The Knowledge Media Generation

Professor Marc Eisenstadt, director-designate of The Open University's proposed new Knowledge Media Instutitue, explains the philosophy behind his team's approach to the new technology.

'Knowledge Media' is an expression I'd like you to rehearse: it's going to change your life. I'm going to spell out what I mean by that expression, and then tell you what's new about it and why it's such an important theme. Moreover, to put my money where my mouth is, I'll be using the new knowledge media to convey my message-- this version of the article is just one of several variants (see below for details, or, if you're trigger happy and still sitting comfortably by the time you read 'http://kmi.open.ac.uk/kmi-feature.html', you'll know just what to do).

You clearly know that computing and telecommunications technologies are converging, that their futures are irrevocably intertwined, and that individually and together they've *already* changed your life. No casual browser of these pages can have failed to miss the twin peaks of excitement over multimedia and the Information Superhighway. For those too embarrassed to admit it, or those who have been swept along by the jargon but were never 100% confident about having followed it, suffice it say that 'multimedia' means that you can now be the proud viewer/observer of professional-quality graphics, text, movies, videos, and audio, all interlinked and cross-referenced in useful ways, in the comfort and privacy of your own screen. Moreover, if you were reading the on-line multimedia version of this article, you could just click your mouse *here* and be presented with some more stunning examples straight away. Well, after a small delay, anyway-- which brings me to my next definition.

The 'Information Superhighway' is all about eliminating that small delay. As many readers are aware, plans are afoot to provide high-speed and high-capacity wiring, via fibre-optic cables and incredibly clever software 'switches', that will provide instantaneous access to an unthinkable wealth of multimedia resources, *regardless* of the distance between the resources and the consumer of those resources. In other words, click *here* and see my home movies in your home, without delay. This is *not* about dialling up CompuServe on a high-speed modem, nor about doubling nor quadrupling the speed of today's 14,400 bits-per-second offerings. It's about a 10,000-fold increase in that speed, using technology that's available now. That

was the original intention of the phrase 'Information Superhighway': don't accept imitations.

So, to recap: vast amounts of high quality moving graphics and sound, instantly accessible anywhere on the, er, Infobahn. 'But this we already knew, Two-Dogs....' I hear you say. Good. Now we need to discuss what goes *into* the multimedia: what fits on those CD-ROMs, what sits on massive file servers, what travels down the Information Superhighway? What do you *call* it? The conventional wisdom says that you call it 'content', and the hip view says 'bits is bits'. Both of these views are widespread, and in my view dangerous, because if we adopt either of these views we are selling ourselves tragically short. Yes, from the perspective of a Hollywood studio, 'content' is ok. And from the perspective of an editing technician, 'bits' are ok too. But its kind of like saying that Mozart wrote notes (content) and used ink (bits). What's missing in the widely-discussed convergence of telecommunications and computing is a very important third strand: the learning and cognitive sciences. This three-way convergence gives rise to what I call 'Knowledge Media'. I therefore want to raise the stakes and talk about 'knowledge' rather than 'content', and show how that relates to multimedia and the information superhighway.

Knowledge assets

Consider the cover story which appeared in *Fortune* magazine on 3rd October 1994: 'Intellectual capital'. The magazine article argues that a major challenge facing corporations is how to figure out what their collective knowledge is worth, and how to maximize the earning potential of that knowledge. Unused yet expensive-to-protect patents are but one example, and it is becoming increasingly clear that vast wealth lies within reach of those who understand how to assess and manage knowledge. To pick a salient case, the wealth of Microsoft resides in what its teams of wizards know. If those wizards quit their current jobs and started working for you tomorrow, you'd be a lot less concerned if they left their computers behind than if they suddenly suffered from amnesia. Sure, the reams of already-written code would have to be reconstructed or rederived (and in ways that didn't violate existing copyright), but that's just what knowledgeable people are good at.

Now consider the school child who can rederive the formula for determining (say) how fast a particular car needs to be going before it flips over when negotiating a tricky bend. Compare that child with the one who has memorized all the formulae, but can't rederive them. What's the

difference? It's in the knowledge of processes, that rich web of interlinked operations that enables creative 'workarounds' in the event of a problem-solving impasse. Who'll get higher scores on exams? In reality, it's hard to say-- very often, the 'memorizer' will perform better, because many exams favour a certain kind of regurgitation (and we mustn't underestimate what the 'memorizer' knows, because surely such a person picks up a lot more than just the facts, ma'm). But in the long run, the 'rederiver' will prevail, because of a richness of understanding. That's knowledge. As Alan Kay, father of personal computing, said in 1972, 'let's not measure number of exams passed per year; let's measure number of Sistine Chapel ceilings per lifetime.'

