce one U.S. patent for every 9,232 Canadians. The Japanese require only 3,592 citizens to produce a U.S. patent. There are other patent offices around the world, however the U.S. patent office is the largest and arguably the most important in market value.

Not only does Enriquez reject natural resource dependency, he challenges assumptions about the value of a service economy. Enriquez argues that wealthy economies in the medium term will be those that produce highly literate, readily communicative citizens who are capable of leveraging the connectivity of the knowledge economy.

The recipe for mining our smart resources is simple: Enable Australians in two ways. One, provide a contemporary educational infrastructure of innovative educational institutions that encourage life-long learning and critical thinking, entrepreneurial spirit and leadership, communication skills and networking prowess and responsibility for the future. And two, provide a world-class information and communication infrastructure to facilitate the educational infrastructure in such a way that not only imports technology, but leverages infrastructural design to create new IP that can be exported as appropriate, but used as competitive advantage as needed.

Information was reported on whether each of five stages of commercialisation was attempted – licensing or spin-off; development; make and sell; mass production; and export. Survey responses came from inventors in a wide range of employment arrangements: a third of inventors were employed in an SME (36.4 per cent); with the remainder coming from large companies (10.5 per cent), public research organisations (6.6 per cent). The residual (46.6 per cent) were individual inventors. The inventions covered a broad cross-section of different technology areas, including electricity and electronics, instruments, chemicals and pharmaceuticals, mechanical engineering, process engineering and ‘other’. The sample also contains a mix of those applications that were granted a patent (54.9 per cent) and those that were not (45.1 per cent).

Table 1 presents cross-tabulations on the percentage of inventions that achieved each commercialisation milestone according to patent status at April 2007.
In order to consider any patent system, industrial coverage of the not biased by the narrow inventor’s decision to apply are not. Since our study only with those that were awarded a patent outcomes for inventions the commercialization therefore able to compare in our estimations. We are technique to control for it sample, we use a statistical non-response bias in our comparison suggests that technology area. Since this (at April 2007); and year of application; organisation type; whether the patent was granted (at April 2007); and technology area. Since this comparison suggests that there is some potential for non-response bias in our sample, we use a statistical technique to control for it in our estimations. We are therefore able to compare the commercialization outcomes for inventions that were awarded a patent with those that were not. Since our study only includes inventions that are potentially patentable (as evidenced by the inventor’s decision to apply for a patent), our results are not biased by the narrow industrial coverage of the patent system.

These findings are merely suggestive since we don’t know whether or not there were other differences between groups – withdrawn, reject and grant – such as the underlying value of the invention that may cause the observed pattern in the data. To isolate the effect of the patent grant on whether or not a commercialisation stage was attempted, we have to account for these other factors by combining data on the potential economic value of the underlying invention in a regression analysis.

Our results from this regression analysis suggest that while the receipt of a patent grant had a positive and statistically significant effect on most commercialisation stages, the magnitude of the average effect is quite modest. In fact, the marginal patent value – that is, the marginal increase in the probability of attempting a commercialisation stage due to the presence of a patent – varies from 2.0 (export) to 8.0 (mass production stage) percentage points. These figures are averages for the whole population of inventions. We expect that the ‘true’ effect will vary from zero to a large amount depending on the technology area, the nature of inter-firm competition among other things.

We also found evidence that the marginal patent value varies across different technology areas. For instance, in highly codifiable technologies – such as chemicals and pharmaceuticals – patents play a particularly important role in decisions to license or spin-off to another entity and manufacture. In fact, the presence of a patent increases the probability that an inventor in the chemical and pharmaceuticals industry will attempt to license or spin-off by 24.0 percentage points. Our contention is that this is a function of the fact that patents are most effective in highly codifiable technologies where an idea is easily reverse-engineered and articulating the boundary of an idea is more precisely conveyed in written form. Our results also indicate that organisations – such as public research organisations, SMEs and individuals – that do not possess the complementary assets (e.g. marketing and distribution) typically required to commercialise an invention are much more likely to license or sell their technology. However, patents only play a modest role in aiding their licensing efforts, all other things equal.

