Emergent technologies and their potential in the shaping of design and technology curriculum

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Abstract
The design and technology curriculum continues to evolve and this evolution has a firm basis both in historical developments and in present (perceived) needs for refinement and improvement. Increasingly, the remodelling of design and technology considers its place in the whole curriculum in which it is expected not only to be a specialist field but also a contributor in many cross-curricular policies (e.g. literacy, numeracy, equity, diversity etc.) For design and technology to maintain a strong position in a curriculum, it has to demonstrate its relevance and its versatility. Meanwhile technologies themselves continue to develop ahead of curriculum, indeed ahead of appropriate accompanying ethical and legal frameworks. For a variety of reasons, the design and technology curriculum cannot keep pace with emerging and society-shaping technologies. These reasons include:

- research, development and marketing have quite different agendas from those of education
- education systems are generally not geared in a forward planning or curriculum development sense, to rapid response to social and technological change
- educational resources are nowhere near adequate for keeping abreast of technological change in anything more than tokenistic ways.

Despite these circumstances, curriculum planners and writers would talk of ‘preparation for new technologies’; ‘futures education’; ‘sustainability’; ‘education for a rapidly changing world’; ‘simulating technological reality’ and so on. This paper cites a range of emergent technologies to illustrate connections with design, values and ethical aspects of design and technology curriculum development. It is suggested that the gap between innovative design and technology curriculum and emergent technologies may not be so wide as at first seems and that it is possible to use their emergence to inform curriculum development in meaningful ways for schools and students alike.

Keywords
emergent technologies, design and technology, curriculum, identity, pedagogy, ethics, existence

An overview of the design and technology curriculum
The design and technology curriculum, like any other aspect of curriculum, continues to evolve and this evolution can be traced back to the 19th Century. (Penfold, 1988) The field has always been a ‘practical’ one and has also tended to follow (politically) instrumental and utilitarian agendas – particularly when economic climes have dictated.

The single most influential shift has occurred with the growth of design-based activity over the last three to four decades. (Eggleston, 1976; Kimbell, 1982; Penfold, 1988; A.E.C., 1994 a&b; Layton, 1994) Like much curriculum evolution, this growth was initially slow and now has momentum. The case for design-based technology education is well established and research in the field continues to grow. This is not to say that design and technology enjoys either the status of the bastions of English, maths or science in the curriculum, or status in the thinking of curriculum planners – many of whom haven’t had the benefit of a quality design and technology education. Nor is this to say that all practitioners in the field articulate the merits of design methodology or pedagogy. Furthermore, it cannot be said that the instrumental agendas of vocationalism and (restricted) ‘skilling’ have been displaced by design-based approaches. At best, the two live in peaceful co-existence.

There are several reasons for the success of design-based technology education, for schools and for students, and these are worth noting when considering the influences that emergent technologies might exert on the curriculum. Firstly, design and technology respects multiple learning styles. It is possible to engage with students from their strengths (from the practical, the computing, the artistic or graphical, or, from a language-based approach) and develop other capabilities from there. Second, because students are designers of their products, they have an invested interest and ownership of the outcomes. As Grant said in 1983: ‘Nowhere in the school curriculum are pupils required to commit themselves to the responsibilities of their own actions as totally as in CDT (Craft, D&T).’ (Grant, 1983: 219) These two reasons alone amount to an excellent case of student-centred learning.

With this ‘student-centredness’ the design and technology curriculum makes valid claims of
relevance because of its ready connection with the designed and built world – hardly an insignificant part of young peoples’ lives and futures. It contributes to their meaning-making in such a world. There are also numerous projections to be readily made beyond school into further study and employment pathways. There is increasing attestation to design and technology’s integrative capacities with other areas of curriculum, especially so in the primary sector.

Along with the strengthening design base come understandings of competing values and, in turn, ethical issues – matters which are by no means alien to young people. A field that develops such an openness about values is also one that breaks down gender-based obstacles in the curriculum.

Finally, and in line with current trends, the field maintains its value to professional interests such as designers and engineers (e.g. Harrison, 2001) and to enterprise culture. (Kimbell and Perry, 2001)

In its manifestation as a holistic curriculum enterprise (rather than as atomised subject), the growing strength of design and technology serves as much of a role in the general education of all students as it does for specialised interests and pathways for some. It is because design and technology can play its part in literacy and numeracy development, in understanding cultural difference, in explaining material disadvantage, and in contributing to civics and citizenship education that it is earning its place in the centre, not at the periphery, of education.

