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CRITICAL THINKING REQUIRED OR SEVEN DEADLY SINS OF INFORMATION TECHNOLOGY

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Nothing is more dangerous than an idea, when you have only one idea.

Émile-Auguste Chartier, from Les Propos d' Alain (1908-19).

INTRODUCTION

This paper is not about pride, avarice, lust, envy, gluttony, anger, and sloth - the Seven Deadly Sins that since medieval times have been castigated by religious teaching. Or rather, it is not explicitly about those things. The failings that I describe here are modern, perhaps even post-modern. They relate to Information Technology and to the ways in which IT can be misrepresented and abused by mortal beings.

In his painting 'The Haywain' the fifteenth-century artist Hieronymus Bosch famously depicted sin through the metaphor of a large wagonload of hay which is grasped for by a greedy world. Updating the metaphor, what today should take the place of the wagonload of hay? Arguably, one prime candidate is the car; another is the computer. At the turn of the twentieth century IT has become a potent symbol of wealth and power. Scotland is one

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nation among many that grasps towards the technology in the hope that it can assure the future in post-industrial times.

It hardly needs to be said that Information Technology offers many benefits. Some personal examples: without IT my research group could hardly function, the labour of preparing this paper would be much greater, and the hospital that treated me recently would be a less effective place. However, the history of technology seems to demonstrate that benefits are usually achieved at a cost. This was understood in the early 19th century by the much maligned workers known as Luddites who resorted to a campaign of breaking machinery. It is understood today by the eco-protesters who campaign around such issues as road-building, sand-eel fishing, and nuclear power.

This paper rests on the claim - which ought not to be controversial - that Information Technology is likewise a mixed blessing. Thousands of articles and books applaud the latest developments but relatively few offer a more reflective or critical view. In education, which provides the main context for this paper, the situation is especially disappointing: critical voices are scarcely audible amidst a clamour that is deafening from 'modernising' politicians, technology quangos, IT sales representatives, and committed enthusiasts. These groups promote what amounts to a single idea: the more technology in education, the better. Émile Chartier, whose quotation it is that appears above, would not have been impressed.

In what follows I discuss some of the grievous attitudes and activities that seem to me to represent the dangerous side of IT. I do so using the device of the 'deadly sin' - an overworked metaphor perhaps but one that is convenient for my purpose. I do not pretend that any of the ideas presented here are original. Authors such as Dreyfus and Dreyfus (1986), Norman (1993), Roszak (1994), Landauer (1995), Stoll (1995), Postman (1998) and others have already done much to open IT to the scrutiny of critical debate. However, the Scottish contribution to (or even awareness of) this literature is meagre. As ever more political and educational initiatives rest on the new technology it seems to be timely to collect some elements of critical thinking that will be essential to ensure that teachers, learners and communities benefit without unacceptable cost.

DEADLY SIN#1: TO LOSE PERSPECTIVE

Will Information Technology save humankind? To judge by Nicholas Negroponte's latest book, the answer is beyond doubt:

> While the politicians struggle with the baggage of history, a new generation is emerging from the digital landscape free of many of the old prejudices ... Digital technology can be a natural force drawing people into greater world harmony.
> (Negroponte 1995, p.230)

In his futuristic vision, digital technology will bring universal 'empowerment' - a key word within Negroponte's IT litany - and change for the better will follow, especially for education:

> my optimism comes from the empowering nature of being digital. The access, the mobility, and the ability to effect change are what will make the future so different from the present ... As children appropriate a global information resource, as they discover that only adults need learner's permits, we are bound to find new hope and dignity in places where very little existed before.
> (ibid, p.231)

To which the critical reader must respond: if only things were so easy. Alas, social scientists and historians can point to any number of deep-rooted problems that stand in the way of 'world harmony' but for which IT is a highly implausible solution. Human development, they will tell us, is founded not upon wire, plastic, and sand - the ingredients of digital technology - but upon deeper and less certain stuff: moral values, social structures, and cultural traditions, for example. Notions that IT will banish prejudice or eliminate the difficulties of learning are simply fanciful.

What is it about IT that provokes such total loss of perspective? Perhaps it is a form of myopia in which the dazzling advance of the technology causes blindness to all other phenomena. A sure symptom of the ailment is the delusion that IT is an end in itself, rather than a means to an end. Thus, when the president of a famous American university tells us that

> The great university of the future will be that with a great computer system.[1]

we should suspect that his admiration for the technology causes him to lose sight of the wider purposes that (presumably) justify the existence of his university.

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[1] *Richard Cyert, president of Carnegie-Mellon, quoted in Roszak (1994), p61.*

DEADLY SIN#2: TO BELIEVE THAT TECHNOLOGY IS NEUTRAL

Difference of view is a part of life. Each of us carries a distinctive interpretation of the world, based upon some set of experiences, assumptions and personal theories, which is part of our individual identity. Anything that we create - a table, a book, a conversation, a computer system - must in some way reflect that identity, because when we create we do so within a context, for a purpose, and using our personal theories about how that particular act of creation should change the world.

Perhaps this is obvious. Yet many people suppose that computer systems are somehow untainted by any ideology or bias. In the public mind, books and films are understood to be 'statement-making' but computer systems are imagined to be neutral. Computers are seen as clinical decision-makers with awesome logical powers that surely guarantee the integrity of their results. Although errors occur occasionally, these are usually explained in terms of operator error and the well-known GIGO ('Garbage In, Garbage Out') principle.

In reality, of course, every computer program is derived from its designer's interpretation of the world. Programs are committed to theories no less than are tables, books, and conversations. When the computer's results are suspect, the problem may lie not with erroneous inputs but with the theories which are deeply embedded into its software algorithms. In such cases critical users will inquire as to whether a very different GIGO principle applies - perhaps 'GOSPEL In, Garbage Out'.

Why is the committed nature of computer software so often disregarded? At least three explanations come to mind. First, software is intangible stuff. Its theories may be publicly documented but undeclared assumptions are common and often well concealed. Second, computers originated as fast calculators or 'number crunchers'. The theory of arithmetic is not very controversial. But as the range of application areas has expanded - for example, into law, medicine, economics and education - so the notion of commitment has become more critical.

