Living on the Future Edge

By Ian Jukes & Ted McCain

Synopsis: Today, in a world where change is the constant, you just can't believe your eyes. As a result, the true of power of existing technologies can only be understood as part of the remarkable compression of computational speed and power that has occurred over the course of the past 50 years through the present to startling implications for tomorrow. This presentation traces the amazing continuum of development from the building based computers of yesterday to the astounding desktop devices of today. But things don't stop there! This presentation will profoundly challenge your fundamental assumptions about new technology as it projects where things are really going - from desktop to palmtop to wearable to embedded computing and well beyond. It then challenges the audience to stand back from their assumptions about technology and consider how this will change the classroom, the curriculum, learning, instruction and even our fundamental definition of intelligence.

Handout:
Let's talk about technology for a few minutes. Have you noticed the absolutely amazing array of new devices and gadgets that suddenly seem to have appeared on the scene? The remarkable aspect of this development is that technology isn't just changing, there seems to be an ever accelerating rate of change. Things are changing so quickly that it's almost impossible to keep up with all of the developments. And it's even harder to grasp the significance of this exponential growth in the speed and power of electronic devices. Why? Because the mind simply can't keep up.

There's a critical point embedded in these observations. Despite the continued proliferation of new gadgets, the issues we face today are less to do with *hardware* than they are to do with *headware.* When push comes to shove, dealing with all these changes has far less to do with the gadgets than it does with people and their mindsets. The problem is, that historically, mindset has always tends to lag behind mindset.

There are many visionary examples of this from the annals of history:

> *What can be more palpably absurd than the prospect held out of locomotives traveling twice as fast as stagecoaches? - The Quarterly Review, England (1825)*
>
> *This 'telephone' has too many shortcomings to be seriously considered as a means of communication. The device is inherently of no value – Western Union internal memo, 1876*
>
> *The horse is here to stay but the automobile is only a novelty, a fad, a passing fancy... President of the Michigan Savings Bank advising Horace Racham (Henry Ford's lawyer) not to invest in the Ford Motor Co., 1903*
>
> *While television may be theoretically feasible, commercially & financially I consider it an impossibility, a development of which we need waste little time dreaming. Lee DeForest, (1926) (American radio pioneer)*
>
> *There is not the slightest indication that nuclear energy will ever be obtainable. It would mean that the atom would have to be shattered at will. Albert Einstein, (1932)*

Now while we may laugh the lack of vision in these statements, it must be made clear that these folks weren't stupid, it's just that at every stage in our history, new technologies have been a challenge to the existing mindset. This is because technology fundamentally changes the way things have been done – in many cases, the way things have been done for years even decades or centuries. And as this happens, the changes tend to challenge our mindsets as they push us out of our comfort zones. As a result, it's

often difficult to grasp the significance of any one development in isolation because the changes they bring may force us to confront the very essence of our human nature. You see, at what point do we "Never!" "This will never happen in my life" – for often this is not you but your paradigm speaking.

As we consider the incredible development of technology today and the challenges it places on our mind, let's consider two trends we simply can't ignore. The first is Moore's Law.

Gordon Moore was the co-founder and chief research scientist of Intel Corporation, the leading manufacturer of microchips for computers in the world today. In 1965, in Electronics magazine, he proposed Moore's Law. The law suggested that the processing power and speed of any electronic calculating device doubled every 18 months, while at the same time that the price for that technology declined by about 35% a year relative to the power. This is exponential (as opposed to lineal) growth. So far, Moore's prediction has been uncannily accurate, but it's very hard to grasp the significance of Moore's Law because the mind simply can't keep up.

To provide a context to exponential growth, let's consider the development in the power of computational devices from the beginning of time. Truly, necessity is the mother of invention. Computers grew out of a human need to quantify things. Early humans were content to count with fingers or rocks. As cultures became more complex, so did their counting tools. The abacus, the Arabic number system, and the concept of zero are only three examples of early calculating tools. Each of these ideas spread rapidly and had an immediate and profound effect on society.