However, we should note the principally materials-based nature of the field as, when considering emergent technologies, it may be that there are differences in the substance of what one is designing with. This is to recognise the historical and predominantly workshop-based nature of design and technology activity. (This is also not to suggest the further constraint of such activity.) With regard to computers, data are materials to be worked and shaped and design and technology has developed accordingly (as far as resources of any kind would allow) with draughting, machining, robotics, modelling and so on. What is of particular interest when discussing the ‘potential of emergent technologies to shape design and technology’ is whether the debate is constrained by the ‘materials’.

Some would say that if design and technology cannot be ‘done’ in a workshop-style setting then it is not design and technology. However, in one recent curriculum development (DETE, 2001), the technologies of agriculture, computing, design, home economics, media, and technology studies were all to be accommodated. This was facilitated by recognising that what was common was the designed nature of any technology. Thus a process focus, rather than a materials focus, provided the way forward. This, coincidentally, gave an excellent basis for the articulation of the cross-curricular aspects of the curriculum (essential learnings, equity, enterprise etc.)

**Curriculum development with foresight or reaction?**

If design and technology is to play its invaluable role in the whole curriculum – and for all students – then it will probably have to continue to develop with flexibility and appropriateness when encountering emergent technologies. New technologies are powerful shapers of personal, social and institutional practices. In time, their influences reach education too. However, curriculum developers can write rich rhetoric about ‘futures’ and ‘sustainability’ and then wait for the technologies to arrive, or they can consider ‘preferred’ technological futures and prepare more appropriately. Such preparation would take a design-based, values-rich and ethical approach based on deep understandings of democracy and humanity. Before presenting a range of emergent technologies for discussion, it is worth taking a brief look at what has happened with the computer in education in schools over the last 20 years or less.

Children ‘do’ computers – or do computers do them? There is a case to be put that the uncritical installation and use of computers is hardly educational at all. As Apple (1992) has pointed out, much of what is happening is little more than skilling in the use of software (the ICT equivalent of ‘design with the corners knocked off’ or death by a hundred web-pages) with the economic intention of socialisation in preparation for the workforce as the ‘cotton-mill workers of Victorian times’. Further penetrating critiques are available from Roszak (1996) and Postman (2000). There is more to computer installation and use than perceived educational merits. Firstly, computer sales have soared. Secondly, governments claim necessity of maintaining competitive edge (as with technical education 100 years earlier, [Penfold, 1988]). Thirdly, school managers have, mostly, accepted uncritically the installation and expense of computers.

What we have not had in place, is an education to question the advance of computer-based systems as time-consuming (recalling the decades-old prediction of the leisure time that would be created); to question their built-in and rapid obsolescence; to question the massive increase of associated paper consumption; to question their use as props, with their associated peripherals of telecommunications, scanning and copying technologies, for a tired economic system; to question their role as backbone of personal, corporate and state surveillance systems;
to question their role in labour displacement; to question their capacity for depersonalisation at home and in the workplace; to question their limits as tools of learning – as themselves being incapable of distinguishing amongst fact, fiction, opinion, belief, wisdom, knowledge or information; to question their role as instrument in the establishment of a digital economy to provide the taxation framework to replace an oil-based economy; to question the ways they shape our personal identities and community interactions; or, to question them as another technology of dependence.

One would not want to be charged with being cynical, but an element of doubt would seem reasonable. More seriously, there comes a focal social and political question, well illustrated by the case of the computer, as to whether we have or even want, any say in our futures. As the festive ICT barrel roll-outs rolls on with the jollification of the computer as its centrepiece, we might look into our schools and ask if anything like a democratic education is happening. As the festive ICT barrel-roll-out rolls on with the jollification of the computer as its centrepiece, we might look into our schools and ask if anything like a democratic education is happening with the ‘new technologies’. Even within the field, one might argue that areas such as modelling and control technology are educationally far more powerful, relevant and stimulating than the manipulation of text and images. At any rate, these former are certainly given disproportionate airing to their societal impact and functions – again, probably as a result of the ignorance of their unwitting purveyors. To go further, on a fundamental democratic issue, might students not be well educated in ethical hacking? The ostracising of the hacker remains a requirement of those who would be in control in the surveillance age. Meanwhile, ethical hacking continues to expose the growing extent of covert digital surveillance across the world.

There is much that a computer education could be, but which it is not.

**Emergent technologies**

Building on what has just been said, the role of the computer in emergent technological development is significant, powerful and fairly obvious. Apart from being the excellent tool that it is, it also has key roles in aggregating information and synergising technologies. As ever with technologies, there are value issues at play when aggregation and synergy are planned and it is people who are planners. That is, technologies neither just happen nor are to be themselves blamed for events. Technologies happen as a result of human intentions – by design.