To summarise, we find that many unpatented innovations were commercialised and therefore patents are neither a necessary nor sufficient condition for successful commercialisation. It is plausible that many decisions about whether to commercialise an invention are made at the same time a patent application is made rather than as a result of the patent examination decision. In this case, inventors have decided to attempt to commercialize their inventions irrespective of the outcome of the patent examination.

Strategies to capture innovation profits

Our findings naturally raise a number of questions: why are people still seeking to commercialise inventions when the patent application has been rejected? How do they make the commercialisation proposition pay when rivals can copy their ideas? Other survey work by economists in the US, Europe and Australia can shed some light on these questions. By enlarge, these other surveys reveal that patents are only part of a suite of strategies firms used to capture profits from their innovative activities. Other mechanisms including using secrecy, organisational know-how or relying on the complexity of the production process can is often more important than legal protection. In addition, sometimes rival firms cannot gain a market advantage over an innovator because the latter sustains its lead-time advantage, is a very fast learner or owns a pivotal brand or trade mark. The effectiveness of patents relative to these other methods depends on whether rival firms can ‘invent around’ the patent, whether the invention is within scope of the patent system and how difficult the patent is to enforce in a court of law. Thus, we argue that while the grant of a patent should increase the profitability of innovating, its effect is not black and white and should vary across industries and technologies. While patents work by promising inventors a market free from imitation, they also provide confidence for commercialisation pathways that rely on transferring ownership from upstream research bodies to downstream development and commercialisation organisations. It is common in certain technologies for the research, prototype, trials, market validation, market launch and mass production stages to be done by a series of organisations which have different specialist capabilities. Research organisations that do not possess complementary commercialisation assets (such as manufacturing capabilities, marketing capital and distribution networks) have a natural incentive to license the invention or sell outright (perhaps to a spin-off company) to an organization that does.
In an increasingly globalised world where small and medium sized firms are under increasing pressure to compete internationally, clusters can play an important role in supporting firm competitiveness. Clusters can support the ability to generate, diffuse and apply knowledge both through facilitated activities and knowledge spillovers. Hence, the promotion of clusters as an integral part of sustainable regional development strategies (OECD, 2001, 2005). Up until the recent impact of the GFC Dubai was considered the powerhouse of the United Arab Emirates due to its modern, progressive rulers. This brief article focuses on the Dubai Free Zone clusters developed in the desert, networking and social capital in consideration of how such strategies may be utilised in Australia.

**The Dubai Model**

Dubai is one of seven emirates, or states, that declared independence from the UK in 1971 and together established a federation, the independent country of the United Arab Emirates (UAE). Over the past two decades the Dubai economy has undergone a significant restructuring emerging as a major transport hub, a diversified economy with over 80 per cent of gross domestic product (GDP) derived from trade, tourism, real estate, construction and financial services.

Dubai (and the UAE generally) was historically a sparsely populated country with a limited capital and skill base, albeit one that has benefited in recent times from significant oil revenues and expatriate labour. While this income has underpinned economic growth, the relatively small and un-skilled domestic labour force was seen as a restraint on pursuing more traditional development strategies. The approach taken by Dubai, the “Dubai Model”, can be viewed as unique in terms of the earmarking by government of direct support for specific industries, a ‘hands-on approach’ to regional planning and the speed of policy execution.

Dubai has relied on importing labour, skilled and un-skilled, on a significant scale and creating an economic infrastructure base and support industries, where none really existed. The key objective of the strategy has been to restructure the economy and move it from over-reliance on oil revenues through the establishment of a significant number of free zones. There are currently over 30 registered free zones in the UAE, with the majority in Dubai. These constitute clearly defined geographical areas with a liberal regulatory environment allowing 100 per cent foreign ownership, no restriction on profit repatriation and exemption from taxes and duties. Companies operating within a free zone cluster also benefit from reduced transaction costs in terms of documentation requirements and government regulations (including those related to the hiring of expatriate labour). This strategy has been clearly directed at foreign firms and an expatriate labour force.

