

## RE-SOURCING SCHOOL: RETHINKING EDUCATION IN A CONNECTED WORLD

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*The best way to predict the future is to invent it.* Alan Kay

Is school a waste of time? Is learning a waste of time? While for some the answer will be the same to both questions, most will agree that they are different questions and that difference is the heart of the issue that this paper seeks to confront.

Over the last few years I have noted a number of things that might be called ‘dead canaries’. These are things that have signalled to me the scope of the issues that need to be confronted now and in the years ahead if we are to do our best in resourcing and re-sourcing education in a connected world.

The term ‘resourcing’ usually refers to practical concerns such as finding someone to pay the bill or finding a way to make things cost less or nothing at all. In terms of this discussion, I also want to use the term ‘re-sourcing’ to consider something I view as fundamental to the changes ahead, and that is the shift from traditional current practice to emerging connected practices. Those connected practices include not only the technological advances of the Internet and the multiverse of applications and content that have been developed for it, but the culture of knowledge sharing and building that characterizes the successful applications and the practices of those engaging with media/ICT also.

The first dead canary was a statement I overheard sometime in 2004 when a prominent thinker in the media/ICT space said something along the lines of:

Australia doesn’t need any more broadband. There is no case for taking FTTP (fibre to the premise). What do people need faster Internet access for? So they can download TV shows faster? The fact is, the access is already there for those who need it. Telstra has put in sufficient broadband where the need for it has been justified. Let’s face it, broadband is only necessary where there is a demonstrable business case to justify putting it in place.

A second dead canary was the near-expulsion of a student at Canada’s Ryerson University because he had set up a Facebook study group and this was deemed ‘cheating’ by the administration. Collaboration and connected exploration of one’s field of study seemed not to fit with appropriate academic practise according to Ryerson University. [Walker, 28 March, 2008] As it turns out, they settled for failing him in the subject but when it comes to demonstrating an understanding of the future of education, it is probably Ryerson that scored ‘epic fail’ in terms of academic record, not only for its decision but the dinosaurian thinking behind it.

A third dead canary was the media coverage alleging that the NSW government’s response to the Federal government’s offer of computers for classrooms had identified – among a number of factors – an existing lack of sufficient electricity in certain schools as a serious impediment to this initiative. The most recent outcome being the decision by the NSW government to reject the Federal initiative. [Patty, 27 September 2008] It is hard to imagine how students can meet first-class, global/urban standards without such basic facilities, let alone meet the challenge of building the ‘clever country’ and so for me, these reports indicated the magnitude of the task ahead.

In these three examples – and there are many, many more that I could cite – important factors can be identified. We have business case bias working as a barrier to innovation and access.

We have out-dated mindsets that fail to recognize the impact of significantly changed cultural practice as a response to technology adoption. We have substantial lag in the implementation of technology from previous centuries inhibiting our capacity to keep pace with current needs – let alone future needs – for technology integration. In simple terms, we have priorities that work against each other and do not reflect the emerging realities that need to be resolved in order to participate in a connected world.

Why does the business case come to be the basis on which we determine the value of an advancement? It has not been the sole grounds for innovation and adoption of advances in the past. Many technologies – and indeed, human endeavours and achievements across the board – have been developed without any business case needed as a fundamental requirement that determined their appropriateness or grounds for uptake.

Societies have been able to make decisions and allocate resources to projects of ‘common wealth’ simply because it was the right thing to do and had been identified as necessary even if hideously expensive and unlikely to recoup investment in cash terms. The public school systems that prevail in the global/urban might have been structured to provide for the needs of industrializing nations but inherent in their establishment was the philosophy that free education for all children would serve society beyond the business interests of factories and employers.

Yet, of recent years, economic factors have been overwhelmingly influential – at great cost when you value other crucial benefits to society that may have been lost because economic arguments have been given priority. In the areas of innovation and science there is an urgent need for investment and development that is not being met either in terms of adequate financial support or social priority. MythBuster Adam Savage describes three ways to fix science education in the United States of America. He argues that students have to be able to get their hands dirty, that we need to celebrate making mistakes and spend more money on science. As he puts it, ‘People say, “You can’t just throw money at the problem.” By all means, throw money at the problem! Learning science by experimentation yields innovation, inspiration and fascination.’ [Savage, 2008]

There are probably a lot of reasons why 140 years have slipped by without some schools getting adequate access to one of the primary resources of modern living. Yet I imagine that the failure to make sufficient electricity available to all schools has been shaped by economic reasons as much as any other combination of factors. While issues of terrain, remoteness, efficient means of supply, sufficient demand and so forth are likely contributors to this situation, when all the priorities that mould a decision are brought to bear, the weight of the economic argument usually gets to exert the most pressure.

This may seem like something of a digression from the subject of resourcing/re-sourcing school, however this issue about the capacity to deliver and integrate an ‘old’ technology such as electricity, gives a useful perspective on the discussion about the delivery and integration of the considerably more complex technologies that are becoming as fundamental to daily life as a powerpoint.

The topic of education – representing as it does the means by which we hope to prepare ourselves and our societies for almost every facet of experience – is both extensive and deep and still only somewhat defined by the volumes already in place by experts from many fields. Add to this the vast issue of ICT and the implications of its development and implementation and we have at hand many lifetimes of work and contemplation. That said, it is ICT and the emerging norms of online culture that offer us our best opportunities to grapple with the challenge ahead. In much the same way that computers have cracked the big numbers that

would have taken several lifetimes to compute by an individual, the uptake and integration of ICT with our educational goals will help us crack the work of e•volving\* the way we learn.

This paper is part of a much more comprehensive examination of these complex and important issues that I am currently developing in relation to the fields of digital visual effects (DVFx) and online culture. As a prelude to that project, I intend to show here – albeit briefly – how DVFx and online culture can offer us a useful template for considering how we can re-source educational structures and practices through the integration of ICT.

That said, I offer a few caveats and proffer certain assumptions upon which – for brevity’s sake – much of this discussion will be based. Firstly, while the arguments here are more indicative than definitive – hopefully – they contribute to the larger ‘whole’ of the issues converging in this area. I have taken a deliberately non-academic approach to this subject because I am convinced that accessibility and engagement with the broadest audience are fundamental to the success of shaping, realizing, and bringing to fruition the participation in, and adoption of, the technologies that are needed. Accordingly, much of what follows will be unacceptably generalized by academic standards but hopefully will make the points sufficiently to spark discussion about the ideas that I believe are important. It is something of a motto for me that thinking is doing if you share it and the e•volution is giving shared thinking the massive power and tools of connectivity to create significant difference in the world.

