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Citation: KEIRL, S., 2002. The significance of choice in design and technology education. Design & Technology Association International Research Conference, 12-14 April, pp. 111-119

Additional Information:

- This is a conference paper

Metadata Record: https://dspace.lboro.ac.uk/2134/3189

Publisher: © DATA

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The significance of choice in design and technology education
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Abstract
This paper argues that ‘choice’, along with similar concepts, has a very important role in design and technology education. The paper seeks to demonstrate the importance of the concept of choice at a variety of levels in design and technology curriculum. It sets out some discourse to highlight and clarify areas of misunderstanding while also articulating the educational power of the concept of choice when delivered in the context of design and technology. Some of its uses are neither well thought through nor immediately apparent. Examination of any forward-looking design and technology documentation unearths terms such as choice, decision making, options, competing variables and so on but the rationale for these is not always consistent.

At a more philosophical level, matters of will, volition and determinism emerge. The manifestation of these variants of ‘choice’ are identified in curriculum contexts and common themes are drawn out. One common phenomenon is that of presenting ‘choice as action’ – the student exercises choices – but these are limited to the requirements of the design task.

Further, the social, political and philosophical dimensions of choice are presented for the ways they are determinants of design and technology curriculum development and for how they might shape pedagogy. There is also explanation of how design and technology fits with general education because of the ways it can teach about choice and the exercise of choice.

Introduction
This paper begins with an overview of the common senses in which we understand the notion of choice. It then explores understandings that have developed around consumer choice and points to relationships between technologies and political choice. These introductory explorations are then set against their associated philosophical backgrounds. Together, these discussions inform the presentation of the educational significance of choice in relation to design and technology – firstly, with a discussion of design practice; secondly with an overview of curriculum issues, and finally, with an articulation of pedagogy.

The common senses of choice (as noun, but also in verbal and adjectival forms) are several and, rather like technology, are so embedded in daily use that we rarely stop to critique them. So far as technology is concerned, Palmer speculates:

‘Do we inhabit a world already formed by technological choices so complex that many seem almost invisible (e.g. the pencil, the telephone, the washing machine)? Do many technologies appear before us as autonomous and beyond choice (computers at work, videos at home, cars to go between them)?’

(Palmer, 1994: 77)

This notion of technology as pervasive yet invisible is also cogently pursued by Sclove (1995). Both authors argue that choice – or importantly, the lack of it – is a focal matter for the social, cultural and political manifestation of technology. Similarly, choice is a focal matter for design and technology education.

What on first examination seems an everyday sort of a word turns out to have rich meaning. We might talk of a choice as one of a set – for example, of foods, of ideas, or of actions – thus, respectively, a plum pudding, a birthday gift, or a means of travel. To have a choice implies ‘more than one’ and from the selection we may organise a hierarchy – first choice, second choice, etc. To have a wide or generous choice may mean we are ‘spoiled for choice’ or can enjoy a choice as a luxury.

Conversely, one may have ‘no choice’ – such as avoiding the oncoming elephant – or, so far as selections are concerned, Hobson’s choice (Hobson kept a stable of horses in Cambridge, England. They were hard-worked on his stagecoach run to and from

Keywords
choice, design and technology, curriculum, pedagogy, ethics, democracy
London yet he would rent out the horses to students who would be obliged to take whichever horse was nearest the stable door. Hence ‘Hobson's choice’ – or ‘no choice at all’). A different sense of ‘no choice’ was offered by Henry Ford for his Model T cars – ‘any colour so long as it’s black’.

We can talk of choice in the sense of picking, for example from a pack of cards, while we might select from a box of chocolates. So long as we can’t see the cards and we can see a range of chocolates, the kind of choice differs. In both cases, if some of the cards or chocolates have already been taken then we have a limited choice. If asked why we chose a particular card we might argue that really we didn’t have much of a choice – they all looked the same. However, with the chocolates the possibilities for rationalisation increase considerably. We might have picked our favourite. We may have picked the most tasty of those left. We might have chosen the hazelnut for it’s nutritional value over the sugar-centred one. We might have avoided the coconut as we knew it to be the favourite of the next person to choose. We may have chosen not to choose because there was one less chocolate than the number of people being offered them, and so on.