For a number of reasons, it is not easy to make accurate predictions about the outcomes and influences of emergent technologies and when highly educated writers try to do so they are often charged with writing science fiction (which might be better termed ‘technology fiction’). Along with such charges come remarks like ‘wow, scary’. Such is our cultural incapacity to understand, or enjoy a discourse about, the deep relationships we share with our technologies, that we seem to be comfortably impotent to cope with any kind of futures-focussed technological dialogue.

Yet education, if it is about anything, ought be about challenging ignorance and designing and creating futures. If, as Broderick (2001) says, ‘… we can set right the error of ignorance and start acting like mature humans’ then it will be partly because of a technology education quite different from that which we have at present. What then are the kinds of emergent technologies, scenarios and issues that we can consider in a debate about redesigning technology education?

**Lifelong learning**

‘Programmed cell death research will allow us to choose exactly when, if ever, we die.’ (ABC, 2001)

Here of course, the suggestion is that the choice will be ours i.e. a personal one. Why so? Who gets to live? For how long? Will the choice be available to everyone on the planet? Will governments or their agents decide how long we should live? (If yes, then the choice will no longer be ours.) If most people want to extend their lives, what are the resource implications for the planet, for other people? How will life insurance be re-framed? How does this fit with the concept of mental health? Will we look forward to our deathday after lots of birthdays? This one example of technological practice alone illustrates there are not only significant ethical issues at play, but also fundamental cultural, social and political ones too.

**Choosing kids, cars and cures**

Like most (all?) technological development, human cloning is now a prospect for market enterprise and, with biotechnology in general, the opportunity of designing people (babies) is a reality, though the version at the moment is still rather ‘design with the corners knocked off’ – you can nominate a few customised details but don’t think you’ll design the whole.

**Romals or anibots?**

Singer (1995) has argued that a measure of our own humanity and ethical being lies in how we treat, and live with, animals. We can anticipate biotechnological practices where, in our judgement, we should be able to design animals for purposes of fun, play, sport, work or for comfort. Meanwhile, we already see the ongoing development of toy pets that are very basic, sometimes furry, sometimes talking, robots – the tamagotchis, furbies and poo-chis. The merging of
biotechnologies with robotics presents the prospect of manufacturing pets or animals with myriad design variables to be drawn upon in order to fulfil both ‘personal taste’ and ‘practical purposes’.

Stranger identities
It is over 30 years since the first human transplant and, as Somerville (2000) points out, this was a milestone for medical ethics. Today, one of the focal points of bioethical discussion is that of xenotransplantation. We are now able to contemplate the genetic design of animals in order to facilitate more readily, (that is, by minimising rejection issues) organ transplants from animals to humans. Somerville contends that:

‘The broadest and deepest level at which we must consider the impact of xenotransplantation technology will have, is on our societal-cultural paradigm – our shared story. As (is) also true for human reproductive cloning, xenotransplantation raises issues related to our sense of identity. Does xenotransplantation take us yet one more step away from an integrated theory of personal identity and towards a modular theory of human identity – away from seeing ourselves as the unique, indivisible human beings that we are and towards seeing ourselves as simply a series of interchangeable parts? Or could the “miracle” that this technology makes possible deepen our awe and wonder about ourselves, our world, and life in general? In xenotransplantation … we need genuine, collective moral thinking and ethical exploration.’

(Somerville, 2000: 103)

Redeveloping ourselves as devices
So far as xenotransplantation is concerned, we may be mixing it with other species but there are more possibilities. The merging of human and machine – as cyborg – is a prospect to consider. Mechanical solutions to medical problems have been under development for centuries. They have moved from the external – crutches, spectacles, ear trumpet, artificial limbs – to the internal – cochlear implants, hips and pacemakers. However, as genetic engineering continues to develop, we are also learning the potential for biological solutions too. As the Aftershock series (ABC, 2001) pointed out, one lab now uses animal-derived tissue to create a muscle-driven robot that feeds on glucose while another is growing human skin merged with computer chips.

Watching you watching me watching us
The ABC titled one episode of their programme, ‘The Death of Privacy’. This is a reasonable assertion in places (homes/work/communities/countries) where communications technologies proliferate. The pervasiveness of surveillance technologies today is far beyond most people’s awareness and networks continue to expand. The commonest justification for surveillance is ‘security’, yet the outcome of our increased security is that we become increasingly insecure – personally, socially or nationally – with the further perverse outcome of seeking yet more ‘security’. Along with most other technological products, surveillance systems rapidly become obsolete and newer ‘smarter’ ones are sought and designed.