The Dubai Government policy has designated zones for defined “industries” or economic sectors, with strict licensing control regarding the eligibility of potential entrants to a cluster. These zones have also been initiated in almost all cases “from scratch”, in contrast to the cluster experience in other countries. Quite literally, an area of desert has tended to be designated as a specific zone, with the actual physical infrastructure and actual presence of firms following later. In each case an independent government authority has been responsible for their initial establishment and continuing development as a managed
Innovation and clusters

Evidence suggests that the innovative capacity of firms and regions is promoted by a clustering of companies (OECD, 2001). Innovation has been defined as an interactive process characterised by knowledge interaction involving various actors (Bell, 2005) - a social process involving people getting together and sharing ideas (Bessant, 2004). Networks are said to be one way that firms can increase competitiveness, tackle problem solving and increase innovation. Research suggests that networks can improve effectiveness by taking advantage of economies of scale and scope; sharing information and knowledge spill-overs; joint purchasing of education and training; developing increased individual capabilities, and gaining better access to specialised inputs and infrastructure. In turn, this can lead to flow on effects, such as increased productivity and enhanced competitiveness (Malmerg and Power, 2005).

Increasingly, it is being argued that the issue is not seen as just knowledge generation (creating the ideas in the first place), but is more about knowledge flows (spreading and applying the ideas widely) – an important role for innovation networking. Bessant (2004) maintains that firms such as IBM, Cisco and Intel are examples of the move towards “open innovation, where links and connections become as important as the actual production and ownership of knowledge”.

Channels through which knowledge can spill over include: public presentations; publications; cooperation; labour movement and subcontracting. Spatial clusters are seen as social systems or networks where it is easier for information to circulate and where social contacts among firms facilitate the communication and the articulation of tacit knowledge (Malmerg and Power, 2005). Solvell, Lindqvist and Ketels (2003) maintain that firms that are active in strong clusters and regions with strong clusters tend to perform better. Clusters offer fertile ground for innovation and upgrading of comp advantage by firms. There are some key reasons as to why innovation tends to be connected with clusters which relate to the:

- Need for repeated and continuous interaction between related firms and specialised institutions (including research and education) and the
- Need for face to face contact to encourage the exchange and creation of new knowledge.

Solvell et al (2003) argue that despite the alleged homogenising effects of globalisation, countries, regions and metropolitan areas continue to exhibit dramatic differences in terms of specialisation and competitiveness. Successful industries and industry clusters in a country or region often retain their leading edge over extended periods of time, despite attempts by others to imitate their success. Standard components and machinery can be purchased by anyone, anywhere, while the latest technology is often being fine-tuned through interaction between firms and institutions in local clusters. In the local business environment people tend to share a common culture, speak the same language and develop networks based on trust. Even the most common forms of communication technology are inferior to face to face contact between people when it comes to communicating. Solvell et al (2003) posit that while physical capital can travel the world as can human capital to some extent, it is the social capital embedded in local cultures and institutions that is enhanced in the cluster environment that provides the network for collaboration and potential for innovation. Social capital is defined as networks, relationships and institutions with shared understandings and values that facilitate cooperation among stakeholders, with trust being an important element (Ionescu, 2005; Axelsson and Easton, 1992). The quantity and quality of these interactions and exchanges have value and create value (Persson et al, 2006).

While Porter (1998) emphasises the role of the market in establishing such synergies within a grouping of firms, with little role for social forces, there is growing consensus that there is a need for more interventionist policies and approaches (OECD, 2005). A question that arises, therefore, is how social capital creation and agglomeration economies generally can be encouraged or optimised within a cluster as it is not enough just for a firm to be located in a cluster to assume that innovation will take place.

