The role for serious games in mining industry induction training: lessons learnt from Project Canary

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Abstract  This paper will report on the actual process of repurposing a defence simulation tool to support induction training in the resources sector. A groundbreaking project on an international scale, Project Canary was built on the VBS2 engine by QinetiQ for the Mining Industry Skills Centre, and launched in (2009) amidst a booming resources sector. Four years on, the disruptive nature of this project is better understood, and the growing prevalence of serious games in heavy industry reflects the relevance of this work. The research goal for this paper was to illustrate how serious games could be used to develop appropriate behaviour within employees around safety critical decision-making in the context of general safety inductions. It addresses four questions: 1) how and to what degree using a defence tool helps overcome cultural barriers associated with bringing games technology to legislation-driven training 2) how to design the tool to maximise learning outcomes and training efficiency 3) how to scale the tool to meet multiple training requirements and 4) how to deliver a commercially viable outcome for the business. The paper highlights issues emerging across the life cycle of the two-year project, from conception to implementation, covering the stages of learning design, concept development, vendor sourcing and acquisition, team formation, scenario design, commercialisation, marketing and training. Key insights relate to the unexpected cultural barriers and skills gaps that emerged from bringing defence capabilities to a sector that is usually considered to have a considerable appetite for innovation.

INTRODUCTION
Project Canary was proposed in June 2007 as a tool that could provide authentic, immersive learning environments for new and existing workers in the mining and other high risk industries both in Australia and overseas to aid in the training of risk awareness, communication skills, safe work practices, environmental awareness. A perceived benefit is the ability to offer single user licences, site licences, distributed or centralised delivery for both single and multi-player applications (Mining Industry Skills Centre, 2007).

The development of a virtual mine training tool was one component of a larger plan to improve access to skills, knowledge and educational resources for mining industry trainers. Through its work in rolling out a fleet of heavy equipment simulators (courtesy of a Queensland Government grant), and an earlier research project validating the industry’s acceptance of serious games for behaviour-based training (Christoff & Eves, 2008), the Mining Industry Skills Centre (MISC) had identified that the industry was both open to simulation training and in need of support in terms of educational resource development.

The key goal of the project that ultimately produced Project Canary was to develop a tool that could

- be used as part of a blended learning methodology
- demonstrate an alternative approach to achieving legislative compliance while delivering effective safety training outcomes.
- offer valid adult learning methodology and a platform for learning by doing and experimentation.

During the first formal planning sessions, which used entertainment gaming as a base for ideas, it was determined that the project focus would be to create a game to support the Generic Induction (GI) with three scenarios each with three levels of skill/difficulty, loosely aligned to the dependent, independent and interdependent stages of culture articulated by Dupont (DuPont, 1995) and tested in MISC’s earlier work (Christoff & Eves, 2008).

DEVELOPMENT CHALLENGES
As is the case for many innovations, Project Canary was hatched from the thinking and conversations among a group of people with a vision. It emerged as a project, and in the embryonic stages much work occurred on the basis of trust. The first formal engagement was for Ball Solutions Group (BSG) to deliver a desktop review of 300 engines and full review of the top 50 commercial and open source engines for the purpose of selecting a technology platform on which to base the game. The assessment criteria developed between MISC and BSG included:
- The engine was built on current technology
- The engine is relatively inexpensive to procure
- The ongoing costs of using the engine or to distribute products developed from it, are low
- The game engine is supplied with full source code versus being supplied as a run-time library only
- The game engine is supplied with detailed documentation describing it’s design and use.
- The game engine supports the playback of sounds and music
- The game engine can support multiple players in a networked configuration.
- The game engine supports the rendering and animation of animated character and vehicle models.
- The game engine has built in physics to detect collisions between ‘in-game’ objects
- The game is shipped with editing tools for the creation of content and design of levels.