Another necessity, in view of the brevity needed within the scope of this paper, is that I will offer the following assumptions without providing full supporting citations or extensive discussion about why I have formed the views listed below. I trust that readers will be generous in looking beyond these omissions because the crucial points I want to make lie ahead and although they relate to the following arguments, the substance of what I want to propose lies not in arguing the assumptions themselves but in looking to the emerging opportunities.

The basic observations that underlie the discussion that follows are:

- educators and the educational systems in most of what I call the ‘global/urban’ are struggling to deal with the pace of change, the expectations placed upon them and the resources (the materials, the funds, the tools) available to them.
- the impact of ‘connectedness’ – that is the Internet and online culture – is substantial and increasingly forceful and pervasive. It is a fundamental force in the re-sourcing of learning and knowledge.
- the curricula and educational systems developed for the industrial revolution are ill-suited to the requirements of the e•volution that is connectedness.

The recent report by the OECD placing Australia second-last in its ranking of countries by public spending on education is one indicator of how things stand in relation to resourcing, but the report – its structure and focus – is itself an indicator as to the extent to which the larger questions of learning and knowledge are still shaped by traditional educational structures and delivery mechanisms and it is in this area that school needs to be re-sourced most of all.

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\* I use the term ‘e•volving and e•volution to signal the magnitude of the impact that media/ICT is having and will have on our lives. I am of the view that what is happening now should be measured in terms of an evolutionary step.

Our measurement of education is structured by looking at a variety of economic and performance indicators of the institutions that are accredited providers of ‘schooling’. We have a primarily linear structure that seeks to provide skills and knowledge from early childhood to adulthood and across the requirements that have been identified as priorities for employment and national benefit. Yet it must be asked: how do these structures and traditions prepare us for non-linear lives in a connected world?

Increasingly the ‘business case’ has been forceful in determining priorities for this overall structure and the content of specific curricula. For the most part, primary, elementary and high schools continue to focus on comprehension, retention and expression of text-based materials whether in book or screen-based format. Generally, technical and trade education liaises with industry groups to provide training that engages various – including physical – skills as well as formal knowledge for specific employment categories. Universities, while one of the oldest structures for formal education, struggle with the desire to provide ‘education’ but also deliver ‘job readiness’. While these things are not necessarily mutually exclusive, business case priorities can impact on how curricula are shaped to meet performance indicators that favour job readiness over knowledge-focused learning that might have less obvious and immediate outcomes.

It is at this level that we can see the tensions that exist in balancing the business case priorities against the concept of knowledge and diverse approaches to its development as being inherently valuable. Even though many great thinkers and innovators credit inspiring teachers for their achievements, it is common throughout universities in the global/urban that teaching excellence is weighted differently to publication track record and capacity to write winning grant applications. In Australia, DEST points and bid-based ARC grant priorities influence the scope of higher education and research opportunities. Performance measures for institutions that focus on graduate employment levels, wages, and on outcomes for research in relation to commercial exploitation and generated income have changed the experience of university life.

Adding to this emphasis in academia, is the issue of the hierarchy of subjects – a problem that prevails from very early formal education right through to the highest levels. In his book *Out of Our Minds: learning to be creative*, Ken Robinson is both engaging and eloquent about the inadequacies of the ‘academicization’ of learning and makes an important case for reconsidering our ordering of the curricula in formal school systems. [Robinson, 2001]

Drawing on his experience in academia, he makes several key points. He states that important abilities are overlooked or marginalized in a system that favours particular kinds of memory and logico-deductive reasoning in a confusion that certain kinds of academic abilities are a comprehensive measure of intelligence. He also raises the problem of the misguided faith ‘that there is a direct linear relationship between general education and subsequent employment.’ [Robinson, 2001.9] He argues also that a text-based approach as the primary focus of an educational system fails to offer us the means by which to develop our full potential across many spheres.

This presumption about the priorities that decide curricula and the nearly exclusive use of text-based learning to deliver that curricula are so pervasive that they almost go unquestioned when matters of education are considered. To use a metaphor, when the discussion turns to ‘fixing’ education, we spend a lot of time talking about how big the box should be, what it should be made of and what should go into it, but do not consider that perhaps a box is not what is needed and that there might be an entirely different way to deliver what is important.

As is often the case, when confronting change of the magnitude facing education, it is easy to get caught up in the sheer scope of the problem, its complexities, and its layers of

interconnecting dependencies and I do not want to be dismissive about the excellence of much that exists within the traditional education system nor sound glib about the scope of what must come next. Accordingly, in order to move away from generalized and abstract discussion of the issues, I will focus now on the field of computer graphics – particularly the DVFX industry – and how I see that it can offer a template to consider the scope and tenor of the change needed to re-source school.

DVFX is a ‘new’ industry that emerged from the development of computer-generated graphics as a means of visualizing scientific concepts and industrial design and then – thanks to Hollywood – had the benefit of capital investment and the glamour of movie-making, a heady combination that ensured that the artists attracted to work in the industry would have the resources to do so. Early developments focused on creating digital tools to undertake analogue processes more accurately and effectively but very early there was a push to innovate and develop entirely new tools and applications. Within a decade, computer graphics emerged as a major force not only in entertainment but as a crucial tool for innovation and R&D across industrial and scientific sectors.

Yet, in many ways, at the time of its emergence, the DVFX industry was ill-served by formal education curricula and the established industrial structures. Traditionally, visual literacy has had little support compared to that given to text literacy and its related skills. Fundamental to the DVFX industry is the capacity to execute representative imagery through high-level technical expertise. One of the building blocks for participants in DVFX, is artistic skill however, as Ken Robinson has observed, art classes are at the lowest level in the curricula of global/urban educational systems. Although art history and the fine arts are well developed as areas of knowledge and expertise, there is little integration and democratization of this knowledge and associated skills compared with the expectations for other kinds of literacy.