Many factors have contributed to the growth in technological power. The growth in population; the increased complexity of the economy; a need for the more powerful computational power required to monitor and manage an increasingly complicated world; and, of course, war technology. All have lead to an increasing demand for more and more sophisticated calculating devices. But there was very little increase in power for most of the 10,000 years of recorded human history. The real growth began with the emergence of electronic calculating devices into our lives. Growth that has been compressed into little more than the last 50 years. However, at every step of the way, understanding and application of the technology has lagged behind the development of new technologies.

> *I think there is a world market for maybe five computers -Thomas Watson, chairman of IBM, 1943*

Let's consider the Eniac computer that first came on line in February,1946. The Eniac, which cost $750,000 in 1946 dollars (about 10 kabillion dollars today) was a 30 ton building-based computer designed to calculate trajectory tables for new guns. It covered two floors - one for the computer and one for the cooling system. The Eniac had 6,000 switches, 70,000 resistors, 500,000 hand-soldered capacitors and more than 19,000 vacuum tubes. One or more of these tubes failed on average every 7 minutes. Not what we'd call user friendly/ But when it was running, it could complete a 10 digit multiplication in 3/1000ths of second. Relative to what had come before, this was a huge jump forward in processing power and its development held huge implications for the people of the time. Yet still the mindset lagged behind the technology.

> *Computers in the future may have only 1000 vacuum tubes and weigh perhaps 1.5 tons... Popular Mechanics - 1949*

Over the course of the next several decades, countless advances in technological power occurred. In the early 60's the introduction of the IBM 360/370 lead to a remarkable acceleration in power and performance. This maturation of the mainframe and a new generation of room based computers turned IBM into a computer giant. Then in the mid 60's, DEC introduced the powerful new PDP computers, which were made possible by large scale integration through the photographic reduction of circuits onto silicon chips.

And in 1969, Intel Corporation introduced the first microprocessor - a CPU on chip. This was absolute conceptual dynamite! What little more than 20 years previous had been the size and cost of a mansion was now the size of a stamp and the cost of a dinner. This was the beginning of a wave that would

engulf us all. But still mindset lagged behind the emerging technology. When shown the microchip in 1969, an engineer from IBM's Advanced Computing System Division commented:

> *But what is it good for?*

For most of us, calculators were the first manifestation of the technological revolution. Big, ungainly and relatively limited in their capabilities, their design nonetheless clearly demonstrated that electronics manufacturers were technically able to make microcomputers. However, there was still very little understanding of, or demand for microcomputers, so initially, they could only be acquired as kits such as the Altair 8800, which required hundreds of hours of painstaking assembly; was programmed by methodically flipping hundreds of switches; and which featured an awesome 1/4 K (256 bytes) or memory.

In 1976, the Radio Shack's TRS 80 became the first commercially available first pre-assembled microprocessor. The entire CPU was contained in the keyboard, data storage was made through a tape recorder, and it had a remarkable tendency to lose all data when the keyboard was placed too close to a the monitor. Just about the only decision to be made was whether you were going to have 4K on board or go all the way to 8K. Nevertheless, relative to the cost and size of previous computers, the capabilities of the TRS 80 were absolutely amazing! Still many people just didn't get it.

> *There is no reason for any individual to have a computer in their home*
> *-Ken Olsen, president and founder of Digital Equipment Corporation, 1977*

