Creativity, Innovation and Life in the Lily-Pond: nurturing the design and technology family while keeping the alligators fed. DATA International Research Conference: International Keynote

Steve Keirl, University of South Australia

Abstract
Casting one's net to capture understandings of creativity and innovation can produce a rich catch that includes: political and industrial ideal; cultural vogue; economic curative; educational whim; psychological theory; curriculum dream; a student's right; or, a school's duty. It would seem that everyone in the lily-pond has a claim but what is a reasonable balance and who should decide? If the whole business isn't just a passing fad then practising design and technology (D&T) professionals have a challenge. The answer lies in a balanced diet of theory, experience, knowledge, history and foresight – and knowing when to chuck which alligator what chop.

Key words
creativity, innovation, design and technology, curriculum.

Introduction
I sincerely thank the Design and Technology Association (DATA) for inviting me to give this International Keynote Address. Our international D&T education community is thinly spread and still without enough opportunities to interact, to debate, and to build much-needed strategic alliances. This quality conference offers one of few such opportunities. I also express sincere thanks to the Sheffield Hallam University team who have hosted the conference and done so much to ensure its success.

This presentation is founded on two of my usual premises. Firstly, I believe that every student in this world should have a quality D&T education. Secondly, I believe that such a quality education will constitute a technological literacy that is both servant and shaper of democratic life. Of course there are significant debates to be had around such premises and this paper is a small contribution to the debates. To take "creativity" or "innovation" at some face value or common understanding would, I hope to show, be erroneous.

Despite the blatant overworking of the term, and consequent attempts by philosophers to elucidate and pin down a variety of distinct species of creativity, it is still frequently encountered and it still, more often than not, has no clear or precise meaning.
(Barrow and Woods, 1988:139)

Much is the case today. I hope to show that the instability of having "no clear or precise meaning" is an asset in developing a professional understanding and some professional control over what we mean by creativity and innovation for our students.

Set against a backdrop of the knowledge economy, markets and utilitarianism, both innovation and creativity can be seen as vogue: fashionably convenient to the whims and/or will of industry and politicians alike. Given that state education systems have a duty to prepare students for life in their societies, it seems that schools therefore, may have some duty to prepare creative and innovative students. Thus from the outset both the vogue and the duty warrant scrutiny.

From the perspective of a D&T practitioner in the classroom the view may be different. The D&T experience is multi-faceted. The term "best practice" has come to include in its meaning highly competent professionals who use sophisticated pedagogy to create learning experiences of which just two facets (common sense would suggest) are creativity and innovation. For many D&T practitioners, when their students "design" it is implicit that they are innovative and creative.

I have chosen the metaphor of the lilypond (I wondered about swamp) to represent the environs of curriculum. I do not accept that "the curriculum" is some neat or defined body. Rather, it is amorphous, rich in life forms and beyond prescription. I recognise that such a broad interpretation of curriculum is anathema to some but I cannot accept the view that curriculum is merely the aggregation of so many syllabuses and policies set out for teachers to implement as a matter of duty. Just as our species tries to shape and control natural phenomena without fully understanding the consequences, so seems the case with curricula. In the lilypond there are many life forms some of which are symbiotic and some of which are predatory. Thus I talk of the D&T "family" in a vulnerable way – of needing nurture.

Alligator spotting (i)
There is no doubt that having alligators around is one way of avoiding complacency. While the aim of this paper is to raise concerns about

RESEARCH

calls for creativity and innovation, there are plenty of saurian precedents. At a forerunner of this conference (IDATER 98 – see Smith and Norman, 1998) Sir William Stubbs, in his opening address, speculated that D&T might contemplate less of a future in the crowded curriculum. Calls for Civics and Citizenship (C&C) education emerged in more than one country and space had to be made for their inclusion in the curriculum – a looming alligator if ever D&T saw one! The following year I offered a paper outlining ways I believed D&T could keep such an alligator fed (Keirl, 2001). Meanwhile, at that (1999) conference, Professor Gunther Kress gave a keynote address, the abstract for which noted "…the centrality of the notion of design as a linchpin for curricular aims, and the recognition of "creativity" as entirely usual" (Roberts and Norman, 1999:244). Kress' case for design as a key to transformative curricular for a "multimodal world" is not something I particularly dispute. However, as we shall see, he too may be an alligator.

Brief philosophy – creation? creativity? creating?

Any close examination of creativity reveals philosophical underpinnings: metaphysical, existential and ethical. I make four brief points.

First, when we create technologies the very creations shape our existence. There was a time about 2.5 million years ago when we were pre-human. Since then we have become more creative and technological – though recognising this fact has only become a comparatively recent phenomenon. Such is our development of technologies today that we can now anticipate the idea of the post-human condition or, at least, post-"human-as-we-understand-human". People create (in the bringing-into-being sense) the technologies that create (in the identity-shaping sense) people. Creating technologies is an essential practice of our species and in continuing to do so we contribute to our own evolution and to the nature of our being.

Second, we carry on this practice rarely on the basis of deep analysis or reflection about the associated value (good or otherwise) of technologies. Our ethical perspectives seem to react to, rather than shape, our technologies.

Third, there are relationships between our understandings of time, evolution, technological determinism and ethics. Some religious or cultural views of creation shape people's/peoples' views of evolution or of technological innovation. To interrogate evolution as technological creativity is to probe determinism and whether true originality ever occurs or creative acts are merely adaptations of existing circumstances. To view time solely in a linear way is to shape one's views of cause, effect, progress, history and future. To claim to be able to determine affairs on an ethical basis is, in some way, to refute determinism (Warnock, 1996; Keirl, 2003a).

Finally, because of all the above, we have not yet worked out new and appropriate ways of "being-with" the world. As our evolution hurtles towards the "spike" (Broderick, 2001) and technological singularity (more below) we still lack the necessary cultural and educational frameworks in which to set our discussions about technological innovation and creativity.

Place, time, peoples and creativity

I would like to offer a range of perspectives on creativity over time and in different settings. In doing so, something that emerges strongly is the appreciation that looking at creativity and technology is a good way to see that history is not a simply a timeline of progress. The notion of progress is, like creativity, readily used but rarely critiqued for its (mis)interpretations (Keirl, 2003b).

Religions and the metaphysical do matter. Some current Islamist critiques of Western materialism are critiques of the creation of perceived excesses of technological goods. Amish culture questions the ways in which created technologies may corrupt community values.