As I discovered through interviews with leading DVFX artists, their skills were gained in spite of the school system more often than because of it. By way of example, most adults graduating from high school in the global/urban are capable of reading the majority of texts encountered in day-to-day life and are capable of producing texts of sufficient standard to meet their needs for communicating on the job and in relation to the daily administration of their lives.

In terms of visual literacy, thanks to photographs, television, and movies most adults are able to read the imagistic texts of their daily life but only a small proportion of similarly qualified adults would be capable of producing images by means of accurately representing their thoughts and expressions through drawing. Up until recently, this has not been observably problematic but as we move into a culture that increasingly is shaped by visual communication and demands for innovative, expressive and accurate imagistic texts, this failure to develop the expressive skills for visual literacy as an equally valued skill requirement might prove to have detrimental outcomes.

While many will argue that the need for drawing skills was reduced after the introduction of photography, the capacity to sketch a visual idea – indeed, the capacity to think in visual terms – is a different ability than that of taking a photograph, (let alone an even bigger difference to the skills engaged by coming up with the proverbial thousand words as a substitute for image). Yet our ability to think in visual terms and express those thoughts imagistically is one that has been fundamental to our advancement in the past and is again a growing means by which we imagine and develop the world in which we live.

Part of the problem lies in the idea that drawing skills require ‘artistic’ talent and that this is a ‘gift’. Similar attitudes prevail in relation to virtually every other human ability. There is a

tendency to attach ‘magical’ qualities to excellence in everything from healing to kicking a football. Even in that universally expected form of literacy – the ability to read and write – we uphold the idea that ‘creative’ forms of these skills are special and inherent to the person expressing these abilities rather than being learned skills.

When it comes to the skill of drawing, this attitude has primacy yet most of my interview subjects were emphatic that they were not innately talented but that they had learned to draw, often because they knew someone of greater ability and that this person showed them what to do to develop their representational skills. Fundamental to their development was the fact that they enjoyed drawing and that they were encouraged to learn the technical skills needed to have facility and range in the work they wanted to undertake.

They also argued that learning to draw meant learning how to see the world around them in a different way and that visualizing something in order to draw it or represent an idea graphically was a particular way of thinking and imagining – also learned. While many of the people I have interviewed are viewed by others – including peers – as ‘gifted’ artists, no artist I have ever spoken to has argued that the foundation skills they rely upon are anything that cannot be learned to competency by most people and all of them insist that whatever ‘gift’ they might enjoy, much of what they do is based on these learned fundamentals.

Yet, that said, many of these subjects commented that they had faced discouragement from teachers, guidance counsellors and parents in pursuing a career in art because it was not perceived as having broad opportunities for advancement, development of intellectual potential, or status except under certain circumstances compared with established professions or roles in mainstream commercial industries. In other words, it was not considered a good career choice because success was limited to the rare, ‘magical’ talent and that anything short of that level of success represented a choice for mediocrity, limited opportunities, and low-status in a society that privileges verbal/text skills more highly. Fortunately for them, the rise of the image and its realization through DVFX changed things.

The difficulties my interview subjects have described in pursuing a career as a working artist are often reflected in the applications I assess for the New South Wales Film and Television Office’s (FTO) Digital Visual Effects Scheme also. I was involved in the establishment of this Scheme in 1998 when it became apparent that the formal education system as it existed at that time, could not meet the demand for skilled workers in the emerging industry of DVFX.

In Australia, up until the late 1990s, most art training was conducted either at the trades-focused level – such as graphic design, industrial design, etc. – or, where part of university-standard learning, through fine arts courses. There were both private and public tertiary courses in various schools of art also but until the establishment of the Silicon Graphics Centre for Excellence at Enmore TAFE and the Digital Media stream at the Australian Film Television Radio School, computer graphics courses for digital visual effects artists did not exist. At that time, practitioners were gaining skills through their workplaces in design studios or overseas through formal courses or work at pioneering establishments such as Industrial Light+Magic or Digital Domain.

Nonetheless, the local demand for skilled workers grew rapidly and, as a means of bridging the quite large gap between the training available through formal education and the quite different demands of the production environment in a DVFX Studio, the FTO established an annual traineeship that would offer a mentored six months placement within a digital visual effects/design studio.

From the outset, a few qualities representative of what we need in a world of connected learning were quite obvious. Firstly, to take up this learning opportunity, there were no

stipulated standards of educational requirements – how could there be when the field itself was in its formative state? As a consequence, the industry had to be flexible and open to laterally-gained skills. Even after a decade of operation, applicants' educational backgrounds range across the spectrum. In every annual Round of the Scheme there are applications from current high school students and recent high school graduates. There are also applications from students enrolled in various TAFE design programs or private art school courses and there are substantial numbers of applicants with degrees from university courses in fine arts or related professions such as architecture. Many applicants have no tertiary training of any kind and only some of these have had the benefit of structured training within a workplace.

In regard to employment experience, another notable quality of the applicants' backgrounds is that cross-training and career transition are important motivations for application to the Scheme. When the Scheme was established many related industries were in the initial stages of transferring production and work practises to computer-based platforms and so this opportunity to have mentored training in a digital environment was crucial for many people who had been successful in the analogue version of the skills for their field and who wanted to move to a digital platform.

People working in the industry often were stuck at the entry and skills-blocked levels or in areas that were still primarily focused on analogue production as the digital 'seat cost' (the expense of the hardware and software licences in high-end digital motion graphics) meant that the competition for opportunities to work at the higher-levels was fierce. This barrier to growing the industry moved substantially once the production innovations were mainstreamed and the cost of hardware and software dropped to desktop affordability yet there continues to be a substantial gap between the kinds of skill attainment that can be obtained in formal training and the particular needs of the production environment.

The impact of non-linearity also became obvious as the Scheme developed. While once upon a time – perhaps long ago mid-last century – a university degree was a lifetime investment and like a good pair of boots, with a bit of upkeep, could last a career. By the end of the century, as many commentators have noted, change was of sufficient pace as to make the phrase, 'here today, gone later today' seem like a quaint expression of yesteryear. Today things are gone before they get here, so to speak. This short-use-by-date for many kinds of knowledge and the churn in employment means that the linear life of school-to-job-to-career-to-retirement is an increasingly rare thing.