Two Dubai Clusters

The naming of the cluster groups in Dubai has been quite literal – just follow the road signs and you will arrive at: Dubai Knowledge Village (DKV) which houses Universities and HR firms - Dubai Internet City (DIC) which houses internet giants Microsoft and the like and Dubai Media City (DMC) where the television and radio stations are situated of course. The rate of growth has been phenomenal for some clusters. For example, in September 2000 Dubai officials announced that more than 100 IT companies had been granted licences to operate in Dubai Internet City. The companies, which included industry giants Microsoft and Oracle and Compaq, invested $250 million in the technology, e-commerce and media free zone. By mid-2004, the number

The “Dubai Model”, can be viewed as unique in terms of the earmarking by government of direct support for specific industries, a “hands-on approach” to regional planning and the speed of policy execution.
Introduction
The essential basis for a smarter economy is the faster and easier exchange of knowledge. Collaborative networking is the most vital infrastructure for the knowledge era. The social computing technologies of Web 2.0 provide the opportunity for a mass democratization of the means of media production, distribution and connection. Both business and education are still absorbing the implications of the new mode of knowledge exchange. The promise is accelerated learning, more extensive diffusion of knowledge, and deeper and richer collaboration in the co-creation of value between producers and consumers.

The business and educational world of computer assisted collaborative learning recently has become turbo-charged by the rapid and often spontaneous introduction of the social computing technologies of Web 2.0. This has caused palpable excitement across the business learning and educational spectrum (by some akin to a moral panic). Extensive surveys of the adoption of Web 2.0 in education have been completed in the United States (Oblinger and Oblinger 2005); in the UK (RCI 2009); and in Australia (Kennedy et al 2008) and Clarke (2009). All reveal widespread enthusiasm for the new learning technologies, but are sceptical on whether this represents the total transformation in teaching and learning that is often suggested.

Social Computing in Business and Education: Collaborative Learning for Co-Creation

Definition of social computing
Social computing software is defined as a class of networked tools that support and encourage individuals to learn together while retaining individual control over their time, space, presence, activity, identity and relationship by Shaley Minocha (2009a) following Anderson (2005). The key aspect of a social software tool being that it involves wider participation in the creation of information which is shared. Minocha records how business and educational institutions are increasingly making use of:

- Tools that facilitate collaborative authoring, such as blogs and wikis
- Websites that enable sharing of bookmarks, photographs, and videos, such as Delicious, Flickr and YouTube
- Social networking platforms such as Elgg and Ning
- 3-D virtual worlds, such as Second Life that facilitate synchronous group discussions and meetings.

While such social software tools are of increasing interest in business and education, they need to be well grounded within the pedagogical activities and objectives of courses. In the empirical research Minocha conducted, insights
into the following issues concerning the application of social computing software were gathered:

- benefits the learners and educators perceive in the pedagogical usage of these tools
- the design of activities and the challenges involved in using the tools, relating these to their pedagogical context
- learning experiences of the educators: what worked and what did not work so well; and whether this is transferable to another context
- obstacles faced by students and educators, whether they are technological, usability-related, skills or training issues, or social issues
- accessibility issues regarding support to users with special needs, and how they are being addressed.

Some useful recommendations and guiding principles for educators and policy makers engaged in social software initiatives are offered including the pedagogical roles of social software: communication, nurturing creativity and innovation, and collaborative learning; but also the influencing factors that can enhance student learning and engagement.

In a startling analysis Bill Ashraf (2009) highlights while it has never been easier, quicker or cheaper to communicate, this has stimulated different and complex patterns of behaviour. Learning and teaching is experiencing a process of transition involving different modes of learning, institutional change, pedagogy and research. Issues of flexibility, personalization and inclusion are being worked through, though most students still want the benefits of face-to-face contact.

**Strategies for Web 2.0**

Some fascinating scenarios and strategies for Web 2.0 are offered by Graeme Martin et al (2009). Two related sets of characteristics of social media begin to emerge, which help address the question of what strategic choices we can make to get the best from Web 2.0 while recognising the risks of doing so. These characteristics are engagement and control, which Martin et al use as dimensions of a matrix of scenarios. They set out four scenarios on the use of traditional and new social technologies intended to enhance collaboration and give employees voice in matters that affect them at work. In doing so they show how Web 2.0 can alter the choices available to employees and organisations to collaborate.
and exercise their respective voices. It is in this sense they argue these technologies have the potential to transform the business model, especially in organisations that are multi-site, multi-country or employ substantial numbers of V-generation or remote workers.