When we choose, the constraints on our choosing vary. Choosing what to wear one morning is governed by our wardrobe and, invariably, what the context will be – the level of formality, factors of comfort and perhaps ‘dress codes’. Choosing who to vote for is a resolution (or compromise) of a different kind. Here, choice is the exercise of preference. Having one’s political values reflected in a single candidate or party may well not happen. The choice is then one of ‘choosing not’ to vote for other candidates. So a voting choice may well be described as ‘the best of those available’ or ‘the least worst’. So far as choosing an idea is concerned, it may seem that our choices are limitless but then the capacity for imagination or the availability of useful and applicable knowledge may limit the choices.

So the notion of the ‘informed choice’ arises and it is from such a notion that the complexities associated with choice begin to emerge. One may often make a choice but, had we held, before the event, some other piece of information, we may well have made a different choice. It is often the case that we want to know more about the attributes of each of a range of choices before we finally choose. For example, knowing the durability and maintenance potential of one product over another may well influence our choice of purchase. Conversely, some would rather not have the full information whether because of a perception of confusion and an urge for simplicity of choice or because the ethical dimensions of choices become more explicit the more one knows about the options. For example, knowledge of the source or method of manufacture of a product – perhaps with dubious labour use and working conditions – may seem better not known so that we need not feel any guilt about buying the product.

Thomson (1999), in her discussion of decision-making, points out that being clear about what choices or options are available is one thing, but that there is also a need to work out the implications or consequences of such choices. One may need more information to support decision-making and, ultimately, one is evaluating options to assess the most preferable. Thomson thus identifies four important components of decision-making – options (choices), information, consequences and evaluation. (Thomson, 1999: 92) Clearly choices do not happen in isolation of values. To have a choice would seem to imply the freedom to be able to choose and is thus an important aspect of the dynamics of democratic life. With this kind of choice comes responsibility – the consequential nature of one’s choices as they affect others.

On a final note for this overview, we might also consider making ‘the right choice’ just to please others or to gain approval from parents, teacher, peers, or colleagues. One may make the ‘right choice’ in the sense of ethically defensible decision-making. This is not to say that ethics can be arbitrated on binaries such as right and wrong. We seek to present a rationale for choosing to act and live in particular ways. (Design decision-making is much the same.)

Consumer choice – oxymoron, fact or fallacy?
To talk of chocolates is to talk of a luxury even in a (materially rich) minority world society. To majority world societies, ‘a box of chocolates’ could be anything from strange to offensive. Thus our choice of a particular chocolate from the box happens as a result of a choice-as-action (of buying a particular box of chocolates) which in turn resulted from the decision or intention to buy chocolates (the choice being available to us) – all of which happened in a context that allowed such choices to occur, namely, a society of a certain economic and material regime.

The kinds of choices we (perceive we) have rapidly become distorted when framed against both the micro and the macro. In the macro-picture of the world we are spoiled for choice. We have technologies the absence of which would start near-revolt. We take a supply of water for granted and any threat to personal car transport is never welcome. In the minority world these ‘givens’ are assumed and are, therefore not matters for any troublesome choice-making.
However, one can choose not to have a car and live consequentially by that decision. The alternatives are generally very limited. Yet, ironically, one can live with the car and enjoy the (also limited) choices the market allows – colour (rarely black), accessories, grunt, style and cost. Difference and individuality are enjoyed within a commonality. Thus what is presented as choice is rarely a real choice guided by a set of ethical principles as with Amish culture (Sclove, 1995) but, rather is a pseudo-choice presented within a tightly constructed market framework.

In the consumer society we may perceive a ‘range of choices’. However, it can be shown that the lifestyles to which we aspire and the needs (or wants) we perceive are rarely more than carefully designed and marketed lifestyles and products. For example, ‘Sony design the products and then convince us we need them. The same culture ensures the gendering of products in ways that choice is steered and, implicitly, limited so that only the most strong-willed (expressors of alternative choices) would resist or challenge. This case is well attested in such texts as Illich (1983); Wacjman (1991); Whiteley (1993); Green and Guinery (1994); and MacKenzie and Wacjman (1999).