Cross-training, re-training, career transition/revision are the new order and so education and industry have to be structured in ways that support this non-linearity and lateral progress and change. Significant to this is validating the lived experience and the importance of point-of-view as a contributor to greater knowledge and insight – qualities that come into their own in a connected environment where diversity of ideas is highly valued. One of the emerging advantages of democratization of knowledge and opportunity is the valuing of the contribution and the development of expertise through engagement.

As a result of these various factors, the expectations, ages, qualifications and career paths of those seeking an opportunity through the Scheme are extremely diverse. Applicants' backgrounds range from professionals working in related but not computer-skilled fields such as props making or sculpture to IT professionals who want to cross-train in a creative area. For some there is a desire to move from a related field such as design in print or web-based areas or traditional animation. For others there is a perceived need to retrain after a career within the industry in another specialty such as cinematography or production design as the computerization of all forms of content-making becomes more extensive.

It is also a 'new' field and attracts many young applicants starting careers who want to start out in feature films, games and online content. From time to time we have applicants that have neither related educational background nor experience but for whom the allure of the industry is sufficient to inspire them to give up successful careers in completely unrelated fields and want to start over, often after some ten or more years in a successful career elsewhere.

In a kind of perfect balance to this desire to enter the industry, the jobs within it are extremely broad in their requirements and so encompass perhaps the full range of training demands and knowledge bases. When the Scheme was set up, computer skills – especially experience with a 2D or 3D software package was extremely rare. In our first Round of selections, we awarded points for computer skills if applicants had used email. Ten years later, competence in at least one of the major software packages used in industry is almost essential. However, the use of the word 'almost' in that last sentence is telling.

One of the fundamental facts that has been consistent across our assessment process is that qualifications, experience, previous positions held, letters of reference and other standard measures of suitability are of secondary interest. Our main focus is the quality of the portfolio submitted and, even within that, we are quite open to materials, styles, and the extensiveness of the body of work.

Primarily, we are looking for aptitude, potential and artistic skill. Some might term this 'talent' but I avoid that term because all too often it leads to the idea of 'giftedness' as opposed to learned abilities and **capacity to learn is the crucial quality**. From the outset, the DVFX industry has been prepared to train people in transitioning to computer-based work. Initially this was simply a necessity because there were no training institutions providing the foundation skills. However, even though educators now provide an extensive range of classroom-based and online courses, learning-while-making is one of the fundamental qualities of working in DVFX. Much of the work being undertaken is innovative and will continue to be innovative and so a culture of learning and innovating prevails in the industry. The nature of the work means that team-based achievement is crucial and the demands of production are such that staff work in an environment where the goal-posts are always moving, and knowing how to anticipate this and problem-solve to meet externally-determined goals is simply the standard that must be met.

There are roles that can be taken up by individuals with little or no formal training in fine arts but there are no roles that do not require constant learning and adaptation. The work is highly technical and computer-based but relies upon many kinds of learning and ability. For example, animation requires performance and kinetic knowledge and, depending on the project, high level ability to comprehend and use knowledge across the sciences in order to visualize everything from the fine details of anatomy – any anatomy, the built and natural environments, accurate historical settings to imaginative visions of the future and alternative worlds.

The ability to problem solve and acquire and innovate in science-grounded knowledge is highly valued. The DVFX industry draws upon the talents of people with highly diverse training and who have come from backgrounds such as astrophysics, aviation, engineering, computer science, pure mathematics and so on. The industry integrates these backgrounds with high levels of visual literacy in order to create visualizations across the range of knowledge and imagination. This practise is in keeping with the origins of the industry itself as the skills that moved from analogue to the digital as part of this building of the industry emerged from the photographic industrial foundations of chemistry and optics and a



chemical/engineering approach to understanding of how light works and how to work with it to capture and create images.

Further, while DVFX artists are the best known representatives of the industry, they work hand-in-hand with legions of R&D experts, systems administrators and engineers, management and support roles, and ICT professionals. The production pipeline requires connectivity within individual production projects but with external collaborators also. Data must be sharable interactively and in real time, and the data transfer load is significant, by any measure. The industry has huge archival and database requirements and is in constant partnership with industries that range from high level research facilities to individual content makers. It is a global, connected, technologically integrated industry drawing expertise from, and contributing expertise to, the full range of fields. The computing and ICT infrastructure alone, is of a leading-edge standard.

As this very brief account indicates, the DVFX industry has arisen from the digital evolution and reflects many of the cultural and social practices that can re-shape and re-source educational and work practices. Its history and these qualities make it an apt example of what lies ahead and offers us a guide for other fields adapting in a connected world.

As described, people enter DVFX from a broad range of educational backgrounds and employment histories. In recent Rounds of the Scheme appointees have included a seventeen-year-old high school student and a gold medal-winning PhD candidate doing advanced work in pure mathematics and computer science. One applicant had taken a TAFE course in 3D but had work experience as a kitchen hand only. Another was a recent graduate from a national fine arts college but had no relevant industry experience.

From a 'schooling' point of view, one trend that has emerged is that some of the least successful applications are from those that have completed a succession of degree-level courses. Many of these applicants have obtained qualifications from programs that seem to have been tailored to perceived industry needs but offer very limited or irrelevant skills development opportunities and provide a theoretical grounding that all too often does not 'fit' with the needs of their chosen careers. Judging from the results observed in many of these applicants' portfolios, the tension between 'education' and 'job readiness' has left them with little more than a substantial fees debt and not much better prepared than many without any formal training at all. In some ways, this was the most profoundly upsetting of the dead canaries that focussed my attention on this topic.

Digital literacy and visual literacy are critical to participation in the connected world. While an academic ability to absorb and redeliver information might lead to high qualification in many areas, no amount of reading about visual literacy will develop an individual's capacity to execute a representation unless it is accompanied also by practical skills development – although I concede that it may be very helpful in shaping the concepts that inspire the representation itself. Similarly, digital literacy requires practise for integration of skills in order for fluency and innovation to follow.

DVFX practitioners may come to the industry from any number of backgrounds but the experience of **learning-through-doing** and **innovating-to-do** grounds their skills in a way that is directly suited to the requirements of a connected world. Many of the fundamental knowledge requirements for success in the field make for a dreadful learning experience when they have to be absorbed for the purposes of sitting an exam or producing an essay, but they can be absorbed – almost by osmosis – through the experience of **the problem-solving-that-is-making** in a DVFX studio. Accordingly, the most effective way to learn DVFX is through active engagement rather than through traditional passive-learning methods and the work

practices of the industry support this also. While many industries are still structured by industrial-age paradigms, the DVFX industry builds knowledge and technological innovations through processes integral to its production practices.