In Ancient Greek mythology creativity was in the hands of the gods – we know this from our studies of Prometheus (foresight), Epimetheus (hindsight) and cunning old Daedalus from whom we have the adjectives daedal and Daedalian:

Skilful, inventive, mazy, manifold, complex, mysterious…(and)…intricate, labyrinthine…cunningly wrought (Fowler and Fowler, 1964).

RESEARCH

Creativity, Innovation and Life in the Lily-Pond: nurturing the design and technology family while keeping the alligators fed

If one were to offer a sceptical inquiry into the craze for creativity in education today, one might say "Why creativity? Why not Daedalism?".

In Australian Aboriginal Dreaming culture, time is non-linear and a variety of creative acts is possible where linear earth lives born of fertility mothers intermingle with spontaneously self-creating beings who appear and leave according to circumstances (Berndt and Berndt, 1989). In such a culture, which is articulated though an inseparability with land, creativity (in whatever sense) is ethereal. In turn, technologies may be discovered, created or "brought into" the world.

Today, in societies such as here in Britain, faith, when probed, is to be found in technology and our capacity to create new technology. Albeit many of the problems for which we try to generate creative solutions have themselves been created by technologies, we continue to have faith that technology will bring the fix.

Diamond offers a comprehensive survey of human-technology relations and frames his work (Diamond, 1998) against Yali's question:

Why is it that you white people developed so much cargo and brought it to Papua New Guinea, but we black people had little cargo of our own?
(Diamond, 1998:14).

Amongst Diamond's conclusions are the following:
• technologies and creativity have enjoyed growth spurts in different places across the planet and at different times;
• the arrival of inventions in their respective locations has been both idiosyncratic and unpredictable;
• societies' receptivity to new technologies matters. Thus, to a nation of sceptics - like Australians (Horne, 1964) - there is always a wariness of the new and the foreign.
• there remains a real curiosity about why some cultures do and some don't behave creatively; and,
• as a consequence of the above there has (been) developed the racist belief that Eurasians and their technological ways are superior.

(I have in mind a story though I don't have its source and would be grateful to receive verification. Mahatma Gandhi, on alighting from a train on his visit to London, was asked by the press: "Mahatma, what do you think of Western civilisation?" to which the Mahatma replied, "I think it would be a very good idea.")

A rough sketch – half a millenium to c1950
One would be wary of asking an audience how many were left-handed, or gay, or thieves or illegitimate, but instead I'll put this question: "Who, above all others, is the most often cited archetypal, creative technological and artistic genius of all time?" And the response quickly comes: "Leonardo da Vinci!" Yet the attributes mentioned were those of Leonardo (Carey, 1995; Kurzweil, 1999). Imagine such attributes being applied in the search for "creative" students. The assessment challenges might be problematic.

Leonardo da Thingy (extract i)

He tried to sell inventions;
Put his name above the shop.
He had a special ladder
With a stop sign at the top.
(Barker, n.d)

Post-Middle Ages, the rate of technological innovation continued to grow and the notion that we, ourselves, might be creative also grew and became a part of a challenge to the authority of state and church alike, reaching a climax in the 18th century (Postman, 2000). It's important to remember that language itself is a technology subject to invention, creative adaptation and innovative change. Whilst our species might always have been creative it was only around 1500 that the word creative (not yet creativity) entered the English language.

Mumford (1934) recognised that from the 15th century onwards our creativity helped establish the reciprocity of invention and regimentation. Thanks to the clock, time and order were all – time-keeping, drill, bookkeeping, and bureaucracy all helped keep the workforce in order and the Protestant work ethic became the antithesis of time wasted. The theme recurs in education today, as we shall see.

Creativity, Innovation and Life in the Lily-Pond: nurturing the design and technology family while keeping the alligators fed

By the close of the 19th century the Industrial Revolution in Europe was solidly established. (Alfred North Whitehead considered "(t)he greatest invention of the 19th century was the invention of the method of invention." [cited in Drexler, 1990:33]), Penfold (1988) has shown how late-19th century schooling served (gendered) domestic and industrial needs. In the same period, the first serious attempts at a philosophy of technology emerged (Ferré, 1995), the earliest attempts at intelligence testing began and the word creativity appeared in the English language for the first time – just over a century ago.

The early 20th century saw the creation of "scientific management" of Taylorism (Taylor in Pugh, 1990) and Fordism (after Gramsci) as model management practices. Efficiency and specialisation are valued over initiative and crafts–generalism. 1934 brought the seeds of a critical literature of technology and invention (see Mumford, 1934).

A rough sketch – half a century since c1950

The mid-20th century heralded new dimensions and an intensely greater interest in creativity:

The notion of "creativity", which blossomed in the 1950s, was intended to describe the ability of some minds to synthesize new ideas from a combination of past and present experience or from elements experienced separately. The notion was trivialised as a fad, best described as a creative craze, that swept through US engineering schools in the late 1950s, in the post-Sputnik period of public hysteria when the Russians were ahead of the US in space and (we were encouraged to think) in military hardware.

> In many engineering schools, new techniques to encourage creativity were expected to yield bright ideas that would result in inventions.
> (Ferguson, 1992:56-57)

A creativity literature gained momentum (see e.g. Koestler, 1964/75 and 1967/70; Vernon 1970). In the 1960s the phrase "knowledge workers" is termed – yes, over 40 years ago! (Florida, 2003) and McGregor developed his Theory X – Theory Y view of management (McGregor in Pugh, 1990). Simply put, Theory X managers hold assumptions that humans naturally dislike and avoid work and, therefore, coercion and direction are necessary and that people like this. Creativity and imagination are under-valued. In contrast, Theory Y people view work and effort as worthwhile. Self-direction and self-control by workers are possible and valid. Rewards matter and creativity and imagination are valued,

By 1969 creativity in many countries was pervasive: the first in-vitro fertilisation of a human egg took place; humans walked on the moon; Concorde flew; two computers talked to each other in California – the internet was spawned; the Arts boomed in all fields (Monty Python appeared); and, creative turmoil hit the streets of Paris. Writing at this time, Toffler warned:

> By unleashing the forces of novelty, we slam men (*sic*) up against the non-routine, the unpredicted. And, by so doing, we escalate the problems of adaptation to a new and dangerous level. For transcience and novelty are an explosive mix.
> (Toffler, 1971:174)

Florida (2003) provides a timely socio-cultural reflection on recent decades and critiques some of the excesses and divisiveness of many innovations, whether political or material, and argues for a form of soft capitalism. He describes "the Bohemians" and "the bourgeoisie" and introduces Brooks' notion of todays's Bo-Bo's - a synthesis of the two groups – a blend of the Protestant work ethic and laissez-faire Bohemianism. Meanwhile, McCartney (2004) reports London company Future Laboratory's identification of an emerging demographic – Generation C ("c" for creativity and culture). Toffler (1971) had predicted that:

> The diversity of novel experiences arrayed before the consumer will be the work of experience-designers, who will be drawn from the ranks of the most creative people in society. (Toffler, 1971:214)

A different way to appreciate where we are with creativity is to recognise how we laugh at/with it. We have created technologies from the mundane to the most life-threatening yet we can also witness a spectrum of lampoonery. Witness, for example, the Heath Robinson and Rube Goldberg designs; Hart-Davis's (1999)

Creativity, Innovation and Life in the Lily-Pond: nurturing the design and technology family while keeping the alligators fed

"spectacular collection of inventions that nearly worked"; Gary Larson's Far Side Cartoons; Stephen Pile's (1989; 1990) books of heroic failures ("To be truly inept requires more than lack of ability. It requires intense originality of vision."); and, Kawakami's (1995; 1997) Japanese unuseless inventions.

Of course, there are radically different perspectives too. Of ever-increasing importance is the need to question political and economic interference and control of technological creativity. Not only is almost all technological research and development funded for profit, but it is also vulnerable to secrecy, patent control and suppression. Altruism is compelled to play a secondary place to markets and public participation in the development of any technology is subject to tight control if not total repression (see e.g. Cannon, 1987; Sclove, 1995; Eisen, 1999; Feenberg, 1999; Keirl. 2001; Tutt, 2003; Schlosser, 2002; Monbiot, 2004).

With an increasing critical literature on all of technology, design, innovation and creativity we are starting to use critical frameworks. We must move from speculation about, to education for, the technologically created future - knowing that the spike or technological singularity (Broderick, 2001) are rapidly approaching. Broderick's spike is Vinge's singularity, which is a two-part phenomenon. First, technologies continue to develop faster and faster and, second, through digitisation we're combining them. Combine powerful nanotechnology with powerful genetic technology with powerful artificial intelligence and singularity happens. This is not far off and when it happens, the post-human age is credible.

A closer look at creativity…

Given the background sketched so what can be drawn from the spectrum that runs from everyday language through to the huge creativity literature spread across many fields? How does a parent's view that their child is creative simply because they paint or build lots sit alongside Caudill's design challenge:

Creativity is a mystery in humans; how then should we judge it in androids?
(Caudill, 1992:175).

We can play a word association game around the concept of creativity (e.g. genius, ingenuity, disruption, eureka, imagination, spontaneity, chaos, etc.). We can assemble examples of what it is (e.g. inventions, art, music, poetry, unusual solutions, etc) or, as is often the case with contested concepts, we can assemble examples of what it is not (e.g. intelligence, thinking, dreaming, deconstruction, building from a plan or kit, etc.). The resolution of such contestation is of little concern to the casual user of the word but for an education profession that is being called upon to create creatives, some sense of which way to move might matter.

We compound the "C" word(s) with others and talk of "creative tension", "creative accounting", being "creative with the truth", and "creating havoc". Create and its derivatives are potent contributors to language use in a variety of cultural settings. The revolutionary and anarchist Bakunin said in 1842: "The urge for destruction is also a creative urge" (in Partington, 1996:47) while, more recently, Agostinho Neto, the Angolan revolutionary poet-turned-President wrote:

Create (extract)

Create create
Create in mind   create in muscle   create in nerve
Create in man   create in the masses
Create
Create with dry eyes

Create create
Over the profanation of the forest
Over the brazen fortress of the whip
Create over the perfume of the sawn trunks
Create
Create with dry eyes…
(Neto, 2004)

When we look at creativity in its cultural settings we can see it as a practice developed within the individual and/or teams and/or communities. We can witness creative anarchy as reaction to political or cultural control. How often do we consider creativity as a luxury? Some of us, on the top of the pond, have the luxury of creativity, of design, of innovation. Not only do we have it but we are free to discuss the phenomenon and are privileged to use it individually or collectively – such is not

Creativity, Innovation and Life in the Lily-Pond: nurturing the design and technology family while keeping the alligators fed

the case in many countries where war, inadequate health or education, and lack of material resources mean more a dependency culture than a creative culture.

So far as the individual is concerned creativity can be considered an aspect of consciousness, of expressing one's being. Perhaps a fundamental of our sense of purpose is met when we are creative. We certainly know this from students' expressions of satisfaction when they come up with ideas and products which, for them, are original. The eureka factor is often associated with individual creative insights. Emotion might even be invoked after much toil – the exhilaration of the inspiration-perspiration mix may even be orgasmic – a case of E = IP squared.

The individual will be wrestling with some sense of changing things, bringing something into being. Choice-making and intention will be at play and experience-building will hopefully be an outcome. Depending on the type of creativity, mischief may be a valid option to find new ways of thinking or doing. Optimism, pessimism and risk are all at play too with the degrees of confidence and control we may have over the problem varying.

We also know that there are many thinking styles for creative outcomes and the range is as extensive as imagination allows – lateral, divergent, crazy, out-of-the-box (CRATE-ivity), reactive thinking (REACT-ivity), self-critical and so on. Some are highly theorised, some are half-baked or gimmicky, some are just working devices for the practicing teacher. The notion of anarchic thinking has served me well in supporting students to be suspicious of singular design/thinking/creativity models, processes or recipes – often served up as crutches that never get discarded. Kimbell and Perry (2001), rightly, I believe, articulate Rittel's notion of wicked problems and the importance of exploratory and fuzzy thinking as creative behaviours. Thouless (1953) offers a discussion of "straight and crooked" thinking and Koestler (1975) distinguished between associative thinking and bisociative thinking. He suggests that, while the former is the thinking we use on one plane or subject, creative acts demand bisociative thinking – where the thinking of different planes interact.

We might also think about:
- creativity as both a way out of, and a way into, problems.
- Perhaps there are three senses of evolutionary creativity: how it has served the species; how it evolves itself – as a practice; and, how it might develop in the individual.
- Thus looking at embedded creativity – the creativity within the creativity and think (especially as educators) whether, and how, we are serving the three evolutionary forms.
- Creativity's durability and whether it becomes redundant.
- Whether we could switch it off or on at will – or whether we (as individuals, teachers, or organisations) become creatively tired or stagnant. Perhaps creativity abates, loses the "extra-" and becomes just "ordinary". Perhaps it has a half-life…
- Creativity of the moment… creativity of the abstract… and of the concrete.
- The interdependence of creative individuals, teams and organisations.
- Creativity at once seemingly pervasive yet seemingly elusive.

