SIMULATION ASSOCIATION OF AUSTRALIA

RESOURCES AND INFRASTRUCTURE SPECIAL INTEREST GROUP

SIMULATION WHITE PAPER

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1 EXECUTIVE SUMMARY

1.1 CONTEXT AND PURPOSE

This white paper has been developed by the Special Interest Group (SIG) of the SIAA to provide the Resources and Infrastructure industry sector with a foundation document from which to plan the integration of simulation into training within these industries, as well as appreciating the widest range of simulation use available.

It is clear that at the present time, the Resources and Infrastructure industries are experiencing unprecedented growth demand. It is also clear that these industries are immature users of simulation in comparison to mature industry users such as aviation, health, rail and the military.

It is the experience of the members of the Resources and Infrastructure SIG that simulation is a central tool of business improvement, as evidenced by the widespread use of simulation in other industries mentioned in the previous paragraph. Based on this experience, it is a strongly held view of the SIG that simulation can provide a means through which the Resources and Infrastructure sector can achieve the workforce transformations necessary to respond to the growth challenges its industries face.

As a communications and training medium, simulation can up-skill the workforce and improve productivity, ensuring global competitiveness. Simulation can also improve safety outcomes, and reduce damage to plant and equipment. In addition, simulation can facilitate improvements in energy efficiency and related environmental outcomes.

1.2 KEY STRATEGIC ISSUES

The paper identifies the following key strategic issues that require serious consideration for the successful integration of simulation into all aspects of business.

- **Training Culture**

  Training culture within the Resources and Infrastructure industries is embedded in a paradigm of compliance versus competence, from which the major industry players are only just emerging. Fundamental change is required in this culture for simulation to add the level of business development that is required for the future growth of these industries.

- **Investment in training**

  Investment in training has tended to be linked to the boom / bust cyclical past of the Resources and Infrastructure industries. However, long-term growth is

transforming this practice identifying the need for long term strategic planning and investment in training.

- **Understanding simulation opportunities**

  While there is an emerging awareness within the Resources and Infrastructure industries of simulation and its uses there is as yet a very significant lack of understanding of its value to the industries concerned. Indeed, it is clear that there is a significant lack of awareness of the broad range of benefits that simulation can offer.

- **Understanding available simulation modes**

  It is clear that there is extremely limited understanding within the Resources and Infrastructure industries of the wide range of simulation modes and applications that are enhancing the operation of other industries. Failure to capitalise on the existing knowledge and future development will penalise the competitiveness of the Resources and Infrastructure industries into the future.

- **Lack of research on the benefits and applications of simulation**

  It is clear that there is a fundamental lack of research evidence to back up the extension of the current limited use of simulation within the Resources and Infrastructure industries. Research evidence is available from other industries and should be utilised in the interim while the resource and infrastructure industries develop a research base for the furtherance of simulation understanding and application.

- **The simulation industry's lack of understanding of the resource and infrastructure industries**

  Apart from Heavy Equipment Simulation suppliers, there is a significant gap in the understanding of the Resources and Infrastructure industries by simulation suppliers. The suppliers have worked with the highly structured industries of aviation, health, rail and the military and are ill-informed and equipped to respond effectively to the resource and infrastructure industries. It is essential that this gap be bridged if simulation suppliers are to provide an appropriate service to the industries concerned.

- **Development of simulation literate trainers**

  It is clear that significant work needs to be undertaken in the development of an appropriately skilled training workforce within the Resource and Infrastructure industries to apply the benefits of simulation to the organisations concerned.

- **Site versus centralised training**

  Significant consideration must be given by simulation companies to the needs of the resource and infrastructure industries in terms of site versus centralised training. Most training within these industries occurs at site and therefore requires simulation applications that are easily implemented in these environments - which are often extreme in terms of weather, isolation and technology support.

- **Standards**

  Mature industry users of simulation have seen standards for the use of simulation in training grow with the growing maturity of simulation use. Within the resource and infrastructure sector there are as yet no applicable standards for the use of simulation.

- **Commercial and industry development tensions**

  From a review of the current mature users of simulation, it is evident that industry-wide approaches to standards and applications of simulation have supported the growth and development of simulation use. Within the Resource and Infrastructure industries, there is a challenge lying between the commercial competitiveness of individual companies and the needs of the industry as a whole. This challenge needs to be bridged for the successful application of the benefits of simulation to the industry as a whole.

1.3 DRIVERS FOR CHANGE

The fundamental driver for change within the resource and infrastructure industries is the challenge laid by the extraordinary growth paradigm for the coming 20- 30 years, where we will see resource production double to treble in the face of emerging demand from China and Asia. In the face of this demand, fundamental workplace practice will change including the introduction of widespread automation. In the area of infrastructure, the main driver for change is the need to provide the necessary infrastructure to support this growth in the resources sector, as well as the projected population growth that Australia will experience in the coming decades.

The change in the skills-base demanded by automation clearly complements the importance and effectiveness of simulation training.

Further, the fundamental shortages of skills and people to meet the needs of a dramatically growing industry base in Resources and Infrastructure will add to the need for automation and fundamental changes to the way in which we skill our workforce.

1.4 PRESENT USE OF SIMULATION AND TRENDS FOR THE FUTURE

At the present time, the Resources industry is well supplied with heavy equipment simulation. However, despite this effective supply, there are significant gaps in understanding of the widest applications of the use of heavy equipment simulation and this links specifically to a lack of standards within the industry as well as training understanding and knowledge.

The first serious games based simulation for the Resources and Infrastructure industry has now hit the market and it is likely that a range of scenario based training tools will emerge in coming years. The use of 360-degree visualisation is growing within the industry.

It is clear that as simulation grows a foothold in the Resources and Infrastructure industries, there will be an explosion of new technology that will be of dramatic advantage in responding to the needs of younger employees who are [1]"digital natives", which at the same time may potentially overwhelm the trainer skills available to the industry.

1.5 EXPERIENCE FROM OTHER INDUSTRIES

The experience from mature users of simulation including aviation, health, rail and the military demonstrates that the long-term value of simulation in training and across the widest business application available requires significant commercial focus to achieve the obvious values inherent in the application of simulation.

It is clear from the experience of other industries that the case for the introduction of simulation into all facets of business is compelling, and that these examples of success must be taken into account in the long-term planning for the growth of the Resources and Infrastructure industry.

[1] A generation to whom the digital world is the natural environment for eduation and training

1.6 RECOMMENDATIONS

It is recommended:

1) That companies within the Resources and Infrastructure sector identify a key resource or resources within their operation to guide the integrated use of simulation into the future.

2) That companies work together with the SIAA to design a professional development program to improve the understanding of simulation for managers, trainers and other staff.

3) That companies within the resource and infrastructure sector develop a clear strategy for the introduction of simulation into all aspects of their business over the coming 5 – 7 years.

4) That training skills within the Resources and Infrastructure sector and the RTO's who service this sector be significantly developed to include clear articulate understandings of how to imbed simulation into training

5) That Resources and Infrastructure industry organisations involve themselves in the Resources and Infrastructure Special Interest Group of the Simulation Industry Association of Australia, including the annual SimTecT conference, to develop forum that is focused entirely on the application and developmental needs of these industries.

6) That companies be invited to provide input as to how simulation may improve their business.

7) That companies be invited to identify how technology has improved their understanding of simulated business variables.

