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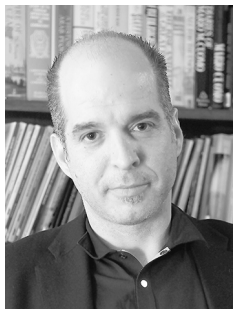

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Waves, Particles, Cats, and Captain Kirk: The Quantum Impact on Social Thought in Education

"To be nobody but
yourself in a world
which is doing its best day and night to make you like
everybody else means to fight the hardest battle
which any human being can fight and never stop
fighting."

— E.E. Cummings

This is a poem by one of my favorites. His ideas, angst, and forms of expression fascinate me. Sadly though, I believe he, among many others, is rolling in his proverbial grave. Why? I'll get to that a little later.

But, before we go there...

An interesting phenomenon occurs when you examine the behavior of light at the microscopic level. Depending on the kind of test you use to observe its behavior as light passes from point A to point B, it is, at the same time, both waveform and particle form. Without getting into what exactly that means, since you can, I suppose, simply Google it, this "wave-particle duality" is central to the field (notion?) of quantum mechanics. I would also venture it is central to, at least correlated with, and perhaps even somehow responsible for the world's current socio-digital zeitgeist, especially when it comes to the sanctity (or lack thereof) of notions of sequence, order, and predictability in time and space. As I see it, this one discovery has led to what is arguably one of the most sig-

nificant periods of technological cum social upheaval, ever. Let me explain.

The cat (likely Schrödinger's) that Planck, Einstein, de Broglie, Compton, Bohr, and others unwittingly let out of the bag, became, I propose, a perceived emancipation (or at least the hope thereof) of human behavior, thought, and potential. To lay philosophers and believers in (as opposed to practitioners of) science, what all of this meant was this: ultimately, and at least in theory, anything is possible, nothing is determined. The problem, that I believe has since led to massive social and societal confusion, is this: what takes place at the micro level does not (at least to any practical perceptible degree) have parallel effects in the full size world where we all live, love, and labour.

As much as religious thought impacts social behavior, so to does scientific discovery and theory. And though my intention here is not to delve into the complexities of quantum mechanics, I do want to suggest that its implications dramatically impacted human thought and behavior. They continue to do so now at an even greater pace, and are indeed motivated by the subsequent technological advanced that appear to support essential quantum notions of indeterminism and non-linear progression. The discovery of quantum mechanics carried with it the promise of a reality that was no longer as fixed and predictable as Newton had suggested. Its implications affected perception, thought, and philosophy at all levels.

Like Homer's sirens, the possibilities suggested by quantum mechanics, along with both its fictional and factual technological consequences that followed, led to a widespread derivative perception: much like the indeterminate nature of the atomic world, success in life can be achieved in much the same way Captain Kirk and his "away team" can "beam" from orbit to surface of any unknown planet, unscathed, and in the blink of an eye. Beaming allows for the total and instantaneous bypass of all of the dirty bits that are unavoidable in any practical sense: the inhabitability of the vacuum of space, the hellish passage into atmosphere, the explosive release of physical integrity in low pressure environments, the science and technology of life preservation, the knowledge of flight and aero-spatial dynamics, and the catastrophic consequences that the lack of understanding of all of the above might have on Kirk and his team could they not simply skip-it-all by being "beamed." And while we are in reality yet to beam one another in a physical sense, we have certainly achieved, via quantum discoveries, parallel phenomena via digital technologies that have changed they way we do and perceive everything.

In educational terms, quantum theory has, through pop culture, fantasy, and its very real impact one society through the advent of digital technologies, led to changes in thought, problem-solving, perception, and expectation that have led to this: we are told we can achieve whatever we want in life; that each of us is unique and deserving. We can beam from A to Z, and skip B through Y entirely in order to get there. We can communicate with anyone from anywhere. While we cannot (yet) beam ourselves, we can certainly beam representations of anything, from anywhere, to anywhere.

We are bombarded each waking second with images and propositions about what life's goals should be, often in fantastical terms and forms that are no longer easily distinguishable from reality. Individually, we can access the sum total of human knowledge, the good and the bad, equally and unfiltered. Individually, we can access, possess, or experience anything we desire, or so we are led to believe; and we can accomplish all of this effortlessly, in milliseconds, without any prior knowledge, ability, or skill, save what it takes to operate keyboards (and even in that, despite never having learned to type). In educational terms, I would argue that now, more than ever before, we are provided daily, freely, and without consequence, what were once goals to be achieved, or frankly, simple dreams. The thing is, and concerningly so, is that, as a society, we no longer produce to live. We consume to satisfy. And our definition of success is more and more determined by what we can consume, and how our behaviors can entice others to do the same (resulting, incidentally, in the aforementioned discomfort e.e. cummings would feel, could he still feel. More on that shortly).