Source: (Ball Solutions Group, 2007, p. 3)
While this exercise delivered an excellent shortlist and valuable insight with regard to available capability, the project team – who had been simultaneously working through concept development and educational validations – had discovered significant cultural barriers to be overcome if the project was to be successful. Specifically, the regulatory environment and associated compliance culture was so deeply embedded in the Dependent stage, subject matter experts were not prepared to allow the learner full free-play within the game, and the project had become bogged in trying to define a gameplay narrative where learners would only be presented with “allowable” options. This was a critical issue, and needed to be resolved before deciding on a games engine. Although Project Canary was developed and implemented in response to requests for access to interactive training resources and improvements to the industry’s training culture, its truly disruptive nature would not be recognised until much later.

The project team turned first to the literature, alas very little had been published about training training in the resources industry, even less about simulation. The take-up of computer-assisted simulation training in the mining industry commenced somewhere in the 1990’s and has accelerated rapidly since about 2005. In 2007, training simulators were used most commonly in the area of heavy equipment operator training, although advancements in the area of rescue and emergency management were effectively broadening the agenda (Tichon & Burgess-Limerick, 2011) (Stothard, Galvin, & Fowler, 2004). Greater exposure to simulation use in other industries through forums such as SimTecT, was flagging opportunities for early adopters to leverage existing simulation capability to solve resources industry training problems. However, simulation was still viewed by many in the industry as an animated graphic representation or scale model (including role plays) of a real entity or event, where fidelity is the be-all and end-all.

In terms of the mining industry’s appetite for simulation, 3-D modelling and computer-assisted simulation had been widely accepted as a tool in the manufacturing supply chain for some time, (predominantly to design, manufacture and market engineering concepts) and more recently as a communications tool (Eves, 2007). The idea that these tools and capabilities might be repurposed to support training is relatively new. While it is fairly widely known in simulation circles that simulation developers rely on CAD models and original equipment manufacturer data to ensure appropriate fidelity of the simulators (Immersive Technologies, 2005), a key influencer, equipment manufacturers, were yet to understand how to exploit the potential for using their own virtual models to support the training they were contracted to deliver with equipment sales (Furness, 2007).

Eventually general educational work was reviewed, centering on constructivist and experiential learning. There is not sufficient space to discuss the full literature review here, however in summary the following ideas were immensely helpful:

- Operant and social conditioning from Pavlov, Thorndike, and Skinner (Becker, 2007) (Windeknecht, 2004, p. 9)
- First principles of instruction (Merril, 2002, p. 45)
- Negative unintentional learning (Dodge, 1998).
- Critical reflection and action learning (Bourner, 2003) (Revens, 1945)
- Unlearning (Becker, 2007)
- Assessment validity (Hopkins, 2006)
- Dissonance (McDonald, Burke, & Stewart, 2006, p. 26)
- Stages of grief/the change curve (Kubler-Ross, 1969)

Armed with this understanding, the team sought to validate how the theory could be applied with the help of simulation to support behavior-based learning in high-risk environments. Simulation use in other industries was considered the most logical starting point. It was hoped that this approach would a) reduce the risk of unnecessary duplication and b) identify opportunities to repurpose and re-contextualise tools and methodologies that could facilitate a more rapid take-up of simulation in the resources industry.

A qualitative study was conducted throughout 2007, involving attending conferences and conducting informal interviews with key stakeholders from defence, aviation, rail, health and simulation organisations. Full details of this study are the subject of other work, suffice to say the research focused on answering three questions:

1. What does resources have in common with other industries that are recognised for their simulation practice?
2. What’s different?
3. How do these factors affect the types of simulation that are in use and how they have been developed and deployed, and more importantly, what does that mean for the resources industry?

The common factors and noticeable differences between resources and other industries using simulation (Jones & Hutchinson, 2008) (Diver, 2007) (Drew, 2008) (Smith, 2008) (withheld, 2007) (McFarlane, 2007) (Walker, 2007) are summarised in Table 1.

This process proved incredibly worthwhile, and provided a loose framework for evaluating comparative simulation tools. Bohemia Interactive’s VBS engine was ultimately selected as the technology platform as it both offered the capabilities defined in the assessment criteria, and brought a credibility that would be beneficial, (the importance of this would be highlighted...
when Project Canary went to market). The proven hypothesis:

No mining boss would argue that his or her site is more dangerous than Afghanistan. If VBS is recognised as being good enough for preparing Australian, United States, United Kingdom, and New Zealand troops for combat, then it should be good enough for miners.