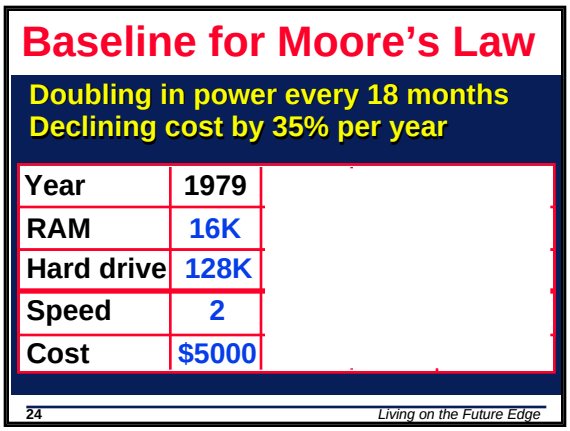
Shortly thereafter, along came the Apple I. Most of us have heard the remarkable story about two young entrepreneurs, Steve Wozniak and Steve Jobs, who started working in a garage. They were rebuffed by Atari when they offered to *give* them their invention. And what an amazing device it became - standard 16K of memory, with the ability to expand all the way up to 64K. Tape recorders replaced by disk drives as a storage device. Desktop printers replaced floor printers. For those who had followed the development of computers since the early days, this was a remarkable event. A complete computer system on the desktop could be had for under $5000.

As a result of their work, in the summer of 1979, the revolution really began when business discovered microcomputers. An absolute sales explosion ensued as Apple, Commodore, Radio Shack, Sperry and Osborne products brought what had previously been the mainframe to desktop. This heralded a new age of personal productivity. But once again, we saw that with the new technology came from an old perspective. As a result, these desktop computers were initially viewed as little more than electronic typewriters in much the same manner that the first automobiles were initially seen as horseless carriages. In both cases, it took people many years to get beyond this thinking.

This is what paradigm paralysis is all about. Perspectives are often held back by previous experiences that delay or limit our ability to understand and use new technology. As a result, when they initially appeared, there was a great deal of misunderstanding about the devices; and consequently, an enormous amount of unused potential. This particularly applied to education, where English teachers struggled (and some continue to struggle) trying to understand how to use computers to enhance the writing process; and in Business Education, where teachers were unable to comprehend the potential of speadsheets and data processing in reinventing business practices.

> *I have traveled the length and breadth of this country and talked with the best people, and I can assure you that data processing is a fad that won't last out the year -the editor in charge of business books for Prentice Hall*

Let's use 1979 as the baseline for considering Moore's Law. 16K of RAM, 5 1/4" floppy disk that held 128 K of files, a blazing 2 Mhz processor (translated into non-technical terms …SLOW!!!) at a cost of $5000.



From the perspective of today, these specifications are laughable, but at the time, and particularly compared to the cost of mainframes and minicomputers, such capabilities were absolutely unbelievable.

From this point forward, things began to move rapidly. One important benchmark was IBM's role. IBM helped set the standard for the new PC industry because their pivotal role in the development of mainframes and mini-computers. But because they came from a mainframe mindset, they initially showed contempt and disdain for the micro-computer market. Their developers wondered out loud why anyone would need a PC – and this clearly showed in their system design strategies.

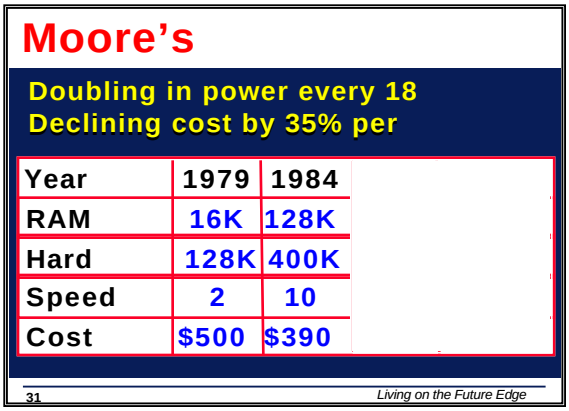
For the sake of speed, simplicity and cost, IBM did not build a proprietary system - instead of using its own in-house technology, as was usually the case, it used industry-standard components available to anyone bent on entering the market. A little known aspect of this story is that in large part due to this, they decided to contract a small entrepreneur from Bellevue, Washington to develop an operating system for the IBM PCs - this was known as PC DOS. But because of the less than careful manner in which the contract was written, three months later Bill Gates, who made $32,000,000 a day last year, released Microsoft DOS and the die was cast.