The third explanation for the imagined neutrality of IT is that computer science inherits some of the prestige of science and mathematics, especially logic. Logic, unfortunately, is more widely respected than it is understood. Logicians distinguish two interpretations of logic: one syntactic and the other semantic. In the syntactic interpretation, conclusions are reached by

manipulating symbols according to standard rules of inference. These conclusions acquire human meaning (semantics) only when the symbols are identified with concepts in the world. Computer systems in use depend upon not only the relatively unassailable syntactic interpretation of logic, but also upon the semantic interpretation which reflects the human programmer's theories of the world. To illustrate the point, let us consider briefly three examples: computer games, CD-ROM databases, and tutoring systems.

Computer Games

Computer games are now an established part of youth culture. The games, of course, mostly make explicit their own rules. These constitute the documented theories. But what undeclared assumptions lie behind titles with names like MDK (Murder Death Kill), Hardline, Duke Nukem and Abuse? What stereotypes are presented by characters like Lara Croft, the improbably proportioned heroine of the top-selling Tomb Raider? What attitudes are represented by images like the Nintendo advertisement's showing of a terrified woman tied to a bed by her wrists? Why out of 65 million Gameboys (sic) have fewer than one million been sold to girls?

Such questions deserve serious analysis. My aim here is more limited. I only wish to observe that the games reflect (some would say distort) certain human preoccupations and fantasies. They are, in effect, a kind of storytelling. It seems impossible therefore to sustain a view of them as a purely neutral, value-free technology.

CD-ROM Databases

CD-ROM databases provide a second illustration. The manufacturers of these products may like to claim that they are culturally and geographically neutral. However a survey of the contents of two widely used CD-ROM databases concluded differently:

> You would be hard pressed to find even a token example of indigenously produced non-Western information for any given subject ... An enormous amount of non-Western indigenously produced information is being disregarded.
> (Fisher 1994, p.26)

Fisher argues that CD-ROM publishers promote an 'unequal and discriminatory supply of information' due to a combination of factors including eurocentric bias and blindness, the greater accessibility of Western information, and commercial imperatives. He relates this to a similar

inequality affecting the publication of feminist literature, almost none of which has been made available in CD-ROM form.

Tutoring Systems

A third example is the case of tutoring systems. Consider Anderson's state-of-the-art program for tutoring in elementary algebra, a program named PAT (Practical Algebra Tutor; Koedinger et al 1997). The program behaves in expected ways - it presents the learner with tasks, provides on-screen worksheets, offers individualised feedback, and so on. In an evaluation with several hundred students in three Pittsburgh high schools, PAT-using students were claimed to outperform students in comparison classes by 15% on standardised tests.

Which seems fine. But those who buy the program should understand that they are also buying into the ACT theory on which the program is based. ACT stands for Adaptive Control of Thought, a name which is to be commended at least for its straightforwardness. PAT's individualised feedback is made possible by continuously comparing the student's performance to that of an embedded model of successful performance. According to the theory of ACT, differences between the two models should be immediately flagged as errors and treated with remediation. Thus learners are treated as 'experts with bugs'. This is pedagogically controversial. Probably most educationists today would argue that learners' understanding make sense to them on their own terms. Good teaching should build from that understanding rather than just attempting to put 'deviant' thinking back on track.

Does it matter? Some would say not - that PAT's success in the targeted skills clinches the issue. But much educational research emphasises that the learning process is as important as the learning product. Critical teachers will ask, for example, what consequences follow from the desocialisation of learning that may occur under such tutoring systems and how PAT's treatment of errors affects children's perceptions of what constitutes good mathematical thinking.

Neutrality and Secrecy

The sin is not the embedding of theories into software, for to do so is unavoidable. Neutrality is an illusion. The sin comes when the theories are concealed or disguised so that people come to believe that they are not really there. In the case of tutoring systems, underlying theories should be publicly documented as is the case for ACT. John Self (1990), an acknowledged

pioneer of computer tutoring, now goes much further and recommends that a system's model of a student should be made visible to and negotiable with the learner.

But there may be commercial reasons for being less open. The tutoring systems known as ILS (Integrated Learning Systems) which have been introduced into some UK schools guard their algorithms, a fact which frustrated a recent evaluation of these programs:

> Lacking such design information, it is not possible to comment in detail on the theoretical or pedagogical strengths and limits of the way in which any particular ILS works.
> (Becta 1998, p.34)

Such secrecy on the part of ILS companies seems to vindicate Roszak's (1994) criticism of the 'hidden curriculum' of the computer. Not only is the ILS machine not neutral, it may conceal an ideology that is at odds with the ethos of the school and its teachers. Imagine by analogy a new type of medical machine which doctors cannot scrutinise because the machine's manufacturers deny access to its internal components. Who would trust such a machine? And who would accept responsibility if it damaged the health of a patient?

DEADLY SIN#3: TO PLACE SYSTEMS BEFORE PEOPLE

Much of the rhetoric of IT presents a technology which is at the service of humankind. Yet the reality may be quite different. Norman (1993) recalls the motto of the 1933 Chicago World's Fair:

> Science Finds, Industry Applies, Man Conforms

Such an unabashed expression of the subordinate role of people relative to science and technology would be unusual today. However Norman argues that the motto lives on and must be challenged:

> It is science and technology - and thereby, industry - that should do the conforming. The slogan of the 1930's has been with us long enough. Now, as we enter the twenty-first century, it is time for a person-centred motto, one that puts the emphasis right: People Propose, Science Studies, Technology Conforms.
> (ibid, p.253)

Sadly the IT industry has more often seemed to prefer what might be termed the Chicago philosophy. As Landauer (1995) notes, the traditional software development process has given low priority to the people who are the intended users of software:

> the overwhelming majority of computer applications have been designed by programmers who know next to nothing about the work that is going to be done with the aid of their program. Programmers rarely have any contact with users.
> (Landauer 1995, p.169)

Computer programmers have an unusual profile. Males dominate; in the UK only one in four programmers is female and female programmers mostly occupy junior positions (Stack 1998). Also, programming attracts twice the proportion of introverts in the general population and three times the proportion of 'intuitive' thinkers (Tognazzini 1992, quoted in Landauer 1995). Even if more contact with users was seen as important, these are hardly the characteristics of empathetic communicators.