It seems that if education wants to be serious about creativity, there are various menus – an elegant banquet, a smorgasbord, or a dog's breakfast. Those who would say "schools should be more creative" or "schools should prepare a creative society" have rarely considered the ingredients set out above. Their way of rationalising is usually by specifying an end (e.g. economic) without considering the educational implications, or by adopting a reductionist definition of creativity itself. Mumford (1934) argues that creative activity is a necessity of human fulfilment which should be socialised, with production being subservient to education.

Florida (2003) considers:

  … perhaps the biggest issue at stake in this emerging age is the ongoing tension between creativity and organization. (Florida 2003:21-22).

Here, he echoes Mumford's observations on the reciprocity of regimentation and invention as well as McGregor's Theory X – Theory Y. He draws comparisons between Whyte (1956) and (1961) to illustrate the "creativity tension"

Creativity, Innovation and Life in the Lily-Pond: nurturing the design and technology family while keeping the alligators fed

(definitionally different from creative tension) he perceives. Whyte documented the "stifling effect of organisation and bureaucracy on individuality and creativity… (and how big corporations favoured people who)…"go along to get along, rather than the goers-against-the grain"…" (Whyte in Florida. 2003:41). Meanwhile Jacobs celebrated the creativity and diversity in neighbourhoods such as her own Greenwich Village, observing "fountainheads of individuality, difference and social interaction" (Jacobs in Florida. 2003:41).

To talk of a culture of a creative society would imply developing such a culture in our schools, our curriculum and in design and technology. Yet current curriculum constructions, policies, systems expectations and assessment regimes are hardly conducive to such a creative culture. How possible will it be to establish a creative culture across the school – a kind of creative multiculture where many creative forms interplay? Given current pressures on the profession (below), how much creative risk for the students is healthy for the teacher? How does design and technology manage, promote or harness creativity? Is it a matter of creativity for creativity's sake, creativity as another tool of design, or creativity as a new or special process in its own right (with potentially new lockstep systems coming into play – "Today we incubate for 50 minutes, tomorrow is eureka-time").

Calling on the theorists…

What, then, have the creativity theorists to say? Given only a half-century of greater focus on creativity, much is still unfolding but I offer a few snapshots…

Koestler, (1975) discusses "one idea men" (sic) such as Copernicus and Darwin. Many "creative" people in fact have had perhaps one or two key creative insights and have then developed a career around these. Koestler points out that Darwin conceived his Theory of Evolution when he was aged 29 but spent a further 44 years developing it.

Koestler describes his view of the evolution of an idea (with parallels between both individual and collective disciplinary creativity) – with periods of incubation, frustrations, tensions, random tries, and false inspirations. He argues

that these collectively amount to "critical periods of fertile anarchy" – crises which have both constructive and destructive aspects to them. His notion of bisociative thinking he describes as "…a double-minded, transitory state of unstable equilibrium where the balance of both emotion and thought is disturbed." (Koestler, 1975:36).

Koestler comments that the creative life is necessarily a social product and that creative contagion – the way creativity stimulates creativity is a phenomenon that counters isolationism. There are undoubtedly cycles of creativity – periods when creativity in any given society are in the ascendant – just as there are times when degrees of political control and freedom have their day. Dissonance occurs and a time of dominant economic conservatism may not be matched by strong creative activity, and vice versa. He describes the ways new territory has been created over the years – when a few geniuses spearheading the way are followed by a "phalanx of mediocrity". He suggests that revolution becomes orthodoxy. There are new settlements. Closed systems of thought, which he calls the "blocked matrix", create new crises – new periods of incubation occur – followed by creative anarchy and the cycle starts again.

As a starting point for more recent and substantial creativity research, Gardner (1983; 1993), Boden (1992), and Csikszentmihalyi (1997) offer a sound basis. Csikszentmihalyi concentrates on creativity (big C) suggesting that understanding it is a prerequisite to understanding creativity (small c) – the stuff of our everyday lives. He argues that "Creativity is the cultural equivalent of the process of genetic changes that result in biological evolution…" (Csikszentmihalyi, 1997:7). In the genetic, changes are passed down the generations without our conscious knowledge and they contribute to our biological evolution. However:

… a new idea or invention is not automatically passed on to the next generation…The analogy to genes in the evolution of culture are memes, or units of information that we must learn if culture is to continue…It is these memes that a Creative person changes and if enough of the right people see the change as an

improvement, it will become part of the culture.

> Therefore, to understand creativity it is
> not enough to study the individuals who
> seem most responsible for a novel idea or
> a new thing.
> (Csikszentmihalyi, 1997:7)

Before Csikszentmihalyi is willing to consider what creativity is, he argues that one must appreciate its context or domain – where it is. He suggests a system of three main parts. (Gardner (1993) uses this model in his discussion of the creativity of seven 20th century "greats") There is the domain, a set of symbolic rules and procedures, for example as with maths or music. Domains are nested in what we call culture: symbolic knowledge shared by a society or humanity as a whole. Then there are fields which include all the gatekeepers of the domain; in our case perhaps the D&T profession. Next is the person. Creativity occurs when a person, using the symbols of a given domain "…has a new idea or sees a new pattern, and when this novelty is selected by the appropriate field for inclusion in the relevant domain." (Csikszentmihalyi 1996:28). So the definition Csikszentmihalyi draws from this perspective is that:

> Creativity is any act, idea, or product that
> changes an existing domain, or that
> transforms an existing domain into a new
> one. And the definition of a creative person
> is: someone whose thoughts or actions
> change a domain, or establish a new
> domain. It is important to remember,
> however, that a domain cannot be changed
> without the explicit or implicit consent of a
> field responsible for it.
> (Csikszentmihalyi 1997:28)

It seems to me that such a model can be challenged, perhaps particularly in the case of D&T which has, in its way, made a creative intrusion to curricula across the world over recent decades. Whatever D&T is, it has resisted being part of any orthodox domain and certainly has not come about at the consent of a field responsible for any orthodox domain. Whether it is yet a domain in its own right remains to be seen. Further, the notion of such domains seems to me to suggest the reinforcement of current orthodoxies of

practice. (This at a time when new ways of seeing and organising education or new knowledge-models are being sought.)

Exploring the individual and creativity, Csikszentmihalyi (1997) discusses "the creative personality", reporting ten dimensions of complexity.

> If I had to express in one word what makes
> their personalities different from others, it
> would be complexity.
> (Csikszentmihalyi, 1997:57).

