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THE VIRTUAL UNIVERSITY

P Cochrane

Rapporteur: Professor John Dobson

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Only 100 years ago it was possible to be an expert educated, fully knowledgeable and respected in any discipline. Exceptional people could achieve this status in two, and have a good working ability in several others. A university education was an investment for life that was steadily topped up as the world of knowledge advanced. How different it is today! In science and technology the only way we can be truly expert in anything is to be in at the discovery phase of something new and immature. We now have experts whose sole task is to marshal the abilities of ranks of more diversified experts. The predicators of this change are technologies that emerge, evolve, and then quickly slide into obscurity.

It is now reckoned that mankind's information base more than doubles every 2 years, as does the power of computers and our ability to transport information through telecommunications. Whilst it has taken mother nature millions of years to evolve humankind to its present intellectual peak, it is likely that electronic computers will attain a similar standing in less than 100 years. It is estimated that the super computer equal to man in terms of raw processing and information storage power will be with us around 2015 - just 100 years on from the invention of the valve and 60 years on from the invention of the transistor.

What has all this to do with universities and education? Can anyone remember logarithm tables and slide rules, plotting graphs by hand, having to pay for computer time, a world without computers and communication? Not if you are young you can't! We are fast approaching an epoch when no PC (Personal Computer) means no degree and no IT (Information Technology) skills means no job. When I went to school it was an oasis of information and learning. My home was like a dessert with only a very few books. Today, for many children, the school is the desert and the home is the oasis! For at home they have powerful computers, CD libraries and network access to almost anything. Similarly we now find students selecting a university on the basis of the terminals - no 32 bit graphics - no chance!

With all this IT you might have expected that teaching methods would have changed radically - not so! In many respects we have seen a regression. Most of our red brick universities have lecture theatres with a fully equipped laboratory bench spanning the black/white board area. Just 50 years ago the common practice was to illustrate a lecture by practical demonstration. Today only a few can remember such radicalism - and yet it was the norm. How different today: the lecturer rushes in at the last minute, at best hands out printed notes and uses previously prepared and used overheads, talks for an hour and rushes out. After the event the students may seek out the lecturer, but will find a much reduced opportunity for air time. Staff student ratios have reduced, departments are below critical mass and the curriculum has expanded, whilst the student dwell time at university has remained static. Little wonder we complain of falling educational standards and a lack of student interest.

It is important to recognise that the acceleration of society through technological change is creating a new paradigm that education has to respond to. Our children are growing up in a regime of increasing access to everything - almost an instant gratification society. Computers, communication and a manufacturing base that can produce almost anything customised to the user. Perhaps we should not then be surprised when many of our students complain of being bored, or that they find the delivery and development of intellectually exciting material so dull. They come from a different world!

The notion of a job for life now seems remarkable! Thirty years ago an average graduate engineer would have expected to work for three companies throughout a 40 year career. Today they can expect to work for 12, and by the turn of the millennium this will have risen to over 20. At the same time the average half life of their first degree studies will have fallen from 12 to 5 to 3 years over the same period. Companies will have moved on from a paternalistic sponsoring of first and higher degrees, to the hire and fire of expertise as required. It will then be the responsibility of the individual to keep topped up, keep pace with the technology, broaden their education, and remain a valuable and employable member of society. We will have entered a regime of continual, and customised, education on demand.

Is all this pie in the sky, and can it, or should it, be done? Actually, it is with us now and in small pockets across the globe the process has started. Some medical schools in the USA issue students with lap top computers containing the first two years' notes. But these are not conventional notes, they are hyper documents with animation and drill down detail way beyond the realms of conventional paper. Anatomical detail is delivered by 3D colour graphics produced by slicing up of frozen corpses. A frame - a slice, body fly through, interactive models and animation of chemical and physical functions are now available. The net result is a far faster assimilation of information and understanding. In Europe there are university degrees that you can start without a PC, but you will fail! In the case of my own daughters I have had to purchase individual machines - they cannot get access to sufficient computer time at university and will not succeed without their own computing power.

In my own company we run internally customised Masters Programmes. These are affiliated to UCL and involve contributions from numerous UK and overseas academic and industry institutions. In fact one of the basic philosophies has been to shop around for the best of the best to educate the company based students. Until last year this was satisfied by flying in feature presenters and tutors. More recently we have experimented with teleporting in lecturers (on dial up Digital Circuits) who appear on a 3m back projected screen. It works - the best of the best at low cost!

This year will see our move to virtualisation take a further step. A complete MBA delivered on a PC teleworking unit with both way communication via screen mounted cameras and interactive software. Instead of taking a year out to study at a residential college, 20 students will complete their course at their place of work over two years. However, the style of teaching, presentation, and interaction will be entirely different. It will not be flat, planar and unmoving, but dynamic and interactive. The difference will be on a par with that between a paper book and a CD ROM!

Last year we brought in Professor Bill Buxton of the University of Toronto to give a one hour lecture plus a half hour tutorial. He delivered this electronically on line in real time from his Toronto Office. The results were stunning. He had gathered examples on Human Machine Interface work from all over the planet, animated it, interspersed with video, still pictures and virtually no text. This probably cost 10 times the preparation investment than normal, but the outcome was breathtaking, and a new teaching and learning paradigm. Having done this once, why should anyone else bother - here it was, the best available! But why not available to everyone? This is the next logical step!

