Cyber Clogs *or* A Step into the Future

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Note: Words in bold can be found in the glossary at the end of this article.

Many readers will be familiar with 'The Sabre-Toothed Curriculum' by Harold Benjamin, first published in 1936. Here Martin Owen, Tutor in Technology Education at the University of Bangor, sets the idea in the twenty-first century and asks how appropriate for the 1990s are the design and make activities of most pupils?

Some time in the future . . .

It was one of those listless days, three days into a cold and Sally's mother had insisted that she stay away from school for another day. Seventy years after the discovery of DNA, thirty years of **nano-engineering** and still there was no cure for the common cold!

Sally lay in bed feeling sorry for herself and let her mind wander to school. She was looking forward to her second phase of life-role placement. The Victoriana Theme Centre really was the pick of the bunch, and show-biz continued to be the only major Inter-Person Sector with any scope for spontaneity — all the others were so bound by regulations and litigation that only a saint would consider work helping others, even for money. Her career counsellor had told her that her personal profile indicated the need for creative potential fulfilment, but Sally knew that the make and do sector in her district was so overpopulated with craftspersons that she would have less chance than a ten-year-old robot of making and selling original products.

On the other hand, if she raised her extroversion profile she would stand a better chance of getting a place on the observation scheme. How could she reach the SAT? She would do some research — get ahead of the competition! She spoke to the **video wall**.

'Come alive!'
What is your directive?
'History (**Knowledge**) **Agents**.'
What period?
'Victorian.'

Instantly a character appeared on the screen, dressed in check trousers, frock coat and top hat. It was a Tommy Traddles clone.

'No, I want female,' said Sally, 'and poor. Industrial, like in Elizabeth Gaskell's stories.'

In a window on the video wall a figure appeared of a Victorian mill worker, dressed appropriately from mob cap to clogs.

Pray tell me how I may help you said the figure.

Sally knew she had more than 2,000 units of learning credit still left that month — her family had just bought a new sofa and the extra learning creds were part of the sales promotion. She could afford to be a bit exploratory and use a lot of **fibre** time. Her guide led Sally on a trip around Styal Mill — Sally recognised it because she'd visited the theme park last year. The stories of hard-done-by children grew boring, but she was really interested in the strange footwear.

The knowledge agent, called Effie, told Sally that these garments were called clogs, and made of wood, metal and leather. Sally ordered the knowledge agent to step out of character and give her some hard information.

Effie came back with a variety of facts and illustrations. Apparently the wood was alder, the leather made from real cow hide, and some clogs had nails in them to make them wear down more slowly. A patent was still outstanding on a set of designs for some clogs which were supposed to be kind to feet and backs — some German doctor or other. Some of these were made of synthetic polymers and a naturally occurring polymer called *rubber*. Apparently these allowed flexibility, but Sally thought they looked very uncomfortable, a sort of bed of nails for feet.

It seemed that alder was a particularly resistant type of wood which came from a tree which had an eco-preservation order on it now. It could be found in cold temperate wetlands. Sally checked its availability: you could only get it on a replacement investment basis, and that would be way beyond her family's means.

At this point, a new knowledge agent appeared on the screen. Sally recognised Roxanne, who she had encountered last week in the Science Home Learning module which she'd had to do because Mr Frogmarch, her teacher, was away on paternity leave.

Can I interrupt?
'Okay.'

The learning monitor program had decided to interrupt, because it was good at linking learning activities. Sally was just glad that it wasn't the spelling tutor.

You have come across a need to know more about polymer design, the topic we were studying last week. The properties of the *natural polymers in the alder wood and rubber are completely synthesisable. Select from the list of properties you wish to explore.*

Sally selected *waterproofing, flexibility* and *durability* from the screen menu. The screen then took her through a sequence of routines of messing with molecule models which had different properties in themselves, and messing with the way they were put together. With a bit of thinking — how much standing she'd need to do, how much she'd be in the open air, how fast she'd be moving when wearing the clogs — Sally was able to generate some typical polymer combinations. Having got this close, she used a **genetic algorithm**. Roxanne explained that trial and error was a useful process in molecule design and combination but that it had taken millions of years to get the design of the alder tree right. The same techniques of mutation were used to get polymers right.

Soon there was a mesh of polymers on screen which seemed to be just the job and match Sally's specified needs. Had it been made? *Could* it be made?

A patent agent checked the lists. Yes, it had been made and it was in the public domain. Some alternative lifestylers living in a human interact centre called a commune had needed them for their children and set up a nano-engineering plant as part of their self-sufficiency. They had made this polymer combination and had a surplus of clogs for sale. Sally went on-line to the commune in the Welsh mountains.