However, the problem runs deeper than any shortfall on the part of programmers. Methods such as SSADM (Hares 1990) that are conventionally used to develop computer systems revolve around the technology under construction, not around the people who will be the ultimate users. A significant feature of these methods is their insistence that the required functional performance of software must be completely analysed before its design and implementation stages can begin. This is intended to reduce the cost of programming. In practice however the introduction of new software typically has complicated and unforeseeable effects upon human roles and practices. Because the software's specification is completed long before these effects can be observed and understood, finished programs are often poorly adapted to their human contexts.

Fortunately, systems-centred development methods are now being challenged. Newer, more flexible software development methods that are known variously as usability engineering, participatory design, and socio-technical design (Ehn 1988; Greenbaum and Kyng 1991; Nielsen 1993) emphasise the need for ongoing collaboration between programmers and user communities. Other significant features of these more human-centred methods are evolutionary prototyping, which allows the specification of programs to be continuously renegotiated, and a central concern for the design of the user interface. In education, Helen Pain and I have combined ideas from human-centredness and action research to produce a classroom-

centred method for software development. Our method is called Persistent Collaboration (PCM: Conlon and Pain 1996).

Systems as Political Tools

The new human-centred software development methods may find hostility, and not only because they are they ill-suited to the profile of typical programmers. In industry it has been observed that managers involved in the planning of new computer systems view their own power and control as key factors in design (McLoughlin and Clark 1995). This illustrates how privileged groups in society may use computers as political tools.

The political function of computers is most apparent in oppressive nation states. For example, the Chinese government is able to prevent its Internet-using citizens from accessing overseas Chinese language sites dealing with Chinese politics. However, every IT system is designed for a purpose and within a social context. Thus there can be no escape from political influence.

As an example from education consider the so-called National Grid for Learning, the flagship educational IT project of the UK government (DfEE 1997). The NGfL's unfortunate name invites comparison with the electricity grid, a medium with well known attributes: tight central control, inflexibility, and standardisation. Yet the project undoubtedly has promise. A human-centred design for the Grid could empower teachers and learners by prioritising horizontal channels of communication (peer-to-peer) and by giving control of content to school and community groups. This would be consistent with recent calls for the democratisation of education (Fairley 1998; Paterson 1998). However the Grid's current design[2] leaves no doubt that nothing of this kind is intended. Central agencies, and in Scotland that above all means the schools inspectors (HMI), are firmly in control of content. The latest DfEE and Scottish Office Education and Industry Department (SOEID) announcements are showcased but there is practically no echo of the challenge to them that comes from teachers and communities.

Selwyn (1998) has charged that the NGfL is an economic project masquerading as an educational one - in his phrase, it is a 'grid for earning' rather than a 'grid for learning'. Support for that charge comes from the participation of private companies which, spurred by New Labour's

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[2] *For existing examples of the NGfL see the web sites of the Virtual Teacher's Centre (http://vtc.ngfl.gov.uk/vtc/) and the Scottish Virtual Teacher's Centre (http://www.svtc.org.uk/).*

significantly titled strategy paper 'Open for Learning, Open for Business' (DfEE 1998), are now competing to supply schools with NGfL hardware, training and maintenance. But the NGfL could also be viewed as the exercise of power through a novel medium. The rhetoric of today's IT may be about individual empowerment but the design of technological systems will mostly empower the already powerful.

Information Technology and the New Managerialism

The IT quangos in education, notably in Scotland the Scottish Council for Educational Technology (SCET), would no doubt claim to shun the Chicago philosophy of Science Finds, Industry Applies, Man Conforms. Yet their discourse suggests otherwise. Consider, for example, the following extract from SCET's publicity for its 1998 conference:

> Continuing the highly successful Tactics and Trends series of conferences, 'The Critical Moment - the Dawn of the Learning Age' will once again bring together many of the most influential policy makers, decision makers and leaders of development. Each keynote provides a first-hand opportunity to hear leading experts in the field provide crisp, insightful advice covering the key knowledge and paradigm changes that must inform and dictate the steps leaders will take tomorrow and in the future.

This vainglorious prose is striking in its reverence towards figures of ostensible authority - to the 'leaders of development' who, presumably, are individuals of exceptional prowess in matters technological. Apparently however not even these mighty types are truly free agents. They are at the mercy of 'paradigm changes' which dictate (sic) their future steps. The spirit of Chicago is alive and well at SCET, it seems.

Striking too is the way in which IT literature of this kind alternates between two discourses. On the one hand there is the discourse of technological élitism and determinism in which our fate is said to decided by technological experts and breakthroughs. On the other hand there seems to be a quite contrasting discourse of liberation in which individual empowerment will be achieved with, for example, the 'dawn of the learning age'.

This is not a new mixture. It is the standard rhetoric of technologists to evangelise themselves as heroic saviours of a barely deserving populace (e.g. Postman 1998). But there is a disturbing similarity between this double-speak and that of the 'new managerialism' which now dominates in education (Fairley and Paterson 1995; Hartley 1997). The new managerialism is

centralist and authoritarian but it effectively combines a technical rationalism (including the now familiar language of performance criteria, national guidelines, 'accountability' by league tables, etc) with an appeal for the alleged 'stakeholding' which comes from the delegation of (strictly limited) powers to lower levels of the hierarchy. What IT offers to the new managerialists is a rich new source of technical rationalisations - ones that are hard to challenge by a teaching profession still nervous about the technology - and a barely concealed threat that professionals who are troublesome may be automated out of existence. In return, the new managerialists offer the system-centred technologists the chance to put their heroic designs into practice.

Postman (1998) observes that computers are unique among machines in that they do no work, their function being to direct the work of others. It might be said that managers are unique among workers in exactly the same way. A case of deadly sinners embracing? Perhaps. But that embrace also suggests the virtuous alternative. Fairley and Paterson (1995) recommend a democratic, consensual approach to policy-making as a morally compelling and more effective alternative to the new managerialism. Similar advantages could be claimed for human-centred as opposed to system-centred IT. In fact, human-centred IT and democratic, consensual policy-making look to be very natural allies in the struggle to move beyond the anachronistic slogan of that 1933 Chicago fair.