In his 2008 Pearcey Oration, Dr. Terry Cutler made the following important observations: ‘We have a declining number of researchers and technically literate people as a proportion of workforce. Australia ranks OECD last for employer investment in vocational education and training (and) Australia ranks last among OECD countries for firms with cross-border collaboration in innovation.’ [Cutler, 2008] This is a succinct snapshot of the challenges facing Australia as it contemplates its future and how it hopes to participate in the connected world.

By comparison, within a decade from its inception, the Australian DVFX industry has grown from a fledgling field to being a highly regarded global provider of DVFX that compares favourably with its international industry colleagues. It competes for business in an international marketplace and relies on innovation and technical expertise to remain a significant contributor to the global industry. Locally trained and skilled DVFX practitioners are leading talents that are able to find employment throughout the world at any level yet they enjoy the rare advantage of being able to work at the highest levels within Australia, in Australian companies.

All of the major Australian DVFX studios provide in-house training and have strong R&D teams. For example, Animal Logic – the DVFX studio that produced the Academy Award winning CGI feature-film *Happy Feet* – has a dedicated Training Manager to conduct in-house training and programs that bridge the gap between school and working in production. It has been a foundation partner with the FTO’s DVFX traineeship scheme as well as establishing various initiatives to connect with high school students and practitioners and educators in the wider community. In the area of R&D, Animal Logic employs 15 per cent of its staff in dedicated research and development roles in addition to having production practices that integrate research and development within the production process itself. Rising Sun Pictures, another major studio, has established a separate research and development business and is a long-standing partner with the FTO traineeship also, in addition to conducting its own internship programs.

These companies are leaders in developing tools used throughout the industry– and the DVFX industry, by definition, is global and connected. By way of example, Animal Logic has created software products such as its MayaMan plugin for one of the industry’s most widely used 3D packages. Again, the connected way in which the industry works and shares tools means that most of the products and digital assets developed by Australian facilities are achieved through, and for, creative collaboration with international partners in producing content for the entertainment industries.

Like the better companies internationally, these companies have worked outside of old paradigms about ‘qualifications’ and linearity in career paths and embraced the qualities of the connected digital literacy that is crucial to re-sourcing learning. They have structured their businesses and work practices to reflect the characteristics of participation, hackability (that is, openness to innovation and re-tooling for improved utility by participants), and the perpetual beta. These qualities – defined by Tim O’Reilly in relation to Web 2.0 – are qualities that I argue have application in content making [McClean, 2007] and recommend here as those needed to shape the future of education and its connection to the world of making and doing.

O'Reilly describes an architecture of participation as the service getting better the more people use it and this aptly captures the nature of learning and doing in DVFX. [O'Reilly, 2005] The industry exists as a consequence of the learning-and-making-that-is-innovating in the production pipeline. Its very structure reflects the flexibility, the openness and connectivity of collaborative creative work. While many of the studios use their own proprietary tools, ultimately there is a point at which there will be the need to transfer and share data and knowledge. Problems solved in one production set up solutions for the future and assets that can be 'remixed' and re-purposed for new challenges. As I argued in relation to content, knowledge is not static, it is iterative and built through tags of reciprocity. Increasingly our achievements are visibly shared endeavours. [McClean, 2007]

The DVFX industry's achievements in building enterprises that embrace these characteristics in both learning and production offer us templates that are transferable and provide significant means for overcoming the problems we face in bringing the evolution to education.

One of the most striking things about traditional educational practice is its predominantly analogue approach. While it is something of a joke amongst DVFX practitioners that their mums still describe what they do as 'something to do with computers', it is unlikely that teachers are described in this way very often. Yet, when you think about it, the integration of technology in workplaces is so extensive that very many people would have to concede that they too, 'do something with computers'. Certainly it might be a quite limited level of interface – the swiping of a barcode over a reader at a paypoint – but it is somewhat strange that teaching is being brought so late to the digital feast of opportunity.

Perhaps the most important task ahead is to engage teachers and connect their expertise in a way that harnesses it to create the new, connected processes and tools for learning without trying to turn them into IT people, per se. This is not about taking the traditional curricula and simply putting it online, there are plenty of people pursuing that already. This is about creating a new way of delivering education that captures the work done (by students and teachers) and builds on it in a contributative and resource-making way. We also need to make this shift in a way that integrates other kinds of literacy (kinetic, haptic, musical, visual, and so on) into learning experiences and tools and to do this we need to be willing to accept new ways of expressing and demonstrating competency.

There are many innovative 'educational' products in development but until we engage the education system in shifting to digital production and connection in the same way that DVFX moved from hand-drawing and photographic production into digital production, we will not get the marrow-deep integration that is crucial for the change that we need. Nor will teachers get to have the non-linear experience of cross-training and building the new kinds of literacy required for the future and for their competence as educators of the digitally literate. In an interview on teachers.tv, Lord David Puttnam (leading education visionary and director of, *Chariots of Fire*, *The Killing Fields*, *The Mission*) asserts that teachers need to be resourced to create their own content [Puttnam, 2006] and I argue that this content should be archived and linked as a resource for learners now and into the future with full credit to the teacher that builds the resource. We need to build validation and accreditation into our archives/wikis/ and online resources.

As Josh McHugh cites in 'Synching Up with the iKid: Connecting to the Twenty-First-Century Student', teachers spend most of their time using technology to deal with the administrative load of their jobs and classroom time attending to the drill-and-practice of preparing students for standardized tests. [McHugh, 2005] If, as he argues in relation to children, 'the best way for students to learn about the world they live in is to have a hand in creating it', surely that should be true also for the students and teachers who will be the

creators of the connected education system. [McHugh, 2005] The new structure of education should be one of an architecture of participation. It is about understanding the ownership-by-all of education-for-all.

In a connected world, expertise requires constant change and upgrading. This pace of change challenges us all as we pursue our own fields but, for educators trying to create structured curricula, this is becoming the very definition of the Sisyphean task. Part of the problem is the perception that today's and tomorrow's knowledge and skill requirements can be met by the structures and tools of a previous order, one where it was possible to define and describe a status quo of knowledge that would have enduring value. If there is one thing we do know, it is that knowledge is mutable. We live in a world where even knowledge that has been part of the firmament of our facts about our world for generations is up for reconsideration (hands up anyone who wants to argue about whether or not Pluto is a planet).