Space doesn't allow elaboration of the dimensions here but they point to a richness that is certainly not universally found and which, for educational purposes, offers an almost unmanageable spectrum if all were present in a classroom – not least because each dimension contains "contradictory extremes" though Leonardo and Daedalics would probably fit.

Csikszentmihalyi argues that the creative process has traditionally been described as taking five steps: preparation/immersion – a time of aroused interest or curiosity; incubation – the churning of ideas below the threshold of consciousness; insight – the aha! or eureka! experiences; evaluation – often the most emotionally trying stage involving high uncertainty and high insecurity; and, elaboration – probably taking the most time and the hardest work.

> But this classical analytic framework…gives
> a severely distorted picture of the creative
> process if it is taken too literally…(the
> creative person) never just slogs through
> the long last stage of elaboration. This part
> of the process is constantly interrupted by
> periods of incubation and is punctuated by
> small epiphanies.
> (Csikszentmihalyi 1997:80)

In disavowing the idea that the "creative genius" is a model to which we should all aspire, Florida (2003) draws on Boden's (1992) work:

> [Creativity] involves not only a passionate
> interest but self-confidence too. A person
> needs a healthy self-respect to pursue novel
> ideas, and to make mistakes, despite criticism
> from others…Breaking generally accepted

rules, or even stretching them, takes confidence. Continuing to do so, in the face of scepticism and scorn, takes even more. (Boden in Florida 2003:31)

Thus, reflecting Csikszentmihalyi's "dimensions of complexity", she adds:

These rare individuals…are in a sense more free than the rest of us, for they can generate more possibilities than we can imagine. Yet they respect constraints more than we do… (Boden in Florida 2003:32).

Florida is showing that creativity (in the sense of its value as part of a culture rather than as individual gift or talent) is not the province of a few "select geniuses" but that it is a "capacity inherent to varying degrees in virtually all people." (Florida, 2003:32). This is very much Gardner's (1983) position on multiple intelligences. Furthermore, Gardner argues that: "If intelligence is pluralistic, so, a fortiori, is creativity." (Gardner, 1993:xiii).

Leonardo da Thingy (extract ii)

The helicopter ejector seat;
One of his less successful devices;
Pilots got out all right
But always in thin slices.

He painted the Mona Wotsit,
And he signed it with his name;
They called him Leonardo Da Thingy
It was hidden by the frame.
(Barker, n.d)

Framing matters, and the message for D&T educators is strong. There is a phenomenon we identify as creativity but who shapes the concept and its educational form is a matter that cannot be taken for granted (witness a century of intelligence theory let alone intelligence "testing"). It is not enough to seek a simple definition and build a body of work around (and totally dependent upon) that definition. Davies (2000) offers an articulate discussion of confidence as a component of creativity in D&T and adopts a phenomenological approach declining dependence on a limiting definition of creativity but one exploring "…values, interpretations and judgements…dealing with "essences", not "facts" relating to the individual constructs around which individuals build their

worlds." (Davies, 2000).

This is not to say that "anything goes". Rather, it involves the building of a well-thought-through and defensible case(s). If we believe we have something to offer in the way of creativity we need to be aware of, and prepared to challenge, some assumptions - there are alligators around and astute professional judgement is needed. To not understand the history, philosophical underpinnings, psychological theory, politics and multiple views surrounding creativity will lead to ill-founded curricula and wasted energy and resources. In particular, the learning theory (and pedagogical implications) and the political agendas warrant interrogation. It would seem that creativity is simultaneously elusive and complex yet deceptively tangible and obvious.

Two 'I's: Imagination and Innovation
First, the briefest of words on imagination and then some pointers regarding innovation:

First Day at School (extract)

What does a lessin look like?
Sounds small and slimy.
They keep them in glassrooms.
Whole rooms made out of glass. Imagine.
(McGough, 1976:8)

As with creativity, the starting points on imagination are plentiful. Whether you start in a child's head, with John Lennon and *Imagine*, or with Ryle's (1949) excellent exposition on "knowing how and knowing that" the concept of imagining is (again) elusive. It is a key of creativity and is of serious interest to sensitive educators yet remains of little interest to educational instrumentalists.

The Taste of the Moon (extract)
…Yet today, many years later,
for my living I sweep the streets
or clean out the toilets of the fat hotels.

Why? Because constantly I failed my exams.
Why? Well, let me set a test.

Q1. How large is a child's imagination?
Q2. How shallow is the soul of the Minister for Exams?
(Patten, 1993:12)

Sutton-Smith (1988) offers a historical analysis

RESEARCH

of imagination having "…four substantive layers: irrationality, role flexibility, "as if" states, and uniqueness, and two evaluative layers: mimicry and childishness." (Sutton-Smith, 1988:18). He suggests that imagination is relative, multiple, differentiated, contrary and power-oriented. Clearly we might want to encourage it but we can't nail it down.

Innovation

Since I believe that it is creativity and not innovation that is the important concept for education to explore I choose for this presentation to give innovation less attention. However, the use of innovation in business, economic and political circles is pervasive. Its occurrence (consult business reviews/journals or the web over the last decade) is pandemic. Such is the fetishism surrounding innovation in industry that some consider that innovation is an industry.

As preparation for a project last year I researched fairly extensively a broad range of sources of opinion, writing and research on innovation. The synopsis I present here is, I hope, informative. There are clear links with, and influences on, education that we should be aware of. I haven't sought to clarify what might be the difference between "an innovator" or "a creative" as this often varies with author or study. As I hope to show, while the people/personality aspects are of interest, it is the organisation/ management dimensions on which I build to close the paper and its alligator alert.

There are traits of innovation which, when taken collectively, (as with creativity) point to the importance of establishing a culture of practice throughout an organisation. Thus innovation:

• may or may not involve technology;
• uses creativity as a tool;
• involves risk-taking;
• has no reliable processes or measures of success;
• involves a leap of individual or collective imagination;
• happens in all organisations – public and private;
• is not the sole prerogative of research and development teams;
• is more than just new products but challenges current practice;
• is not simply "new ideas" but must add value;

• is, in many respects, quite ordinary, good sense, unsurprising;
• infuses the ability and the will to innovate throughout an organisation;
• is anything but business as usual;
• may be innovation for some but old hat for others;
• is the monopoly of no individual;
• has no necessary relationship to funds invested.