DEADLY SIN#4: TO FIXATE UPON 'IT SKILLS'

The UK government has declared as a target that:

> By 1999 all Newly Qualified Teachers would need to become ICT-literate[3] to mandatory standards to receive the award of Qualified Teacher Status.
> (DfEE 1997, p.24)

For England and Wales, a definition of 'mandatory standards' has been duly produced by the Teacher Training Agency. Their 'ICT curriculum' consists of seventeen pages of instructions and 116 IT-related learning objectives that must be addressed by teacher training courses as a matter of statutory law (TTA 1998). In Scotland an SOEID-commissioned report claimed to identify

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[3] *ICT (Information and Communications Technology) is the alternative acronymn for IT that is favoured by New Labour and dutifully selected at all times by HMI.*

42 'essential IT competences' for primary trainees and 26 for secondary (Lamont and Munro 1995). More recently the SOEID has proposed no fewer than 67 new IT competence requirements that are expected to be addressed by Scottish teacher training courses. Considering that a mere 32 competences describe the requirements for all other areas of training, this is a remarkable extension of centralised course prescription.

The Scottish Office justifies these vast demands for 'IT skills' on the part of student teachers by the claim that they will lead to better teaching. But the evidence to support this claim is thin and it can be challenged in at least four ways. First, IT is a minority activity in today's schools and the time that is spent on training courses pursuing IT objectives must diminish that which can be devoted to more mainstream activities. Second, the fact that lengthy lists of competences are deemed necessary only underlines the point that computer systems at present are hard to use. Third, it seems fairly clear that most successful IT users progress not by studying a prespecified IT skills curriculum but by a needs-driven learning process that is situated within a context of use. Fourth, the technology is changing so quickly that any list of IT skills will be of little long-term value.

Hard-to-Use Systems

Winograd and Flores (1986) probably speak for the vast majority of computer users when they write:

> It is not necessary to belabor what everyone knows from experience - computer systems are frustrating, don't really work right, and can be as much of a hindrance as a help in many situations.
> (Winograd and Flores 1986, p.174)

This commonplace truth is one that the IT industry pretends not to recognise. But it cannot be dodged. The explosion of telephone support lines and the numerous books with titles like 'computers for dummies' reflect the collective cries for help that, alternately with tears and curses, represent too much of the ordinary user's experience at the keyboard. System-centred design is partly to blame, but so too is the primitive state of current human-computer interface technology. Interfaces tend to be so non-intuitive that it often isn't clear how to do what you want your system to do - you can't talk to a computer nor expect it to show much understanding of your intentions. Other big problems

that make systems hard to use include over-complexity[4], unreliability, incompatibility and obsolescence.

The IT industry makes much of the progress that has been made towards more usable systems. Certainly there have been improvements, often stimulated by a combination of insightful academic research and innovative development. Apple's Macintosh graphical user interface is the classic example[5]. But the machines are still too often impenetrable. Amazingly, people have been persuaded to blame themselves - to call themselves 'dummies' - when things go wrong. Only occasionally is the frustration directed more accurately at the designers, manufacturers, and sellers of the machines.

I tolerate hard-to-use systems because, for me as a computing specialist, the benefits (and the salary cheque) outweigh the aggravation. When the printer won't print, the menu options baffle, or the network cuts me dead, I generally have the time and the knowledge to put things right; failing which I can find help from technical support staff. This is very different from the situation of typical teachers in a busy classroom. Too many of the computer systems which were bestowed upon teachers in the past, often with great fanfare, were neither usable nor useful and neither were they adequately supported by technical expertise. Critical teachers today will want to know how far the situation has changed.

Needs-Driven Learning

Although IT systems are hard to use, they do offer benefits that for many people justify some form of investment of learning. For example, we may curse our word processor but we learn to live with it because, for all its faults, it still beats the old typewriter. But what learning process is best?

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[4] Even word processors now threaten to overwhelm users with complexity. A recent study (Linton, Charron and Joy 1998) reported that Microsoft Word version 6 on the Macintosh has 642 different commands. Observation of 16 users over a one-year period showed that on average they used only 56 of these commands (the range was 15 to 104). A mere 20 commands alone accounted for 90% of all use.

[5] Nevertheless, the rise of graphical interfaces was bad news for many blind computer users whose screen-readers no longer worked correctly, reminding us again that technological benefits are often not clear-cut. For a discussion of this problem relating to Windows 95 see Coombs (1995).

As mentioned above, the TTA prescribes a learning process based upon a formal curriculum with preset objectives. However, this does not seem consistent with the findings of Carroll (1992) who conducted a major study of IT skills development. Carroll concluded that a formal curriculum failed to motivate learners and led to inert knowledge. Much more effective was an approach based on real tasks (ones that the learner sees a need to tackle), set in real contexts (e.g. based in the workplace) and supported by the bare minimum of formal teaching. Carroll named this approach 'minimalist instruction'. I prefer the term 'needs-driven learning' because it makes clear the essential idea: you learn an IT skill only when you need it to do something you want to do. Instead of following the learning objectives of an external curriculum, the needs-driven learner pursues goals that arise naturally from her context of use.

Needs-driven learning has a basis in common experience. Few people learn to use a video recorder, microwave oven, car radio or calculator by taking a course. Instead, they learn what is necessary to get by. When later a need arises to do something novel they extend their knowledge, perhaps by asking a friend, by trial-and-error investigation, or (reluctantly) by consulting a manual. Although this approach may seem haphazard, it works because it respects the user's view of technology as subordinate (a means to an end) and because learning is situated within a meaningful context and synchronised to real needs. The success of the Multimedia Portables for Teachers project (Harrison et al 1998), in which over 1000 teachers were presented with free portable computers with only minimal instruction and ongoing support, can be seen as recent evidence that needs-driven learning in an IT context can be highly effective. So too can the project reported by Robertson et al (1996) in which pupils of a first year secondary class, presented with palmtop computers for a year, quickly familiarised themselves with word processor, spreadsheet and database applications.

If Carroll's study is a guide then a mandatory prespecified IT curriculum like the TTA's will be ineffective. Students on training courses who are forced to jump through IT hoops that seem irrelevant to them will become disaffected. Any skills that are learned may be too brittle to transfer into real school contexts. The TTA seems to anticipate these problems by insisting that IT learning must be 'rooted within the relevant subject and phase', but why then are the IT learning outcomes detached from the rest of the teacher training curriculum? Should IT determine teaching approaches or should it be vice-versa? This is a question to which we shall return later.