2 INTRODUCTION

2.1 BACKGROUND

The simulation white paper produced by the simulation interest group of the Simulation Industry Association of Australia is designed to establish a starting point for the Resources and Infrastructure industries to consider the importance of simulation for their future growth and development.

The Simulation Industry Association of Australia is the peak body for simulation users and developers. The SIAA charter is to assist industry and simulation suppliers to gain the best competitive advantage for their businesses through the introduction of simulation.

The Simulation Industry Association of Australia has created a number of special interest groups (SIGs) to service the needs of the following industries: Transport, Health, Defence, Emergency Management, and Resources and Infrastructure. The work of the SIG is designed to engage the relevant industries at their particular level of engagement within simulation and create a structured approach

for those industries to advance research knowledge and understanding of simulation applications. The Resources and Infrastructure simulation interest group is a newly established SIG and has taken as its first step the formal publication of a white paper that is designed to set the scene for the industries concerned and the work that confronts them in utilising simulation to advance their businesses.

2.2 OBJECTIVE

The objective of this white paper is to highlight the role simulation can play in assisting companies in the Resources and Infrastructure industries to achieve the workforce transformations necessary to respond to the challenges these industries face.

2.3 WHAT IS SIMULATION?

For the purposes of this paper, simulation is defined as one or more humans interacting with a representation of a real process, equipment, environment or situation.

2.4 VISION – INDUSTRY TRANSFORMATION

As a communications and training medium, simulation can up-skill the workforce and improve productivity, ensuring global competitiveness.

2.5 SIMULATION USAGE IN INDUSTRY

At the broadest scope, modelling and simulation can improve industry's performance over all spheres of operation, including:

- **Forecasting** - modelling of macro systems, for trend analysis and forecasting, or supply-chain modelling
- **Capability Development** - planning for a new capability e.g. the introduction of a new mine – how big, workforce issues, risk management
- **Communications** - visualisation and animation can be used for effective communication with various groups – e.g. the Board and staff of a company, the public for Environment Impact Statements, local councils
- **Plant / Process Design** - optimizing and validating a new plant, prior to construction
- **Infrastructure** - modelling of plant construction to avoid wastage, delays, re-work
- **Plant Operation Optimisation** - decision support, or operator utilization
- **Equipment Design and Testing** - prior to manufacture

However, this paper concentrates on the use of simulation for workforce issues, including:

- Recruitment and retention;
- Aptitude testing;
- Training in technical and non-technical skills;

- Safety culture;
- Process, Plant, Equipment Operation; and
- The impact of automation.

3 POSITIONING AUSTRALIA INTERNATIONALLY

In an ever-increasing globalised economy it is important that Australia is able to effectively compete. There are four issues of strategic importance where simulation can add value:

- Improving productivity;
- Improving the sustainable nature of business;
- Engaging a new generation of digital learners in an industry typically focused on hand-eye coordination; and
- Enhancing our knowledge economy.

3.1 IMPROVING PRODUCTIVITY

The recently published 3rd Intergenerational Report[2] highlights the challenges that demographics pose for Australia. By 2050 it is projected that there will be 2.7 people of working age for every person over 65. Today's ratio is five to one, and in 1970 it was 7.5 to one. While Australia has obviously coped with this trend to date it is true that this has occurred through improving productivity. Analysts however also point to the easy productivity gains having been realized e.g. office automation, business process re-engineering, manufacturing automation, quality systems and lean thinking.

To cope with a further need for productivity gain (without the compulsion that is facing northern-hemisphere economies) organizations will need to focus on smarter processes and leaner operations if margins are to be protected from what undoubtedly will be market share and price competition from America and Europe.

Simulation, while around for a number of years, has yet to be fully exploited for its potential to refine processes and model improved outcomes. Just one example of how simulation can assist in productivity gains comes from the Mining Sector. A small-scale simulation was undertaken on production cycle times and through simulation, improvements were made - increasing the productivity of haul-trucks by reducing lost time during manoeuvring, improving reaction times for departure, and reducing measurable shock loads to driveline and suspension.

In construction, simulation was used by Balderstone to model work processes for an incrementally launched bridge on the Bridge to Bay Alliance in NSW. The results of the simulation helped them plan the work processes and caused them to re-design aspects of the work to get the construction right first time. Simulation

[2] www.treasury.gov.au/igr/igr2010/

helped them redesign the form-work so that it would be effective and the work could be undertaken in a safe way. Without the use of simulation these issues would not have been apparent until the job was underway proving costly in time and money and potentially a safety concern.

Modelling and Simulation (M&S) is increasingly becoming a central activity in design of new systems and in the analysis of existing systems because it enables designers and researchers to investigate system's behaviour through virtual representation. For this reason, M&S is gaining a primary role in many industrial and research fields, such as space, critical infrastructures, manufacturing, emergency management, biomedical systems and sustainable future.

3.2 IMPROVING THE SUSTAINABLE NATURE OF BUSINESS

Regardless of the mechanism for reducing greenhouse gases and improving our environmental sustainability, there will be increased pressure for businesses to think and go 'green'. This pressure will come from shareholders, regulation, incentive and innovation. Simulation has a role to play in the greening of business in two key ways:

- Modeling and simulation provides a means for businesses to determine the scale of greenhouse gas reduction through changes to component parts of their operations. This affords the possibility of determining which elements to address first, and run the model through both the product/service life-cycle as well as back into procurement to bring much greater precision around carbon accounting than has existed thus far.

- The ability to replace a carbon intensive activity for a low carbon alternative. In the realm of heavy equipment use for example, simulation, through the application of heavy plant simulators provides a greener alternative for delivering a proficient plant operator. Aside from safety considerations which simulation can deliver, plant operators can learn to operate equipment more economically, and to generate less wear and tear on vehicles (which also provides a fuel efficiency gain). If the actual operation of heavy plant, while in training mode, was sufficiently reduced then the reduction in greenhouse gases emitted could be significant. It is acknowledged that training on real-life plant has higher degrees of repetition which alone contributes to greenhouse gas emissions - higher than the equivalent plant hours if operated by an experienced proficient operator.

3.3 ENGAGING A NEW GENERATION OF DIGITAL LEARNERS

It is important that the transition from a learning environment to a work environment is as seamless as possible. Employers talk about the importance of having new entrants (particularly school leavers) more work-ready and with a skill-set attuned to the world of work. With an increased emphasis on digital learning Generation Alpha (the generation coming along after Gen Y) will want a sense of engagement that at least offers an experience akin to the environment they have left. Research shows that where the worker feels fully engaged their productivity is optimized. The greater involvement of simulation across industry, but particularly at the front end where training is likely to be provided, offers the opportunity for employers to engage their workforce in a more comprehensive manner.

3.4 ENHANCING OUR KNOWLEDGE ECONOMY

The need for Australian business to exploit the knowledge economy will be paramount as the BRIC nations (in particular) and South-East Asia establish themselves at more complex ends of the supply chain. It is essential that Australia develops knowledge in areas like modelling, simulation and serious games to exploit opportunities in the low-volume high-margin business areas. Where Australia can play a role is in:

- Development of behavioural approaches to work that is underpinned by simulations;
- How simulation is integrated into mainstream training, operations, disaster preparedness, business improvement etc;
- Development of simulation as a decision-making tool;
- Development of aspects of high-end simulators particularly in specialist areas of aerospace, transportation and medicine;
- Integration of serious games into training and compliance testing.