She ordered some stuff from Patrick, the guy on the other end, and he offered to show her around their workshops. Sally found it really interesting: people were using real tools to make things. Some of the things they made could actually be made hundreds of times over — she thought it was called mass production or something, but the twentieth century wasn't in her National Heritage Curriculum. Patrick said that being able to make hundreds of one object instead of designing individual ones each time let them gain from something called economy of scale. Mass production gave them more time to roam in the Welsh hills or engage in tele-entertainment.

Sally was told she could buy time in the workshop, but replied that she was 250 miles away. Effie interrupted to say that Sally could go there by **telepresence**, which she could afford if she cancelled her music class that week. It was a deal.

Roxanne told her to don a Cyber Helmet to VR (**Virtual Reality**) into the workshop and use their tools, lathes, sanders and shapers. Sally felt overwhelmed — suppose she cut it the wrong shape?

That won't matter said Effie, whose responses were now clued into the Welsh centre. *You just use the 3-D mouse on your foot. The co-ordinates will go into the machines. The machine's tutor system will help you to get the right shape. If you do make a mistake, you won't be doing it to the real material, you can just ask the machine to undo it. You'll be working with virtual reality until you have all the measurements right and it feels comfortable on your foot. The machines will then mimic the bits you did right, eliminate the mistakes, and then make the stuff on the real material. You'll get the pleasure of doing real old-fashioned craft but with the benefit of twenty-first century robotics.*

Sally measured her feet and donned the cyber helmet and gloves. She could see herself in the workshop, feel the vibration of the tools as she worked with the material. She winced when her fingers went too close to the saw blades and the machine did a simulated safety shut-down. The guide told her that they did not make her workshop simulation completely real — the polymer she was using was a good simulation of alder and the cutting and shaping would be quite a muscular activity. Also, its flexibility would make it difficult to work — apparently, rigid materials were easier to cut and shape with this technology.

Sally enjoyed real craft. Working with real material to make something that was shaped by her own hands was a complete novelty. When the Overnite package arrived the next day, she was thrilled to receive her own personal pair of clogs. Her cold was better, and she wanted to go and make sparks on the cobbles, just like the children in the Victorian mills.

■ A commentary

I tell my students of a CDT department of a school I worked in. It had a good craft tradition and pupils produced many fine artefacts. The burnished fireside combination set was a popular project and would make the boys' mums proud of them. Sad that the school largely served an estate built in the sixties which had under-floor electric heating. Not one had a hearth. Somewhere along the way, the craft, the design and the technology had lost their way.

I was a 'high techie'. At this time I was ensconced in the science department and I taught about programming in BASIC, control with relays, and we designed, made and soldered transistor amplifiers using printed circuit boards we drew and etched ourselves. Who has the last laugh? There are still plenty of teachers doing the same as I did twenty years ago, but the technology I taught has long since been outmoded in the real world. Nobody at Sony does anything like I did. Yet the craft skills remain as they were, the ability to make aesthetically pleasing artefacts by the deftness of human limbs and the sureness of the eye.

Manufacturing technologies will change, and they will change radically over the next few decades. Already the ways in which computers are programmed using special software engineering tools makes the notion of computer programming as it still appears in schools a historic pastime. What passes for electronics in many schools is as quaint as teaching copper-plate handwriting for the purposes of keeping accounts. Electronics has moved on! There is a massive trap in teaching what we think is high technology — you end up with the fireside combination set syndrome, but without the joyous article to behold.

Yet as recently as 1988, an NCET publication on IT and CDT debated the pros and cons of using BASIC or program x for doing this and that, at a time when in the real world these arguments were already out of date. Practical electronics of the kind that is widely taught should only be merited as a hobby interest (which is alright in itself), but why should one hobby be elevated above others?

What can we make of this dilemma? There are some powerful messages that should be in the technology curriculum. The messages must be about quality. There is a pleasure and skill in making, and it is an enduring pleasure. The artefacts of *The Antiques Roadshow* bring joy to thousands, and the skills that went into them bring joy to those who still possess those skills. If I now have powerful adhesives and polymer finishes, I should revel in them and be thankful that I no longer have to boil the pot of Shellac. Improved methods should not be disregarded, even if in my heart of hearts I know that a dovetail joint is superior in spirit than any knock-down joint.

