

## **Game Based Learning; Reinforcing Process Safety**

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### **Abstract**

The concept of process safety has been around a long time but a spate of major accidents in the last decade has further emphasised the need for better and wider training and education. This paper, and accompanying presentation, will outline a novel approach to developing process safety knowledge and competence through Game Based Learning (GBL).

Making learning stick is a universal problem but, based on research that suggests people remember 90% of what they 'do', GBL takes your message out of PowerPoint and broadcasts it interactively to the trainee. A GBL session typically lasts 30-60 minutes, is hands-on and, by using every-day analogies for technical subjects and grounding them in the real world, it is accessible to all personnel across an organization. Indeed, GBL for major accident awareness has been run for school children as part of Science, Technology, Engineering and Mathematics (STEM) teaching. GBL comes into its own in high hazard industries where, generally speaking, improvement is about small margins. This paper will touch upon a number of games developed by Risktec in recent years, covering common process safety themes such as layers of protection and safety-critical systems. These games can be used 'off-the-shelf' or tailored to suit a specific application, operation or asset.

### **Keywords**

Process Safety, Game Based Learning (GBL), of Science, Technology, Engineering and Mathematics (STEM)

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## 1 Introduction

Process safety is a blend of engineering and management skills focused on preventing catastrophic accidents associated with loss of containment of energy or dangerous substances such as chemicals and petroleum products. These engineering and management skills exceed those required for managing workplace safety [1] and, as a consequence, much has been done in recent years to define the required competencies and improve process safety training. The purpose of this paper is to present a new and novel approach that has been applied to help develop knowledge and competence in process safety; Game Based Learning.

A perennial frustration within high hazard industries is that incidents continue to happen even though organisations go to great time, cost and trouble to train their personnel. Making learning “stick” is clearly not a trivial pursuit. Game Based Learning (GBL) provides an innovative solution to this problem and can be used to get across any message in the workplace. But it is in high hazard industries - where, generally speaking, improvement is about small margins - that GBL comes into its own.

## 2 Learning by Doing

GBL uses a fun, every-day analogy or metaphor for a traditionally technical subject, making the training more memorable and accessible to all personnel across the organisation. Through playing the game, trainees develop an appreciation of how the analogy/metaphor relates to their specific roles and responsibilities. When people participate in an interactive, hands-on activity, their retention of knowledge is much better compared to traditional training methods.

This claim is supported by the work of Edgar Dale, an American educationist, who developed the concept of the 'Cone of Experience' [2], which provides an intuitive model of the concreteness of various audio-visual media. Whilst Dale included no numbers in his model, it is commonly suggested elsewhere that people remember 90% of what they 'do' when they simulate, model or experience a lesson. Whatever the validity of such percentages, most people would generally agree that they remember more about something they do rather than what they read or hear for example. This is the fundamental basis of GBL and its advantage over traditional training by PowerPoint.

## 3 Developed Games

In conjunction with some of its key clients, Risktec has developed a series of games (some examples are provided below) which instil a fundamental understanding of key process safety themes at all levels of an organisation. The games are designed to align with the root causes of the majority of process safety incidents and instil a fundamental understanding of key process safety themes.

Figure 1. Tipping Point

The figure displays two game cards. The left card, titled 'TIPPING POINT', features a blue and orange background with a stack of orange blocks. It includes the Risktec logo, 'Game Based Learning', and the text 'TEAM BASED', '30-60 MINS', and 'AGE 2-102'. The main text asks 'CAN YOU AVOID COLLAPSE?'. The right card, titled 'DEFENCE IN DEPTH', shows two people playing a game with blocks. It includes the text 'Everyday operational issues can be tough on your barriers against failure.' and 'Put your judgement and technical skills to the test, to see how well you can manage your facility and keep it from collapse.' Both cards have a footer with a small Risktec logo and a brief description of the game.

Figure 2. RiskJet

The image shows two panels for the RiskJet game. The left panel features the TÜV Rheinland Risktec logo, 'Game Based Learning' branding, and icons for 'TEAM BASED', '30-60 MINS', and 'AGE 2-102'. The central illustration shows a white private jet flying over a landscape with a question box that says 'Can you fly without...?'. The right panel is titled 'SAFETY CRITICAL ELEMENTS' and features a grid of 48 icons representing various aircraft components and systems. To the right of the grid is a text box: 'SPEC YOUR OWN PRIVATE JET FOR THE HOLIDAY OF A LIFETIME! A lottery win means you can afford it all - on-board disco, pool table, the works... But when reality bites, can you afford what you really need to fly at all?'. Below the grid is a 'For Grown-Ups' text: 'This game illustrates the concept of safety critical elements in the context of an aeroplane's systems. The players use their judgement to identify components which are essential to the safety of the flight. This mirrors the identification and justification of safety critical elements essential for the prevention and mitigation of major accidents.'

