Submersive Learning

Chemical Engineers take a ride on the (not so) wild side with 'Budgie' and get to grips with a Chemical Plant through a computer simulation

What were the learning and teaching issue that this capital award sought to address?

The most important aspect of the simulated chemical plant (VIRILE -see information box on page 46) was the idea of giving a problem to the students that doesn't just require 'turning valves' and 'following a recipe'. Chemical engineering kit, quite often, has a specific operational procedure which gives little scope for curiosity. Students run the experiment, collect the data, write up the data and hand it in. The criticism can be that the process is very 'samey'. If the experiment is particularly limited in flexibility, it may require students to do exactly the same as every other group has ever done in times passed. The experiments are useful and important for demonstrating engineering principles but they don't necessarily stretch them in all directions. So the challenge was to think of new ways of giving them problems that aren't necessarily straight forward and that require a bit more lateral or creative thought.

Did they enjoy the experience?

Yes. The feedback has always been positive. The software we have generated has been novel. They have never seen anything like it.

We have run it across different year groups as appropriate. Some of the things we do, like the full version of the virtual chemical plant, would be appropriate for 15 to 25 year olds. For example, with final year undergraduates, we would give them minimal information and they have to optimise the chemical plant using all the knowledge gained over 3 to 4 years of study. With secondary school children, we'd present a very narrowly-defined aspect of the chemical plant software to demonstrate how process engineering works and to explain what 'unit operations' are. Some of the games we have developed, on the other hand, are better for first and second years, although the fourth years enjoy playing them!
We are trying to convince our students at an early stage that there is a huge range of things that they will be looking at and will become interested in, so introducing it to the first years sets the tone.

"We just wanted to put them in an environment where they felt they were making important decisions, and communicating those decisions to their colleagues. The game itself is an irrelevance. It is all about the problem that you are posing them"

Dr Ed Lester

Research Interests:
Nanomaterials and supercritical fluids
Microwave technology and commercial applications
Combustion Technology

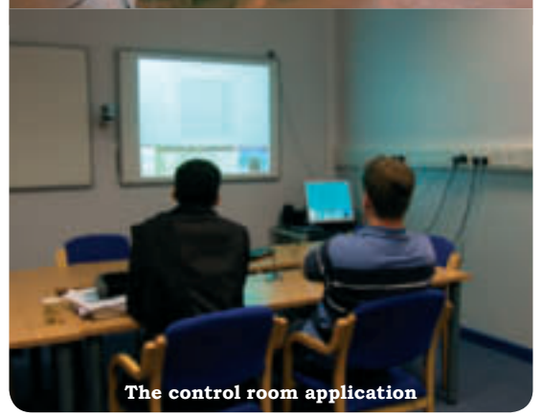
Expertise summary:
Ed started out as a Marine Chemist as an undergraduate before taking on a PhD in Chemical Engineering. Since then he has been busy working at the interface between chemistry and engineering. He is a member of the National Centre for Industrial Microwave Processing (NCIMP) and is Technical Director of a company called Promethean Particles that makes and sells nanomaterials using reactor technology that he developed whilst working in the Engineering Faculty at Nottingham.

What is Budgie, and what is its purpose?

Budgie is based on the popular and widely played Minesweeper game but with several unique twists. Firstly, the mine sweeping exercise is conducted in a 3D environment, promoting the use and development of 3D spatial skills. Secondly, the application is divided into two sections, an in-sub element, and a control room element. The user of the in-sub element is given a first-person view from within the sub and can control its movements in the 3D environment, while the control room element gives a 3D overview of the search environment itself. Contact between the two elements of the Widget is maintained visually and aurally through a dual webcam setup, although either aspect of this communication can be removed at any time by the system administrator. The Budgie Visual Lab Widget, as a result, also includes a large element of group interaction, team dynamics, and establishing effective means of communication within its basic minesweeping premise.

The game is easy to pick up but playing it well is really hard. The purpose is more important, which is about teaching students to think in groups, make decisions in groups, and communicate as a group.

Budgie - A team-building 3D environment based on minesweeper games



The control room application

Why is teamwork an important skill for chemical engineers?