IT Skills Become Outdated

Yesterday's IT skills are obsolete. Who nowadays cares about the key combinations that provided shortcuts in WordStar; or the commands for disk operations on the Apple II; or the methods used for creating batch files in MS-DOS? Today's IT skills will surely go the same way, for the pace of technological change is not slackening. For example, the 'skill' of formatting a disk - which Lamont and Munro (1995) proposed as an 'essential competence' for student teachers - is probably irrelevant to users of the latest network computers and Apple iMacs. These machines no longer provide floppy disks, which are regarded as obsolete technology.

It is obvious that IT is evolving, making IT skills transient. But the rate of development is hard to comprehend and its implications for what counts as 'skill' could be far-reaching. Indeed, some experts regard the whole idea of general-purpose personal computers as an evolutionary dead-end. For example Norman (1998) predicts that today's machines will be superseded by special-purpose 'information appliances'. His argument is that general-purpose computers, precisely because they try to do everything, are intractably over-complex. Usability can only come through the dedication of machines to specific classes of application. Norman claims that the way forward is being signalled today by the 'invisible computers' that are games consoles, digital watches, personal organisers, and Web-TV set-top boxes, for example.

What if Norman is right? Tony Blair asserts that:

> Children cannot be effective in tomorrow's world if they are trained in yesterday's skills.
> (Forward to DfEE 1997)

Blair's remark prefaces a report that argues for more use by schools of PCs and the NGfL. But his claim may be prophetic in an unintended sense. When 'tomorrow's world' comes, will people demand to know why their schooling inflicted upon them the arcane technology of 1990's IT?

IT Skills in the School Curriculum

Prescription by the UK government of IT skills for teacher education follows similar developments in the school curriculum. The overnment has set as a UK target for 2002 that 'school leavers ... have a good understanding of ICT, with measures in place for assessing their competence in it' (DfEE 1998). In Scotland this target will be addressed mainly by the new Higher Still

curriculum for the upper secondary school stages. IT is one of Higher Still's 'core skills'. All pupils are expected to 'use an IT system to support a range of information processing activities' (SCCC 1996) and their certificates will state the level at which they have performed in IT.

My argument is not that IT skills should be ignored. Given that computers offer benefits but are hard to use, some modest accommodation of them seems sensible - preferably with low-profile support along the lines advocated by Carroll and by making the best of current technology readily available to schools, homes and communities. The problem arises from a fixation upon these skills which risks making them an end in themselves when in reality they are only a means to an end. Fixation elevates a relatively trivial set of utilitarian skills far beyond their due, equating them for example to 'literacy'. But real literacy is a mountain's climb and a lifetime's gift. As an educational achievement it is not remotely comparable to the ragbag of tricks needed to operate today's computers.

The signs of fixation are already there. In Higher Still, IT is given equal importance among a set of core skills the other members of which are surely far more vital: numeracy, communication, working with others, and problem-solving. Other signs include the elaborate IT curriculum for the 5-14 stages that is recommended by SCET (SCET 1994) and the Scottish Office's dash towards the dubious scheme to transfer into schools those second-hand computers that are unwanted by banks and businesses.

To some degree these developments are supported by what Goodson and Mangan (1996) call the 'ideology' of computer literacy: a set of widely-held but extremely naïve beliefs about the coming 'information age' and the impact of IT on job markets. In reality, numerous studies have shown that employers value the traditional core skills much more highly than IT and that school IT provision is largely irrelevant to labour market IT skill shortages. The school curriculum evolves slowly over decades. The IT industry on the other hand is intractably volatile. It is also ruthless in the way market forces operate. A recent labour market assessment indicates that UK IT jobs are hardly secure, except perhaps for a technological élite:

> Increasingly there is a global labour market for IT skills. UK based IT companies can retain control of design and customer liaison, while tapping into a large pool of low-wage, expert programmers, for example in India, thus controlling their costs, while exploiting time zones to work a 24-hour day. It makes no sense to tool-up UK workers with product specific programming skills to compete against this global labour pool.

> To ensure long term competitiveness, the UK must focus on those skills which create the most value, and are least susceptible to low-wage competition.
> (DfEE 1998)

The danger of the IT skills fixation is that schools and colleges will mount a massive effort on teaching and assessing a highly dubious IT skills curriculum. The irony is that the technology which should empower learners, threatens to enslave them instead. The machine that was claimed to support their learning now becomes the thing that is to be learned - while the curriculum at all levels becomes more prescriptive and crowded.

DEADLY SIN#5: TO MAKE MISLEADING CLAIMS

IT is the latest wave in educational technology. No doubt it is the most impressive. Yet we should be warned by the events of previous waves and by the fate of the claims that were made by the enthusiasts of their time. Some examples:[6]

> My judgment is that the *radio* can do its part; that it is a perfectly legitimate and satisfactory way for distribution; that it would carry more genius to the common child than he has ever had or ever possibly could have; that it is the greatest system for training teachers that we know; and all together I think it is justified even in a technical sense as a medium for instruction in public education. (Robinson 1931)

> *Motion pictures* have all the vital ability to influence and improve education that the printing press had five hundred years ago. (Hoban 1942)

> Education at last has a method by which different approaches and attitudes towards various subjects can be subjected to detailed scientific scrutiny ... *Programmed learning* ... could very well aid in the amelioration of some of the deplorable conditions in our educational system, to say nothing of feeding the hunger for learning in emergent nations. (Foltz 1961)

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[6] *All these come from* ***Future Schlock: Using Fabricated Data and Politically Correct Platitudes in The Name of Education Reform****, by L. Baines, Phi Delta Kappan, Vol. 78, No. 7, March 1997, p. 492. The emphases in italics are mine. I am grateful to Jean McKendree for drawing this material to my attention.*

> There is no limit on imagination. Thus there is no limitation on how you can use *transparencies and overhead projection* to communicate effectively with your class. Just as science is opening new vistas for mankind, overhead projection is opening new doors for teaching. (Schultz 1965)

> The first major social impact of the *HL [hypermedia learning]* revolution is to make schooling obsolete. ... In the new economy, where mindcraft replaces handicraft as the main form of work, HL makes obsolete the teaching, testing, and failure on which academic credentialism rests. (Perelman 1993)

Very little of this iconoclasm was justified by subsequent events. So will the use of computers in education have significant, consistent learning benefits? Research from two large-scale UK school-based studies, ImpacT (Johnson et al 1993) and Plait (Gardner et al 1992), is not particularly optimistic. These studies looked for learning benefits arising from the use of IT by 2300 primary and secondary pupils (ImpacT) and the provision of free portable computers for one year to 235 secondary children (Plait). ImpacT failed to find consistent significant learning benefits and Plait reported insignificant or 'at best marginal' gains in pupils' performance. Yet other studies have reached different conclusions. For example, Kulik and Kulik (1991) provide a meta-analysis of 254 studies ranging from kindergarden to college level which leads them to conclude that computer-based learning is significantly and consistently beneficial.