**Politics, technology and choice**

Historically, technology has evolved along with the species. It was used and developed without much questioning and enjoyed a special status – still advocated in populist ways – under the banner of ‘progress’. Mumford (1934) refers to the ‘Doctrine of Progress’:

‘The mechanism that produced the conceit and the self-complacence of the paleotechnic period (loosely, the 18th and 19th Centuries) was in fact beautifully simple. In the 18th Century the notion of Progress had been elevated into a cardinal doctrine of the educated classes…

Life was judged by the extent to which it ministered to progress, progress was not judged by the extent to which it ministered to life. The last possibility would have been fatal to admit … What paleotect dared ask himself (sic) whether labor-saving, money-grubbing, power-acquiring, space-annihilating, thing-producing devices were in fact producing an equivalent expansion and enrichment of life? That question would have been the ultimate heresy. The men who asked it, the Ruskins, the Nietzsches, the Melvilles, were in fact treated as heretics and cast out of this society…’

(Mumford, 1934: 182-185)

However, it might be argued that recent times have provided us with something extra. It is important that we recognise the amassed bodies of knowledge and sophistication available to us in the 21st Century. We are now equipped to realise consequences, to understand the intertwined nature of technology, culture, society and politics. We are able to discriminate and choose. Or are we?

Today, it can also be argued that, in the absence of a critical and questioning climate, society is unable to make adequate choices about technologies and continues to shadow them under the guise of ‘progress’. Postman (2000) demonstrates the strong links between the technological and political climate of the closing 18th Century and that of today, arguing that a critical technology education is both necessary and urgent.

Rybczynski (1983); Palmer (1994); Sclove (1995); Winner (1995) and Feenberg (1999) all write lucidly of technology-politics relationships. They show how our choice-making (in free, limited or non-existent forms) about technologies mirror the kind of society we have in both enabling and (more would argue) disabling ways. Sclove (1995) discusses technology as both enabler and disabler of democracy and democratic process and points to the potency, or impotence, of the individual in society. As these political-democratic issues are explored it is matters of the individual and collective choice that emerge – choice of lifestyle, choice of environment, of education, welfare, governance and so on. Sclove’s key claim is this:

‘…it is possible to evolve societies in which people live in greater freedom, exert greater influence on their circumstances, and experience greater dignity, self-esteem, purpose, and well-being. The route to such a society must include struggles toward democratic institutions for evolving a more democratic technological order. Is it realistic to envision a democracies of technology? Isn’t it unrealistic not to?’

(Sclove, 1995: 244)

To ‘struggle toward’ implies the exercise of choice in the active sense and this is predicated on the choice of vision. The engagement of democracies presupposes ethical engagements with justice, welfare and futures. To such ends, discussion and envisioning of democracy is essentially an ethical question, of which, more below.

Rybczynski (1983) discusses three ways of controlling technology, all of which imply choices and decision-making. He considers the evolution of the design of machines – from the tool stage, to powered devices...
and then to automated processes – that ‘...progressively, and specifically, increases human control.’ (Rybczynski, 1983: 166). (Although Fry [1992] also illustrates the way such evolution has a disempowering and dehumanising side for the individual.) Rybczynski continues, citing White:

‘But there is a second way in which the machine is under control: the choice is made whether or not to use it. Technology is not automatically used simply because it is there. Lynn White Jr has cautioned: ‘As our understanding of the history of technology increases it becomes clear that a new device merely opens a door; it does not compel one to enter. The acceptance or rejection of an invention, or the extent to which its implications are realized if it is accepted, depends as much upon the condition of a society, and upon the imagination of its leaders, as upon the nature of the technological item itself.’ If there is a technological plot we are far from being its passive victims and are more like co-conspirators.’ (Rybczynski, 1983: 166)

His third, and for its time and today, much more ambitious consideration of technological control promotes the notion that we recognise that there are different (small 'c') civilisations on earth and that it may well be that one civilisation exercises its choice to reject the technological condition (sometimes called, pejoratively, 'sophistication') of another. If one section of the world attempts to force its ways – through a version of technological imperialism – on another then it must certainly be anticipating a constraint of choice for the latter.