Table 1: Industry Commonality

<table>
<thead>
<tr>
<th>Common across all</th>
<th>Unique to mining</th>
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<tr>
<td>o Skills shortage.</td>
<td>o Legislative dispersion.</td>
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<td>o Regulatory environment with an emphasis on safety.</td>
<td>o Distributed training models – centralised models aren’t trusted.</td>
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<td>o Machinery.</td>
<td>o National training frameworks are used but portability is an issue.</td>
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<td>o Training systems that accommodate the entire workforce from neophytes right through to CEO’s.</td>
<td>o Training and assessment methodology.</td>
</tr>
<tr>
<td>o Restricted or closed access to industry training for those not already employed.</td>
<td>o Cadetships and apprenticeships slowly disappeared after the last downturn.</td>
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<tr>
<td>o Small number of very large organisations servicing the majority of the industry.</td>
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This was a decision that would generate considerable dissent in the project team for a variety of reasons, some of which are discussed in the lessons learnt section of this paper. But there was another hurdle to climb. The owners of VBS clearly articulated a disinterest in supporting the development of Project Canary, citing heavy workloads within their core market area of Defence. “You can use our tool but we won’t help you” was the clear message. The Project Canary team were to go it alone. (Fast forward to 2009 when BISim CEO Peter Morrison first saw the completed Stage 1 of Project Canary…

MISC CEO Derek Hunter: So you like it? We’ve passed your test?

Morrison: Yes (smiling)

PROJECT CANARY GOES TO MARKET

The first release of Project Canary was in March 2009, and included four single player scenarios with accompanying trainer guides. These scenarios targeted the most common situations encountered by workers in the industry, and were mapped to the core competencies from the national training framework (in Australia) associated with conducting local risk assessments, applying safe work practices, communicating in the workplace, applying site procedures. Funding from the Australian Government was also sought to develop a scenario and guides for ‘participating in environmental work practices’ however this was denied.

The marketing materials stated:

“The scenarios that have been developed in Project Canary are designed to aid in the accumulation of knowledge through behavioral-based training within the resource industry. The tool consisted of various scenarios that allowed players to interact in a virtual world and focus on understanding the subconscious decisions that drive their safety behaviour.” (Mining Industry Skills Centre, 2009)

The Project Canary software was accompanied by varying trainer guides relevant to the Generic Induction that allowed for practical facilitated training recognizant of multiple levels of expertise within the industry. Everyone from new entrants through to Senior Site Executives were able to interact uniquely with the tool and be assessed in line with their particular responsibilities in every scenario.

For trainers, the suite of scenarios offered two main teaching methods:

1. follow the set narrative - by following the on-screen prompts and print materials, the “lesson” follows a somewhat predetermined path.

2. create your own narrative - VBS 1 essentially offers an environment in which objects can be interacted with. A traditional military game, the environment is designed to create “missions” for players to complete, implying a discovery/constructivist approach to learning typical of first person shooter or strategy games. This means that players are not necessarily constrained to the predetermined path set out by the mission narrative. For Project Canary this meant players could “explore” the broader environment (as the environments were large >20km²) even though not all objects were interactive.

PLANS FOR SCALABILITY

It was planned that with new training manuals, the initial scenarios could readily support higher-level skills. The project team had mapped the first scenario to the statutory competencies for supervisors, Open Cut Examiners and senior personnel who have authority for safety on site. Plans to integrate the non-statutory components of these roles were also devised, such as soft skills and leadership development to support ongoing skilling requirements of the industry, particularly as new technologies such as automation emerged (CRC Mining, 2010). (The release of the ‘supervisor’ training manuals were planned for late 2009 – aligning with a sister project at MISC “The Supervisor Framework” – however industry demand saw changes to the scheduling of that initiative, and only a lite version of the supervisor framework was released, meaning the detail required for Project Canary would not be available until much later.)