Naturally the first iterations of the operating system were clunky. It became accepted as simple fact that using technology was painful - and that in order to properly use the machines, you had to spend long hours hunched over a keyboard learning to speak in technological tongues in order to become part of a specialized priesthood.

Meanwhile, over at Xerox's Palo Alto Research Center, a small group was working on a fundamentally new concept. The Alto was a windows-based computer that used a Graphical User point and click interface. With this concept, Xerox could have cornered the market on PCs, but they just couldn't see the potential. They did very little with the concept. Enter Steve Jobs from Apple, who had a semi-religious experience when he saw the Alto for the first time. In short order, he bought it and renamed it first as the Lisa and then the Macintosh. For many, this event has been heralded as the most significant conceptual breakthrough in the history of PCs, as in 1998, Microsoft holds its cutting edge product Windows '98 up to a standard that was set back in the 70's at the PARC.

> *I see no advantage to the graphical user interface -Bill Gates, Chairman of Microsoft, 1984*

Meanwhile, the relentless power of doubling of Moore's Law was really starting to impact upon the processing power and cost of computers:



As Moore's Law continued to relentlessly churn, things evolved rapidly. In the mid 80's, we saw the first appearance of "portable" or "luggable" computer. These machines were bulky and more than occasionally unreliable. The funny things was, that while the technology that made portable computing possible had existed for some time, it would be several years more before the enormous potential for increased productivity would be really understood and utilized. Once again demonstrating that it takes years for the thinking to catch up with the technology.

And now, here we are in 199, 5 staff development days away from the millennium, we've finally caught up to the present. It's very clear that the portable computing paradigm is really beginning to hit stride. People are beginning to understand the incredible potential contained in what is now the equivalent to a mainframe sitting on your lap.

However, we haven't got time to relax, because as this happens, new generations of technology continue to rapidly appearing. At any one time, there are probably 3 to 5 generations of technology already in the pipeline that just hasn't got here yet. In fact, the technology that you will be using in the next ten years has probably already been invented – you just can't buy it yet. This is due in large part to Moore's Law.

Doubling in power every 18 months
Declining cost by 35% per year

Year	1979	1984	1998
RAM	16k	128k	16mb
Hard drive	128k	400k	2gb
Speed	2	10	166
Cost	$5000	$3900	$1000

But it doesn't stop there. In a recent interview in Wired Magazine, Gordon Moore suggested that there is absolutely no indication that the rate of doubling will diminish for at least 10 - 15 years. This suggests that the technological transformations of the past five decades will be absolutely dwarfed by the changes of the next few years. If this is the case, extrapolating out to the year 2010 (when students who are presently in the primary grades will graduate from school) the impact of the doubling becomes so incredible as to almost be unbelievable...

Year	1979	1984	1998	2010
RAM	16k	128k	16mb	10,640mb
Hard drive	128k	400k	2gb	1,230gb
Speed	2	10	166	110,390
Cost	$5000	$3900	$1400	$10

Don't believe us? We don't believe us either. But think back to the first Hewlett Packard calculator from the earlier 70's - $795 –so clunky you had to use a wheelbarrow to move it around – and with the ability to add three digit numbers as long as it didn't have to carry. Now they're so tiny and common they're given away in cereal boxes.

It's important to understand that in times of radical change such as these, it's critical that you consciously force yourself to stand back from the technology so that you can get a better sense of the bigger picture. Standing back, it becomes clear that we cannot view any technology outside of the continuum from past to future - from where its come from to where its heading. The power exponential growth means that new technological *paradigms* are now appearing before the previous paradigms have been properly implemented or even fully understood. The Apple II computer was sold for more than 10 years. Now the renewal cycles for most new technologies are calculated in terms of *months* or *weeks* rather than years. As a result, when we consider a "new" piece of technology, it's important to keep in mind that in all likelihood, there are 3 or 4 newer generations of the same technology that have already appeared or are on their way.