Notwithstanding such apparently conflicting outcomes, there is a form of consensus among serious workers in educational technology. The consensus is that learning is influenced vastly more by the selection of content and teaching method than by the selection of the medium (radio, film, OHP transparencies, computers, or whatever) that is used to deliver the instruction. To rephrase McLuhan (1964), the message matters much more than does the medium.

The problem for many research studies is that the variables of content, method and medium can be very hard to separate. This is illustrated by the PAT tutoring system mentioned earlier: the program combined a novel instructional method with a novel curriculum, thus making the real cause of students' improved test scores impossible to discern. But when the separation is made, the effect upon learning that is attributable to the medium seems to be negligible (Clark 1994). Russell (1994) reports 248 research studies that

support this conclusion, which has come to be known as the NSD ('No Significant Difference') effect.

If the NSD effect is correct then studies such as those on which Kulik and Kulik based their conclusion may be explained by a poor research methodology in which variables were not adequately controlled. Effective computer programs will be those that provide a judicious combination of content and method. Of course, the same content and method can generally be delivered in many different ways, not just with computers. Computers might provide a convenient and cost-effective medium for packaging a particular content/method combination. But the effectiveness of the package will need to be assessed within its context of use and on a case-by-case basis. A package certainly cannot be assumed to be automatically effective merely on account of the use of a computer as the medium of instruction.

Common Sense Advantages?

Faced with equivocal research evidence, IT enthusiasts have often resorted to claiming 'common sense' advantages of the technology. Prime examples are:

- computers are interactive and can provide feedback;
- computers can make available vast quantities of data;
- computers support active learning;
- computers can help learners in different countries communicate;

- and so on. There is some truth in all of these claims; but they must be interpreted critically or we may be misled. I will try to illustrate this point in the context of each of the above examples.

First, feedback is indeed crucial to most successful teaching methods (e.g. Spencer 1991). But the weak state of the art in artificial intelligence greatly limits the forms of feedback that can be achieved by computers. For example, a very large proportion of the programs featured in the Kulik and Kulik studies (1991) used the drill-and-practice teaching method. This method is characterised by repetition and routine. It relies upon only primitive forms of feedback; hence the method is a popular choice for computer implementation. By contrast, tutoring programs are more ambitious in the feedback they attempt to provide and these are much rarer. They have been developed mainly in curriculum domains that are narrow and easily formalised, such as the elementary algebra of the PAT tutor mentioned earlier. Some have claimed that tutoring systems for non-formal domains will not ever be feasible (Dreyfus and Dreyfus 1986). As a rule, programs that

might support the learning of higher-order thinking skills are extremely difficult to design. Their development and evaluation is an area of current research.

Second, there is no denying the vastness of the data which can be made available through computers, notably through the Internet and the World Wide Web. But how much of education suffers from a lack of data? Most school subjects do well enough on very modest quantities. Even in those cases where the data requirements are unusually large, the need is almost always for well-indexed, carefully selected material of very high quality and reliability - in short, data that realistically can be learned as meaningful information towards some relevant curriculum. The Internet, with its hundreds of millions of chaotically arranged documents, total absence of quality control, and erratic performance, hardly fits the bill (Conlon 1997).

Third, it is true that computers can support active methods of learning. But they also support drill-and-practice, as we have just noted. The medium does not determine the message and, just like text and films, computers can be used to deliver many different kinds of teaching method.

Fourth, computers are indeed powerful tools of communication. But they are not the only such tools and they must be considered for their benefits and limitations alongside fax machines, telephones and the postal service. Computers will sometimes emerge as the best choice. However, the image of the classroom as a place for animated 'social constructivist' activity - that is, activity of the kind which educators today would tend to value most highly - is hardly helped by directing children's faces away from each other and towards computer monitors. Many schools have some way to go in developing discussion between and collaboration among learners. It would be ironic if learners worked independently and facing each others' backs within their own classrooms, whilst communicating privately over the internet with people in other countries.

Technology Misses the Point

The NSD effect indicates that if schools seek to improve learning, they should start by considering the design of curriculum and teaching method. This is what Spencer (1991) means when he calls for an emphasis upon the application of the technology of education rather than the provision of technology in education. The UK government on the other hand seems determined to focus on the introduction of computer networks. For example, the SOEID claims that:

> The NGfL will change the face of education in Scotland by integrating the new information and communications technologies into the process of teaching and learning. (Scottish Office 1998b)

The problem is not only that grand claims are being made of a technology that is far too little understood to make 'integration' a realistic project. It is also that, by highlighting the medium, the more important factors of curriculum and teaching method are downgraded. Technological glamour may capture the headlines but it misses the point.

The focus on technology is unfortunate also for the teaching profession. Teachers are not generally confident with IT, a fact acknowledged by the SOEID which has announced that lottery funding will provide every teacher with a 'training' in relevant IT skills during 1999. Although the SOEID's plans could be said to reflect a demand from teachers themselves, they are questionable for two reasons. First, the whole notion of 'training' seems dubious in the context of a development that is characterised by an absence of recognised experts. Second, the 'competences' that this training is supposed to develop are the same as those mentioned earlier for student teachers. Treating experienced teachers as beginners seems a curious way to improve the quality of education.