As it turns out, I could easily list what the memorizer knows (e.g. a long list of formulae, vocabulary items, etc.). If that list became impressively long, I could even put it on a CD-ROM, or send it down the Information Superhighway for perusal by others (yawn, yawn). But in the case of the 'rederiver', how on earth could I capture what that person knew? Even if I *could* capture it and store it, how could I impart that knowledge to someone else? This is surely one of the great challenges of educational theory and practice! Indeed, if I could capture the knowledge, store it, and impart it to others, I would coincidentally be well on my way towards a theory and practice of knowledge media, because knowledge media is about the capturing, storing, imparting, sharing, accessing, and creating of knowledge.

Now, is 'knowledge' the answer to what 'fits' onto CD-ROMs, what 'sits' on a file server, or what 'travels' down the information superhighway? Most emphatically not! Knowledge is an emergent property which transcends the fixed-size-and-space concepts of media and information, rather the way it transcends the notion that you can 'impart' it to students by 'filling' them up from the teacher's 'vessel'.

And therein lies the key: the early years of Computer Assisted Learning fell into that very same trap, thinking that 'filling from a vessel' was precisely what you *could* do, and fruitlessly trying to 'fill up' the poor pupils. The six-year-long debate about the National Curriculum still hasn't resulted in a clear statement about what it thinks knowledge is. In contrast, decades of work in Developmental Psychology, Cognitive Science and Artificial Intelligence has led to an inescapable conclusion: knowledge is a dynamic process, a vibrant, living thing, resting on shared assumptions, beliefs, complex perceptions, sophisticated yet sometimes crazy logic, and the ability to 'go beyond the information given'. 'Knowledge' is the correct

abstraction for describing what people communicate to one another. 'Content' is not.

Knowledge capture

Modern specialists in knowledge capture have in fact developed an impressive array of tools for addressing precisely these problems. We now know that it is possible to represent common sense rules that lead children to go through a brief phase of saying 'I gived' instead of 'I gave'. We can equally represent complex chains of reasoning such as the way astronomers discovered the formula describing the motion of the planets, or the way investment bankers hedge their bets in the currency markets. We know that there is a consistent logic present in children who think that 63 - 36 = 30. Even better, we know how this mistake arises, why it persists, how to detect it, and how to fix it. Forever. (Not, incidentally, by saying 'Wrong! Do it again!'). What all these examples have in common is a rich symbolic representational language which allows us to describe the innermost thoughts of learners in fine-grained detail. Not that we know 'the truth', just that we know considerably more fine-grained detail than did others in the past.

To illustrate some of these points, a group of researchers led by Enrico Motta within the OU's Knowledge Systems Group has developed ways to capture knowledge using a range of what are called conceptual modelling tools. These tools enable a knowledge engineer to sketch out in an informal manner the relations, properties, and processes involved in the problem solving behaviour of what we call a 'domain expert'. More importantly, however, is that the informal sketching tools are tied to a formal modelling language that enables a rich encoding of knowledge sufficient to capture a vast range of problem solving expertise, and to capture it in a modular way so that relevant portions can be used in different contexts.

In a related vein, but with a more obvious educational focus, Roger Schank's group at the Institute for Learning Sciences at Northwestern University looks at how and why students fail, and what motivates them. Time and time again, his group comes up with a mismatch between the student's perceptions and the teacher's expectations. He finds that students can be motivated by stories which illustrate key points, because the human mind is geared to pick up analogies between the story and the current real-life situation or problem. The trick is in finding a good story, something which master teachers are quite expert at. Schank's learning 'environments' are dependent upon the students traversing their own

pathways, asking questions, finding analogies, listening to stories. Oh, and these learning environments are delivered by a computer, nicely demonstrating the convergence we described earlier.