Figure 3. Peak Performance

The image shows two panels for the Peak Performance game. The left panel features the TÜV Rheinland Risktec logo, 'Game Based Learning' branding, and icons for 'TEAM BASED', '30-60 MINS', and 'AGE 2-102'. The central illustration shows a mountain range with a question box that says 'Have you got what it takes to make it to the top?' and the title 'PEAK PERFORMANCE'. The right panel is titled 'ROLES & RESPONSIBILITIES' and features a diagram of a mountain climb with stages labeled 'BASE CAMP', 'CAMP I', 'CAMP II', and 'SUMMIT'. To the right of the diagram is a text box: 'HAS YOUR EXPEDITION TEAM GOT THE SKILLS TO REACH THE SUMMIT OF MT. EVEREST?'. Below the diagram is a 'For Grown-Ups' text: 'Complete four tasks in the right sequence and the team will safely ascend Mt. Everest within the weather window. However, critical factors will conspire against you. This game illustrates that, in the workplace, it is essential that key roles are fulfilled by people with the right training, experience and knowledge, and who are provided with the right tools and information to perform those roles effectively.'

#### 4 GBL Disadvantages

The only commonly encountered barrier when adopting GBL is a reluctance to embrace what can be viewed as a potentially flippant approach within the serious environment of a high hazard industry; "safety is not a game!" However, given the highly visual, hands-on nature of the games, a quick demonstration is usually all that is needed to show the benefits of this innovative approach. Having fun within the serious environment of a high hazard industry should never be taboo, particularly when it enhances learning and therefore the process safety competence of a workforce.

#### 5 Case Studies

GBL sessions are short, typically lasting 30 to 45 minutes. They are extremely flexible and can be delivered in a number of ways, for example:

- To provide a diverting, energising break from a traditional classroom session.
- To deliver a serious message (e.g. a process safety improvement) in a short, high-impact memorable session.
- As an entertaining ice-breaker within a meeting, workshop or conference, that can also convey relevant learning.
- As part of the roll-out of a new initiative or operation, e.g. to support the use of a new facility safety case.

The low cost and significant flexibility and effectiveness (in terms of impact, coverage and knowledge retention) of GBL presents a hugely compelling business case. Some case studies are described briefly below:

1. A tailored version of *RiskJet* was played as part of a two day classroom safety case training course for sixteen design engineers at a large European energy operator. Having introduced bowtie analysis as an excellent technique for identifying safety-critical equipment, the trainees played RiskJet in groups of four for about 45 minutes to reinforce the understanding that safety-critical equipment is designed to prevent or mitigate major accidents and that processes need to be in place to ensure they continue to function as designed.
2. Tailored sets of *Tipping Point* were provided to support safety case roll-out in the recreation rooms of an offshore oil and gas installation. Each game comes in a box with instructions, requires no additional materials and no expert facilitation. It therefore allowed mass roll-out by the operator and avoided expensive trainer mobilisation and delivery costs. Also, given its simplicity and flexibility, it was played around operational commitments and thus reached crews on different shifts who would most likely have missed out on more traditional training.
3. A bespoke version of *Tipping Point* was played as an ice-breaker at a two day formal conference of about one hundred engineering managers from a multi-national provider of electrical and electronic products for the aerospace, defence and transportation sectors. The managers played the game for about 30 minutes in five groups of twenty. The focus of the learning was on the main causes of failing to integrate safety into the design process.
4. GBL has been used for a process safety awareness programme at onshore plants and various offshore plants, with a wide range of audiences<sup>[3]</sup>. The first session focused on layers of protection and the second on functional safety-critical equipment and instrumentation. The training gathered support and popularity from the leadership and the workforce and the feedback was overwhelmingly positive.
5. As well as engaging the operational workforce, GBL has also been used to inspire the workforce of the future. GBL was run at STEMS (Science, Technology, Engineering and Mathematics) school career events to help illustrate the careers available in the oil and gas industry. School leavers played games which highlighted the roles that discipline engineers and operational personnel have in ensuring that engineered barriers are in place and are functioning, to ensure continued production whilst preventing major accidents.

## **6 Future Developments**

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Whilst the games discussed above have delivered significant value to organisations already, the process behind their development also offers significant benefit to the organisation. Process safety concepts can be readily combined and metaphors developed to create a bespoke game which delivers the intended message in an effective, memorable way to suit a specific application, operation or asset.

Drawing upon a bank of ideas, new games continue to be developed to extend the benefits this technique offers in enhancing learning efficiency and effectiveness with the ultimate objective of improving process safety performance.

## **7 Conclusions**

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GBL gives all trainees an enjoyable experience whilst delivering a serious message in a high impact and memorable way. It makes much more effective use of training budgets, ensuring the message that needs to be communicated is received, understood and implemented quickly and efficiently, providing a long-term benefit to the business.

By linking process safety themes to every day analogies or metaphors, GBL is industry agnostic. With the messages it seeks to communicate transcending industry and discipline boundaries, GBL provides clear benefits to all industries.

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Although having fun in the workplace may still be seen as taboo by some, especially those within the serious environment of high hazard industries, when it enhances learning, competence and process safety, perhaps we all need a bit of GBL?

## **8 References**

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