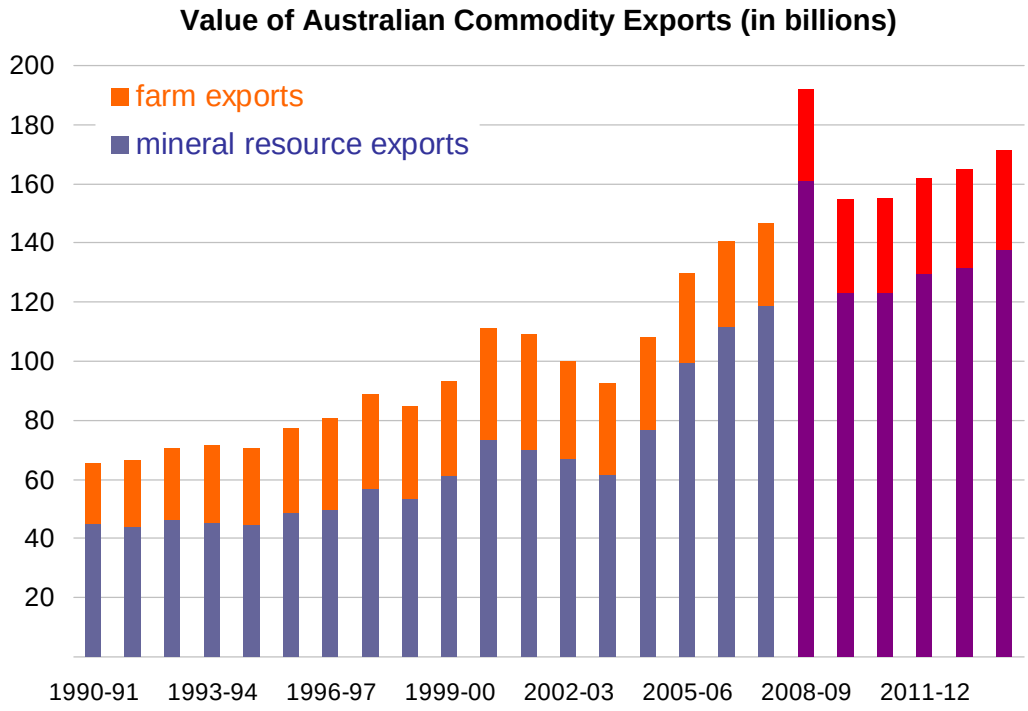
Expertise in these areas offers business opportunities for Australia to export this knowledge overseas as well as assist Australian business competitiveness - enabling a competitive or differentiated product/service to be brought to market.

4 INDUSTRY ANALYSIS

4.1 RESOURCES

Until 12 months ago, the resources sector in Australia was experiencing a period of sustained growth that analysts believed would continue for the next 10-15 years, provided that the industry continued to focus on productivity. However, this picture was interrupted by the global financial crisis which, from the perspective of many, seemed to return the sector back to a boom / bust environment. Analysis of growth in the resources industry going forward, predicated on current data, suggests that the sustained growth-line for this industry continues despite the fact that we have had a bubble of extremity including extraordinary prices for resources. The following graph from economist Michael Pascoe[3] illustrates the continued growth in commodities exports despite this bubble in terms of the industry's future.

[3] M. Pascoe: 2009 Mining Industry Skills Centre Conference – Title



What this tells us is that we have experienced a significant but temporary interruption to a period of growth. This is not the traditional boom / bust behaviour that has been the recent history of the resources industry in Australia. The impact of this previous history is significant at the present time, as long-term growth presents a different paradigm for the development of an appropriate environment to ensure long-term growth of the industry.

During the global financial crisis, it was clear that the majority of resource companies held on to their skilled staff, including apprentices and graduates. This was done at cost to the companies due to a recognition of the ongoing skills shortage that would revisit the industry as soon as the financial crisis abated. This is a seminal change in understandings about workforce planning and the development and sustaining of a skilled workforce within the resources industry.

The impact of boom / bust on the mining industry in Australia has created an environment where skills have been purchased and long-term investment in the development of skills has not been the norm for all companies. While there are exceptions to this, it is clear at the present time that the industry is poorly positioned in relation to the current national skills shortage.

The impact of the skills shortage in a time of sustained boom is bringing about a sea change in understandings relating to attraction and retention of staff, the introduction of automation and the rationalization of training for the industry's needs.

This industry environment is one in which simulation has a huge role to play, not only in the world of automation but in all aspects of maturing the resources industry's response to not only training but the wider application of simulation to all aspects of the resources industry. The adoption of simulation could dramatically assist the capability of the resources industry to improve its productivity.

4.2 INFRASTRUCTURE

The Australian infrastructure sector has an estimated net worth of $60 billion a year, employing over 800,000 workers. In contribution terms this varies State by State but in the case of Queensland, building and construction contributed 28.6% of the economic growth in this state's economy 2008-9, which is equal to the three next largest contributors, mining included. The boom / bust cycle once associated with the sectors has become a thing of the past with significant growth and therefore job security and opportunity as a result.

In the five-year period 2002-2007 92,500 new jobs were created. As a sector it is experiencing a skills shortage and even in the current uncertain economic times the shortage is certain to remain. The Federal Government now estimates that there are 25 occupations within the building and construction industry that are currently in a skill shortage situation. These figures are exacerbated when the current Queensland building and construction industry apprenticeship and trainee completion rates are considered. At only 64.8% and 57% respectively, approximately 35% of these potential new workers never get to join the workplace as fully skilled workers.

4.3 KEY STRATEGIC ISSUES

4.3.1 Training Culture

Through research in Queensland[4], it has been identified that the current culture within the resources industry is dominated by a compliance versus competence paradigm. This research reflects that a number of companies are much more advanced in their thinking about training culture but by far the majority of companies are only just beginning to address the problem of poor training culture. It should also be noted that, based on less formal investigations, the research based in Queensland reflects the industry Australia wide.

The training culture, certainly in Queensland and New South Wales relates strongly to a heavily regulated industry. In this situation the demand of regulation for compliance has distracted the focus from competent behaviour by employees. It is to be expected that significant work will require to be done in training trainers to gain the best benefit from the introduction of simulation. This view is reflected in the poor use of heavy equipment simulation in recent years where it has been purchased without a clear understanding of the training requirements around simulation.

In introducing simulation training into the industry it is therefore imperative to recognise that trainers will not necessarily be skilled in the use of simulation nor have a full appreciation of adult learning concepts.

It is clear that simulation can actually provide a catalyst for change in the nature of training within the industry. It is to be hoped that the importance of simulation

[4] Mining Industry Skills Centre 2007-8 Skills Strategy Research – Title

to improving safety through better training will drive an agenda for trainers that will catalyse the overall understandings of what makes training effective for adults.

In the case of the infrastructure sector there is a history of training being provided through the support of the Building and Construction Training Fund ((BCITF) Queensland only). In reality this has promoted training but in some ways there has been an avoidance of ownership of training - often resulting in employers believing that training is someone else's responsibility. The situation has been exacerbated by the significant degree of sub-contracting that features within the industry with the larger companies under-represented in terms of apprentice numbers. While there are instances where this is not the case and the situation is changing it is true to say that there is still some way to go before the industry could say it has an ingrained culture of training.

4.3.2 Investment in Training

The constant boom / bust cycle experienced in the past by the resources industry has resulted in a mode of thinking where maximizing short term gain takes priority over long term planning.

