Foundations of the Future

Rethinking Education for the Photonic Age

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Synopsis

The foundations of the current climate of frenetic technological development can be traced back to Samuel Morse and the invention of the telegraph in 1844. This began an incredible story of the exponential increase in power of communications technology. Seen in the context of the continuum of development of communications systems from the past to the present and into the future, startling challenges of monumental significance to our way life await us. Are we really ready for what lies just ahead?

Never before have educators had to deal with a future where fundamental uncertainty is the norm. If schools are to survive, it is imperative that we stand back and carefully rethink our notions of intelligence, learning, instruction and evaluation in light of the new age of communications. This presentation traces current advances in communications technology from their roots to the present, and then projects some incredible repercussions for human society and consequently for how we as educators must prepare students to meet this challenge.

And away we go!

The purpose of this presentation is to get you to stand back and consider things from a different perspective. We'll start by looking back on the development of communications systems. We cannot view any device or development in isolation – the focus must be not on a single product, but on a process. We must understand that the present reality is just part of a continuum – looking back to where it's come from and then projectingn where things will go and what this might mean for education . Being successful in envisioning the future all begins with mindset – will we look at it from inside the box vs outside the box.

Consider this quote:

> *Everything that can be invented, has been invented - Charles Duell, - US Commissioner of Patents, 1899*

Believing this Duell closed down the US Patent Office for more than a year. We also

suffered from paradigm paralysis – he was constrained by the walls of his perspective. It ws hard for him to get beyond seeing with eyes to visualizing with his mind.

What really happened?
The extent of tech revolution in the 20th C developments was so dramatic that it's almost beyond our ability to comprehend. Consider that during the 20th Century we saw the appearance of the electric power grid, the automobile, airplanes and jets, satellites, rockets to the moon, computers, biotechnology, nuclear weapons, helicopter, computers, telecommunications and so much more. In fact, there were 200,000 patent applications at the US Patent Office in 2000 alone.

But what's that got to do with us?
We face exactly the same challenges when it comes to anticipating the future. Will we think inside or outside the box. Many educators find it particularly hard to think outside the box because they have an educentric point of view. They have spent most of their lives in schoo and have difficulty seeing things from any other point of view. As a result, their thinking tends to lag well behind new developments. Because they have lived inside the educational box for so long, it becomes extremely difficult for them to understand the implications of new developments. Only by stepping outside their present thinking will they able to examine current trends and gain fresh perspectives as to where things are heading. Let's start by considering the evolution of communications:

The Evolution of Communications
Consider bandwidth. Bandwidth is the carrying capacity of communications system. It has been traditionally measured in terms of the number of bits of information that can be transmitted per hour, day, week, month or year. For the longest time, communication and transportation tied together. Whether it was carried by runner, Pony Express, wagon or sailing ships, all had same problem – bandwidth was limited by the distance and amount of info carried – as a result, two way communication was very slow and unreliable. For example, the Battle of New Orleans, the bloodiest battle of the War of 1812, was fought two weeks after the war officially ended because it took that long for the cease fire message to travel from Washington DC to the front line.

The Telegraph
In 1844 Samuel Morse introduced the telegraph to a skeptical public. This was the first recorded transmission of electrical impulses. The1st words sent, in the form of a series of dits and dahs corresponding to 0's and 1's of computer talk, were interpreted by specially trained operators. The first message – "What has God wrought?" travelled at roughly 5 bits per second. This was a momentous event - the beginning of electronic communications – but many people didn't get it because inside the box thinking persisted:

Men might as well project a voyage to the moon as attempt to communicate electronically - Dr. Dionysus Lardner (1838) Professor of Natural Philosophy and Astronomy, University College, London

Unanticipated developments

Despite such perspectives, communications infrastructures quickly began to have impact upon the world at large. The telegraph facilitated colonization, erased international boundaries, transformed financial markets, wrapped the continent in a new information grid and allowed for quicker response to events from law and business.