So far as people are concerned, extensive research continues. Anything that will give a better market edge is worth trying. Research on personality types of innovators (see, for example, Stevens et al., 1998; Keirsey; WinOvations, 2004) offers the following:

• "fuzzy front end" personalities are as important as the process itself;
• one "creativity-measuring" instrument, the Kirton Adaptor-Innovator (KAI) Measure, shows "innovators" to be cataysts to settled groups, irreverent of their consensual views, seen as abrasive, and creating dissonance. Meanwhile, "adaptors" tend to be good at finishing jobs started by innovators; and,
• Stevens et al. (1998) drew from the Myers-Briggs Type Indicator (MBTI) Creativity Index and the KAI to create a new Rainmaker Index "tuned to profitability and the "fuzzy front end" of New Product Development" and concluded that those (analysts) with strongest thinking-intuition scores (the top third) "generated 95 times more profit than (the) bottom third - $8,230,000 vs $87,000 per analyst"!

Thus there are implications for management including the risk of losing rainmakers who may be under-appreciated. Rainmakers (if uncoached) are typically undisciplined in their thinking and difficult to manage even when coached! Management therefore have a real need to consider the theories and the people they are managing if a true culture of innovation is to be maintained. Courage at an individual, managerial and a corporate level is sought. Everyone is a potential innovator. Risk-taking is needed and must be imaginatively rewarded while over-management may be inhibitive. Indeed, there is extensive speculation on what the enablers and facilitators of innovation might be while constraints and frustrators include:

Creativity, Innovation and Life in the Lily-Pond: nurturing the design and technology family while keeping the alligators fed

• combating negativity, fear of change, risk-aversion and over-bureaucratisation;
• cultures of spoon-feeding;
• getting bogged in administrivia;
• cultures of blame;
• short-sightedness;
• misunderstanding innovation as "progress re-cast"; and
• remembering that "…it appears to require 3000 raw ideas to produce one substantially new commercially successful industrial product." (Stevens & Burley, 1997:16).

It can be seen that the world of business resonates with the world of education. Many issues are the same and perhaps the single important one is that, to facilitate creativity and innovation, organisations must foster cultures of creativity and innovation. How plausible is this for education?

D&T, creativity and innovation as curriculum components

We know that creative and innovative thought and action are a part of designing. This is nothing new to practised D&T professionals. However, whilst innovation and creativity are implicit to us, it may be that there are disjunctures between what the professional position might be and what those beyond the profession might say, or want. It seems to me that there are several ways that we might look at creativity and innovation (C&I) in education.

Thinking first of the student, perhaps we could frame education on the basis of a student's right to fulfil their creative potential, to have teachers who foster their creativity and to open up possibilities and show the way. We know that students express satisfaction at the ownership of their creative output: "I/we thought of that" as a part of "I/we made that".

Clearly, this presumes a certain kind of teacher and teacher education. D&T demands particularly sophisticated teachers who develop particularly sophisticated pedagogies. This is no grand claim. To successfully facilitate the spectrum of learning styles needed in D&T as well as to foster designerly behaviours, critical thinking and value judgements is a far cry from centuries-old apprenticeship models of learning. Good D&T teachers have it well within their pedagogical repertoire to foster a culture of innovation and creativity with their students (respecting the

Brunerian notion of appropriateness for the abilities of those present). However, the teacher and the students are not an isolated entity.

Prescriptive curriculum components such as syllabuses and assessment regimes can radically shape a teacher's methodology. Further, industry and political calls for creativity to be "taught" in schools can have the opposite effects to those intended. Assumptions that the student is a consumer (Apple, 2001), or a product, or a passive being are not only dehumanising but also inhibit any attempts to develop C&I cultures. This curriculum cramping creates professional compromise and negates the significant independent experience and reflection that the profession brings to bear on the shaping and delivery of its teaching (see e.g. Kimbell & Perry, 2001; Barlex, 2003).

To establish a "culture of creativity" in the quality teacher education and pedagogy matter but so do the culture of the school and of the community. It is much easier to facilitate a culture of risk-taking, questioning, and "being different" if such behaviours are both valued and well-managed. However, even with supportive and stimulating management, policy can be the greatest inhibitor. To overcome this, the battle continues to gain what Kimbell (1997) called for in his text on assessment – respect for teachers' professional judgement and recognition that the exercise of such judgement is both an aspect of professional practice as well as one of professional development.

The world and teaching today

The kinds of professional contradictions or tensions that exist for the D&T profession are prevalent elsewhere too. It is informative to examine research on the increasing politicisation of education for instrumental purposes. This is not a new phenomenon (Penfold, 1988). I want now to establish the global reality of teaching and education.

In a globalising world we hear and see lots of globalising rhetoric. Any websearch on combinations of creativity, innovation and education and will find the economy lurking alongside – and in almost all countries and jurisdictions too. For many economies, creativity, innovation and education are mere tools. The student is the tool personified. The teacher is the tool personified.

Creativity, Innovation and Life in the Lily-Pond: nurturing the design and technology family while keeping the alligators fed

Apple and Teitelbaum (1986) illustrate how teaching has been, in various periods, tightly controlled (most recently since the 1980's). One might like to see teaching as an occupation of skilled and self-reflective practitioners but major transformations and erosion of teacher-control have been enacted. Taylorist management, reductionism and time/motion efficiency have become the norm. Apple and Teitelbaum (1986) suggest two special consequences as a result of the new managerialism. First, a "separation of conception from execution" in teachers' work and, second, "deskilling". The authors point out that "[a]s employees lose control over their own labour, the skills that they have developed over the years atrophy." (Apple & Teitelbaum, 1986:179). This is precisely the negative consequence of Kimbell's point regarding professional judgement. Collins (1998) also critiques the deskilling of educators alongside the parallel (and ironic) call for greater creativity and "critical thinking" in the workforce. The holistic is placed with the reductionist.

> The artificial reconstruction of critical thinking competencies that will match the requirements of a wide variety of occupations is absurdly reductionistic. (Collins, 1998:53).

Hargreaves and his associate researchers are internationally renowned for their work on educational administration and change. His latest text offers invaluable analysis:

> [As] teachers try to reach for the sky in education, too many have found themselves shackled to the base concerns and uninspiring bottom lines that policy makers and the public impose upon them. These teachers' working reality has not been an energising one of expert judgement, invigorating learning and strong professional community. It has been a dispiriting world of micromanagement, standardisation and professional compliance, in which demands have increased, resources have been scarce, and public trust has been wanting. While policy makers should be the wind beneath teachers' wings, they have more usually been an albatross around their necks. This is not an accident, or an unhappy coincidence. It is a direct consequence of the knowledge economy itself – or of the

way that many governments have responded to it.
(Hargreaves et al., 2003:53)

The authors describe teachers as:

> casualties of the knowledge society. Having to coach children to memorise; to teach as they are told; to undergo in-service training on government priorities; to work harder and to learn alone; to treat parents as consumers and complainers; to perform emotional labour, to respond to imposed change with fearful compliance; and, to trust in no one.
> (Hargreaves et al., 2003:59).