Mumford (1934) recognised the significant cumulative effects of choices, arguing that:

Technics and civilization as a whole are the result of human choices and aptitudes and strivings, deliberate as well as unconscious, often irrational when apparently they are most objective and scientific: but even when they are uncontrollable they are not external. Choice manifests itself in society in small increments and moment-to-moment decisions as well as in loud dramatic struggles; and he who does not see choice in the development of the machine merely betrays his incapacity to observe cumulative effects until they are bunched together so closely that they seem completely external and impersonal.

(Mumford, 1934: 6)

Meanwhile Barr (1994) offers a note on the social and political consequences for technological choice relating to information technology and Australian society.

In the context of debate about technological change and the future, the political system as a whole has the effect of inhibiting curiosity and limiting public awareness. In terms of the knowledge and confidence to contribute to discussions about technological futures, the Australian people are very information poor indeed. In this climate the public learns passivity, helplessness and cynicism in the face of technological choice. (Barr, 1994: 102)

Philosophy and choice

Although an everyday term, ‘choice’ has good reason to appear as an issue – something about which people might be concerned – in society and politics. ‘Choice’ has enjoyed a place in more than one field of philosophical discourse and an overview of these is helpful.

Weatherford discerns similarities and differences between choosing and deciding. These are not of great concern here although he does contend that a choice may occur without deliberation whereas a decision calls for it. He comments that 'Also, it is at least more natural to speak of deciding and not choosing what is true' (Weatherford, 1995: 133). However, when considering technologies and designs we are often faced with multiple possibilities and thus multiple truths. Final decisions may well be rational choices.

Clearly, choice plays its part in discussions of freedom, free will and determinism. Are we truly free to choose – either within our cultural, social and political contexts or given the level of information we may hold? Have we a free will to exercise? The determinists would say not. The broad thesis is that all events in the world are the effects of earlier events. A more focussed view concerning humanity questions:

‘...whether we ourselves, persons, are subject to the same sort of causal necessity....Indeed, determinism has been taken as the more limited thesis that all our choices, decisions, intentions, other mental events, and our actions are no more than effects of other equally necessitated events.’ (Weatherford, 1995: 194)

Initially it would seem that the determinist question matters to design and technology education. There is, amongst a variety of genres of determinism (e.g. scientific, historical, psychological, sociological), a view that technological determinism holds sway. Here, technology in its holistic or universal sense is deemed to be determined by earlier technological events and so drive social, cultural and political developments. Any interactive model of the interplay of, say, a cultural influence on the development of a
technology is denied. Technology drives us and is beyond our control. In a logical sense we can see when an innovation is a re-development of an existing technology but there is an equally significant sense in which the decision or choice was made to carry out (or not carry out) the re-development.

Such choice-making is, arguably, an exercise of free will, yet many of us would deny that we played any part in the decision-making and development concerning the technologies in our lives. Whilst we might deny technological determinism we are not best positioned, at present, to say that we willed our technologies into existence. Here the sense of our individual and collective disempowerment seems to emerge.

It is hardly surprising that populist views on technology hold sway. ‘That’s the way things are going’; ‘You can’t stop progress’; ‘It’s all inevitable’. To yield to such views is to deny a capability to act, which, of course, is both to deny the existence of choices and to deny the point of choosing to act. Sometimes this is the easy way out, since making choices and exercising will in a democratic society also require responsibility.

Stances against technological determinism, are several and strong. Oliver (1994) refutes ‘fatalistic determinism’ (there are soft determinists and hard determinists) and advocates:

‘human intervention (her emphasis) rather than reliance on the divine, free flow of market forces in an open economy ... It will demand that communities and governments go through the difficult, yet immensely exciting, process of choosing a preferred destination and charting a path to achieve it.’

(Oliver, 1994: 49)

Other philosophers and sociologists of technology are adamant that the determinist argument be nailed and humanity’s capacity-to-choose and act be recognised and validated (Rybczynski, 1983; Wacjman, 1991; Green and Guinery, 1994; Mitcham, 1994; Sclove, 1995; Feenberg, 1999; MacKenzie and Wacjman, 1999; Postman, 2000).