The Internet Revolution!
It's hard enough just having to deal with Moore's Law. But then combine with the subsequent emergence of the Web as a commercial force in our lives. Do you remember when you could actually look at a newspaper or magazine and NOT see some gee whiz articles about the amazing potential of the Web? Do you remember when surfing was done outdoors? When Java was something you drank with milk and sugar? When you didn't have to know what the @ sign was for? When you could actually turn on a show or watch a movie and not see http:10/9/99/ spend.bucks? It's hard to believe that our world was a simpler place a little more than 3 years ago.

But then, everything changed in the summer of '95, when using the Web went from something done by geeks to a sign of being cool – from being a specialized thing done by propeller heads who spent their time waxing their modems to get higher speeds to something deeply embedded in the public consciousness. In '93, there were no users of Web – this was mainly because Marc Andreassen (sp??), the creator of Mosaic, which eventually became Netscape, was still in high school suffering from terminal acne. Now, according to the latest stats there are 130 million users in 86 countries, with a new user being added every second, 24 hours a day, 365 days a year. It's projected that there will be between 250 and 400 million regular users by the year 2000 and 1 billion users by the year 2005.

Latest estimates are that there are approximately 400 million web pages out there and that a new Web site is being added every 4 sec – that there will be more than 1 billion web pages by 2000. Conservatively, in terms of pages of content, the Web is doubling in size every 120 days, which means that conservatively it is doubling in size 3 times per year! If this is the case, more than 80% of the sites that will be existing a year from now don't exist today. This is absolutely stupendous, biological growth – like bacteria or disease.

Things are growing and changing so quickly, that we have to viewing developments in dog years. One year of Web development is the same as seven in almost any other medium. If we measure Web development by this standard, it' s been more than 2 centuries since the Internet was born, more than 20 years since the emergence of the Web; and by the year 2000 (5 staff development days away) the Web will have undergone another decade of growth & development
Then combine this with the explosion of E-mail. Current estimates are that more than 8 billion e-mail

messages are sent daily –this figure is anticipated to reach 17 billion e-mail messages daily by the year 2002. It's use is currently growing at 1000 times the rate of conventional mail. Access to the Web combined with use of e-mail has lead to a fundamentally new mindset for many people. Until recently, cyberspace was only for modem jockeys who spent their lives sitting in the ethereal glow of a computer screen getting a great tan while drinking Jolt Cola and eating Hostess Twinkies. Now, it's a middle class suburb. And the amazing thing is that this has happened in a world where it's till going to cost you $2000 by the time you've bought your computer, modem, software and service access and where downloading files is literally like trying to suck peanut butter up a straw.

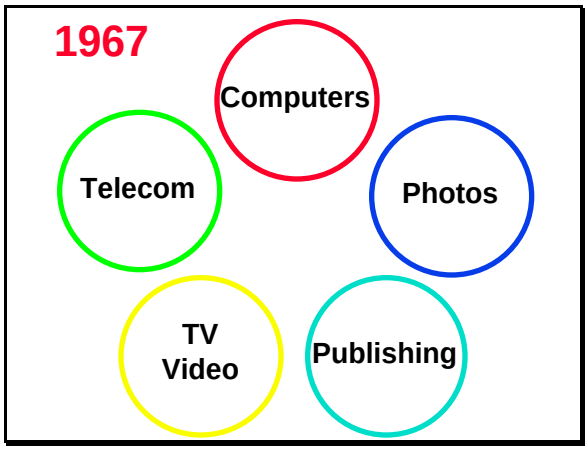
But stand back for a moment and consider where things will go tomorrow when we see the appearance of little $500 network and handheld devices in combination with new products and services, and growing awareness of the power and potential of on-line communications. Where's do you think that usage is going to go? Down or up?