Such is the background against which curricula have been formed today. They are ideological (Apple, 1979) and they are to be contested. They are a product of their times and times can change. Freire (1972) saw curriculum as a dialogue to be created and re-created. Perhaps we should remember that we inhabit curricula and that we can modify our surroundings – that is the way of things, to design and to redesign as an articulate professional group. I see curriculum as I see democracy – as an ideal always in need of re-creation and reconceptualisation. If a democratic society calls for a democratic curriculum and a thinking society calls for a thinking curriculum, then surely a creative society calls for creative curriculum.

Alligator spotting (ii)
To maintain a strong professional identity we need our local, national and international cohesion and we must be ever wary of numerous alligators – there always will be in a contested curriculum lilypond. I'll name just a few of the many I perceive: atomism; curriculum whims and fads; vocationalism; pursuit of "our knowledge base"; education theorists and researchers who misunderstand or misrepresent our field (see eg Keirl [2002b] on Gardner); ourselves, as cannibals; emergent generalist curriculum formulations such as Essential Learnings in some Australian states (Keirl, 2002a); assessment systems which are pedagogically negative; and, old and new empires – science, ICT, maths, English. I return to Kress who talks of:

…education for instability [by invoking]…notions such as creativity, innovativeness, adaptability, ease with difference and comfortableness with change. These will form the bedrock values in my own educational vision (in my idea of education for utopia).

Which school subject is likely to deal with this as an issue, both as an issue of preparing the young appropriately for their societies and as an issue of making overt the principles of design which suffuse every aspect of the aesthetics of the market? For me the answer is quite clear: if the subject of English in the English school curriculum does not do so, then there is nowhere else at the moment where this will happen. But it is an issue which is both essential for the design of a new form of communication and for the understanding of life in a consumer (i.e. market dominated) society. (Kress, 2000:133)

In conclusion

For all our D&T progress, much greater in some places than others, we will ever have battles to fight and cases to argue. The key is to continue to build that which matters: a solid research base, excellent teaching, and first class professional collaboration.

Creativity is a mere example of the many and continuing encounters we'll have in the lilypond. Our life with creativity can be symbiotic or we can find it an alligator to wrestle with. The question we are lead to believe is important is "What kind of education is to serve creativity?" I'd suggest that the better question is: "What kind of creativity is to serve education?" Better still "What kind of creativity is to serve a democratic education?"

If students and teachers alike are not to be merely "tools personified" of economies then we cannot afford to lose sight of global democratic principles for education, or to lose sight of rich understandings of technological literacy or of vision and educational imagination.

Today, while wars are designed, while millions starve or remain sick or uneducated, while the planet continues to be corrupted and while we continue to keep on designing "knick-nacks for dickheads" (Bell, 1989:82) our collective imagination is suppressed, our vision is sidelined and our creativity is purely functional. In the big picture of the cycles of history, the current cycle has brought us economic rationalism that is a panacea for little and has done education no favours. As the cycle turns, I suggest that we, as an international professional group have real creative opportunities to play a central role in any curriculum which values creativity for a common good.

References

Apple, M.W (1979), *Ideology and Curriculum*. Routledge and Kegan Paul, London.

Apple, M.W (2001), *Educating the "Right" Way: markets, standards, God and inequality*, Routledge Falmer, New York.

Apple, M.W. and Teitelbaum, K (1986), 'Are Teachers Losing Control of Their Skills?' in *Journal of Curriculum Studies*, 18, 2, 177-184.

Barker, Les (n.d.), 'Leonardo da Thingy' in *Pup Yours*, http://www.cix.co.uk/~ackroyd/welcome.htm

Barlex, D (2003), *Creativity in Crisis?*, DATA, Wellesbourne, U.K.

Barrow, R. and R. Woods (1988), *An Introduction to the Philosophy of Education*, (3rd Edition), Routledge, London.

Bell, S (1988), 'If…' Cartoon Dec 5th 1998, in Bell, S (1989) *The Vengeance of If…*, Methuen, London.

Berndt, R.M. and C. H. Berndt (1989), *The Speaking Land: Myth and Story in Aboriginal Australia*, Penguin Books, Ringwood, Victoria.

Boden, M (1992), *The Creative Mind: myths and mechanisms*, Basic Books, New York.

Broderick, D (2001), *The Spike: how our lives are being transformed by rapidly advancing technologies*, Forge, New York.

Cannon, G (1987), *The Politics of Food*, Century Hutchinson, London.

Carey, J (1995), *The Faber Book of Science*, Faber and Faber, London.

Caudill, M (1992), *In Our Own Image: building an artificial person*, Oxford University Press, Oxford.

Collins, M (1998), *Critical Crosscurrents in Education*, Krieger, Malabar, Florida.

Csikszentmihalyi, M (1997), *Creativity: flow and the psychology of discovery and invention*, HarperPerennial, London.

Davies, T (2000), 'Confidence! Its Role in the Creative Teaching and Learning of Design and Technology' in *Journal of Technology Education*, 12, 1, Fall 2000. URL: http://scholar.lib.vt.edu/ejournals/JTE/v12n1/davies.html

Diamond, J (1998), *Guns, Germs and Steel: a short history of everybody for the last 13000 years*, Vintage, London.

Drexler, K.E (1990), *Engines of Creation*, Fourth Estate, London.

Eisen, J (1999), *Suppressed Inventions and other Discoveries*, Avery, New York.

Feenberg, A (1999), *Questioning Technology*, Routledge, London.

Ferguson, E (1992), *Engineering and the Mind's Eye*, The MIT Press, London.

Ferré, F (1995), *Philosophy of Technology*, The University of Georgia Press, Athens, Georgia.

Florida, R (2003), *The Rise of the Creative Class: and how it's transforming work, leisure, community and everyday life*, Pluto Press, North Melbourne, Australia.

Fowler, H.W. and F.G. Fowler (1964), *The Concise Oxford Dictionary*, (Fifth Edition) Oxford University Press, London.

Freire, P (1972), *Pedagogy of the Oppressed*, Penguin, London.

Gardner, H (1983), *Frames of Mind: the theory of multiple intelligences*, Fontana, London.