**Digital Natives?**

The ‘Digital Natives’ phenomena is critically examined by Thomas Clarke and Elizabeth Clarke (2009) in the context of the shift to a knowledge society creating a skill revolution (O’Hara 2007). Potentially there is a widening culture mismatch between what members of the knowledge society need to succeed and what current systems of higher education are geared to offer in order to adequately prepare people and communities to thrive in the global knowledge society. Students need to master higher-order cognitive, affective, and social skills not central to mature industrial societies, but vital in a knowledge based economy that include thriving on chaos (making rapid decisions based on incomplete information to resolve novel situations); the ability to collaborate with a diverse team – face-to-face or across distance – to accomplish a task; creating, sharing, and mastering knowledge through filtering a sea of quasi-accurate information (Dede 2005; 2008).

It has been suggested that the various generations of students enrolled in today’s higher education institutions as well as different generations of employees in the corporate workplace require a different approach to education and training (Reeves and Oh 2007). According to Prensky (2001) the N (net)-gen, D (digital) –gen, or Digital natives, are “native speakers of the digital language of computers, video games and the internet” and those who are not born into the digital world are ‘Digital immigrants’ as they learn to adapt to their environment. The disconnect is evidenced in that:

‘Digital natives are used to receiving information really fast, they like to parallel process and multitask, prefer graphics before text, random access (like hypertext) and function best when networked and Digital immigrants typically have little appreciation for these new skills’…

Today’s teachers have to learn to communicate in the language and style of their students, this doesn’t mean changing the meaning of what is important or of good thinking skills, instead it means to reconsider the methodology and content of education.”

Contemporary pedagogy must address the disconnect between how students learn and how teachers teach by recognizing that today’s students, “process information fundamentally

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**Table 1: How Digital Students Learn and How Non Digital Teachers Teach**

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<thead>
<tr>
<th>Digital Native Learners</th>
<th>Digital Immigrant Teachers</th>
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<tbody>
<tr>
<td>Prefer receiving information quickly from multiple multimedia sources.</td>
<td>Prefer slow and controlled release of information from limited sources.</td>
</tr>
<tr>
<td>Prefer parallel processing and multi-tasking.</td>
<td>Prefer singular processing and single or limited tasking.</td>
</tr>
<tr>
<td>Prefer processing pictures, sounds and video before text.</td>
<td>Prefer to provide text before pictures, sounds and video.</td>
</tr>
<tr>
<td>Prefer random access to hyperlinked multimedia information.</td>
<td>Prefer to provide information linearly, logically and sequentially.</td>
</tr>
<tr>
<td>Prefer to interact/network simultaneously with many others.</td>
<td>Prefer students to work independently rather than network and interact.</td>
</tr>
<tr>
<td>Prefer to learn “just-in-time”</td>
<td>Prefer to teach “just-in-case” (it’s on the exam).</td>
</tr>
<tr>
<td>Prefer instant gratification and instant rewards.</td>
<td>Prefer deferred gratification and deferred rewards.</td>
</tr>
<tr>
<td>Prefer learning that is relevant, instantly useful and fun.</td>
<td>Prefer to teach to the curriculum guide and standardized tests.</td>
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differently from their predecessors and these differences go far further and deeper than most educators suspect. This disconnect, as stated by Dosaj (2007), is the result of poor communication between “digital natives” (today’s students) and “digital immigrants” (many adults), and their differences on how digital students learn and how non digital teachers teach (Table 1).

A Universal Technology?
Other authorities dispute this dichotomy between the digitally literate and illiterate. As Bennet et al (2007:783) suggest, “The picture beginning to emerge from research on young people’s relationships with technology is much more complex than the digital native characterization suggests. While technology is embedded in their lives, young people’s use and skills are not uniform. There is no evidence of widespread and universal disaffection, or of a distinctly different learning style the like of which has never been seen before. We may live in a highly technologised world, but it is conceivable that it has become so through evolution, rather than revolution. Young people may do things differently, but there are no grounds to consider them alien to us. Education may be under challenge to change, but it is not clear that it is being rejected.”

A recent survey of the adoption of Web 2.0 social computing in UK Higher Education indicates use of social networking sites is high with nine out of ten students being regular users by the time of entry to university (RCI 2009). In contrast older age groups are adaptable and pragmatic in their approach to new technology use, and where it makes their lives easier are fast catching up with early adapters. Even younger students demonstrate different degrees of comfort with using technology at the beginning of their courses (Figure 2).