Look, we still aren't there yet. There's lots of criticism about slowness, security, under/over regulation, and system overload. But we need to get over it. These things will eventually be resolved. Just like the early telephone system, things aren't perfect yet, not all have the necessary access, it's not always easy to use...but despite all of the "Yeah buts", this thing is coming at us like a freight train. In just more than 3 years, it has reached full-fledged status as a commercial medium. It is probably the dominant communications medium for next century – a veritable 10.5 on Richter scale of social significance – and so, it's almost impossible to overstate its importance. Then combine this with rapidly increasing bandwidth speeds.

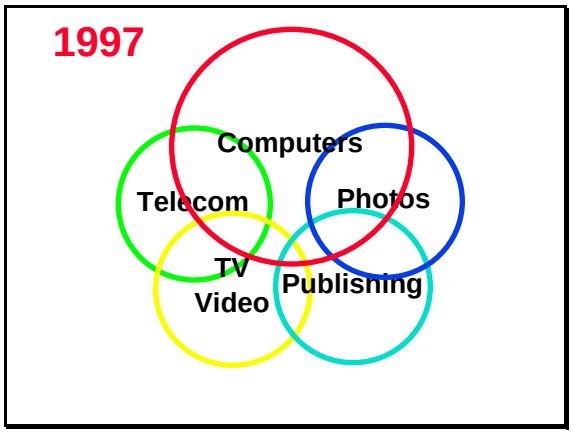
See – how fast is fast? Anyone out there still using a 14.4 modem (no one laugh hysterically)? When you jump to 28.8 or 56 K modems, the speed increase is pretty incredible. Anyone experienced a cable modem – whew!!! Blows back the hair. Or how about a cable modems chugging along at 10 Mb per second. Ten megabytes per second is a CD ROM in 60 seconds – A CD ROM represents a secretary typing at 100 words a minute, 60 minutes and hour (this is fantasy!), 8 hours a day, 5 days a week, 52 weeks a year, for more than 12 years. Is that fast? What about fiber optics - 10 gigabytes per second traveling down a single strand of glass fiber - 16 CDs per second – that's everything that Shakespeare has ever written (he hasn't written a lot lately has he?) translated into 200 languages and sent from New York to Los Angeles in .0043 seconds. Is that fast? Well, at the Lucent Bell Labs in New Jersey, they have just announced speeds in excess of 5 trillion bits per second or 8000 CDs per second down one single strand of glass fiber.

But if you think that this is fast, you need to get over it. George Gilder, a widely respected and quoted futurist from San Francisco says that we need to deal with the Law of the Photon, which tells us that bandwidth speed and capacity is currently tripling every 12 months. Gilder asserts that this tripling will continue for at least another 20 years. If so, bandwidth speed will increase during that span by 1 billion times. If this is the case (and there is little reason to doubt that it isn't) this means that here in 1999 we are literally in the Stone Ages of optical communications. Fiber, wireless and coaxial cable are truly the concrete and steel of the information highway. As a result, photonics is the near and distant future of global information economy and means that the technological and informational transformations of the past 20 years will be absolutely dwarfed by the transformations we will experience in the next 3 to 5 years of our lives. These changes will have a profound effect upon the way we work, the way we play, the way we communicate and particularly, the way we learn. This pushes and will continue to push our mindsets

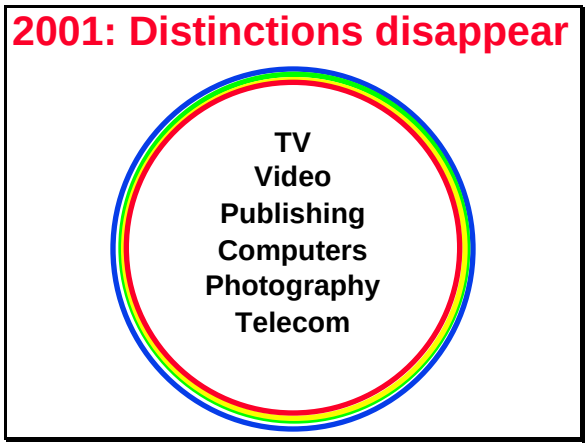
But it doesn't stop there. When these powerful trends get together with the third trend, technological fusion, things start to get really weird. Technological fusion occurs when technological cybrids are created when previously separate fields are fused together. In 1967, there were five very distinct technological applications - telecommunications, computers, photography, publishing, and TV/Video