Working in DVFX, change is the order of the day. Built on a foundation of visual literacy, digital literacy is subject to constant skilling. DVFX practitioners understand that they will learn how the current tools work and some of that will be helpful when the new tools come out and, in deed (that is not a typographical error, by 'in deed' I mean, by doing), they will be part of making the new tools.

Educational structures that continue to ground themselves in fixed knowledge transfer from authoritative to passive learner will have some time yet but as a participative, experiential and collaborative culture of learning+working becomes normative and expected these structures will need to adapt. Authoritative knowledge is not becoming obsolete, quite the contrary. But the mechanisms by which authority is validated and how it emanates from pooling and sharing of expertise will change and this is part of the infrastructure that we need to build and we will need to build it with an understanding of change management and the courage to embark upon the journey.

In 'If You Have a Problem, Ask Everyone', Cornelia Dean describes open-source science and the emerging practise of establishing shared learning and knowledge-building projects that cover everything from how proteins fold to sharing computer downtime in order to undertake massive calculations. [Dean, 2008] Key to the whole approach is the insight that, 'solutions can come from anywhere, and from people with seemingly unrelated work.... Dr. Lakhani said his study of InnoCentive found that 'the further the problem was from the solver's expertise, the more likely they were to solve it', often by applying specialized knowledge or instruments developed for another purpose.' [Dean, 2008]

As I said at the outset, in a connected world, knowledge sharing and building is crucial. By way of example, drawing on the most advanced work available across a variety of scientific specialties, work undertaken by DVFX artists modelling ocean waves under extreme storm conditions for feature film representations provides valuable data sets for scientists developing storm models that will be used by government agencies and environmentalists. The interconnectivity of disparately undertaken knowledge development needs to be facilitated through tomorrow's versions of what we call RSS and search and need to confront two of the things Cutler raises in his Pearcey Oration: inter-operability and bottlenecks.

In discussing the need for inter-operability – the ensuring of any-to-any connectivity – in the building of the shared space of the cyberinfrastructure, what Cutler is discussing in terms of essential premises for the regulation of telecommunications also describes a quality that emerging educational systems need to incorporate. Non-linear lives require the support of a culture of life-long learning and this means that access to knowledge and skills development

needs to be universally available: any-to-any and without ‘bottlenecks’ that allow dominant structures and the status quo to limit access and innovation.

Many of the online DVFX training resources are working to provide this standard of opportunity to subscribers who, enrolling in a program, have access to the full archives, the online-mentors and their networks of practitioners – often in real time as they work to develop a skill, problem-solve or create an innovation in the form of a piece of code. Very few of these training resources establish themselves as ‘elite’ access only programs. If you want to learn about DVFX, sign up and get to work is the order of the 24/7.

Anathema as it might seem to some now, many of the set pathways to advancement and employment in various fields might have to be reconsidered entirely. Linear models of careers based on set milestones of text-based/verbal literacy-privileged qualification might have to be extended to include means of accessing knowledge and expressing competence and validation in new ways.

Continued participation in some areas might be less about formal qualifications and more about demonstrated capacity and willingness to learn. This willingness must be supported by tools for learning that facilitates staying current with emerging developments by offering access through means that reflect the different ways people learn and know. In order to meet the realities of non-linear lives that require re-skilling and fast-skilling as an ongoing fact, education is going to have to become increasingly connected, accessible, searchable and provide meaningful feedback and validation on competencies.

In the same way that a toolbox is a collection of useable items, creating a diverse set of skill/learning tools ensures a more comprehensive fit with different learning and doing styles. A non-hierarchical valuing of skills and approaches (and by this I mean a more egalitarian view of different skills rather than not distinguishing between levels of ability within a skill) might permit a better fit for matching learning and future employability than relying on formal scores based on agreed, but perhaps not directly relevant, abilities such as capacity to remember and regurgitate the contents of a text book. We do not rank hammers over screwdrivers in absolute terms except when we look to the task that we want to undertake. Similarly, privileging verbal literacy over visual literacy as a paradigm, for example, is like arguing that hammers are superior to screwdrivers in absolute terms.

There are many areas of endeavour that are not necessarily best served by this kind of bias. For example, depending on the learning style of the student, teaching science through a virtual lab/game environment where mythbuster-style exploration and testing of ideas allows participants to learn key facts and win points and higher levels through gameplay might be more useful than rote memorizing slabs of the latest theory, especially if this practical exploration of ideas is tagged with metadata – within the game and supplementary to it –by access to an archive of the most immediate thinking and data across the sciences as a ready, any-to-any resource.

For every person comfortable with inhaling the text there is likely another that just wants to see what happens when you put the mentos in the diet coke and who can learn more from trying it out than they will from being told about it or working their way through dry text explaining the chemical reaction. Furthermore, creating learning opportunities that recognize and validate these different learning styles is increasingly resourceable in an cyberinfrastructure-spaced educational system than in one where the cleaners’ contract prohibits making a mess and the HSC results are based on the ability to recite whatever has been lodged in the short-term memory the night before the exam.

Clay Shirky, author of *Here Comes Everybody: The Power of Organizing Without Organizations*, has described some of what we are seeing in online content as a direct consequence of the cognitive surplus that grew while everyone was watching TV. Describing Wikipedia as an output equal to something like 100 million hours of thought, he gives this estimation context by citing the following: television watching in the USA amounts to something like 200 billion hours per year, 100 million hours of which is simply watching ads on the weekends. [Shirky, 2008] In this article, he references the idea that ‘the critical technology for the early phase of the industrial revolution, was gin.’ [Shirky] He develops this along the lines that the institutional structures associated with the industrial revolution – including education – arose once society stopped thinking of the social surplus of the massification of civilization as a crisis and started seeing it as an asset. He then speaks of the equivalent ‘lubricant’ of the 20<sup>th</sup> century as the sitcom and argues that while we’ve been busy watching TV, a cognitive surplus has been growing [Shirky] and is now manifesting in the form of the 13 hours of content per minute uploaded to YouTube. [Wickre and Eagle, 2008]

This leads me to the question: what is the cognitive surplus of doing homework? How many hours do students spend working on projects that are read by their teachers and *no one else*? How futile is this exercise when it could be channelled into creating the world they will live in as McHugh recommends? Of recent times, much has been made of the prospect that the current generation has been born into a world that will not let them prosper beyond the advantages that their parents enjoyed. What would happen if we gave them back the time of their lives? What if we engaged with them in building a world of learning and doing that was meaningful and contributory from the moment of connection?