There are a few unalienable truths about being human. One is that we are indeed different from one another: in capacity, biology, physique, composition, social role, heritage, cultural grounding, spiritual affiliation, morality, location, climate, strength, psychological constitution, and many other qualities of being. And yet, we belong to communities of commonality in order to survive. From them, despite our differences, we must achieve standards of thought and purpose in order to survive. Within the communities we are part of, we must find fit. Where I am weak, others' strengths compensate. And this interplay between all members of every community results in the stability and well being of the community itself. If indeed the quantum realm is, ultimately, indeterminate, can the same uncertainty be applied to social role, responsibility, and interaction and the health of communities?

Yes, we should strive to investigate, discover, understand, apply, and

achieve towards goals that gain their definition through that very process. And yes, we should strive to maximize the satisfaction we gain from our lives. And yes, this does presume mitigating things that are noxious, dangerous, and unpleasant that run counter to our instinctive tendency to avoid those things that foster discomfort and anxiety. However, the truth is, sometimes we must abandon our reflexive tendency to defend self in order to become stronger, more capable, and better at doing exactly that. We must engage in activities to which we may be instinctively averse. By doing so we learn how to master them. By doing so we remove from them the very noxious qualities that led us to avoid them in the first place. Ultimately, they become a part of what we consider our strengths. The path we should take is from A through B in order to arrive at C. Once we master that, then, and only then, should we look into the merits of beaming.

I may be completely misguided in this perception, but it's one I hold: the trend in education for decades has been to lessen the burden for people to learn by removing learning challenges that produce anxiety and discomfort. No matter how counter-intuitive that may seem, I believe it to be true. People are less and less required to achieve rigorous standards of skill and ability. Instead, their abilities to calculate, communicate, and problem solve are weighed against none but their own paces of accomplishment over time, and only in areas they are comfortable in pursuing. My experiences tell me that what we are required to learn is being further and further modulated by a perceived justice in allowing individuals to set their own objectives and parameters. I would indeed venture that in certain curricular circles we are no longer "required" to learn anything. Here the laws of entropy thrive, as more and more of the learning that takes place does so at the expense of anything that might produce anxiety and discomfort, the tough stuff, the things that may in fact be some of the most worthwhile things to be learned. However, where Challenge is reduced, Assessment and Achievement rise. In a world driven more and more by perception, accountability, and transparency, this is, I suppose, the perfect outcome.

Slide Rules, Abaci, and the Googolplex: The Quantum Impact on Education

When I was in my early teens, I recall my father, a teacher (of English Literature incidentally), lamenting the loss of geometry from the standard school curriculum. While I could not understand his frustration completely

at the time, I did infer this: we appeared to be losing the ability to learn something that held secrets that would forever forward be lost. Even at that young age, I remember feeling something very unfair was happening. I believe that more than ever today. Indeed, a good grasp of geometrical theorems might help me during those occasions in the mountains when I would dearly like to understand how far I am from a mountain peak. A little prowess at astronomical concepts would allow me to find direction without the use of Google. How my father learned to use the slide rule with such fluency, and others the abacus, I have no idea. To me they were, and as a result likely always will be, as unintelligible as, well, a slide rule.

In my father's mind, our learning was being whitewashed. Perhaps to stem that tide, within the same timeframe he set out to teach me Latin. I think he did so driven by a compulsion to sustain, in the education of at least his own child, the power inherent in the kinds of knowledge being lost and the advantages he perceived they would provide in life. I think he was onto something, and I am grateful for the effort he made. I have often found those few things I was able to retain to be useful ever since. In his mind, the institutional expectations of our learning were being whitewashed. In my mind, here, today, I believe, for most, the power provided by many tools of understanding, along with the skills to use them, are being and have been completely, well, Googled (to the detriment of the googolplex itself).

I'm not sure of the nature and trend of education discourse 50 years ago. I am certainly not aware of the perceptions held by education academes a century ago. That deserves to be Googled! However, I am well aware of the trends and mantras amongst education scholars and fashionistas of the preceding 30 years: student-centeredness, 20th (now 21st) Century approaches to learning, the provision and application of information and communication technologies (ICT, for those in the know), inquiry-based approaches, teacher-as-mentor, learners (as opposed to students), flipped classrooms, flexible learning spaces, among many others. And all of these appear to be reactive to a dark age of "traditional" education in a murky yet not so distant past: oversized populations of students sitting row by row silently, watching, listening, and note-taking in front of all knowing teachers filling their minds with knowledge and facts, assessing them on their ability to retain what they are told against impersonal and detached metrics, and applying techniques devoid of anything that would engender critical thinking or the ability to inquire, discover, learn, evaluate, and understand. The thing is, I cannot pin-

point where, at least in my own experience, this traditional approach to education has ever existed.