Intelligence plus …
Gardner (1983) did education a great service in challenging the notion of a single, general, measurable ‘intelligence’ and offering his theory of multiple intelligences. The holism of our being and the question of consciousness continue to be a challenge to ‘artificial intelligence’ (AI), the pursuit of which has been underway for some decades. Whilst the processing and manipulation of data has been the fundamental of this technology, and computational power continues its exponential growth, the question of consciousness is a central one.

Reporting on the Riken Project in Japan, Sigman (2001) sets out the anticipated stages of research and development and comments that:

‘By around 2010 researchers hope to have developed structures that will think (this will come before the awareness of thought) and to be able to make memory machines that do not need to be programmed, but are capable of intuitive thought and logical reasoning. In 15 years it will be possible to create computers with intellectual and emotional qualities, capable of experiencing feelings. In 20 years there will be supercomputers that can establish amicable relations with human society … a symbiotic relationship between humans and computers … robots capable of taking a part in human intellectual life.’

(Sigman, 2001)

Sigman sees these changes as ‘… far stranger than the genome, the Internet or cloning. They are the greatest offensive ever against humanity. They threaten to topple us into post-humanity.’

Drexler (1996), Kurzweil (1999), Joy (2000) and Somerville (2000) all articulate the vision of the evolution of AI beyond being a machine and gaining consciousness. They raise questions about our existence with such ‘machines’ and who will be empowered in such circumstances to make what kinds of decisions about quality and continuity of life. Thus might we be adjudged, by our creations ‘them’-selves, to be inefficient, sentimental, logical, superfluous?
Might we be contributors to our own genocide? Might we become the pets? Might our demise as we know ourselves simply be our role in our evolution? Thus, in turn, how can we shape the future? – a design challenge; How ought it be shaped? – an ethical challenge; Have we the will to shape the future? – an anti-determinist challenge.

Intelligence with a little help
Lastly for this round-up of emergent technologies, a recent advert researching current nanotechnology (nano – one billionth of a metre) practice in Australia described the technology thus:

- The ability to work at a molecular level, atom by atom, to create larger structures with fundamentally new molecular organisation.
- Creating materials and systems whose structures and components exhibit novel and significantly improved physical, chemical and biological properties, phenomena and processes due to their nano-scale size.
- Applications may be found in electronics and computing technology, human health, diagnostics, food production and processing, environment and in advanced materials.

(Ernst and Young, 2001)

In the world of nanotechnologies, Drexler (1996: 80) points out that a ‘designer’ may be human or AI and will build, at a molecular level, nanocircuits and nanomachines. Drexler talks of ‘replicating assemblers’ (Kurzweil uses the term ‘nanobots’) and their capacities to ‘… be able to make almost anything (including more of themselves) from common materials’ (Drexler, 1996: 172). With some understatement, Drexler does caution, ‘… if we handle them properly’. He describes what is known as the ‘grey goo’ problem – where the replication never stops and goes on to either take over species or ‘obliterate life’. Kurzweil concurs:

‘Finally, a really important requirement is that it needs to know when to stop replicating … without self-replication, nanotechnology is neither practical nor economically feasible. And therein lies the rub. What happens if a little software program (inadvertent or otherwise) fails to halt the self-replication? We may have more nanobots than we want. They could eat up everything in sight.’

(Kurzweil, 1999: 140-141)

Kurzweil also articulates the warfare or terrorism possibilities of nanoweapons readily programmable for very specific (eg geographical) targeting and he argues that the self-replicating nature of nanotechnology makes it a far greater danger than nuclear weapons. Here again is huge potential for good and ill. The potential of nanotechnology for reshaping us and our identities as we travel our evolutionary path is such that, within a generation, its impact will have been enormous. Its significance is recognised in the fact that the Clinton administration allocated $500,000,000 to nanotechnology research and development.

The aggregation of technologies
None of the technologies cited is far-fetched. They are under development now. None of the authors cited is writing technology-fiction. They articulate reality and posit forthcoming scenarios. As many argue (and this fact is emphasised at this point in the paper) it is not only the design and development of these technologies singly that is of interest but it is their aggregation and interaction that warrants scrutiny.

There are profound political considerations. Guillebaud (2001) argues that the revolutions in technologies are wrongly being considered separately. He contends that the real problems of the future will come from their uncontrolled interaction suggesting that they recreate old forms of domination and are anti-humanism. He argues that: ‘… we urgently need a lucid and rational critique of the inter-linked revolutions. If we don’t recognise their cumulative effect, they may destroy not only democracy but humanity itself.’