In the current environment, we are now seeing, in spite of the global financial crisis, a long-term sustainable growth of the industry over the coming 15 to 20 years. However, in the face of this long-term growth there is a compounding skills shortage which is impacting all industries but in particular the Resources and Infrastructure sector. The whole process of investment in human capital and training is being in many cases rediscovered

Automation is now becoming an obvious pathway for industry to follow as a means of improving productivity, and improving safety by removing workers from the most dangerous situations. This approach will impact the whole nature of required skills for these industries.

The use of simulation both in training and in management of the Resources and Infrastructure sectors is in its infancy. The emphasis on heavy equipment simulation has simply reflected the drive of simulation suppliers in an area which was both obvious as well as appropriate at the time. However, it is now clear that heavy equipment simulation may not have a long-term future in the face of automation.

There is an urgent need for the development of understandings about the nature of the contribution of simulation to all aspects of the Resources and Infrastructure sector, specifically looking at cost/benefit analyses in the broadest sense. This will inform the decision-making process regarding how to make investments in training.

4.3.3 Understanding Simulation Opportunities

The resources industry is on the verge of very large-scale involvement in the use of simulation across all sectors of its business operation. At the present time we have seen the use of heavy equipment simulation as the first major element of simulation being introduced into the industry. This has been complemented by,

for example, the development of 360-degree simulation to create a 3-dimensional environment for underground mining in NSW. This particular development and its offshoots, including “idome”, are just entering the market at this time.

In the past 12 months we have seen the development Project Canary[5] which has introduced serious gaming to training in the resources industry. Project Canary is seen as a world first in the application of this technology and offers a dramatic challenge to the way in which training is currently undertaken in the industry.

We are also seeing a range of early attempts at the introduction of scenario-based simulation for problem solving across a range of industry areas.

When an industry that has not widely accepted the use of simulation decides to enter into simulation on a much larger scale, it will enter at the highest point of simulation technology and development available at that time. This is of immense benefit at the present time to the resources industry and will see the industry become a leading edge user of simulation over the coming five years.

There is a growing awareness within the Resources and Infrastructure sector that simulation is a major part of the future and it is now timely that work is undertaken in this area particularly in the development of understandings regarding the value of simulation.

Within the infrastructure sector however, while simulation is regarded as of potential value, there is a lack of clear understanding as to what constitutes simulation. Many believe that real work in an area associated with the workplace, or where there is no substitution for actual tasks through the use of technology or other methods is the preferred modus operandi. There is little appreciation for what is available currently in the form of ‘true’ simulation or where this development might go if there was a greater application of technologies currently available. The notion that simulation must be proximal to the real work environment is a firmly held belief by those that do have some feel for the concept of simulation.

4.3.4 Do the Resources and Infrastructure sectors understand the range of simulation modes available – what is simulation, and what it can achieve?

The SIAA Resources and Infrastructure SIG holds the view that there needs to be better engagement with the industries to improve communication.

To follow up on this, we need to engage with the Resources and Infrastructure sectors to recognise the need to develop a deeper understanding of the issues core to our respective businesses, and consider how simulation may be effectively utilised.

Industry has only a limited knowledge of available simulation products, as the most visible are generally focussed on skills based training solutions for machine operators. It is felt that if there is a greater general knowledge of products, services and suppliers of simulation solution products, many opportunities will become apparent.

[5] http://projectcanary.com/

As the SIG Committee is able to put together the planned taxonomy from both perspectives, future opportunities for the utilisation of simulation in Resources and Infrastructure will be highlighted.

Simulation has been used in a broad, mathematical algorithm perspective to design, quantify, cost and schedule project management for both the Resources and Infrastructure sectors for many years. The limit of opportunity was only bounded by time available, cost and resources required for each version run.

"Moore's law" in regard to affordability of computing power is transferring to graphic engines, meaning applications previously only in the domain of defence and aerospace are now well and truly within future planning reach of the Resources and Infrastructure sectors.

The use of graphics to represent infrastructure projects and resource models are well advanced and accepted. Logistics modelling is well accepted. Spatial studies now involve more graphics than ever before.

The Resources and Infrastructure sector prefers to purchase Commercial-Off-The-Shelf (COTS) products to avoid risk. The Simulation Industry prefers detailed specifications to be able to nominate from a product range.

We need to build the bridge between by providing a library of mutual interest information as a start.

4.3.5 Lack of Research on Benefits and Uses

There is a significant demand at the present time by industry for educational research that demonstrates exactly why simulation is an appropriate tool for training. While to those of us involved in simulation training this may seem obvious, it is clear that research needs to be collated and developed to ensure that the industry has ready access to the rationales for the use of simulation.

As has been identified by the SIG Committee much research has been done but it is not readily accessible and the development of an Australian database for research in simulation is certainly of importance.

It is further the case that information on simulation research is not easily disseminated and again this is a development that must occur if the industry is to have the best possible information available to make judgements on the purpose and implementation of new simulation.

The establishment of the Australian Simulation Research Centre at Central Queensland University Mackay Campus is designed to fill this void.

4.3.6 The Simulation Industry's Understanding of the Industry

The SIAA Resources and Infrastructure SIG Committee has the opinion that there needs to be better engagement with Industry to improve communication.

To follow up on this, we need to engage with the Simulation product suppliers and the Resources and Infrastructure sectors to recognise the issues core to our respective businesses, and consider how simulation may be effectively utilised.

Simulation supplier companies have invested heavily developing technology for Defence and Aerospace, and are now looking to expand utilisation and sales of their product into other markets. The Resources and Infrastructure sectors may have similar needs, however, are likely to insist on far different commercial arrangements. The Resources and Infrastructure sectors will not automatically purchase items because they exist.

The Simulation industry also understands that techniques considered the domain of homeland security have immediate relevance to Resources and Infrastructure. Advanced simulation concepts to build interpersonal and cross-cultural skills will also play a part in helping avoid high-risk scenarios.

The Resources and Infrastructure sectors have only a limited general knowledge of available simulation products, and those most visible have been generally focussed on skills based training solutions for machine operators. There are many opportunities for task training, command and control centre training, mission planning and rehearsal and after action review to name but a few.

As the steering Committee is able to put together the planned taxonomy from both Industry perspectives, future opportunities for the utilisation of simulation in Resources and Infrastructure may be highlighted.

The biggest concern to-date in this relationship is that simulation use has been almost entirely supply-driven. In a situation where simulation is a glitzy tool it has been easy to sell simulation without the appropriate development of the training understandings in relationship to simulation and the overall objectives of the training.

There is in many areas of the resources industry an antipathy towards simulation because of this approach in the past that has seen huge expenditure frequently moth-balled because of lack of ability to apply the technology within the training context. There is an absolute need for industry education in the development of understandings regarding the role of simulation and the benefits that it can bring.

In line with this understanding it is important that there is leadership on behalf of the industries that gives industry-wide focus on the use of simulation rather than just the individual commercial benefit that particular companies will pursue.

Where the market does not articulate clearly a need or desire for simulation (partly due to lack of awareness of what is possible and available in technology terms) so too the manufacturers/developers of simulation are reluctant to spend valuable R&D resources on what may well result in few sales of simulators. There is some evidence of this changing but as most simulators are focused in the mining sector where there are likely to be larger multi-national players interested in product lines there is a significant lack of targeting of the potentially large but more fragmented infrastructure sector. This has a ‘catch 22’ effect in that take-up within the infrastructure sector is likely to be lower where the product does not appear to be differentiated for different skills sets, nor contextualised to different terrain. Without expressed demand that has a commercially viable mass there will continue to be reluctance by the suppliers of the technology to target and develop products expressly positioned for the infrastructure market.