The Telephone

In 1876, Alexander G. Bell invented the telephone. His first words were, "Mr. Watson - come here, I want you." This was because he had just spilled battery acid on himself. Strangely enough, Bell himself didn't comprehend the power of his invention. He thought he'd invented a personal radio that would allow his deaf mother to listen to concerts. Even at this early stage, capable of only 15,000 bits per second, this held great promise for the future of communications. But inside the box thinking persisted...

Well informed people know it's impossible to transmit the voice over wires and that were it possible to do so, the thing would be of no practical value - Editorial in the Boston Post (1875)

Unanticipated developments

Let's fast forward to today, where there are more than 900 million phones world wide; and where more than 1 billion phone calls happen in the US daily. In short order, the telephone turned our ideas about communications upside down. In compressing time and distance, the telephone brought new meaning to work and to play. But inside the box thinking persisted - many didn't initially understand the long term implications. The telephone has changed forever our notions of communications – whether its down the street or across world. In doing so, it has brought new meaning to business and personal, relationships, the definition of leisure, national boundaries, the nature of employment. Today, entire industries (telemarketing) and work structures (office buildings) are built around the telephone

The TV

The TV was invented in 1926 but not broadcast regularly until late 40s. At first, it ws simply considered to be an extension of radio - just radio with a picture. Just an extension of the one way broadcasting of radio with initial speeds of about 16,000 bit per second. In the beginning, inside the box persisted. Consider:

Television won't be able to hold on to any market it captures after the first

Unanticipated developments
Let's fast forward to today – TV is now capable of transmitting more than 5,000,000 bps. In less than 50 years, it has become a ubiquitous part of the lives of a significant poriotn of the world's population. More than 2 billion people tuned in for Lady Diana's funeral because of the immediacy of TV. Although largely unanticipated, in short order it has lead to the compression of time and distance whether it from down street or around world. As a result, we now see history has it happens and world events as miniseries.

Interactive Communications
Of these new devices, only the phone was interactive. However, initially the telephone was limited by speed, geography and mindset. Despite these limitations, the development of the telephone was the pivotal point in communications history. The development of the telephone has had a profound impact across society. The interactivity of the telephone is far more powerful than broadcast alone, thus it has had far more impact than TV.This is because interactivity completely changes the way things work because it allows instantaneous, anytime, anywhere connections to friends, business, information and ideas

The Growth of Interactive Communications
This was a stealth trend for much of the 20th Century as the power of interactivity grew incrementally. In1930, it was possible to send 3 phone calls per copper wire at 30,000 bps, but these calls became inaudible at distances of over 40 miles. By 1956, inter-continental communications was possilbe through a cable capable of 36 calls at1,152,000 bps. By1962 the launching of the Telstar satellite heralded the first wireless communications. The satellite carried 12 voice circuits but was used to initially only to transmit local calls wth its 768,000 bps capability. Very few understood where this was going because, as usually hapapens with new technological innovations, inside the box thinking persisted...

> *Anyone suggesting that artificial moons will someday become inexpensive and dependable enough to permit cost-effective global communications is a dreamer living in the impossible folly of pure science fiction...New York Times, 1948*

The emergence of photonics
In 1983 the first glass fiber transmission trunk went into operation between New York and Washington, D.C. The principals of photonics allowed digitized information to be sent in the form of light at a remarkable 45,000,000 bps down a single strand of glass fiber. By 1997, 100-gb fiber-optic capability was possible. Morse's first telegraph message transmitted in 2 nanoseconds. Is that fast? At Lucent Bell Labsin New Jersey by early 2000 they were sending 5 trillion bps down a single strand of third generatin hollow fiber – that's the equivalent of 1000 CDs ps. In his latest book *Telecosm,* futurist George Gilder has outlined his Law of the Photon. He states that since 1983, bandwidth

of in excess of 1 billion times the speeds we see now. Whether you think the speeds are dazzling or not, we are today literally in the Stone Ages of optical communications – and this doesn't even BEGIN to address the issues related to the emergence of high speed wireless access. The problem is that this happened so fast, it pushed mindset even those close to it missed it...