Multimedia and telematics

I've been talking about knowledge, so now it's time to say something about the media. An advert for 'presentation software' (which assists in giving public lectures and demonstrations) in the popular computing magazines reads 'He grew up with MTV and 50 cable channels. Unfortunately, he's in your audience today.' The point they're making is that this guy has very high expectations based on his lifetime of watching slick videos. But the advert also highlights a crucial factor in education as well, something long understood by the Children's Television Workshop (makers of Sesame Street): attention-grabbing graphics matters a great deal. It's tempting to hark back to McLuhan's 'the medium is the message', but that's not what this is about. Today, we need to have a rich approach to both the message and the medium. The message is not just 'content', as we argued above, because a deeper analysis of the knowledge is required. Similarly, the medium is not just a technical format, such as 'video' or 'CD-ROM'. Rather, it is the whole presentational style, the user interface, the accessibility, the interactivity. Just as 'film' evolved from being a medium of filmed plays to its current cinematographic wonders, so are telecommunications, computing, and multimedia facilities evolving towards rich new art forms.

At the Open University, teams of researchers are experimenting with such art forms. Tom Vincent and his colleagues in the Multimedia Enabling Technologies Group developed a 'Virtual Microscope' to allow disabled students to use a polarising microscope (click *here* for a whizzo demo if you're reading the on-line version of this article-- see what I mean?). Superficially, it's a CD-ROM containing thousands of photographs of rock samples at different angles and degrees of magnification and polarization. The overall product is of such stunning clarity and power that non-disabled students are choosing to use it, as the facilities go beyond a conventional microscope, giving new insights into the study of earth sciences. Other projects in this vein include a dynamic visualisation of changing weather patterns, and CD-ROMs with large-print and spoken course materials for visually impaired students.

Another group of OU researchers working in Paul Bacsich's Electronic Media Research Group has explored ways to deliver full Internet capabilities to students who live in distant lands not even connected by

conventional phone lines (click *here* for more details). His group provides a facility for computer-mediated communications, or groupware, based upon a nice-looking and easy-to-use email and conferencing service known as FirstClass. The basis for this environment is a commercial product from a company called SoftArc in Toronto, and the crucial thing is that Paul's group has enabled access to users anywhere in the world, so that they might be connected via phone lines, dedicate satellites, high-speed fibre-optic links, or a host of other methods, and never need know which method they're using. Because the environment is itself a powerful knowledge enabler for thousands of Open University students, and because it has been used for everything from teacher training to advanced Masters degree programmes in Computing, it fits nicely into the knowledge media paradigm.

Virtual Summer School

The last example I want to give you comes from a project that my colleagues and I ran last summer. For a dozen students who were unable to attend a Psychology summer school, we decided to use a range of computing and communications facilities to bring the summer school to them. We provided Internet videoconferencing to bring them guest lectures from abroad, as well as bulletin boards, email, World Wide Web access to retrieve relevant journal articles, and some experiment-control software to design and run memory experiments. To live comfortably within the restrictions of present 14,400bps modems, we also supplied mobile phones so that students could conduct audio conference calls while their computers were connected to the other groupware services. Even a Virtual Disco was provided. The overall experience was intense and exhilirating for the students, though more time consuming than they had anticipated (sorry Guardian readers: click *here* for examples, discussion, and evaluation reports). For us, it was a prototypical exercise in knowledge media: students were accessing, sharing, and creating knowledge, using a range of communications and computing tools, and pushing the fronteirs of the available technology within plausible cost constraints.

The Knowledge Media Institute

Above, I referred in several places to my colleagues at the Open University: the Knowledge Systems Group, Multimedia Enabling Technologies Group, and Electronic Media Research Group. These groups, and indeed others throughout the OU, share a belief that

Knowledge Media represents the future of research and development in life-long learning, and have recently proposed a merger under a joint umbrella that we call the 'Knowledge Media Institute'. We are not interested in 'multimedia authoring' per se, just as we are not interested in the 'content' of a CD-ROM. Instead, we want to gain some insights into what it means to share knowledge; how knowledge can be captured and conveyed; how to exploit new technologies to satisfy the ever-increasing appetite for communication bandwidth; how to meet the needs of mobile students; what radical new methods are needed to assist disabled students; how to work in groups with students scattered around the globe; how to harness software in the service of human understanding. Our research agenda is large and exciting. We are as interested in corporate knowledge management and intelligent agents as we are in the needs of students in the wired society. We want to foster life-long learning, but to do that we need to evolve new media, harness them appropriately, and ensure that they are firmly rooted in a rich representation of knowledge.