In 1999, we are beginning to see a distinct overlap between what were previously separate technologies:



As we extrapolate this trend, it's easy to anticipate where things are heading:



In very short order, we are moving from multimedia to monomedia – it's all zeroes and ones to the technology – how they get put together is entirely up to the user. This is a direct result of technological doubling and technological fusion. Today, we're seeing more and more electronic devices being compressed into a smaller and smaller piece of electronic real estate. All forms of media are now converging around the portable digital desktop while at the same time we are seeing a movement toward natural interaction & technological transparency.

Consider the Newton by Apple. The Newton was the first hand-held device. Smaller than a paperback, the Newton was a powerful palmtop computer complete with handwriting translation software, a

writable plasma screen and the ability to wirelessly send/receive email and surf the Internet. Once again, when it was first introduced, most people didn't understand how it could be effectively used. The Newton is no longer being made, having been over run by smaller, more powerful technologies such as the Pilot, that have extended the power of the palmtop well beyond the original vision of the Newton.

The hard lesson is, that if it exists, there are probably several more generations of the technology already on the production line. So these palmtops, as is the case with all new technologies, must be viewed as museums - today's high technology quickly become tomorrow's discarded antiquities. They are simply a portent of things to come. As we write this article, new indicators are already on horizon. Hitachi has been profiling an early prototype of Bill Gates' long talked about wallet PC – Nokia has released a digital celleputer – Mentis is selling a wearable multimedia computer with voiceprint and a GPS system. And it doesn't stop there.

Technological fusion leads quickly to powerful new electronic cybrids. Moore's Law ensures that these devices are quickly being superseded by even more powerful devices. One doesn't need to be a rocket scientist to predict that based on the emergence of these cybrids, by the year 2001 such devices will be as common and transparent as pencils. However, unlike pencils, these devices will be able to communicate effortlessly with all of the other devices that are also out there.

Unfortunately (or perhaps fortunately, depending on your definition of "disposable income") these devices have not been developed primarily for us, but rather, for our children. Such devices are the next natural next step for Nintendo generation as they move from schools to the workplace. Since children have no previous experience, the current technological paradigm easily becomes their personal technological paradigm. For them, these devices are merely part of the everyday fabric of their lives. It's our problem if we're having difficulty understanding and/or embracing this.

Looking to the Future

So where do things go from here? A wise man once said that those who live by the crystal ball usually ending up eating crushed glass. It's hard to accurately anticipate the future when you live in a world of fundamental uncertainty. Nevertheless, we must try. We all need to start thinking in future tense – to live life like a quarterback. A quarterback must be a futurist – learning to throw the ball not to where the receiver is, but to where the receiver is going to be. It's much the same with technology. We need to be looking ahead, considering where things might go 3, 4 even 5 generations down the road.

The future possibilities are absolutely amazing. Miniaturized electronics built at the micron level; palmtop technologies effortlessly connected to the global digital network; the ability to fax three dimensional objects; molecular and bacteria based computers; new cyborg controls; remarkable new implant technologies and body transceivers; intelligent pacemakers; biofeedback technology; thought control computing; virtual experiences; virtual existence - all of these and much, much more are in our immediate future. These will be remarkable new devices that create potential for amazing new possibilities.

But are we becoming the Borg? We will become the computer at the point when the power of the computer is no longer able to be viewed in isolation from humankind. Increasingly, we will live in an anytime, anywhere world where if you're not connected, you're really won't be computing. To really understand where we are and what we need to do, we must stand back and consider the profound implications all of these developments will have for education. And as always, mindset will be the key to bringing the many possibilities to reality.