While it is reassuring that an impassable digital divide may not be emerging, social computing represents an exciting technological frontier to many. The potential of Web 2.0 social computing collaboration to transform business processes and products, and to achieve revolutionary change in the delivery of the business curriculum are being explored by intrepid digital adventurers. What ultimately will emerge are clever economies defined by the speed and facility with which they produce, exchange and utilize knowledge to create value.

Figure 2: Students’ degree of comfort with using technology at the start of their courses

<table>
<thead>
<tr>
<th>Familiar</th>
<th>Comfortable with using</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instant messaging</td>
<td></td>
</tr>
<tr>
<td>Administrative materials online</td>
<td></td>
</tr>
<tr>
<td>Text messages Admin. update</td>
<td></td>
</tr>
<tr>
<td>Not comfortable with using</td>
<td></td>
</tr>
<tr>
<td>Submitting assignments online</td>
<td></td>
</tr>
<tr>
<td>Using podcasts</td>
<td></td>
</tr>
<tr>
<td>Making podcasts</td>
<td></td>
</tr>
<tr>
<td>Making wikis</td>
<td></td>
</tr>
<tr>
<td>Unfamiliar</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Online Quiz assessment</th>
<th>Web CT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course-specific materials online</td>
<td></td>
</tr>
<tr>
<td>Posting questions online to tutors</td>
<td></td>
</tr>
<tr>
<td>Emailing tutors</td>
<td></td>
</tr>
</tbody>
</table>

References
Small is beautiful: Is mining about to go micro?

Introduction

For many years, the business of mining has been a story of more mechanisation, bigger and bigger mines, and bigger and bigger equipment. Advances in the technology of moving large amounts of material in open cut mines has driven the development of bigger and bigger trucks. But will it be like that forever?

I don’t think so, because I believe a whole new set of technology developments will mean that the transport of mass materials will be done by smaller and smaller machines, each operating autonomously, making their own decisions, and at a much lower total cost than a fleet of large haul trucks.

Issue

So why are bigger and bigger haul trucks about to see the end of their run? Haul trucks are really expensive to buy and to maintain. At about $5 million for a Caterpillar 797, and a significant ongoing cost for maintenance and operating inputs, there may be a case for doing things differently. Add in the costs of all of the people and other systems that are needed to enable the management of truck fleets, such as roadways and critical parts, and the cost keeps piling up. What if there was a better way of doing things?

Why we are hooked on big trucks

For the moment, we use large equipment because the economies of scale have tended to support their development. The industry has been in this evolutionary paradigm for many years because bigger trucks means fewer drivers, less trucks needed per kilometre/tonne of ore moved, and the development of more efficient large engines means the fuel component is less cost per km/t. I’m sure there are also many other...
efficiencies that work well for large trucks over small ones. So why has the ‘going small’ option not been considered to date?

In most cases, new ways of doing business are strongly resisted on a few fronts. Firstly, people are pretty conservative and won’t take the time to consider alternatives to the way things have “always been done”. Secondly, there is a cost associated with change that might mean that large amounts of invested capital will need to be abandoned, and despite the best efforts of economists worldwide to convince people that invested capital should not be considered for future investment decisions, it usually is. In this instance, there is a lot of existing infrastructure associated with supporting big haul trucks, and few will want to write it off. Perhaps the biggest issue is the risk involved in taking on a new idea - what if it doesn’t work - can I bet the company on this?

But enough of this, because all of these issues will be as nothing if the ideas I introduce here are economically viable.

Small is the new Black

Let us imagine for a moment, replacing your $6 Million Caterpillar truck with 400 Ford F150 pickup trucks - that’s how many you’d need to match the carrying capacity. At $20k each, that would cost you $8 Million, but you’d be able to make up the Km/t figure by doing more trips because the F150 is much faster. The biggest issue though is that you’d need a lot more drivers (1200 as against 3 or 4 per truck) so the economics don’t work. Unless, that is, you can remove the need for drivers completely.