If we build and implement this kind of flexibility in developing knowledge and skills we can stop focussing on turning all students into ‘hammers’ and encourage more diverse learning experiences. At present, educational approaches that are based on using and building Wikis, searchable archives, networked collaboration – in real time or as an ongoing mutating artefact – open learning up to a more connected and e•volved world. Tools that encourage haptic and experiential engagement and structures that offer purpose-driven learning are all being set up using the tools we have at hand today: facebook, youtube, flickr, and so on. A vast range of computer games – such as the Wii and so on – are starting to move learning into the ‘You and i’ of online culture and the any-to-any of connectedness. Underlying all of this development is the principle that if we imagine a way to build ‘school’ into the fabric of the playground that is *the playful world* described by Mark Pesce in his book of the same name, then, as he says, students will connect to learning through means that speak ‘louder than any lesson taught in any (traditional) school, because the lesson is repeated – reinforced – with every button’s touch’. [Pesce, 2000. 12]

The upcoming technologies that offer virtual spaces, real and convincing haptic interactivity and AI driven mentor-like feedback will open up our opportunities to develop a host of learning tools but only if we work with the development of these tools with the intention of mainstreaming them and according them a validated place in the educational system. These and the emerging many-ways-of-learning and acquiring skills have to be supported and acknowledged and there has to be an acceptance of this in the assessment/qualification process; a many-pathways structure must be created. There has to be acceptance and encouragement of lateral transfer of skill, knowledge and experience. Qualifications need to be determined in a more inclusive way and the measures of quality that are fundamental to ‘qualification’ must have direct meaningfulness.

For the DVFX industry this tends to be measured in terms of: ‘show me what you have done, in a way that lets me see how you have done it and gives me an insight into how you work

and learn, and I will see how that fits into what I need in skill sets right now'. One of the important qualities of connected industries is that they are always changing and there are many ways to develop new skills and higher level skills. In DVFX the quality of the portfolio is the persuasive factor not the institution or level of the degree. The skills are measured in terms of their utility and current relevance whether they have been developed through a DFA or through an non-accredited online course. If watching *You Suck at Photoshop* on YouTube helps someone improve their skills as a compositor, then those improved skills are what matters.

Even in fields where accreditation testing and certification of skills are fundamentally necessary, the relevance of standards and the capacity to change those standards is crucial. In an e•volving world, the ongoing fireworks-like knowledge-burst of advances is so great that no one person can know everything they need to know but they may be able to access the bit they need to know *right now* if everyone plays well together, collaborates, shares knowledge, and networks achievements to create the connected 'common wealth' of ideas, resources, and solved problems. While we are as yet some way from the science fiction-style download-the-expertise-you-need-to-have-right-now level of connected learning, it has been imagined because we are beginning to understand that over a lifetime our skills and knowledge will have to be upgraded, constantly and quickly.

To build upon these initiatives we need to validate them and acknowledge their place alongside of traditional methods of learning. They have to be given parity – as do the skills and knowledge that they represent. When we talk about learning through connected means, we often talk about following, and helping to make, threads. Online culture is an-ever weaving/woven fabric of ideas, knowledge and linkages that unfold in layers that cross, recross, uncross and go off in new directions. Unlike the censored/edited texts of the past that sought to create a definitive/locked construct, *what has been* in the online can be reviewed/revisited/reconsidered/reconstructed as per the edits on Wikipedia. Caches mean that any genie of an idea that escapes the bottle should be regarded more like the little brooms of *Fantasia* than a creature that can be recaptured and contained.

The advantage of these qualities is that it fosters a culture of openness and democratizes knowledge and knowledge-sharing. It allows us to explore data and ideas in powerful ways. By archiving iterations and the processes by which things have been constructed we can go back to the source and re-think ideas from point of origin. We can construct and deconstruct. We can trace and retrace ideas and re-source them. This culture of access and mutability is a powerful opportunity for innovation in thinking and creating.

The computing power of the future – even of the very near future – will allow us to put aside many of the 'scarcity' mindsets of the past and allow us to build magnificent resources harnessing that cognitive surplus. Traditional face-to-face teaching is expensive and in many ways wasteful because it requires doing the same job over and over when we can leverage this effort through building databases and archives of 'teaching' that are universally accessible. We are seeing moves toward this already with iTunes university and online courses and as a pioneer in distance learning, Australia should be particularly well-placed to take up the digital challenge if it is resourced/re-sourced to do so.

Instead of portioning out capital funds like parsimonious keepers of medieval dole boxes, we need to be building virtual laboratories, 3D/iCinema-style tours of geographical places, museums, archaeological sites, and so on that have capacity to explore the world through time tagged with metadata about the historical record available as audio/text/or visual representations. A connected world that lets a student see the Book of Kells in a virtual environment where pages can be turned and metadata can be accessed to follow threads that

link to what is on the virtual page is infinitely preferable to a photograph of a single page with a paragraph or two describing the glory of a book that simply could not stand up to the rigours of being explored by the billions of hands that would want to turn its pages in the physical world. The future of ICT, computer graphics and immersive environments will give us a chance to explore the world as it is, as it has been, and how it might become.

There needs to be an open source approach to building digital archives of texts, events, images, recordings (audio and visual in both raw – that is, rushes, location camera footage, motion capture data, etc., – and finished formats such as films, documentaries, television programs, news reports etc.), and approved ways of creating new artefacts with these materials using the same kind of conventions that we have in place for citing reference materials from the texts that have built our wealth of written resources and knowledge. There are initiatives in this area also as Judith Bowtell's presentation on the Film Australia, DIY Documentaries project describes later in the program.