This product development program was specifically structured to sequentially drive professional development for trainers. The use of Project Canary at its most basic form would require a transformation in the approach to training mandatory content. The

1 Many games engines offer this capability, VBS is discussed here as relevant to the development of Project Canary, and offering an example of the considerations for serious games development
complexity of multi-player and emergency management scenarios would require a much deeper understanding of adult learning, and trainers will need to be flexible and adaptable in their approach.

This was in line with the Skills Strategy goal of improving the quality of training generally (Mining Industry Skills Centre, 2007, p. 30) as these skills are fundamental to delivering appropriate adult learning, with or without Project Canary. (Later in this document, a list of specific attributes for simulation trainers is suggested, which emerged from the first stage of Project Canary rollout.)

Interestingly, the project team had not considered that external stakeholders might hold different views about what, exactly, Project Canary was. Until a conversation with the then Australian Managing Director of QinetiQ, whose team had completed the software development work for Project Canary. During a lunch meeting, as the team prepared to demonstrate Project Canary to a meeting of the Leightons Asia Pacific safety and training managers, he asked “so are you selling a software product or a two-year culture change program?” (Hawketts, 2010)

RESULTS

After conducting approximately 300 demonstrations with senior safety and training personnel, and more than 20 ‘train the trainer’ courses across Australia and New Zealand within a year of releasing Project Canary, it was clear that the industry would benefit from Project Canary, on multiple levels.

The demonstrations followed a format of introducing MISC and the rationale for Project Canary followed by a challenge test style discussion about risk management practice and culture within the target organisation, aided by various Project Canary scenarios. The facilitators would talk about the key outcomes required of an induction program, and using a deliberate style of questioning, seek to create dissonance for the audience around their own personal understanding of risk management and their confidence in their organisations’ approach to training it.

Anecdotal evidence reinforced the value of both a tool and the skills required to support these types of discussions.

“I wasn’t even in the hotseat and I was sweating, thinking ‘sh*t Keepy, when did you last do your fire training?’ ” (Keep, 2010)

“It gets people interactive, and that’s what you need…you’re not only learning from the trainer, people are actually learning from one another” (Engelmann, 2010)

“That incident could have been prevented if they’d used Project Canary” (Richardson, 2010)

One clear outcome from these sessions is a comprehensive list of the attributes necessary to use Project Canary effectively. These attributes could be extended to apply to simulation more broadly.

A good simulation trainer…

- Uses questions to probe for understanding and force judgments
- Relates knowledge to the cues from our senses to aid understanding and assess performance
- Recognises denial and bargaining as a sign that learning is being resisted
- Is able to explain how an “unconscious” competency is performed
- Encourages learners to build new knowledge onto old knowledge
- Provides opportunities for learners to apply/practice new knowledge
- Works with learners to relate learning experiences to their personal situation (and places learning in the context of authentic problems)
- Knows that simulation is confronting, and offers appropriate support
- Believes in what they are training
Figure 3: Crossing the language barrier: Orica trainers Mick (Australia) and non-English-speaking Valdir (Brazil) collaborate on lesson plan development using Project Canary. Orica now uses Project Canary worldwide.

LESSONS LEARNED
In this case study, there were several areas of identified weakness that hindered the initial efficiency of the project. These are summarized in Table 2.

Despite the obvious educational challenges and cultural barriers (industry readiness), probably the single most important lesson from Project Canary is to recognise the level of disruption involved with the innovation. A separate paper deals with models for predicting the degree of change, examining the relationship between decision making authority (Scott, 2004, p. 121) and transformational change (Pennington, 2003), and relating the properties of innovation (McCarry, 2003) to simulation. However Harvard Business School’s Clayton Christenson offers a simple guideline for deciding if the innovation is disruptive: “It is at once destructive and creative.” (Howard, 2013). By seeking to completely unpack and rebuild the way induction training is conducted, the Project Canary team had unconsciously adopted a highly disruptive strategy to improving training quality. Perhaps the road would have been less rocky had this been understood at the time.