Mitcham (1994) critiqued a range of soft and hard determinist authors and then builds an existentialist case of three ways of ‘being-with technology’ (after Heidegger). He suggests that:

‘Humanity and technology can be found together in more than one-way. Rather than argue the primacy of one or the other factor or the cliché of mutuality in the humanity-technology relationship, we can better pursue understanding through a structural examination of three forms the relationship itself can take...’

(Mitcham, 1994: 275)

Warnock (1996) points to the common interest held by existentialist philosophers in human freedom. ‘They are all of them interested in the world considered as the environment of man (sic) ... because of his power to choose his own courses of action’ (Warnock, 1996:1). Her postscript, some 25 years on, places existentialism ‘...with other decision-making moral theories’ (Warnock, 1996: 141). This moral philosopher argues that ethics implies choice and is thus apparently incompatible with determinism or, conversely, that ‘choice’ is illusory for determinists. She argues the centrality of ethics to life, she shows that moral value cannot ‘be without a human, and she asserts the necessity both to value, and pass on, from one generation to the next the idea of ethics’ through moral education. (Warnock, 1998: 109).

Singer’s (1995) practical text on ethics is concerned with the question of how we should live. He grounds his work on what he terms ‘The Ultimate Choice’ between two fundamentally different ways of living – between ethics and self-interest. His case is both challenging and articulate. He points to two kinds of choices:

‘Ultimate choices take courage. In making restricted choices our fundamental values form a foundation on which we can stand when we choose. To make an ultimate choice we must put in question the foundations of our lives.’

(Singer, 1995: 5)

This is as far as the philosophical discussion of choice need go for this paper. Suffice to note that if one is to engage with notions of determinism, freedom, free will, ethics or democracy then the concept of ‘choice’ is a key one.

**Design and choice**

Winner (1995) articulates the capacity of design to give space for matters of ethics and choice when considering technologies.

‘To seek genuine choice in technology – a matter about which there often seems to be no option but to respond to firm economic imperatives – involves an effort to explore alternative prospects for the making of useful devices and to understand what importance those options would have in practice. If we are to appreciate qualitative differences between the works found in a technological society and the forms of civic life they sustain, such differences must first be seized within the space of design possibilities.’

(Winner, 1995: 151)
He points out that in this design space alternatives can be considered ‘…before choices have hardened in cement…’ (Winner, 1995: 151) and this highlights the valuable fluidity of design practice. We know that design is about resolving competing variables. We know that we can revise and refine existing designs. We also know that we can choose to create anew. We know that multiple solutions are often possible and just as we can set about creating a choice so we can subsequently offer choice to others (the client, the community etc.).

Roberts (1994) highlights ‘intention’ when asking, as Singer does – how do I/you/we want to live? He talks of design as the ill-defined problem, working with uncomfortable choices and also of the significance of informed choice. Out of these aspects of design practice he rightly identifies the potential for the student to ‘...(make) meaning, knowledge and cultural identity.’ (Roberts, 1994: 178)

When one is designing it is almost impossible to avoid choices. Invariably, by searching for them, more issues or problems arise. To make the effort (to choose) to create choices and pursue, with both comfort and discomfort, increasing possibilities can lead to an ultimate satisfaction but it can also engender frustration. However, we also know that with the right teaching, frustration can be managed and the professional designer and student alike learn that there are ways to achieve outcomes and satisfy our choices (see e.g. Kimbell and Perry, 2001). Cross (1995) also gives a useful analysis of design ability and draws on Gregory’s notion of design as ‘…the action of intentional intelligence.’ (Cross, 1995: 106). The significance of intention occurs again and this cannot happen without, at least, choice-as-will and, if followed through, choice-as-action.

It must be remembered that the ethics of design matter if one is to have responsible design intentions, choices and outcomes. The notion of responsible design is now well broadcast (e.g. Papanek, 1974; Whiteley, 1993; Ellyard, 1998) but far from adopted in the world of economic rationalism. As moral philosophers show with ethics so do design theorists with design – both activities are about choice making. Both are classed by the less informed as being ‘out of touch with the real world’. Nothing could be further from the truth so far as ethics and design are concerned. Both are about values and about humanity. As for our ‘ultimate choice’ posed by Singer (1995), if the way forward is not to be self-interest then it will be ethics and design that shape a preferred future.