If you could have smaller vehicles operating independently and automatically you might be able to make an economic case for this scenario. Of course you’d need to implement all of the technologies you need to operate a large number of autonomous vehicles. I’ll cover a few such technologies here and provide some idea of where that technology is today and where it might be heading.

Advanced Analytics

The use of analytical algorithms that assist with making many low level decisions is quite advanced in many industries. Because the mining industry is not as technologically mature as others, there is plenty of opportunity to learn from how, say, the aerospace industry uses these advanced analytical techniques to remove the need for human intervention in many processes. Aircraft can now land themselves on autopilot, a specific and highly complex event that needs microsecond by microsecond adjustment of aircraft and engine power in three dimensions, and responding to highly dynamic changes in the surrounding environment in real time. All of this can happen with a plane load of hundreds of people. As a specific task, they don’t come much more complicated, and this level of knowledge is in use today in commercial airliners. Many of the technologies and techniques are available for use in the mining industry today.

Smart sensors

Many of the individual, microsecond decisions can actually be undertaken away from the smart core algorithm by smart sensors operating at the periphery of a complex computer algorithm. For very well understood and constrained processes a smart sensor might ‘decide’ to provide data to a central algorithm only when the process deviates from a pre-established norm. For example, a smart thermometer might only report fluctuations in engine temperature outside of a particular range, or if the temperature changes much faster than expected. This takes pressure off the central processing ability of the system.

Machine Intelligence

Both advanced analytical capabilities and smart sensors lead the way to ‘machine intelligence’, the ability of a machine to have some level of understanding of the environment around it and of its role within that environment. At the moment, small mobile machines are being designed with levels of intelligence approximating insects. Indeed, some of these machines are incorporating insect neurons within the machine’s IT architecture. These machines learn!

At the moment, these machines are even programmed to behave like insects - seeking areas of warmth, running away from the light etc, which might not immediately seem of use to the mining industry, but that is not the limit of what they might be ultimately be capable of.

Automation

With all of these things being either in existence now, or being actively researched, machine autonomy may not be very far away at all. Indeed Komatsu and Caterpillar have already produced haul trucks that can be operated remotely, and are working on being able to operate autonomously.

Work at the CRCMining (www.crcmining.com.au) has some machinery automated for some of their functions. To help cope with the communications lag times the Mars Rovers have limited levels of autonomy to allow them to move around on the service of Mars with minimal intervention by people.

Robotics

Another technology that is critical to automating machinery is robotics. Robotics incorporates all of the other technologies discussed here, but also
concerns the form and function of the machines. Robotic science is very highly advanced and very sophisticated. Some of the recent advances look to nature to inspire the development of robots, and it is here that I believe the mining industry can look for the future of the mining process.

**Small robots**

Predicting the future uptake of technologies is a difficult thing to do. Not many people would have predicted the internet or its impact, even as recently as 15 years ago. Lots of people wrote of trains, planes, automobiles, even telephones as things that wouldn’t be much use. Even so, let’s suspend our disbelief for a while and see where this might go.

Imagine small earthmovers - not Ford’s - but small ‘microbots’. As an example, consider the dragonfly robot. This small robot can see, fly, and power itself by the sun. What would you be able to do if you could have 1 million of these machines each moving a small amount of crushed ore? While this is perhaps far-fetched, it is worth considering as a possibility just as an exercise in reviewing the economics of the small.

If you could engineer it so that the bot know where to pick up a load and where to drop it off, travel in as straight a line as possible to get it there, and rest in the sun to recharge itself when it needed to, little else is needed.

As the prototype of the bot already exists, and the swarm intelligence distributed algorithms already control robots in the laboratory, and the sensor and control systems already exist to control such a system, there is little else for which to wait.

The way this works might look something like this: Two radio beacons are placed, one on the pile of crushed ore at the bottom of the pit (you need the crusher to be at the bottom of the pit) the second at the drop off point. Once activated, any dragonfly bot that has a sufficient charge, and is not carrying a load will fly to the beacon. Once in the vicinity of the beacon, a local control system vectors the bot to the top of the pile where ore of the needed characteristics is known to be located. The bot grabs its load of say 50-100g of crushed ore, and on automatic, it flys to the beacon at the drop-off point. On the way, using a standard swarm model, the bot negotiates the rest of the swarm and its environment until, in the vicinity of the drop-off beacon it is vectored to the release point.