> *I see little commercial potential for the Internet <u>for at least 10 years</u> -*
> *Bill Gates, Comdex, 1994*

Why did people miss this?
Because we moved from incremental to exponential growth. The problem is that when things shift exponentially you can no longer deal just with what is. Rather, you must anticipate what will be. This is what futurist Jennifer James calls thinking in future tense. That we have to view things with BOTH our eyes and mind, because if we view only with our eyes, we can be deceived.

Unanticipated developments
The emergence of the Internet meant that overnight we had instantaneous, interactive global communications. This had (and is continuing to have) an enormous impact on business infrastructures. It has lead to a blurring of boundaries between work and home, and has lead to the rise of multi-national corporations and international commerce that are based on global communications systems. This is pretty amazing by itself but not just rapid growth in interactive communications combine this with...

The Growth in the Power of Computers
Let's consider the Eniac computer, one of the world's earliest mainframe computers, which first came on-line in February 1946. The Eniac, which cost $750,000 in 1946 dollars was a 30 ton building-based computer, 8' tall and the length of two tractor trailers that was 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. It took a staff of 200 several days manually flicking 6000 switches to program it. It took enough power to run a city of 100,000. One or more of these tubes failed on average every 7 minutes. It was not what we'd call user a friendly machine. 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 mindset continued to lag behind the technology.

> *I think that there is a world market for maybe 5 computers -*
> *Thomas Watson, chairman of IBM, 1943*

Unanticipated developments
Now let's fast forward to today and consider how pervasive microelectronics have become in our lives. - ATMs, cash, calculators, video games, copiers, fax machines, microwave ovens, digital watches, robotics, voice recognition, pagers – microprocessors are ubiquitous - then consider that a typical new car has more than 3000 microprocessors built into it. Microprocessors in these and countless other devices have altered virtually every aspect of our lives.

Unanticipated growth
Now consider the growing power of new generations of TVs, telephone and computers – each demonstrating outside the box thinking that has been developed for many years behind closed doors . Suddeenly they explode into view in a synergistic frenzy with the emergence of the WWW in '95.

Taking a closer look
Why did things happen so quickly? What was it that gave the WWW such instantaneous mass appeal? The answer is...

Synercation
Synercation is the synergy of converging modes of communication. Synercation was the overnight fusion of separate TV, computer and phone technologies into a single synergized entity. Synercation combines the interactivity of telephones, the content of TV, and the processing speed and power of computers to create radical new forms of communication. The key to synercation is interactivity, not broadcast. Consider the rapid emergence of the WWW – the seemingly overnight progression from stand-alone devices to inter-connected local area devices to wide area networks that have become the melting pot for data. In the blink of the eye, things have gone from multimedia to monomedia - it's all zeroes and ones - how they're put together is entirely up to the user. This sudden appearance of full spectrum communications is impacting virtually every aspect of our lives...

The impact of synercation
Synercation has already accelerated the transformation of the US economy from an industrial to a service one. According to some estimates, as much as three quarters of the gross national product now consists of services. In the hands of small, nimble firms, powerful computers networked together have dissolved the economies of scale that normally attach to large organizations. In the near future, the airwaves may well become a primary carrier for important business and government information. Because of it, in the past decade the Fortune 500 companies have cut employment by 4 million - more than 25% of the workforce they had when this telecommunications revolution began

Tapscott calls disintermediation. As things make the shift from incremental to exponential change, where will things go tomorrow? How do we get beyond focusing on what we're seeing today to the logical and imminent next steps in an exponential growth pattern

Beware of Assumicide
It's common for people to assume that change is a straight line progression. In a linear world, you get a linear tipping point – that is, things tip only when you get to half way plus one. But in an exponential progression, things tip much sooner than half way.