**Curriculum and choice**

Before discussing pedagogy and in particular, design and technology pedagogy, it is necessary to comment on curriculum – which is taken here to be ‘…all those discursive practices which affect what and how students learn, and what and how teachers teach.’ (Reid and Johnson, 1999). This holistic approach is necessary if one is to appreciate curriculum as a matter of ideology and contestation (Apple, 1979 and 2001). As Apple (2001) says:

‘The idea of the ‘consumer’ is crucial … For neoliberals, the world in essence is a vast supermarket. ‘Consumer choice’ is the guarantor of democracy. In effect, education is seen as one more product like bread, cars, and television … Thus, democracy is turned into consumption practices…the ideal of the citizen is that of purchaser. The ideological effects of this position are momentous. Rather than democracy being a political concept, it is transformed into a wholly economic one.’

(Apple, 2001: 39)

However, the ideology is nothing without effective practice. The shaping of curriculum as purveyor of ideology was well documented by Simon (1985; 1988) in England and Wales. More recently, Smith (1999: 172) comments ‘The official ‘mood’ of school education in contemporary western society is dominated by a ‘specify, measure and report’ approach.’ The flow-on is programmes of unenlightened vocationalism, basic skills tests and uncritical adoration of information technologies. Skills (prescribed ones) are valued. Independent or student-centred approaches to education are not. The teacher is positioned as technician delivering the curriculum – or so it is wished.

Good practice, good ideas and good teaching do not disappear on the arrival of ideological imperatives and there are democratic ways that the curriculum can be constructed and enacted. Boomer (1999) articulates democratic classroom attributes of explicitness, negotiation, questioning and reflection. In such a climate notions of ‘diverse personal individuality’ (Harrison, 2001: 62), working from and promoting ‘the learner’s strength’ (Kimbell and Perry, 2001: 13) and cross-curricular ‘essential learnings’ such as identity, futures and thinking (DETE, 2001) are all facilitated – and through all of these choice is expressed.

For design and technology, at its best and properly supported, there can be no doubt of its efficacy and place in a democratic curriculum. The fact of the matter is essentially simple. When students are actually empowered to express their individuality, develop their identity, work from their strengths, they can do so with ease through design activity. If such design activity is enabled by system and teacher alike, then choice will be mobilised, and democratic, values-
rich practice will be the norm not the curiosity. How then does choice manifest itself in design and technology pedagogy?

Pedagogy and choice
Whilst the actual practice of design is rich with choice activity in several different ways, there are some obvious limitations on true choice occurring. However, these are not as problematic as at first may seem. The student may not be able to make the most informed choice at a particular stage of their development. The same lack of knowledge could be said for most adults when it comes to resolving technological choices. Invariably, the skill of the teacher is about leading a group (legitimately, from behind at times) in ways that both model democratic practice and facilitate quality learning.

The oft-heard argument that children are not ready for democratic practice and must be benevolently dictated to has its parallel in design and technology for democratic practice and must be benevolently seen – as the journey progresses, choices can cease to be and new ones emerge. This is knowledge creation on-the-go and it is personal and without end. Between the choices there are times of critical reflection, new realisations of further possibilities. Seeing what is possible and finding ways to realise these possibilities are learned through design education and are applicable in ethical and political life beyond schooling. In all of design, ethics and politics, matters of choice are exercised.

Conclusion
Choice is not the simple concept that we might take it to be. As individuals, communities, societies, civilisations and as a species, we have choices and there are many ways we may exercise them and there are many ways in which they are inhibited or denied. We have a human capacity to choose – it is something of our essence. Further, we can choose to choose and we can create choices. We can even choose not to choose. These are manifestations of our free will and our determination.

A most fundamental educational achievement would be to teach children and students that they have choices – from the seemingly insignificant to the highly significant – and that there are many ways they can exercise choice.