To give you a feel for the kind of research projects that we hope to undertake, here is a representative sample, taken from some pending bids, several of which build on work already in progress:

- **Very large virtual classrooms:** this project will look at ways to deliver high-bandwidth 'virtual presence' capability to hundreds of students on a single course. The focus is on scalability of tutorial methods and workgroup activities, given effectively limitless computing and communications resources.

- **The Mobile Student:** many of our students need to study while on coffee breaks, on the road, on the move, and in unusual places. This requires us to push the limits of mobile computing and communications technologies in order to provide a seamless integration of easy-to-use, easy-to-read, and comfortable resources for our students. A group of our most mobile (and demanding) students would test the latest generation of courseware which keeps students fully in touch with course resources and tuition from anywhere in Europe.

- **WorldWide BA:** we're developing the first complete profile of courses which can be taken by students from anywhere reachable via the Internet, and which lead to a Batchelor of Arts degree recognized by the UK's Open University and numerous other quality institutions around the globe. This activity will require the development of new styles of tuition, course presentation, delivery, and facilities management.

- **Spiderman Web HyperCruiser:** Internet navigation can be tricky. This project will develop a 'space-eye' view that lets users visualize the Web in terms of content, topology, access history, popularity, traffic flow, and a rich mixture of other user-defined attributes.

- **Agents on parade:** What do software agents do when left to themselves? This project will study the behaviour of unsupervised (but monitored) software agents. What will it take for the agents to discover how (or whether) to disable our monitoring? Even if they don't get that far, we will learn a lot about the nature of unsupervised agent behaviour.

- **Net surfing for blind people:** many disabled users have been at a disadvantage on the Internet. We want to develop a suite of software tools which provide full Web functionality for a large range of disabled users including those who are blind.

- **Reusable courseware:** snippets of text, animation, video sequences and multimedia documents produced for Course X may be of great value not only to Course Y, but also (in arbitrary combinations) to individual life-long learners around the globe. This project will look at ways to index, store, retrieve, and configure coherent 'knowledge modules' for use by different learners in different contexts.

- **KMI top 40:** we want to develop a multimedia authoring environment that helps school children design and implement their own community service or entertainment package. These packages will be released onto the net, and their fate will be decided by the public. The top package each month will be awarded a KMI prize and the designers will be offered a KMI summer internship.

- **Multimedia in science:** the resources available for laboratory work in schools are limited. It is recognised that pupils need to be introduced to new methods of experimental work and analysis that cannot be achieved through conventional laboratory provision. The Knowledge Media Institute would provide (a) an opportunity to experience multimedia emulations of laboratory experiments that have been gathered from around the world, and (b) an environment in which new creative ideas can be explored with a view to prototyping these ideas on a collaborative project basis.

- **Talking Net Newspaper:** new communication facilities offer the potential of distributing newspapers in alternative media in

> more effective and efficient ways. The project would investigate how a national network could be created to enable local, regional and national organisations to provide immediate access to news.

KMI is not only about blue skies research, of course. As you can see from the summaries above, there is a strong emphasis on the needs of our current and future student population. KMI will be committed to a throughput of ideas and developments to course teams at the Open University. The OU itself is finding that the very nature of everyone's roles is changing. Academics, editors, designers, producers and software developers are increasingly involved in one another's work, and the KMI will explore creative ways of intermingling these evolving roles.

Finally, we are seeking significant external funding to enable the KMI to serve as a major focus of activity in other relevant arenas. There has been talk recently of the 'Education Superhighway', and we want to forge partnerships with both educational establishments and industrial concerns in order to ensure that we help empower the average citizen with tools relevant to everyday needs. We cannot stress too strongly that just the wiring of homes and the creation of 'content' is too simplistic a view of how things ought to proceed. The interlinked processes of accessing, sharing, and creating knowledge require significant research and development. Re-skilling society is a major agenda item for all of us, and we fondly trust that the next generation of life-long learners will grow up in an environment that uses knowledge media to radically improve their lives.

The text of this article is also available in several electronic formats:

1. World Wide Web: http://kmi.open.ac.uk/kmi-feature.html
2. Anonymous ftp from kmi.open.ac.uk in directory /pub/documents in the following files: kmi-feature.ps (postscript), kmi-feature.ps.gz (compressed postscript), kmi-feature.txt (plain ASCII text), kmi-feature.doc (Microsoft Word).
3. By email: post a message to kmi-info@open.ac.uk saying which version you want.

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