Understanding the tipping point and exponential growth
A floating lily leaf has a 40 day growing cycle. It grows at a stupednous rate, doubling in size daily. On day 1, the floating lily leaf not noticeable on the pond, By day 10, even though the lily leaf has been doubling in size every day , there is still very little to see on the pond. At day 20, half way through its growth cylce, the floating lily leaf continues to double in size daily. but still not too much to see. At day 39, with one day to go, the pond is half covered. So what happens tomorrow? This is the key aspect of synercation. You can't trust your eyes or depend just on what you see. Because on day 40, the whole pond is now covered. But in an exponential world, the critical point of no return happens long before it becomes apparent. For the floating lily leaf, the tipping point happened many weeks before

Extrapolating Synercation
So what's really happening in our increasingly technological world? Think of the Web as a lily leaf conservatively doubling in size in terms of number of pages every three months (4 times a year).. Despite the existence of 4 billion million plus web pages today, we're only at Day 20 in the growing cycle. Even so, the Web's exponential tipping point was reached long ago. In such a world, we can't view developments only with our eyes . We must also anticipate with our minds, thinking in future tense, because what we see is only history – it's only a portent of things to come. We must learn to view developments as a continuum from where they have come from to where they're going?

So where are we? The Web is a done deal! Handheld and wearable devices - done! Worldwide, interactive, real time multimedia communications - done! Voice input - done! These and many more technological developments have sprouted into view. But at the same time, many, many more lily pads are sprouting along edge our pond What's out there? MUDs and MOOs, global access phones, wireless data ports, Teledesic Internet-in-space connections, WebTV, micro-robotics, nanotechnology, biotechnology, neural computers … the list is goes on and on.

Each of these technologies is not yet completely established – in each case, much work

even if we don't realize it yet, but what other developments aren't apparent yet? What other stealth developments have yet to reach their tipping point?

It's time to shift gears! The old ways of thinking about the future just won't cut it anymore. We must start to look over horizon. We must try to anticipate which new developments are approaching the tipping point even though they have yet become widely apparent or understood.

So What Are the Emerging Technologies?
Out there on or beyond the horizon are whispers about new technologies – wireless anytime, anywhere access to anything - push media - PointCast Networks - smart agents - Internet telephony - avatars - augmented reality - virtual reality - virtual existence. All are in their infancy today as the Web moves from being a point of passage to a point of presence – from a pipeline to place - from working the Web to the web working for us.

What does this all mean for education
So now it's our turn. What does future hold for education? What trends hint at the winds of change? What new technologies will challenge us to rethink what's important in education? What stays and what goes? Today, we're at the same crossroads that many others before us have reached. We are being presented with the same challenges to our existing mindset. The question is, will we continue to see only with our eyes or begin to perceive with our minds? Will we think inside or outside the box?

Have you heard this somewhere before?

> *There is no good evidence that most uses of computers significantly improve teaching and learning- Todd Oppenheimer, The Computer Delusion, 1998*

> *Most schools would probably be better off if they just threw their computers in the dumpsters - Clifford Stoll, Silicon Snake Oil, 1997*

> *Computers are merely ingenious devices to fulfill unimportant functions… the computer revolution is an explosion of nonsense - Neil Postman, Technopoly, 1994*

Does this sound familiar?
It's inside the box thinking. It's not that they're stupid! It's their paradigm that's talking. they're just responding to what they see – to their comfort level. They're not perceiving the transience of what exists today in our rapidly changing, synercative world. What will it synercation mean to education? What will it mean to the who, what, when

How do we do our job?
Through communication. We communicate the accumulated wisdom of our culture. We use communication skills to guide students through experiences that lead to skill acquisition. Education is a communications business. Our edge is our ability to interact with students. If there's a problem, we rephrase it - we adjust our instructional delivery - we take a different approach - we change the pace. Until now, there has been no technology that has been widely available that has been able to effectively match our interactivity. But ut to gain a futures perspective, we need to apply an understanding of the exponential tipping point, combined with future tense thinking