Extravagant claims are made too for the economy. The recent White Paper **Targeting Excellence: Modernising Scotland's Schools** (Scottish Office 1999) makes clear that the technology agenda is as much about public image and balance of payments as it is about education. Thus we have eager children pictured at classroom workstations. And alongside bullet point listings of NGfL and other IT cash commitments, there is the familiar but highly dubious claim of a direct relationship between IT in schools and economic success:

> The knowledge economy will pose challenges and opportunities. Knowledge and know-how are taking over from buildings and machinery as the most valuable assets of business ... Competitive advantage will come from the application of intellect and knowledge to business problems. The skills Scotland will need to be successful can and should be fostered and grown in schools. (Scottish Office 1999, p8).

DEADLY SIN#6: TO BE UNFAIR IN SHARING OUT THE BENEFITS

Writing in the mid-1980s, Alan Burns (1984) correctly predicted that increased productivity brought about by IT would reduce the amount of work available in society. He discussed various strategies for coping with this situation, including reduction of the working week to 30 hours; longer holidays; sabbaticals for all workers; job sharing; retirement at 55 for men and women; and a switch of perspective from the 'work ethic' to a 'life ethic' in which citizens find their purpose not through employment but through education, leisure, culture, relationships, and other areas of life.

What happened? In 1998 around 1.8 million people in the UK were unemployed. In most European countries the jobless totals are rising. Those in work continue to put in long hours, with the UK having the highest levels of overtime in Europe. Retirement for men remains at 65; for most workers, sabbaticals are no more than a dream and job sharing is at best a marginal possibility. And far from adopting a 'life ethic', schools are now told by government to develop vocational courses, to teach 'enterprise', and to prepare youngsters for a world of work - ironically, not least by teaching skills in IT.

Of course, ideas of 'fairness' vary according to the moral, or political, stances of individuals. Still, the gap between rich and poor in society has widened in recent years and many people will reach the conclusion that the benefits of technology have been unfairly shared. The symbolic figurehead of the new elite is Bill Gates, the Microsoft boss who controls the software which operates 90% of the world's computers. Gates is the richest man in history. At the time of writing, he faces a battery of charges filed by the US Justice Department and 20 federal states. They allege that Microsoft is using unfair methods to extend its monopolistic position, particularly in relation to browser programs that provide access to the Internet. However the case unfolds, there is no denying the widespread resentment that is directed at Microsoft and at Gates personally.

A commitment to fairness and social justice has characterised the work of many educationalists. And on the issues of class and gender there has been some progress. For example, Paterson (1997) records that, in Scotland, inequalities in educational attainment that are related to social class narrowed in the early 1980s as a result of comprehensive education, although they remained fairly constant thereafter. During the same period girls' academic attainment equaled and surpassed that of boys.

It is interesting to ask whether IT will affect these trends, and if so how. For gender equality the signs are ominous. In the home, boys dominate computers and computer games consoles. At school, boys dominate the subject of computing studies. In the IT industry, as was noted earlier, male programmers greatly outnumber females. On the Internet, males and male concerns again dominate, notwithstanding the encouragement given to women to go online by feminists like Dale Spender (Spender 1995).

For social class equality the impact of IT again seems negative. Schools in wealthy areas are typically far richer in IT resources than are those in areas that are poorer. Also, children in well-off families are more likely to have access to the Internet at home. **Guardian**/ICM research in January 1999 reported that 14% of all UK homes are 'online' but dramatic differences between social classes have developed, with one in three homes online among social class AB compared to 16% of white-collar class C1 and only 2% of the DE class of semi-skilled and unemployed. It is not clear how much of an educational advantage this provides. However, the government proposes that the National Grid for Learning will be accessible from homes and it claims that this will improve children's literacy and numeracy (DfEE 1997). If this turns out to be so then children from well-off families will benefit most. New Labour, despite its expressed commitment to equality of opportunity, offers no solution to this problem beyond saying that additional lottery money will be used to widen community access.

A society that had greater concern for justice could counter these trends in many ways. The benefits of technological automation could be shared by a more equitable distribution of wealth. Parents, teachers and IT employers could ensure that males and females have equal opportunity to learn about and use the technology. Government could do more to provide a level playing field in education, for example by giving free computers to teachers, schools, and school pupils. Telecommunication companies could provide free domestic access to the Internet, as is done in the USA where 27% of all homes are online. It is evident that IT may serve to widen social divisions, but that outcome is not inevitable; the 'life ethic' remains an option, if we can think critically and with imagination.

DEADLY SIN#7: TO BE UNCRITICAL

This paper started with the observation that critical thinking about IT in education is in very short supply. Why is this so? Roszak (1994) lays the blame firmly on teachers and schools:

> schools invest in glamorous machines without any clear idea of their use. They are doing so because they have absorbed mindless clichés about 'information', its intellectual value and vocational urgency, that are little better than advertising copy. This has led them to overlook the degree to which educational problems are political and philosophical issues that will not yield to a technological fix.
> (Roszak 1994, p.63)

But this seems harsh. Many schools do contain reflective teachers who have voiced good ideas about the technology and how it might be developed in a way that respects the school's judgements about appropriate curriculum and method. The problem is that these voices are almost overwhelmed by the near-hysteria that has been created around IT by a formidable lobby that includes technology quangos, sales representatives, 'modernising' politicians and enthusiasts. This lobby presents only one way forward - the way that says that more IT is better - and offers as factual ideas that really should be contested, such as the idea that putting computers in schools will somehow boost the country's economic performance. They exploit the imbalance of power over technological expertise to justify their control and to intimidate a profession that is least secure in this area of knowledge.

For teachers, critical thinking in this climate is hard. The computer literacy ideology is deep-rooted and its messages are endlessly replicated by documents that flood into schools from HMI and other government agencies. For others more superficially involved with education, the rhetoric of empowerment combined with the promise of a quick technological fix to educational problems has strong appeal. But what is at stake may be no less than the nature of teaching and the quality of learning. I illustrate this with two final examples of ideas that need to be challenged.