Gardner, H (1993), *Creating Minds: an anatomy of creativity seen through the lives of Freud, Einstein, Picasso, Stravisnky, Eliot, Graham and Gandhi*, Basic Books, New York.

Hargreaves, A (2003), *Teaching in the Knowledge Society: education in the age of insecurity*, Open University Press, UK.

Hart-Davis, A (1999), *Eurekaaargh! Inventions that Failed*, Michael O'Mara Books, London.

Horne, D (1964), *The Lucky Country*, Penguin, Harmondsworth.

Kawakami, K (1995), *101 Unuseless Japanese Inventions: the art of Chindogu*, HarperCollins, London.

Kawakami, K (1997), *99 More Unuseless Japanese Inventions: the art of Chindogu*, HarperCollins, London.

Keirl, S (2001), 'As if Democracy Mattered… design, technology and citizenship or 'Living with the temperamental elephant'' in E. W. L Normand and P.H Roberts (eds.) *Design and Technology Educational Research and Curriculum Development: the emerging international research agenda*, Loughborough University, Loughborough.

Keirl, S (2002a), 'Against the provincialism of customary existence: issues arising from the interplay of 'essential learnings', design and technology and general education' in Middleton, H., M Pavlova and D Roebuck, (eds), *Learning in Technology Education: Challenges for the 21st Century, Proceedings of the 2nd Biennial International Conference on Technology Education Research*, Centre for Technology Education Research, Griffith University, Queensland.

Keirl, S (2002b), 'Hedgehogs, foxes, a passing crow, and other 'intelligent' beings: explorations of the relationship between multiple intelligence theory and design and technology' in Middleton, H., M Pavlova and D Roebuck (eds), *Learning in Technology Education: Challenges for the 21st Century, Proceedings of the 2nd Biennial International Conference on Technology Education Research*, Centre for Technology Education Research, Griffith University, Queensland.

Keirl, S (2003a), 'Ethics and Technology Education: another ac-prac trap or an

education for humanity?' in Martin, G and H Middleton (eds) *Initiatives in Technology Education: Comparative Perspectives, Proceedings of the American –Australian Technology Education Forum*, Sheraton Marina Mirage, Gold Coast, Australia, 5-7, Jan, 2003, Technical Foundation of America and the Centre for Technology Education Research, Griffith University Queensland.

Keirl, S (2003b), 'Plus ça change, plus c'est la même chose mit vorsprung durch technik; the concept of progress in relation to Design and Technology curriculum' in Norman, E.W.L and D Spendlove (eds) *Design Matters: Proceedings of the Design and Technology Association International Research Conference*, 2-5 July, 2003, Warwick Hilton, Warwick, England, DATA, Wellesbourne, UK.

Keirsey, D (2004), 'Temperament Sorter' in *WinOvations*, URL: http://www.winovations.com/Keirsey.htm

Kimbell, R (1997), *Assessing Technology: International trends in curriculum and assessment*, Open University Press, Buckingham, UK.

Kimbell, R and D Perry (2001), *Design and Technology in a Knowledge Economy*, Engineering Council, London.

Koestler, A (1970), *The Ghost in the Machine*, (Pan Edition), Pan Books, London.

Koestler. A (1975), *The Act of Creation*, (Picador Edition), Pan Books, London.

Kress, G (2000) 'A Curriculum for the Future' in *Cambridge Journal of Education*, 30, 1, 133.

Kurzweil, R (1999), *The Age of Spiritual Machines: when computers exceed human intelligence*, Allen & Unwin, New South Wales, Australia.

McCartney, K (2004), 'Crafting the C-Generation' in *The Australian* p.12, 6th May 2004.

Monbiot, G (2004), *The Age of Consent: a manifesto for a new world order*, Harper Perennial, London.

Mumford, L (1934), *Technics and Civilisation*, Routledge & Kegan Paul, London.

Neto, A 'Create' in *New Internationalist*, May 2004, No 367 p28.

Partington, A (Ed.) (1996), *The Oxford Dictionary of Quotations*, Revised 4th Edition, Oxford University Press, Oxford.

Patten, B (1993), 'the taste of the moon' in *New Internationalist*, Oct. 1993, p12.

Penfold, J (1988), *Craft, Design and Technology: Past, present and future* Trentham, Stoke-on-Trent.

Pile, S (1989), *The Return of Heroic Failures,* Penguin, Harmondsworth.

Pile, S (1990), *The Book of Heroic Failures*, Penguin, Harmondsworth.

Postman, N (2000), *Building a Bridge to the Eighteenth Century: how the past can improve our future*, Scribe Publications, Carlton North, Victoria, Australia.

Pugh, D.S (Ed.) (1990), *Organisation Theory,* Penguin, London

Roberts, P.H and E. W. L. Norman (eds.) (1999), *Proceedings of the International Conference on Design and Technology Educational Research and Curriculum Development*, Loughborough University, Loughborough.

Ryle, G (1949), *The Concept of Mind*, Hutchinson, London.

Schlosser, E (2002), *Fast Food Nation: what the all-American meal is doing to the world*, Penguin, London.

Sclove, R.E (1995), *Democracy and Technology*, The Guilford Press, New York.

Smith, J.S. and E.W.L. Norman, (eds.) (1998), *Proceedings of the International Conference on Design and Technology Educational Research and Curriculum Development,* Loughborough University, Loughborough.

RESEARCH

Creativity, Innovation and Life in the Lily-Pond: nurturing the design and technology family while keeping the alligators fed

Stevens, S. and J Burley, (1997), '3000 Raw Ideas = 1 Commercial Success!' in *Research-Technology Management*, in WinOvations, URL: http://www.winovations.com

Stevens, S, J Burley and R Devine (1998), 'Profits and Personalities: relationships between profits from new product development and analysts' personalities' in *WinOvations*, URL: http://www.winovations.com/article3.htm

Sutton-Smith, B (1988), 'In Search of the Imagination' in Egan, K and D Nadener, (eds.) (1988), *Imagination and Education*, Teachers College Press, New York.

Thouless, R.H (1953), *Straight and Crooked Thinking*, Pan Books, London.

Toffler, A (1971), *Future Shock*, Pan Books, London.

Tutt, K (2003), *The Scientist, the Madman, the Thief and their Lightbulb*, Pocket Books, London.

Vernon, P.E. (ed.), (1970), *Creativity*, Penguin, London.

Warnock, M (1996), *Existentialism*, Oxford University Press, Oxford.

WinOvations, (2004) URL: http://www.winovations.com