This unconsciously disruptive goal brought dissonance across the full breadth of the project. From a purely operational viewpoint, the following list contains some project management considerations:

1. Agile vs waterfall development – people and system challenges
2. Building a software product vs building a culture change program
3. Reproducing the existing educational methodology or seeking to disrupt
4. Innovating vs disrupting
5. Being given access to the tools vs being supported to utilize the tools
6. Selecting a technical architecture that supports strategic goals ahead of operational goals (credibility and transformation vs ease of use and familiarity for programmers)
7. Stuck in the storming phase of group dynamics – skills gap, dissonance or both?

| Table 2 Summary of lessons learned through Project Canary Stage 1 development |
|---|---|
| Assumptions | Lessons |
| 1. Simulation, serious games would be a logical mechanism for supporting trainers to improve training quality | >> 1. The use of simulation required training skills not possessed by the majority of the training community |
| 2. Trainers and subject matter experts intimately knew the content they needed to teach | >> 2. Trainers and subject matter experts had learned to reproduce the rules, and struggled to unpack and explain them in a meaningful way |
| 3. The national training framework is well understood by a sector driven by “competencies” | >> 3. The industry recognizes the need for competencies but doesn’t understand how they should work |
| 4. We could fall back on research about safety training in the mining industry to answer questions or support our theories | >> 4. The mining industry is not the subject of prolific publications showing the empirical relationship between safety and training |
| 5. Even basic risk management was complex and difficult | >> 5. Risk management can be distilled down to a few simple principles |
| 6. The mining industry had many similarities to defence and the differences were easy to spot | >> 6. One subtle difference between defence and mining was the impact of culture on the way risk is treated |
| 7. A defence contractor could bring the necessary skills to repurpose a simulation tool for our industry | >> 7. Defence contractors are used to working with demanding clients who have established frameworks for communicating their needs |
| 8. The mining industry is always looking for innovation | >> 8. The mining industry has a low appetite for innovation – ‘if it aint broke, don’t fix it’ |
| 9. We needed to keep our work secret to protect our IP | >> 9. We should have talked more openly about our work to address wrong assumptions sooner |
| 10. Project canary would be a runaway success | >> 10. Project canary was a disruptive innovation |
WORKS CITED


42. withheld, n. (2007). site visit to Alteon flight training facility in Brisbane. (D. Hutchinson, Interviewer)
Research Goal

The project involved four primary research phases:

1. Quantitative review of games engines
2. Review of educational theoretical and qualitative systematic review of simulation studies in other high and high risk industries - 10 field interviews and 6 meetings at conferences
3. Qualitative study of stakeholder acceptance of the developed tool - 30 mock demonstrations and 20 "train the trainer" sessions
4. To design the tool to maximise learning outcomes and training efficiency

The research addressed four questions:

1. How and to what degree using a deflection tool helps overcome cultural barriers associated with bringing games technology to legislation driven training
2. How to design the tool to maximise learning outcomes and training efficiency
3. How to scale the tool to meet multiple training requirements
4. How to deliver a commercially viable outcome for the business.

Methods and Materials

The research goal for this paper was to illustrate how serious games could be used to develop appropriate behaviour within employees around safety critical decision-making in the context of general safety inductions. Specifically, the research focussed on creating a serious games tool that could

- Be used as part of a blended learning methodology
- Demonstrate an alternative approach to achieving legislative compliance whilst delivering effective safety training outcomes
- Offer valid adult learning methodology and a platform for learning by doing and experimentation.

Lessons Learnt

Simulations, serious games would be a logical mechanism for supporting trainers to improve training quality

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Citations


Disruptive Innovation

By seeking to completely unpack and rebuild the way induction training is conducted, the Project Canary team had unconditionally adopted a highly disruptive strategy to improving training quality. Perhaps something that had been less rocky had this been understood at the time.

This unassumingly disruptive goal brought dissonance across the full breadth of the project. From a purely operational viewpoint, the following contains some project management considerations:

- Agile vs waterfall development - people and system challenges
- Building a software product vs building a culture change program
- Reproducing the existing educational methodology or seeking to disrupt
- Innovating vs disrupting
- Being given access to the tools vs being supported to utilize the tools
- Selecting a technical architecture that supports strategic goals ahead of operational goals (credibility and transformation vs ease of use and familiarity for programmers)
- Stuck in the scoping phase of group dynamics - skills gap, dissonance or both?