4.3.7 Who is the Customer?

Time after time we hear the stories about simulation products that are purchased with all good intention, but without any utilisation plan. The common questions that arise are:

- Who wanted it?
- Who has lost their budget to pay for it?
- Who is going to administer the contract(s)?
- Who has to account for it?
- Who is going to man it?
- Who is maintaining it?

Who is going to use it?

- The supplier sees the person who said they were going to place an order as the customer.
- The person who said they were going to place an order sees the person whose budget is being raided to pay for it as the customer.
- The procurement division sees contract services as the customer.
- The person who lost their budget control now has to find room for it, staff it and produce results within their original budget.
- Who provided the room?
- Who provided the staff?
- Who knew what was expected?

Who knew what to do next?

- The person who placed the order expected results.
- The expectations were not specific.
- The trainers needed training
- The users needed briefing
- The man-hour owners saw a mess in the making
- That was going to cost them KPI

Recent discussions within the Industry[6] seem to be grappling with Verification, Validation and Accreditation (VV&A) much better after they establish the desired Return on Investment (ROI) toolbox to focus purchase recommendations.

4.3.8 Development of Simulation-Literate Instructors / Trainers

As highlighted in the training culture comments it will be absolutely essential to provide professional development of instructors and trainers in the use of simulation.

Development of an advanced skills program to introduce and model advanced adult learning concepts to trainers will be essential. This work is necessary given the nature of training in the resources industry and the fact that the majority of

[6] SimTecT 2008 observation

trainers are qualified with a Certificate IV which does not go far enough in terms of the sophistication required for the use of simulation in training.

It is recognised that a national training program for use by instructors and trainers will be required for simulation to spread rapidly as a standard training tool.

4.3.9 Site Versus Centralised Training

Site based training allows for training of individuals at the site of employment during the normal daily operations structure.

This requires the availability of staff, transport, training Resources and Infrastructure, and can be a big ask for a smaller project. Site based training provides the greatest opportunity to influence the quality or customise the desired outcomes to meet local needs. There is a general view within the Resources and Infrastructure sectors that training at site adds significant value and lowers cost. In this situation it is important that simulation must take account of this.

However, there are significant exceptions to this situation. In NSW Mines Rescue has developed a centralised simulation training system. These centres are placed in a geographical mining region where it is easy for mine sites to access the centralised training setup. In these areas we see the use of 360° simulation, “idome” simulation and underground mine simulation all housed in first class training facilities.

Central training facilities, whether it be for a cluster of smaller nearby projects on a local basis, regional to assist with wider resource clusters, or city-based to support basic training and recruitment have their own advantages. Centralised facilities can provide an opportunity for reduced individual costs by sharing facilities, cheaper transport and accommodation, and higher utilisation of training resources.

A downside is the continual marketing for customers to participate, and the resources this ties up. The fulfilment of the business case is a major pressure for any commercial facility, and will require predictable utilisation to maintain viability.

Academic research and other learning and development studies will be utilised to augment primary purpose utilisation.

The central versus site model is an argument that has played out in more mature industries and it is fair to say that the application of simulation has become more distributed over time. However there is a strong argument to suggest that commencing with a more centralised approach allows for the following:

- Development of a critical mass of expertise in training and applying the principles of simulation;
- Establishment and maintenance of training and teaching standards that can then be rolled out into the field;
- Support for development of standards (see below);
- Support for development of curriculum and the necessary refinement involved;
- Ease of recruitment;

- Expansion of the simulation envelope into other domains; and
- Development of a research and development potential as well as improved assessment and evaluation techniques.

Once some core principles have been established it is a natural progression for simulation to be delivered more in the field, to take advantage of proximity to the real workplace. This then becomes an iterative process to determine the best balance between core and periphery and how to manage resources (human, intellectual and plant capital) with such a distributed model and how to maintain standards.

4.3.10 Standards

It is clear that all industries that move down the pathway of significant simulation usage in training will be required to establish a governance model including an appropriate set of standards.[7] This will be no different in the Resources and Infrastructure sectors and this work is urgent if we are to fast track the value of simulation.

In setting standards it is clear that significant work has to be done on the assessment of skill levels within skill sets. Skill revision and existing curricula will also need to be brought into the work to understand how best to set standards around the use of simulation.

Training and training policy will be required to create focus through a set of technical standards that will allow simulation to play the fullest role in the development of training in the resources industry. At the present time, discussion regarding the use of simulation in haul truck training reflects a view that somewhere between 70-90% of training for haul-truck driving can be undertaken on a simulator. Without industry-wide standards this is an area of contention for many stakeholders and requires to be set as a formal standard. With the introduction of simulation across a wide range of applications within the industry standards must be set in relation to these developments.

It should also be noted within the area of standards that regulatory issues are different between states and it will be necessary to consider this when developing standards for the industry.

4.3.11 Commercial and Industry Development Tensions

For simulation to be successful and for the ultimate benefit of not only the Resources and Infrastructure sectors, but also the States and country as a whole, there is the need for industry leadership. Such leadership may at times conflict with the commercial reality of operating enterprises where the need to secure a defined return on capital employed, or to make profit is overwhelming. In such circumstances there is the need for industry and Government at both a State and Federal level to produce partnerships that allow this seemingly paradoxical situation to be resolved. There are examples of this in other sectors where a lead

[7] The Mining Industry Skills Centre has already identified that it may undertake this work in consultation with Standards Australia and SIAA

organisation has pushed the frontiers of simulation enabling other organisations to enter the market with more confidence.

A recent example of this is the pioneering role taken by Queensland Health's Skills Development Centre which has played a pathfinder role in simulation in not only the Australian context but also on a world stage. The Mining Industry Skills Centre and the Construction Training Centre, both headquartered in Brisbane are well poised to create such a partnership with Government and fulfil such a role. They both have charters that support this role and have a commercial focus to ensure that where development is undertaken there will be a commercial reality to its application. Without supporting these 'hybrid' organisations i.e. commercial but with a focus on development and growing the application of the technologies, it is possible that the opportunity to exploit the potential of simulation will be lost while the financial business case for simulation awaits being constructed.

As is the case in most industries there will be a tension between the commercial self-interest of particular industry players and the need for broader industry co-operation and development. This is currently reflected in the Resources and Infrastructure sectors in relation to simulation. Some companies who have taken a world view of how simulation will impact their business are working in isolation from the rest of the industry.

It is important to recognise that the sharing of information and understandings regarding the value of simulation are necessary on an industry wide basis to allow for the development of simulation standards and for the transportability of qualifications gained through simulation. The SIAA Resources and Infrastructure SIG Committee is well-positioned to try to bridge the commercial self-interest of companies and the larger need of the industry as a whole. If we are to progress satisfactorily through this agenda it will be necessary to identify the clear benefits that lie in the sharing of expertise and understanding for the benefit of the whole industry as opposed to a splintered approach based on commercial self-interest.

Examples of industry cooperation to improve the overall quality and outcome of performance across the board are well documented. An excellent example is that of our four banks in Australia who share resources through the use of ATMs, undertake work on behalf of each other in areas such as processing, and have an articulated understanding that sharing across the industry has wider benefits for all concerned. At the same, in the above banking example none of the four banks would accept that it is not in serious competition and seeking serious competitive advantage over the others. Fostering this particular approach to the introduction of simulation to our industry will be necessary if we are to achieve the best outcome for all concerned.