However, in building these resources/re-sources we have to be on guard against business case and IP ownership biases muddying the waters in the digital space. These concerns need to be resolved in a way that acknowledges IP without creating barriers to innovation. Imagine the thin offerings that would replace our current approaches to writing if anyone wanting to quote another source had to engage a lawyer and pay for a licence in order to refer to ideas or use words that have been subject to previous printed copyright determinations. We have managed to find agreement for this kind of connectivity in thought and imagining in the world of the written word, surely we can find our way in this new space also and the creative commons initiatives are a good start in the direction we need to support.

Building tool boxes of code and apps is another way to re-source the future and the open source community has championed this approach. Again, open source applications – such as those being developed by Sugar Labs – are based on a philosophy of building and creating collaboratively and in a world where only by sharing and contributing toward the greater common wealth can we continue to innovate and grow. These paradigms are valuable not only for their tools but for the principles they offer.

George Lucas has established Edutopia.org, a foundation for the integration of technology in education. The Foundation maintains that, 'Integrating technology into classroom instruction means more than teaching basic computer skills and software programs in a separate computer class. Effective tech integration must happen across the curriculum in ways that ... deepen and enhance the learning process. In particular, it must support four key components of learning: active engagement, participation in groups, frequent interaction and feedback, and connection to real-world experts.' [Edutopia Staff, 16 March 2008]

Currently we are working on putting in place computers (and perhaps electricity) but if we are limited to shared download connectivity of 10Mbit/ps (the NSW commitment) or even 12Mbit/ps (the Federal commitment) we are not even going to catch up to the past, let alone make it into the future. If connectivity was the Olympics, Australia wouldn't be earning gold medals, it wouldn't even be competing. In relative terms, we would barely be able to watch the broadcast. The cost of connectivity is a serious problem. As one report described, 'A University of Leicester space scientist has worked out that sending texts via mobile phones works out to be far more expensive than downloading data from the Hubble Space Telescope.' [University of Leicester, 2008] So it seems that the business case is working one side of the deal to its advantage but when, for example, local performance of 10Mbit/ps over copper is saturated with only 40 people trying to conduct business with mainstream ICT productivity apps, and Telstra's response is that there is no fibre available in the Sydney CBD and that the



user is not at liberty to install their own, then the case for participating in the connected world looks like it is in trouble.

With the infrastructure on offer, the likelihood of students being given the basic computer skills and software programs Edutopia warns against is probably the best case scenario. Which means that we might have to hope that the CSIRO or NICTA are working to resolve that wormhole idea so that we can send the graduates of 2020 back to 1990 where those Microsoft Office skills are going to come in handy. Although local scientists have been instrumental in helping create the technology of the future, in a report on the Centre for Ultrahigh bandwidth Devices for Optical Systems (CUDOS) work on a photonic integrated circuit that offers the potential to speed up Internet performance, Professor Eggleton is quoted in the conclusion as saying, 'It won't be deployed in Australia first.' [Smith, 2008] Given that we are still struggling to provide reliable 10Mbit/ps download and can offer symmetrical download to only those with the deepest pockets or the most robust business case, it is hard to figure out how our mathletes of the future are going to win gold in the Olympics of connectivity.

In *The Playful World*, Marc Pesce quotes Douglas Englebart on how humans would cope with the pace of change. Englebart's answer was that, 'people need to get smarter, and they need to apply their smarts to getting smarter, constantly *augmenting their intellect*, using intelligence in a leapfrog game to gain ever greater intelligence.' [Pesce, 2000. 149] Contrast this with the comments of Professor Geoff Masters, the chief executive officer for the Australian Council for Educational Research, who observes that, 'Most students can complete 13 years of school (in Australia) and be awarded a senior certificate without having to demonstrate minimally acceptable standards of proficiency across a range of fundamental domains such as reading, writing, numeracy, science, civics, and citizenship.' [Patty, 7 August 2008] Putting these two statements into context, David Brooks has answered the question of why the United States had become the leading economic power of the 20<sup>th</sup> century with the argument that it was because they made 'an unparalleled commitment to education, hard work and economic freedom.' [Brooks, 2008] A commitment that seems to have faltered of recent times.

If Australia is going to be an active participant in the global/urban of the 21<sup>st</sup> century, then it is time to step up to the challenge with an unparalleled commitment to education at the very least. The challenge for education has changed. Lifelong, self-directed and assessable learning is essential because change happens so very quickly now. Reading two or three professional journals is not enough. Doing a course every couple of years in the hope that enough of it will be useful and at the very least the qualification will look good on the resume is insufficient because that approach is not about learning. It is about school. If the information age is what we live in, then the education age has to be its reflection in the mirror. How do we move from a paradigm of school established centuries ago where learning relies upon being lucky enough to get a good teacher to a paradigm where the focus is on being assisted in finding out what you need to learn and having the tools to do so? Why train expert teachers in the hope that there is a fit when the information is already there, it just needs to be accessible and engaging in a user-suited way?

Learning is the killer app of the 21<sup>st</sup> century. In order to create a learning culture, the equation is fairly simple: learning must equal fun. However, it is very likely that there will never be a good 'business case' to justify the changes that this paper recommends but I believe that they are crucial for survival. It simply may be a case where it is necessary to accept that survival is expensive. E•volution argues that the cost of failure is greater than the cost of building the infrastructure and tools for success. To win it, you've got to be in it or, as Adam Savage says, by all means, throw money at the problem! By all means!

The caveat in this is that we should not throw money at doing more of the same thing. We need to leverage the qualities of the connected world and engage students and teachers in creating the world we live and learn in. If we do this then hopefully the future – after the e•volution – is a time when school and learning will neither be a waste of time nor really that different from each other.

That said, we really are going to have to do something about the broadband – perhaps we should start talking about and demanding hyperband (or whatever it is going to be called) – and, of course, the electricity.

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Also:

Animal Logic: <http://www.animallogic.com/>

ED.gov: [www.ed.gov](http://www.ed.gov) (US Dept. of Education/national education technology plan).

FTO Digital Visual Effects Scheme: <http://www.fto.nsw.gov.au/poa.asp>

Film Australia: DIY Docos

iCinema: [www.icinema.unsw.edu.au](http://www.icinema.unsw.edu.au)

Rising Sun Pictures: [www.rsp.com.au](http://www.rsp.com.au)

Sugar Labs: [sugarlabs.org](http://sugarlabs.org)

TeachersTV: [www.teachers.tv](http://www.teachers.tv)