(Guillebaud, 2001)

The technologies presented here demonstrate a potentially transformational threshold for our species. So far as education is concerned, they cannot be ignored.

Education and emergent technologies
At this point, we can imagine a range of simplistic possibilities so far as the design and technology curriculum is concerned. We can argue that these technological futures are beyond our remit. Either they’re not ‘hands on’ so not our bag, or, they must remain ‘theoretical’ and the business of social studies. We can go to the other extreme by virtually abandoning workshops, studios and the world of the human hand. Perhaps we can strike a middle path of considered change and allowing these (some, already with us) ‘futures’ into our brief. If we choose this path, what ought we consider?

Until now, we have had to play a constant game of curriculum catch-up with industrial and professional practices. It is very easy for design and technology to model itself on such practices and to forget its own very special educational integrity. With growing discourse on ‘futures’, ‘identity’, ‘thinking’ and ‘ethics’ as core curricular interests, it would seem that
the integrated and holistic educational path is the way forward.

Clearly, aspects of these emergent technologies can hardly be practised in schools but the design process can be legitimately explored and simulations undertaken. Of particular merit, is an expanded role for criticism and critical thinking through design and technology. Design as mental modelling and critiquing, as a dimension of technological practice, will never be more important. There will remain the powerful lesson that design and technology teaches, namely, that designing and creating technologies are human acts that change, in large and small ways, the world we live in.

Resource issues may well remain the same – there may neither be enough hardware to facilitate modelling, nor adequate numbers of educated teachers to practise the curriculum, nor enough ethically considerate, humanity-focussed curriculum developers. This remains a political matter for resolution. On the temporal scale, matters may well seem more difficult for design and technology professionals. If we are unable to cope with technological change now, how then will the emergent technologies, singly and cumulatively, be addressed? Firstly, cope with change we must. It is an attribute of the forward-looking design and technology profession that it has demonstrated admirably over recent decades a very real capacity to be a part of change. It would be regrettable if, just as there was (once) a resistance to adopt a design-based approach, there were a resistance to adopt further appropriate change. The fact that technology per se is a dynamic phenomenon, will be ill-matched by a static curriculum. Secondly, there must be a greater role for design and technology in democratic curriculum development (whatever shape that role might be). Thirdly, there will be needed a greater flexibility to educate about technologies, not through their individual (‘material’) properties but through their commonalities in how they come to ‘be’ – a consideration of all four phases of technologies – initial intention, design, realisation, and use.

Where things get more interesting, is in consideration of two senses of design and technology’s existential role in education. The first sense relates to what we know anecdotally but on which we have scant research, namely, the huge satisfaction students have always had from designing and making their own work. Such work is an extension of human being, in an optimum form both productivity and fulfilment combined.

The second sense relates to all the technologies that we knowingly and unknowingly encounter every day, which are a very part of us and our existence. It reminds us that we are not ‘us’ without our technologies. This is another under-explored aspect of our field that warrants development and could embrace the profound issues of identity and existence so challenged by emergent technologies. As the post-human condition approaches, any search for fulfilment and identity will not be met without a design and technology education that addresses the existential.

Conclusion
The political and ethical considerations of technologies call for a parallel democratic education. The matter here is to see us and our technologies and our curriculum conditions, in their human evolutionary context and not to be so concerned with matters of the very short term or what, in educational terms, seem like technological paradigm shifts or quantum leaps. In his excellent text, Kurzweil (1999) sees technology as ‘… the continuation of evolution by other means’ and he argues that:

‘What is uniquely human is the application of knowledge – recorded knowledge – to the fashioning of tools. The knowledge base represents the genetic code for the evolving technology. And as technology has evolved, the means for recording this knowledge base has also evolved, from the oral traditions of antiquity to the written design logs of 19th Century craftsmen to the computer-assisted design databases of the 1990’s.’

(Kurzweil, 1999: 16–17)

Given the enormity of the potential and the enormity of the issues connected with our technological existence it is clear that, currently, we are not at all well placed to determine a preferred future – either individually or collectively. To be able to design such a future it would seem that four conditions need to be met: a collective (political) will; an ethical consensus; knowledge of both how technologies work and what the associated issues are; and, personal and collective senses of identity and humanity.

This is no small task and design and technology education has a pivotal role to play in addressing these conditions. It is suggested that our own curriculum evolution can embrace these conditions and that a revolution, bloody or otherwise, is not required. So long as design and technology continues to develop its own integrity and a robust position within the total curriculum, it will contribute strongly to the necessary development of ethical and democratic futures.
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