4.4 DRIVERS FOR CHANGE

There are a range of drivers for simulation in the infrastructure sector:

- A depleted workforce that requires replenishment of both people and skills at a rate faster than currently applies;
- Reliance on immigration to fill some gaps which brings different challenges and that has a time lag;
- The need for skills that are predominantly psychomotor and behavioural both of which can be delivered through simulation training;

- Changes in licensing that demands a greater number of logged hours before competency can be assessed;
- A shift to a more competency-based approach to training;
- A need to engage the workforce of the future to secure future workers through offering exposure to a training medium that is both appealing and linked to their digital education experience;
- The need to resource infrastructure projects such that costs and timelines do not blow out; and
- The ability to rapidly cross train staff between sectors e.g. infrastructure and resources to provide greater labour market security.

Simulation is able to deliver across a range of the above. As the infrastructure industry becomes more familiar with the potential of simulation and more comfortable with the outcomes of those who have undertaken simulation as part of their training, there will be a greater drive to shorten training times by either augmenting or replacing some traditional training methodologies with virtual or simulated alternatives. This is a clear trend in other industries e.g. aviation with a greater use of simulation to shorten the training time for pilots and in healthcare to train some surgeons to desired levels of proficiency in complex procedures through simulation before allowing them to operate on a real patient. Given the application of simulation in these two 'high reliability' environments the arguments for increased usage in lower reliability domains becomes more compelling.

The Resources and Infrastructure sectors both have a significant history of boom / bust operation. In times of boom the sectors have been in a position to buy what was needed and to let it go when the good times rolled by.

Despite the global financial crisis which has impacted all industries over the past 12 – 18 months, it is now clear that the paradigm for boom / busts has changed for the resources industry with the industry locked into long-term sustainable growth and at the same time a compounding skills shortage. There has been a clear change in the resources industry in terms of recognising that the global financial crisis was a bubble in what is an ongoing period of long-term growth. As such we have seen the industry hold on to skilled staff in a way that has not been seen previously. This is a fundamental change and heralds a new era in the way in which workforce planning and workforce development is applied within the industry.

This change in the approach particularly to training is encompassing a wave of fundamental change in terms of how adults learn best in the work environment. This pre-disposes the Resources and Infrastructure sectors to the use of high-level technology including simulation.

Another driver for change within the Resources and Infrastructure sectors is the move to automation. In the face of escalating skills shortages automation is now becoming an avenue for achieving business outcomes. The technology for automation has existed in many areas for a number of years. However, the will to implement automation is now being driven by the need to respond in a growth economy in the face of skills shortage. As automation begins to move further into the work place we will see a change in the actual roles for operators at work sites and an increase in the use of simulation to train for these roles.

4.5 PRESENT USE OF SIMULATION

At the present time the resources industry is well supplied with heavy equipment simulation through three major providers: 5DT, Thoroughtec and Immersive Technologies. Heavy equipment simulators are available across a range of heavy equipment including haul-trucks (including electric), graders, bulldozers, loaders, dragline and in the underground sphere, roof bolter and shuttle car.

The introduction of these particular simulators is at the high end of technology and there have been difficulties in integrating them into training programs due to the appropriate conceptualisation of where they fit within training.

The development of 360-degree, 3-dimension simulation by University of NSW has had a major impact on training for underground mining. Other products related to this development including “idome”, are now available to the industry. The use of simulation modelling is limited in its current use and is certainly not integrated into the fabric of the resources industry.

The first application of serious gaming as a tool for training in the resources industry has been launched. Titled “Project Canary”, this application of simulation is designed to not only introduce the industry to the highest level of serious gaming simulation application, but also to bring about a fundamental culture change in the way that training is undertaken in the Resources and Infrastructure industries.

There are also some scenario-based simulations for specific training scenarios being created by a range of providers.

It is clear at the present time that simulation is not regarded as a holistic part of training and discussions around the actual use of simulation at a variety of levels has not yet occurred. There is a significant requirement for the industry to recognise simulation as a tool at all levels and to build it into the curriculum and into trainers’ understandings as a valid approach to training and management.

In training terms there is very little use of simulation within the infrastructure sector. Its use though in modelling, design and risk management is reasonably widespread. The issues for the infrastructure sector are as follows:

- A shortage of true advocates;
- A real lack of understanding within the industry of what simulation is capable of and what is available;
- An increasing average age of plant operators approaching the mid 50s;
- A lack of numbers coming through to match those exiting the industry;
- The lack of clarity regarding prescribed occupations as to whether simulation time is valid in terms of logged hours or for training as a precursor to testing;
- No established curriculum that has simulation embedded;
- Does not appear to be on the agenda of the relevant skills councils;
- Resistance to change by the industry to re-think approaches to apprenticeships and traineeships;

- A belief that no training can match the real thing;
- Lack of willingness by plant owners/clients to have inexperienced operators i.e. those without significant hours in an actual vehicle;
- A culture that has not embraced training as a core value;
- The lack of availability of simulators that are regarded as a good training fit for the skills needed in building and construction;
- Scepticism about the role that simulators can play with particular distrust of fidelity;
- Lack of trainers with a knowledge of or skills in simulation;
- Belief that the available suite of hi-fidelity simulators are oriented towards mining;
- A belief that it is someone else's role to provide such simulation facilities
- A more difficult cost / benefit case to be made given the cost of high-fidelity simulators are about equivalent if not cheaper than real plant;
- Higher salaries being offered to be a tradesman rather than a trainer reducing not only the available pool numbers but also the quality;
- A belief by some that simulation needs to be delivered at the worksite and therefore be located away from built up areas and be highly mobile;
- Lack of standards for instructors;
- An industry so busy with its order book and staff shortages that there is no time to explore and advocate for simulation; and
- No mandatory imposition or encouragement of simulation from the regulatory authorities unlike other industries such as aviation.

5 TRENDS IN SIMULATION

5.1 TECHNOLOGY

5.1.1 Fidelity Increase

Rapid increases in computer power, together with the better quality of available data and the following Human Interface Improvements, means that the fidelity (realism / accuracy / training transfer) of the simulations has improved.

5.1.2 Human Interface Improvements

- Visual systems (driven by the entertainment industry)
- Graphics and display devices
- Haptic devices
- Motion systems
- Sound Systems

5.1.3 Serious Games

- Suits demographics
- Various learning styles
- Generation Y
- Multi-player

5.2 COSTS AND RESOURCES

Operating costs are increasing – including:

- Salaries
- Energy use
- Compliance regulations
- Environmental impacts
- Opportunity costs – where real equipment is taken out of (optimum) production, for training purposes.

Technology costs are decreasing:

- Computers
- Peripherals
- Support / maintenance

Curriculum costs are increasing:

- More, and more effective curricula, are required

Training Instructors are becoming harder to find:

- Opportunity costs of taking an experienced person out of production is increasing
- Experienced people are retiring.

5.3 IMPACT

What does this mean for the Resources and Infrastructure industries?

When one takes account of trends in simulation it is recognised that the opportunity for the Resources and Infrastructure industries is immense. By leveraging off the experience of more mature users of simulation and at the same time being able to enter the simulation market at the current level of simulation development these industries can place themselves at the forefront of simulation use if they are prepared to appropriately design the environments in which simulation will be used.