Let's consider the future implications of synercation on learning, Up front, it's not here yet, but it's coming! Something powerful is about to happen. We must step outside the box and perceive the future, rather than continue to just try to see it. Synercative learning is about more than just the exponential growth of technology. Children today live in graphical, interactive, multimedia world - it's their native language! Synercation is a vehicle for the world-wide transmission of new forms of learning experiences. This is the first serious alternative to traditional classroom learning experience. In the next few years, synercation will challenge us to explain why kids must come to school in order to learn

This's because much of what happens in schools now can be done with synercative devices on an anyone, anytime, anywhere basis. There are many compelling reasons why kids should come to school to learn, but not necessarily for everything that they come to school for today. Let's take a closer look.

What might learning look like a few years out?

Scenario #1
Imagine students working at home with synercative devices using on-line materials and instructional resources. The instructional management system gathers signals as to where the students are in terms of their personal study plan, analyzes any problems encountered and assesses the learners' readiness for new material. The individual devices send a signal which identifies those students who need help as well as which students are ready for a group experiment. A smart system reviews the progress of each student, assesses the schedules of all in the class who are ready, determines that the new topic can be covered in a seminar next Wednesday. The system automatically places the date and time in the schedules of the students and the teacher, informs the students and the teacher by voice mail of appointment contacts the district resource center to book materials, books a room in the community school, contacts a local engineering firm to arrange an on-line video conference interview with an engineer who has special expertise in the topic; contacts library to deliver resource materials to

of the necessary systems to allow this to happen. How long will it be before such approaches start appearing in our schools?

Scenario #2
Imagine an elementary student researching whales. The eyeglass based reading system built into the student's glasses detects an apparent reading difficulty. The system contacts the state curriculum department to determine if the reading level is appropriate for the student, determines that it is, automatically does a pre-test diagnoses, then checks the schedules of the student and the Learning Assistance Teacher and makes an appointment. The system automatically accesses the district database then forwards the student records to the LAT Because it knows that the student is underprivileged, the system contacts the appropriate office for approval for bus fare. The system informs student by voice mail of the appointment, brings up a GPS and prints a map of directions. How about this scenario. Is this possible? Before you respond, once again step outside the box and start thinking in future tense.

Scenario #3
Consider a teacher working at home who receives an electronic message from a student advising the teacher that a new assignment in history has been completed. The teacher puts on Virtual Reality headgear and walks down a virtual hallway until she comes to a room with the student's name on it. The teacher enters the virtual room where she is met by virtual presence of the student. The virtual presence begins to narrate a simulation of the construction of the pyramids

Thinking in Future Tense.
This is not a matter of IF this will happen, it's a matter of WHEN. And when it happens everything goes back to zero. Will the skills needed by educators to operate in this environment be the same or different? The answer is obvious. Ignore or deny this at your peril. If we are going to make a smooth transition from where we are to where we'll need to be to operate effectively need to start right now to develop the necessary skills needed to operate in this environment. Even if your plates are full, you can't ignore any opportunity that will lead you to classroom of future.

Will this happen tomorrow?
No, it won't – but it will happen much sooner than we think. And if you and your colleagues don't start preparing for tomorrow now you may be in for a big surprise. We must participating in the changes yet to come right <u>now</u> if we want to be ready for tomorrow

Busines futurist James Crupi says tht there are three kinds of people in this world – those who make things happen, those who watch things happen, and those who won't know

The difficulty of life is not the new but giving up the old - the task is not just to see it, the task is to enable it – but before we change what we do, we must change what we think, but before we can change what we think, we must change what we believe - Lora Dobyns & Clare Crawford-Mas

The world we have created is a product of our thinking. It cannot be changed without changing our thinking – Albert Einstein

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