Present day video and TV based teaching and training packages suffer from two key limitations; they are not available on line and on demand, and are not interactive. Imagine having the ability to call up any course on demand, anytime, anywhere, and the improvement afforded by an interactive capability. Ask a question of the expert and they come right back with an explanation! Products of this kind are now starting to appear on CD ROM. You can now visit the Natural History Museum and ask the experts questions. So why not capture the questions of all the students for all time on topics like mathematics or the arts and commit them to electronic memory along with the responses?

One of the biggest limitations of UK universities is their small size. Many less than critical mass departments are struggling to cope with an increasing diversity of information and accelerating change. Overall the UK does have critical mass - but distributed across its institutions. Why are the same topics taught in a similar fashion across 30 departments at about the same time to groups of 40 to 80 students by lecturers who may not be at their best in the subject ? These self same lecturers are stressed by having to cover to much diverse material, deliver too many lectures and as a result spend too little time with individual students. How different it could be if a library of interactive multi-media teaching material was available on line backed up with access to enthusiastic academics!

In many subjects practical experience is essential to reinforce the theoretical and known. Providing sufficient laboratory or practical facilities has now become fundamentally impossible and a new raft of facilities is essential if students are to be well educated. Whilst we should not abandon the real laboratory, it is now possible to augment them with experiments on the screen. Much of our industry now employs simulation as part of integrated CAD/CAM (Computer Aided Design and Manufacture) processes Why not extend this to teaching? We have computer minded students, thirsty for hands on, held back and denied education in many of the relevant skills they need.

I well remember my introduction to field theory, thermodynamics, structures, machines and quantum mechanics by enthusiastic mathematicians and physicist. My understanding and rate of progress was almost solely dictated by their level of artistic attainment - which often left a lot to be desired. How different today when a simulation package gives a porthole of much greater precision to the truth. Unfortunately no such teaching package is readily available and 30 years has only seen a migration from black to white board to overhead slides! Having systems on a screen, with knobs to adjust and interactive pictures to see, is far more edifying and satisfactory. It is a new and more communicative process that strips away much mystique embedded in complexity. Best of all, it can be on line with groups inter working on the same system or problem at the same time, but not in the same place!

Throughout my life it has seemed that the best of teachers were able to put themselves in my place, assume my level of ignorance, and impart their understanding in a very graphic and enthusiastic way. Unfortunately, with the speed up of technological development, and subsequent broadening of the curriculum, the masters of this process are becoming all too rare. To some extent the hard sciences overcome this through mathematical and physical models that rapidly convey a mental image of a given process. However, in the soft sciences the process is far more difficult. For example: medical students are faced with a bewildering repertoire of problems, diagnostic and remedial techniques, and like other sectors medicine is under increasing pressure to become more efficient.

A fundamental constraint to gaining sufficient practical experience is the limited access to patients. Just how many people can physically crowd around one patient to witness and/or participate in an examination or operation? At best only a handful! The use of commercial TV cameras and screens provides a partial solution, but lacks depth of vision and reality. However, miniature cameras are now the size of a shirt button and can be mounted on a spectacle frame worn by a consultant as he operates. The visual scene could then be transmitted to a multiplicity of sites where students equipped with 3D or VR (Virtual Reality) displays could observe and learn in 3D colour, with binocular depth of vision. Microphones on the consultantís head mount could also provide stereophonic sound for the observers. This would increase the sense of realism and allows remote students to hear the commentary and interchanges with operating staff.

Such a surrogate heading might appear far fetched, but the technology is at an experimental stage, and operations on real humans were completed this year. Clearly the development of such techniques could see the introduction of broadcasts to a large number of medical personnel world wide. The surrogation roles could also be reversed. This would see the expert sitting behind the eyes of the trainee, guiding through commentary and sight. It could bring about a dramatic reduction in the time to disseminate information and experience, and could impact significantly on our established means of education and training.

As we move into the 21st century we can look forward to a world where the global sharing of information and ability will become the norm through telecommunications linking centres of need and expertise. Entirely new ways of educating and training people on a continual, on demand, and Just In Time basis will evolve as our activities become virtualised. It is important to recognise that this may turn out to be the only way of balancing the rapidly changing demand and expectation. We have the technology and the need - all we have to do is change!

DISCUSSION

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Lecture One

In view of the nature of the presentation, it is not possible to provide a sensible record of the discussion, which was spread throughout the whole multimedia presentation. Readers should follow the links from Professor Cochrane's home page
http://www.labs.bt.com/people/cochrap

Lecture Two

In answers to questions, Professor Cochrane replied that the technique described was more sophisticated than genetic algorithms though the real test was the confidence to try it out in real life. He commented that it was often the case that we do not understand what we rely on, but it seemed to work satisfactorily because it gave a sufficiently good approximation in practice.

Professor Farber observed that some work in the finance industry was very similar and seemed to work despite the market being chaotic. Another example was the way that presentation of information was sensitive to the underlying network.

Professor Cochrane explained that there were a number of important concepts with no definition, for example life, intelligence, scalability, complexity. But through the method described they had learnt more about sex than the biologists, because they had looked at it through building it. As another, large scale, example, the audience was invited to consider an enterprise with 28 million customers and 7000 nodes with 100 million customer events and 2 billion network events every day. This approach has been used in such an organisation to making decision rules and then letting the system make up its own mind what it is going to do.

Dr Quint drew attention to the work of the Santa Fe Institute and asked what insights were to be gained from their approach.

Professor Cochrane replied that there is a natural tendency for things to move into synchronism, because everything that lives does so on the edge of a strange attractor. Their work demonstrates some principles that come out without involvement of the hand of human beings.