It would also be true that large-scale investment from these industries is the norm and that the ability to switch completely to a new technological approach to training will be grasped by many companies.

6 EXPERIENCES FROM OTHER INDUSTRIES

6.1 DEFENCE

Defence is in many areas a mature simulation user; particularly for training applications.

The Defence Simulation Roadmap 2006[8] outlines Defence's vision statement for simulation over the next 15 years, for:

- Capability Management
  - Attracting, selecting and retaining the right people
  - Optimising its strategy, development, acquisition and execution processes
  - Planning for major projects
  - Supply chain management.
- Operations
  - Planning and decision support
  - Training, including mission rehearsal

The use of simulation for training has broadened from individual, platform oriented training, to team or group training for mission training. This is achieved by:

- Individual simulators being linked together so that geographically (and often internationally) separated personnel (often with varying roles) can be trained in procedures, doctrine and tactics
- Massively Multi-player Games are being re-purposed for team training using PCs connected to a Local or Wide Area Network.

Operational Training is relatively recent, including:

- Decision support modelling tools in a Command centre which receive real-time situational data, and predict likely outcomes or what-if analyses
- Mission rehearsal where the latest intelligence and data from the intended operational area is rapidly input into the simulation, and the participants train in the strategy, tactics and logistic issues involved with the actual mission.

Modelling and simulation is being increasingly used for non-training purposes; including:

[8] www.defence.gov.au/Capability/adso/docs/defence_simulation_roadmap.pdf

- Recruitment – games to attract young people, and to expose them to life in the services
- Capability development modelling – where options for numbers, capabilities and deployment strategies, and risk analyses of various proposed systems are modelled as part of the decision-making process
- Supply-chain modelling for logistics optimisation.

Despite the success of Defence simulation, its use is by no means ubiquitous and assured, and the SIAA continues to educate and lobby Defence as to the benefits of simulation.

6.2 AVIATION

Aviation is the most mature user of simulation for training. The famous "Link" trainer, developed by Ed Link in the late 1920's, was used to train thousands of pilots for WW II (see the History of Flight Simulation[9]).

Today, simulation is used for training most safety-critical aviation activities:

- High-fidelity full-flight simulators – certified to be sufficiently realistic to allow conversion training (ie a pilot qualified in one aircraft type can be accredited to another aircraft type purely by undertaking simulator training);
- Part-task simulators – PC-based or simplified simulators for training in detailed operating procedures of complex sub-systems such as the Flight Management System;
- Crew Resource Management – training in non-technical skills such as leadership, decision-making, communications, under conditions of stress; and
- Air Traffic Control training.

Characteristics of the Aviation sector have enabled the use of simulation to flourish:

- The sector is highly nationally, and internationally regulated;
- Simulator standards have been developed and accepted world-wide. This means that training curricula can mandate the use of a simulator of a certain fidelity standard. The simulators themselves are designed, maintained and accredited to meet these standards. The regulators can therefore accept that pilots trained and assessed under a certified curriculum, with a certified simulator, meet the legislated training requirements.

Forecasts of air travel before the recent Global Financial Crisis indicated a significant shortfall of pilots, and the need for a rapid increase in training. It is anticipated that this need will continue as the effects of the GFC decrease.

[9] www.siaa.asn.au/get/2395364797.pdf

6.3 HEALTH

Simulation in healthcare has been around for many years but in the context of present day simulation it is still a relatively new science but one that is advancing rapidly. Broadly speaking healthcare simulation has seen three reasonably disconnected growth areas:

- Use of manikins and part-trainers for procedural skills
- Non Technical Skills e.g. Crisis Resource Management (CRM); and
- Surgical skills

Given the position of the learned colleges in the development of the medical profession's professional standards much of the development of simulation has been driven by the colleges and/or enthusiasts.

There has been a long history of procedural skills being taught in part or whole by the deployment of part-task trainers and manikins. For example it has been *de rigueur* for some years for the training of CPR and Cardiac Resus teams to be underpinned by the use of manikins, the sophistication of which has reflected both the development of improved technology as well as the complexity of the skills being taught. In the case of surgical/interventional simulation a key driver has been the manufacturers of the simulators which now include imbedded curriculum, learning management systems and advanced haptics. In the area of non-technical skills the Anaesthetists have led the way with fellowship of the Royal College having as a requirement participation at an EMAC Course (Effective Management of Anaesthetic Crisis). More recently the emergency physicians, paediatricians and midwifery staff have joined them in using a variation of CRM tailored to their particular skill set requirements.

Historically the surgical and non-technical simulation areas have developed separately, however there is growing recognition that in order to have successful outcomes teams that work together need to train together across professional boundaries and that technical and non-technical skills are required. Simulation centres were regarded as the domain of enthusiasts and struggled for both capital resources (buildings, manikins, simulators and associated equipment) as well as on-going operational funding. In Dec 2003 the paradigm was shifted by Queensland Health, who, at a senior level within the Department agreed that a centralised simulation centre of significant scale was required and that in establishing such a centre would bring together surgical, non technical, procedural, communication and other simulation variants under one roof and one unified management structure. Essential to the success of the Centre were the following:

- Adequate funding recognising the costs of delivering training using the new technologies;
- Recognition that the expertise and experience of the other centres was both desirable and necessary;
- Providing managerial rather than medical leadership to design, build and operate the Centre, thereby avoiding an emphasis in one specialty at the expense of the other;
- A recognition that a research component/capability was necessary;

- Underpinning the Centre was a culture of commercialism and innovation; and
- Drawing on best practice from around the world.

In terms of non-technical skills the main approach adopted within Australia has been based on that developed in Sanford by Dr David Gaba, regarded by many as the founding father of non-technical skills within healthcare. Based at VA Hospital in Paolo Alto, Gaba has been responsible for the growth of CRM training across the world. A major driver for the advancement of simulation in Australia aside from the enthusiasts like Drs Flanagan, Morris, Owen and Waterson has been the success of SimTecT Health which has forged ahead as a conference in its own right under the overall umbrella of the SIAA. Now in its 5th year the number of delegates has increased year on year. The other major driver for change has been the mandating of simulation training by the US Food and Drug Administration, who for the recognition of doctors undertaking certain high-risk complicated procedures (carotid stenting), have required simulation training as a precursor to undertaking the real procedure.

The current challenges facing health are:

- It is still not considered a mainstream training/education modality;
- Transitioning simulation into a mainstream modality given resource constraints;
- Using simulation as a focal point for a range of initiatives from patient safety, accreditation and assessment, litigation reduction, team building, improving clinical outcomes, human factors and design, recruitment and retention tool;
- A lack of suitably qualified trainers and a shortfall of available sessions for simulation by those practitioners who are experienced;
- Simulation is still under-resourced with the exception of Queensland;
- Access – centres are few and far between and therefore relatively few get access to this form of learning/training;
- Access in terms of being able to free staff to attend a centre when so much training is still delivered by trial and error ‘at the bedside’;
- Technology is still evolving in terms of fidelity, especially in the appearance and functionality of manikins;
- A transition from vendor-led to user-led technology. This is of real importance in the development of surgical simulators;
- The embedding of simulation in curriculum such that simulation is seen as process to enhance learning rather than the end in itself;
- Lack of validation of some of the hardware and approaches although the science of simulation has improved in recent years;
- Finding an adequate voice at a Federal level to give healthy simulation a much needed boost;
- Some reluctance to engage in the difficult area of assessment, especially high-stakes assessment despite their being a public appetite for such endeavour;

- Proving VR to OR (i.e. the transfer of skills from the virtual environment to the real environment);
- An increased realisation of the value in training and dollar terms of low-fidelity simulation;
- Health now finds itself poised at a significant juncture in that there is likely to now be a major push for the widespread application of this technology. The reasons for this are:
    - Mandating of the use of simulation for some complex procedures by the US Food and Drug Administration;
    - Significant public concerns over patient safety and the profile that clinical mishaps now receive in the media;
    - The high cost of litigation in healthcare particularly in the US;
    - The challenge of finding meaningful clinical placements for the optimal training of clinicians; and
    - Recognition of the importance of behavioural aspects in healthcare delivery and the role that simulation can play in raising the standards in thus area e.g. improving communication skills.