And it doesn’t have to be a flying dragonfly robot, there are small crawling robots, snake like robots, and many other variations, any of which may be able to fundamentally change the mining process.

**What is the advantage**

So what is the advantage of this idea? How could a ‘many small’ system of movers compare to a ‘few large’ system that currently exists.

The economic viability of this idea has not yet been modelled, but as with all technologies, the costs reduce over time, and with take-up. A single mine using flying microbots would probably be enough to reach those long run efficiencies in terms of manufacture of the robots, and continuing advances in solar power technology mean that the path to sufficient power resources for this idea is quite predictable.

For me the biggest single effect lies in the ability to change the dynamics of pit morphology. By not having to step the pit back to get to deeper parts of the ore-body, the options for continuing mine operations to depth are very different.

---

### Reference

Swarm Intelligence
www.tranism.com/.../2007/02/robot-swarms-ev.html

These robots swarm, evolve, seek food, avoid poison, co-operate, and steal food from other robots.

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<table>
<thead>
<tr>
<th>Factor</th>
<th>Few/Large</th>
<th>Many/Small</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example</td>
<td>Haul Trucks</td>
<td>Flying microbots</td>
</tr>
<tr>
<td>Capital expenditure</td>
<td>$5 million each</td>
<td>Maybe $5.00 each (in the long run) but you’d need a lot of them.</td>
</tr>
<tr>
<td>Ongoing Maintenance</td>
<td>Complex, expensive</td>
<td>Disposable individuals but may still be significant.</td>
</tr>
<tr>
<td>Operators</td>
<td>Many people needed to support operations of haul trucks - drivers, water carts, graders etc etc.</td>
<td>Very few - supervisors located remotely.</td>
</tr>
<tr>
<td>Fuel</td>
<td>Significant cost</td>
<td>Very little - solar powered.</td>
</tr>
<tr>
<td>Infrastructure</td>
<td>Roads, ramps etc - significant, in fact determines long term viability of the mine</td>
<td>Little - no roads etc.</td>
</tr>
<tr>
<td>IT System support</td>
<td>Significant number of systems to help manage all aspects.</td>
<td>Significant (but not so much as current state).</td>
</tr>
</tbody>
</table>
Conclusions

There is no doubt that flying dragonfly robots will not replace haul trucks in the next 5 years or maybe ever. Even though most of the technologies are in place, or being researched now, there is still a while before they’ll be bought together to this one task. But there is one thing that technology futurists well understand. The pace of technological innovation is relentless, is accelerating, and most people underestimate what can be done, and when.

**ROBOT DRAGONFLY**

Robotics, artificial intelligence, automation, and remote management are all technologies in which the rates of innovation now are enormous. *New Scientist* reports on a robotic dragonfly that could guide Mars rovers - giving the fly’s eye view in a task analogous to helicopters being used as force projection assets of naval warships.

In the near future, further miniaturisation of the electronics, and better smarts will mean that this kind of technology can be used to continually update the topography of an open cut mine, with swarms of such robots preceeding ultra large automated vehicles, helping automated shovels load automated trucks. Perhaps they will even be able to replace the truck fleet, with millions of tiny robot flies moving enormous tonnages of ore without the need for roads, ramps etc. Just the saving in the profile of the open cut pit would change the economics of mining.

Underground mines could benefit too, with robot miners like the fly moving in to survey the mine after blasting - testing the air, rock face stability, everything. There is also my previous post of the robot crawlers which could also operate underground in very confined spaces.

There is a lot to consider, and the extraterrestrial problems being solved by robots can also be applied here, today.

REFERENCE

Caterpillar 797B - Wikipedia, the free encyclopaedia
See document Caterpillar_797B
http://en.wikipedia.org/wiki/Caterpillar_797B

![The Caterpillar 797B is an ultra class mining truck manufactured by Caterpillar Inc. The 797B is one of the largest mechanical dump trucks in the world.](image-url)
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