This is not the message of the nineties, however. We should be offering students the opportunity to have an education which has a technological validity for the twenty-first century. The process orientation of the National Curriculum is correct in spirit, but it is no excuse for offering pupils 1970s experiences when the real world is using quite different materials and processes for manufacturing artefacts, and significant technologies (which it is not appropriate to dump on Te5) are being left ignored by teachers and examination boards. Where is multimodal and multimedia communication and modelling? Where is artificial intelligence, neural electronics and computing?

There is an inherent danger in following specific processes. One well known manufacturer of MS-DOS PCs aimed specifically at the education market has been keen to highlight a survey which shows that employers prefer pupils to have learnt on their industry-standard computers. We can understand why manufacturers think this way, but the argument is flawed: today's pupils need education that can take them beyond the specific instances of current industrial and commercial practices. I am convinced that there are activities which we can teach in technology which will allow for the diverse strategies available to the designers and technologists of the future.

I have to face up to what is a contradiction in my personal views of pedagogy. I have an implicit belief that the design and make philosophy is right: that practical activity is at the core of school technology. I also have anecdotal evidence that the intellectual content of designing and making that pupils achieve is not at the level of their understanding of the potential of technology: what my Year 9 son understands in mechanisms is the differential (as constructed in his remote control car kit); what he does in school technology is a cardboard lever and an MDF toy which operates from a primitive cam mechanism. There is a gap in the credibility of the subject that demands that pupils learn by making use of the primitive resources found in most of the schools I know, and the technology of the real world. Is it possible to make in high-tech ways? Is making always necessary?

The teaching of technology has to reconcile the relentless advancement of its contents alongside its concern for needs, values and the processes of designing and making. As good as some resources for the 'high tech' end of the content spectrum are (Alpha Resource, for example), the current response is woefully inadequate. Let us teach aesthetically satisfying design and technology please, but if we are also to teach 'high tech' let it keep pace.

Making cyber clogs is only partly fanciful. Most of the technology is either here or on the horizon. The information and communication technology exist. The materials technology is nearly there. I have written the piece to stimulate debate amongst practitioners as to what technologies we should teach and how we should change current practice.

Cyber Glossary

All the topics listed here are well covered in editions of *Scientific American* over the past two years. It is an invaluable resource for all advances in modern technology, and I would think it an essential ingredient of any magazine rack in the technology faculty.

fibre: The widespread introduction of fibre optical cable to distribute interactive communication services.

genetic algorithm: Imagine you had a vision of an ideal specified behaviour for an object or system, but you were not quite certain of how to make it, and the complexity of the design was such that simple application of scientific rules would not help because of their simplicity. One way forward is to have your best shot at designing and making the object and seeing how it works. Then you mutate that design slightly. Does the mutation work better or worse? Continue this mutate and test process, with the fittest acting as the survivor. This is Darwin applied to engineering.

To speed up and make the process more economic carry the process out as a computer model acting on a computer model: genetic algorithms. It is a process that can be applied on structural engineering or materials science or circuit design or....

knowledge agent: An artificially intelligent computer object that keeps a record of your interactions with a computer so that it is aware of your interests and abilities and previous excursions into the Cyber world. It is also aware of what information is available in the computer (or more correctly how to know what information is available). With these two abilities combined you have an 'entity' which will be aware of your information needs and how they may be fulfilled. A database searching system with personality and memory.

nano-engineering: My next door neighbour, a Japanese biochemist, is growing computers in much the same way as I used to grow crystal gardens with alum and isinglass. He is joining molecules together in particular ways so that they respond to electrons in particular ways: molecule scale computers. Not content with that, some Nano engineers are also joining molecules together to make specific shapes and forms: Nanometre sized cogs and gears! The devices made possible by such technologies make the mind boggle: mood sensitive clothing? Drug delivery systems with the precision of Exocets? It makes soldering look a quaint activity.

telepresence: The technology of virtual realities is almost at a domestic stage. It is possible to manufacture computer peripherals that will be sensitive to all our body movements and be able to relay them down a fibre cable to anywhere else in the world. At this remote location it might be possible to have a mechanical device which will echo our body movements, and provide feedback to us about the effect of those movements in our environment. This technology is important for routine maintenance in dangerous and hostile environments where human skill and discretion may still be valued: but the technology which allows you to do physical things elsewhere need not be confined to that. We have had audio virtual realities (the telephone) for quite some time.

video wall: The age of the cathode ray tube as an interface for the computer is nearly at an end. Active transistor matrix screens will be the order of the day by the end of the decade.... but where are they on the school curriculum?

Virtual Reality: see telepresence.

References

Alpha Resource by D.J. Martin and M. Coleman is available from Unilab.

MESU (now NCET) (1988) *Information Technology for Craft Design & Technology,* MESU, Coventry