6.4 RAIL

Rail is rapidly becoming a mature user of simulation for training. The nature of the rail business lends itself to simulation:

- High-cost equipment
- Technically / procedurally complex operation
- Safety critical
- Cost sensitive

Simulation was initially used for training long-haul freight trains, where the driver's actions in braking and acceleration have a direct impact on equipment failure and resource usage.

In the last 10-15 years, training passenger train drivers has become commonplace. This application is relatively recent because the normal practice was for on-the-job training, and trains were freely available. However, as non revenue-service trains are becoming rarer, and the overall task is more complex and safety critical, the case for simulators is more compelling.

Other train driving trends are:

- Computers have reduced the human motor skills required to drive a train. However, this has led to the development of part-task trainers to train in complex sub-systems such as the Train Information System, and the Passenger Surveillance System
- Rail Operating procedures have become more extensive and the train crew tasks more complex as rail organisations become more customer service oriented (for example, first-aid training, law and order training; passenger information). Simulators are now more holistic in training for all aspects of operations.

- As rostering and training time becomes more critical, there is a drive to take the training to the depots, rather than forcing the crew to travel to a central training facility. This means simulators may be mobile – able to be driven to the depots, or may be PC-based.
- Similar to the aviation industry, simulators are being used to train drivers for new types of trains (eg for train testing and introduction into service) – before the train itself is available. This makes the simulator critical to the overall success of the program.

Simulators are also used for non-driving training:

- Signallers – signalling system plus part-task trainer for radio
- Station staff – dealing with difficult passengers, risk assessment
- Guards – in late 2010 RailCorp NSW will have the world's-first Guard's simulator as part of the new "Waratah" class train.
- Maintainers – part-task trainers for identifying train components, and diagnosing and rectifying train faults and failures
- Track-side workers – work-site planning and safety awareness

Modelling and simulation is also used for non-training activities:

- Concept proving and design validation
- Infrastructure modelling for traffic flow
- Timetable optimisation
- Incident investigation

6.5 LESSONS FOR THE RESOURCES AND INFRASTRUCTURE SECTORS

It is clear that industries who are mature users of simulation have gone through a period of significant growth in understandings regarding simulation and where it fits within the overall context of the industry's operation. It is clear that the resources industry can gain dramatically from understanding the way in which mature industry users have worked through the implementation of simulation in its widest context within their industries.

It is abundantly clear that an industry-wide focus is required that is based on dissemination of clear information regarding the uses of simulation in other industries, as well as the current use within the resources industry. Further, it is important that the debate regarding simulation is driven from within the industry rather than by simulation suppliers. Some of the current negativity relating to simulation is due to the industry being swayed by the strength of simulation suppliers rather than the discussion as to the value of simulation within the industry.

The development of standards for the use of simulation in these industries will be of major importance to their development as a mature user of simulation.

7 OPPORTUNITIES FOR SIMULATION

7.1 RECRUITMENT ATTRACTION AND RETENTION

With Generation Y and beyond educated through the digital medium, there is a much greater expectation now that the educational phase of learning will be followed up with similar, if not better technology when entering the world of work and further training. Those industries that are able to offer an information-rich and digitally engaging experience are more likely to attract recruits. For industry there is an increasing reliance on more tech savvy workers as well as those able to perform well in a team environment. Those industries offering simulation or training modalities of a similar level of engagement are more likely to attract and retain staff. This will become critical to the economic viability of not only individual companies but sectors and the macro environment as well.

It is clear that the Resources and Infrastructure industries will have ongoing problems with recruitment attraction and retention. The average turnover of staff in the resources industry in recent years has been extraordinarily high creating an enormous cost impost on the companies concerned.

The Resources and Infrastructure sectors have generally been perceived as dirty industries and they have not successfully drawn their share of school leavers to enter the industry. Indeed, in the resources industry there is little career path information for young people other than at the graduate level.

If we place against the above situation training methodologies that are locked into compliance rather than competence and rely on old-fashioned training methodologies we will further alienate a major part of the potential workforce.

In the light of the above challenges a move to simulation will make the industry and training in the industry a great attraction to young people.

7.2 APTITUDE TESTING

At the present time there is some aptitude testing for the skills required to drive heavy equipment based on simulation. The aptitude testing reflects understandings relating to hand/eye co-ordination and can provide good prediction for an individual's capability to handle heavy equipment effectively.

7.3 NON-TECHNICAL SKILLS

The use of scenario-based simulation to develop understandings around decision making under pressure is not well used within the industry. At the present time, many other groups outside of the industry are using these decision-making tools to high level effect, including the police, military and other mature users of simulation.

The question of developing understandings around decision making under pressure and indeed testing current approaches to problems is an extraordinarily valuable use of simulation yet to be experienced to a significant level within these industries.

7.4 IMPROVING SAFETY

Data from training on heavy equipment simulation in the resources industry is now beginning to demonstrate that drivers trained initially on simulation before final training on the actual equipment appear to have far higher levels of operational safety by virtue of the fact that they have trained extensively on safety procedures for events that cannot otherwise be trained for in the real world. In particular, automatic response and trained muscle memory are outcomes of heavy equipment training that will see major improvements in emergencies such as engine fire, brake failure, steering failure and tyre blowout.

This level of emersion in training for safety in a simulated environment cannot be replicated in the real world and therefore the overall impact on safety and the use of simulation across a much wider range of applications will have major safety outcomes for the industry.

7.5 PROCESS, PLANT, EQUIPMENT OPERATION

Advanced simulation is now being developed for the running of process plant maintenance. Process plant simulation has been around for quite some time and has been a valuable asset of the industry over past years. The application of modern technology to existing simulation will see major benefits in this area.

7.6 THE IMPACT OF AUTOMATION AND AUTONOMOUS OPERATIONS

Automation is beginning to impact the resource and construction industries. Moves to automate railroads, haul trucks and underground equipment are well advanced and we will see over the next few years examples of automation that transform the way mining occurs in Australia.

Autonomous operations with remote centralised monitoring, is well advanced in Rail, and reaching advanced testing and discreet Operational acceptance in the Resource Industry. Autonomy takes automation to the next level of automated on-board decision making utilising situational awareness sensors. Operators will likely be required to have simultaneous control of multiple units.

Given that generally the technologies required for automation are not new, but rather require to be transferred to the Resources and Infrastructure sectors, there is little time lag difficulty in moving towards automation.

Automation and autonomy will of course change the nature of roles; particularly control room operator roles in these industries. These roles will become more the handling of automated processes and vehicles and as such will require simulation technologies that support decision-making and time-critical thinking skills to provide the training necessary.

Simulation represents the only viable means by which such skills can be trained, assessed and maintained.