Okay, let's stop for a moment and take a deep breath - I suspect that many of you are convinced I've gone right over the edge - that this will never happen - that the medication must be wearing off. My friend and colleague David Thornburg once said that the difference between science fiction and reality is that <u>science fiction</u> must be believable. That's because much of the reality coming down the pipeline at us right now is absolutely <u>unbelievable</u>. And while things may not turn out exactly like they have been described here, the bottom line is that these new technologies and their accompanying mindsets are coming at us like an absolute tidal wave. Without doubt, tomorrow's student will use voice activated/thought activated computers that will be directly connected to the Global Digital Networks through such things as body-implant transceivers, wearable computers and transplanted cornea virtual

retinal displays. Stuff that's worth a fortune or not even available today will be on the clearance table at WalMart tomorrow.

So how will teachers react when this stuff starts appearing in kids' backpacks? Before we consider that, let's reflect back to what happened when the first ballpoint pens started appearing in classes back in the 40's – we banned them. When the first calculators showed up in the early 70's? We banned them. When the first student assignment appeared on a disk in the 80's? We refused to accept it. The bottom line is that this is all about mindset. So how will teachers react when the first Borg walks into the classroom? Will we be banning the kids? Will we be telling them to "stop thinking that", "stop being that!" or "stop going there!"

Stand back! Our job is to stop and consider what this all means for education. That's because, for education and educators, the treadmill appears to keep getting steeper and steeper; and faster and faster. It's becoming increasingly harder to keep up with the radical changes that we are being confronted with each and every day.

Does this mean that the situation is hopeless? The answer to that question is absolutely yes… if the focus continues to be on the acquisition of technology - because we in education just haven't got the financial or emotional wherewithal to keep up. So the critical questions that must be asked are: What should our focus when these kids walk into our classrooms? How will these new technologies change the way we view curriculum and learning? Are there principles and processes which transcend the new technologies and the proliferation of new technological paradigms?

The answer to these and many other questions is that it's all about making the move to transcendental teaching. The answers are founded on the development of a new educational paradigm that makes the fundamental shift from a content based curriculum to a process based curriculum. A curriculum that emphasizes the process of learning rather than just the product of learning. A new paradigm that focuses on the transparent usage of technology rather than on just the tool - on information fluency - on critical thinking and problem solving skills - and on real world communication skills. It's all about moving technology from being a toy to being a tool. The bottom line is that technology is not a subject or curriculum, it's a process – so the critical issues we must consider are far less to do with hardware, that they are to do with headware. It's about organizing technology around student learning, not student learning organized around technology. And our job as educators is to step back and consider where and how this stuff all fits together – but to do this we must understand that it's not the tool, it's the task that must take center stage.

Will this all really happen? It's not a matter of IF but of WHEN. And the message to all educators is that it's time to get over it and get on with making the necessary changes before its too late. The bottom line is that we must move quickly - otherwise the market will find its educational experiences elsewhere. It's this that should be pushing our mindset!

What we are dealing with are matters of inner space. In the 21st Century, you will be what you think because the new frontier is a mental one, not a physical. Our greatest challenge is to comprehend the magnitude of the changes that will be necessary. As we move to 21st Century be certain that the biggest challenge will be to continually let go of your current mindset. This process starts and ends with us. What's our job? To prepare kids for their future rather than our past or present. We need to start by retooling our minds.

> *Change is the law of life... ...those who look only to the past or the present are certain to miss the future John F. Kennedy*
>
> *This epoch will pass - indeed, it is already passing. We are beginning to grasp that although power can be contained in a boiler, mastery exists only in the brain: in other words, that it is ideas, not locomotives, that move the world. To harness locomotives to the ideas is good; but do not let us mistake the horse for the rider. Hugo, Victor. (1862). Les Misérables*

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