Here's To the Sage

IT enthusiasts have often claimed that the teacher's role must change. For example, Schofield (1995) offers the following observation of teachers using IT:

> the teacher's role tends to change 'from the sage on the stage to the guide at that side' ... from that of the expert who presented information to that of a coach or tutor who assisted students when they encountered difficulties in their relatively independent work.
> (Schofield 1995, p.201)

This sage-to-guide metaphor occurs often in the IT literature, invariably without critical comment. But it should be challenged on at least three grounds. First, it is a caricature to describe the role of teachers as mere experts who 'present information'. Certainly teachers who qualify in Scotland are required to master a much richer and more child-centred pedagogy than is implied by that description. Recent research on teaching, for example the work on cognitive apprenticeship (Collins et al 1989), has only served to underline the complexity and diversity of the teacher's task. Neither is it remotely accurate to assign to teachers a role that is limited only to children's cognitive development. Second, we might observe that in an era of 'information overload' the need for sages must be greater than ever. Only people with a broad understanding of a subject's core concepts can hope to distinguish the wheat from the chaff among the millions of pages on the World Wide Web, for example. So, here's to the sage; long may wisdom flourish in the age of data glut. Third, if it is true that the teacher's role changes, what justifies that change? Is it another example of people adapting to suit the functioning of machines? Should not technology be designed to accommodate human practice rather than vice-versa?

Motivation, Learning and Entertainment

Many research studies report that children using IT enjoy the experience and are highly motivated by it. Since motivation has been related to learning, this is taken as a good sign. However, the relationship between motivation and learning is not simple. We have to ask what learners are being motivated to do and what kind of thinking is stimulated by the process. Learning requires the accommodation and assimilation of new information - processes that generally require conscious effort or reflection. Some experiences, such as watching a game of football or eating an ice-cream, are motivating but may involve no significant learning in this sense. The motivation is only to continue or repeat the source of pleasure.

Television is a very relevant example. In the UK children watch television for 28 hours per week on average. A study of domestic TV viewers mentioned in Postman (1985, p.165) found that 51% of them could not recall a single item of news a few minutes after viewing a news program on television. According to Norman (1993), domestic TV viewing generally operates within an experiential, non-reflective mode of thought. Entertainment, perhaps; learning, probably not.

With the growth of multimedia and digital TV it is becoming harder to distinguish the technologies of television and computing. Recent multimedia

CD-ROM software, almost all of which is produced in the USA and animated by upbeat computer-synthesised transatlantic voices, bears a striking resemblance to Disney-style cartoons. TV set-top boxes enable armchair browsers to surf the Web as well as the cable and satellite channels with their remotes. It is salutory to watch the CD-ROM and Web button-clickers as they click through the icons - motivating, perhaps, but where is the reflection? Is the process one of entertainment or learning? Should children who already spend too many hours watching TV and playing computer games be encouraged to do more of the same in the classroom?

Perhaps the answers seem obvious. But the appeal of the IT rhetoric can hardly be overestimated. Thus Alan Kay, a longstanding researcher of educational computing in the USA, writes:

> Perhaps the saddest occasion for me is to be taken to a computerized classroom and be shown children joyfully using computers. They are happy, the teachers and administrators are happy, and their parents are happy. Yet, in most such classrooms, on closer examination I can see that the children are doing nothing interesting or growth-inducing at all! This is technology as a kind of junk food - people love it but there is no nutrition to speak of.
> (Kay 1996)

But perhaps the problem is not that children love IT too much but that they love their other classroom activities too little. Critical thinkers will naturally demand to know whether children using IT are learning from or merely being entertained by the experience. But they may also ask whether a healthy alternative to junk food could not be made more attractive; and whether teachers need more freedom from the government's state-prescribed curriculum and from the HMI-controlled targets towards which schools have been directed.

CONCLUSION

Here is a list of my seven deadly sins:

- Sin #1 is to lose perspective.
- Sin #2 is to believe that technology is neutral.
- Sin #3 is to place systems before people.
- Sin #4 is to fixate upon 'IT skills'.

- Sin #5 is to make misleading claims.
- Sin #6 is to be unfair in sharing out the benefits.
- Sin #7 is to be uncritical.

I make no claims about the profoundness of this collection. For example, it is almost certainly not complete. Also, those who wish to avoid my seventh sin are duty bound to criticise the other six!

In this paper I have tried to provide a critical perspective on Information Technology in education. Such a perspective is necessarily ambivalent. For although IT can and does contribute to educational progress, past history provides plenty of evidence that technology contributes to problems as well as solving them. It seems clear that IT in education will continue this pattern.

Educationalists are probably destined for a long running and difficult relationship with IT. It will be difficult for at least four reasons. First, the technology was designed primarily for processing and communicating information. That it does this moderately well does not imply that there is a straightforward adaptation to meet the needs of teaching and learning. In fact it is clear that the more promising application areas for education will need a major investment in research and development, including extensive evaluation within classroom contexts. Funding for such work will not be easy to win whilst misconceptions abound that the mere use of computers, equipped perhaps with some generic business software or cheap USA-produced multimedia CD-ROMs, will be enough to ensure worthwhile learning benefits. Second, a powerful lobby exists that has a vested interest in pushing the technology. Some of what this lobby says may be true but all of it needs to be interpreted critically and some conflict between educationalists and the vested interest groups is probably inevitable. Third, the central prediction of many IT enthusiasts - that the technology will in some sense liberate and empower teachers and learners - may be well-founded, but there is reason also to fear that IT will mostly empower the already powerful. For example, computer networks if centrally controlled by government are likely to increase the extent to which teaching and learning are dominated by the state. Fourth, there are aspects of the 'IT culture' - its ephemeralness, entrepreneurial ruthlessness, elitism, chauvinism, and fondness for system-centred methods - that seem to be very much at odds with the culture of liberal education. Unfortunately, they do chime rather well with the new managerialism. I have only touched upon these aspects in this paper. They deserve much more attention.

Writing at the end of the 1980s, Peter Cope lambasted the unaccountable and domineering 'leadership class' of Scottish education for its failure to think critically and independently about the field of educational IT (Conlon and Cope 1989). Events in more recent years would hardly justify a different verdict. Today, however, the new Scottish parliament surely offers a better prospect. A recurring paradox with which it will have to grapple is that the technology which could empower, may also enslave. Empowerment requires teachers and learners to appropriate the technology - to design and participate in systems that reflect their own creativity and beliefs, rather than being designed into systems that impose the beliefs of others. The crystal ball is cloudy, as always. But if educational communities can approach IT with an optimism that is tempered with a knowledge of the seven deadly sins then the prospects for the future will look very much brighter.

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