It is important to everybody. But engineers generally work in teams. You generally end up working with some people that you get on with and some that you don't. So learning to make decisions and to be dynamic in a group where there are other equally dynamic (or less dynamic people) is an important skill to learn. We wanted to put the students in an environment where they had to make decisions, and communicate those decisions. The game itself is an irrelevance. It is all about the real problem that you are posing them.

Apart from developing team-building skills, what are the other outcomes?

You are giving them a challenge that they have never had before, so you asking them to develop a structured approach to solving a new problem. You are stretching them in different ways and getting them to think outside the box, think about things that are not specifically chemical engineering-related. You are teaching them about communication, leadership and decision making.

The most unique thing is putting them in a situation where there is a bit of pressure. You are simulating something that actually counts – where there are consequences. They are not recording data, or observing some engineering principle. With Budgie, they have a lot of freedom to experiment but they also want to get it right, and the net affect of not getting it right is that they 'lose' one of their colleagues. I think that is the most novel thing that we have done.

Can you think of contexts in which this technology could be used in different subject areas?

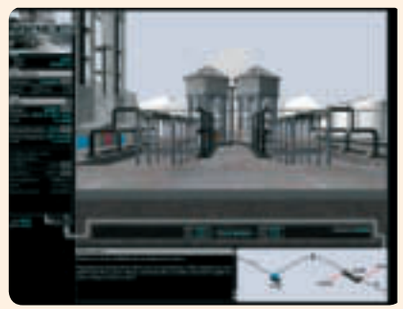
As I said, it is the purpose of this game which is important – developing teamwork skills. And this is a skill that all students need. Almost all of the games could be transferred to any other faculty. You don't have to be good at maths to understand even some of the more complicated elements of the games that we have. The Virtual chemical plant is most appropriate to engineers and to scientists. Chemists, for example, even though they wouldn't be involved with a chemical plant in the same way, would have an interest in seeing how it worked.

How are you able to measure the success of something like Budgie other than student feedback?

There has been a lot of interest across the University and outside the University. Most of the software is designed so that it is not geared up for a specific age group: most games are as much for five year olds as twenty-five year olds. It is the level of engagement that is different. My own children have tried out some of the software that we also run for undergraduates. What you expect of them is different but the game itself remains the same. Colleagues in other departments have asked to borrow Budgie to help their students develop some of the more generic communication skills. It might be, that in the future, we find a more central location, like the Hallward Library, to house it.

The VIRILE Plant Simulator

The ViRILE (Virtual Reality Interactive Learning Environment) simulator was developed to provide engineering students with access to 'real-world' large-scale processing equipment which they would not normally be able to experience as part of their studies. Virile, with its 3D polymerisation plant and extensively configurable processing simulation, provides an environment in which students can apply theoretical knowledge to 'real-world' engineering challenges and connect this knowledge and process-flow with the spatial context of a plant setting.
The Virile Polymerisation Plant application has been used in a number of ways. It has been used as the basis for experimentation conducted by Professor Claire O'Malley and colleagues in psychology investigating the use of 2D diagrams in enhancing the understanding of 3D relationships; it has been used within the Chemical Engineering curriculum as an assessed piece of work for undergraduate students; and it has been used with prospective University students as a practical demonstration of real-world processes and high-tech visual spatial teaching methodologies.

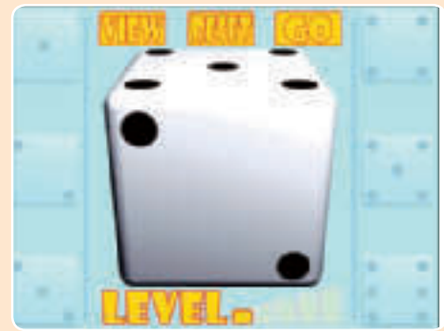


The ViRILE plant simulator

Diceeee

The Diceee Visual Lab Widget was designed to help students think about and develop spatial visualisation skills and spatial memory. Diceee involves a 3D rotating dice which can be viewed from all sides before each round. When the user is ready the numbers on the sides of the dice are removed and the dice rotated. The user then has to determine which side is facing the front. After a series of correct answers the difficulty of the game is increased by increasing the number of rotations and rotation speed.

Diceee is a web-delivered Visual Lab Widget which has the facility to record detailed online data logs of users' interaction with the application and the results they achieved. Diceee has been used with a range of students including those enrolled on an engineering summer school and widening-participation schemes held by the University of Nottingham.



The Diceeee game