Design and technology has a particular educational role to play. Choice-making (choosing) and choice-creating are both key aspects of designing. Design is intentional and pro-active. It involves defending decisions and imagining alternatives. By exercising and understanding choice in its richest sense,
students enhance their designing capability and efficacy.

Of at least equal importance, there are the ‘whole person’ and general education benefits to be gained from choice education through design and technology. For the former, students develop their intentional intelligence and their identity. For the latter, their choice education works synergistically with ethical education, civic and citizenship education and their political education. Too often the textbook and hypotheticals approaches remain removed from the student – too often these approaches are teacher-centred.

Children of all ages and cultures live and engage with their built environments and can use their sense of fairness and justice to explain when things aren’t ‘right’. They can learn through quality design and technology education that technologies don’t have to be taken up and that all designs and technologies can be held liable to criticism and, if need be, alternative choices can be created. Students can learn that will can be expressed and that ethical action is a matter of choice. Their design decisions and all they entail provide an ideal grounding for learning that the future can be determined by their choice.

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Abstract
The paper commences by way of some general comments on the potential of technology in education. It recalls the characteristics of the early technologies, i.e. paper and printing press and post-war technologies, i.e. telephone, radio, photographic film, slides and audio recordings, overhead projector, film, video and mixed media and transmission through satellite networks. It examines the ever growing interest and 'needs felt' to employ the 'new technology', for education in general and for technology education in particular. It briefly explains the transient concepts of mass education, individualised learning and group learning, which occurred in quick succession. Research findings on the effectiveness of different educational technologies are briefly stated in terms of the real benefits of technology in technology education.

The next part of the paper is devoted to examining the phenomena of learning, retention, recall and critical thinking from the point of view of behaviourist and cognitive psychologies and to look at the concepts of higher-order learning. An attempt is made to show how human learning curves improve with the infusion of educational technology and variety in learning. It is proposed to adopt a graphical observation form, which includes the effective use of educational technology for classroom activity analysis. Salient features of technology education in the context of design and technology are highlighted. An attempt is made to discuss the technology-propelled paradigm-shift and to identify the extent of software and hardware of technology required to create better learning through teaching-learning processes based upon new technology. Critical issues for evaluating the effectiveness of new technology are identified. Facts and figures on technology integration in the teaching-learning process are quoted from different parts of the world.

Finally, the paper dwells on the last decade of the turn of the millennium and the scenario with the onset of video conferencing, Internet conferencing, e-learning, etc. with regard to their outreach and relative effectiveness. Possible impact of the one-computer classroom is taken up to show how the availability of minimum infrastructure can be used in the developing world. Criteria for selection of appropriate technology is spelt out in some detail. A case is made for greater investment in staff development in the integration of new technology. The paper concludes by enumerating the ways in which the impact of new technology is made visible and by envisioning the not-so-distant future.

Keywords
education, technology, design, development, communications, learning, teaching

Introduction
You might have noticed that the word ‘technology’ occurs twice in the title of this paper – both as the cause and the effect. The first one refers to educational technology and the second is technology education. It follows that the word technology is going to be used repeatedly with techno-terms but I shall try not to ignore the words ‘teaching’ and ‘learning’; I propose to use them to limit my discussion to these areas of application.

A topic like 'Impact of New Technology on Teaching and Learning in Technology Education' occurs naturally to policy makers, who would like to see the positive correlation between improvement in education and technology costs, as in Curve A, Figure 1, before committing further investments. They would also like to see if smaller incremental costs in technology could bring about greater improvement in education as shown in Curve B. Let me clarify at the outset that educational improvements depend upon a multitude of factors including school setting, curriculum, staff development, management, students interest and of course, state of technology. Even the effectiveness of technology is a function of several variables that we shall discuss and there is no way an educationist can produce such graphs!

Figure 1: Expectations of policy makers.

The best we can do is to step back and ask ourselves some practical questions:

- can a new and emerging technology be reasonably evaluated in relation to improving teaching and learning processes? If so, how?
- can we create technology-based infrastructures for technology education? If so, how?
- can a new technology meet the new challenges of knowledge explosion and diverse learning