Waves and Particles, the Analog and the Digital, and the Death of Radar

You see, if light travels as waves, blocking those waves will stop their progress. So, to progress from one point to another, waves of light must travel across the space between, unfettered, in order to arrive at their destination. Should there be obstacles in between, they will be prevented from completing their journey. In this sense, light must follow a path from here to there and travel through whatever lies between, sequentially. The obstacles between are relevant, each requiring its own solution that will allow the light to pass it and continue towards its ultimate destination.

If light, however, also behaves as particles in a quantum realm, as the gentlemen mentioned earlier indeed determined it does, then suddenly the concept of the space between becomes irrelevant. Even with barriers between here and there, the particles of light arrive at their destination. And they do so instantaneously, as though they, as with Kirk and his away team, were simply and somehow "beamed" there. And so, given this duality, the possibility that all that exists can somehow follow the same indeterminism becomes a possibility, a consideration, a fantasy, and an influence on social thought and behavior. And as an interesting caveat, if you try to observe particles of light in their mysterious transference from here to there, they will simply disappear. From this rises a whole other set of implications that have also manifested themselves in current social thought, and education theory.

Current trends in education seem to mimic quantum phenomena. If, as light, we should be able to arrive at our destination without concern about obstacles that lie between, then anyone can believe s/he can achieve anything he or she desires simply by desiring it, without complication, period. As individual particles of light achieve their destinations without interference or observation (and indeed, even simple observation impedes their ability to arrive where they should), individuals should be left alone to decide what is and what is not important for them to learn according to goals they determine they would like to achieve.

The trend in education has been to remove (perhaps better put, ignore) the obstacles, the complications, the challenges, and the rigor that would otherwise, possibly, redirect or derail people in their journeys through life.

Current curricular theory reflects this. Assessment is no longer based on standards; it is a derivative of each individual's own capacities. Learning objectives are no longer wholly derived from prescribed outcomes; they are derived from what individuals would like to achieve. Left as such, the objectives of learning in many centers of education are now lacking those things that were once core to standards that defined competency according to the needs of community and society.

Now, the argument here is that individuals will learn on their own what their capacities are, and by doing so determine the learning paths they are best for them. However, left completely unprescribed, so much is potentially missed. Were I not exposed to the theorems of geometry, how would I know they exist. Were I not made privy to the mechanics of language, how would I know the rules that apply to the ways we communicate as we do. Were I not taught to memorize passages and learn about icons of our language through memorizing and deciphering the mechanics, meaning, and purpose in prose and poetry, how would I learn to appreciate how language can be an art, a tool, and a means to influence the world around me in multiple and wonderful ways. Were I not taught numbers, formulas, patterns, and process, how would I understand the mechanics of social and physical world of which I am a part.

Very few of the foundational objectives of learning are easy. Few, if any of them, can be learned without frustration. None of them can be understood clearly and in practical terms without the experiences that only life, in the analog, can provide. Sadly, none of them is now necessarily required to be learned. While in my youth we lost geometry, there is so much more that has since been deemed unnecessary in terms of formal learning curricula. Instead, they have become options for people to choose in their own self-direction. The sad thing is, in most cases, they are options not chosen since they are simply no longer on the radar. Indeed, GPS has replaced the radar, the particle the wave, and the digital the analog.

For better and for worse, quantum theory played a crucial role in, and has had more and more impact on, the rise of the digital era. The social impacts have, as a result, been greater than any other technological shift that has taken place in the history of humankind. It's consequences have affected the nature of the human condition in, I would argue, all ways: from the most fundamental needs of survival to the gratuitous wants of escapism, and across all levels of human endeavor between. Social institutions once

fundamental to human existence are crumbling. They are deemed as no longer relevant, and indeed, perhaps even as historical mistakes. In many ways, current social thought exudes particular confidence in having seen the light of truth. In metaphorical terms, I understand why: since light is apparently particular, it no longer shines in waves on the messiness of challenges inherent in survival. It beams only on the desirable destinations that lie apparently at the end.

The digital world has allowed us, in fact, to beam ourselves out of the complexities of life and straight to what were once the objectives we ourselves were required to achieve, step by step. We no longer must kill beasts for nourishment. We are no longer required to understand grammar in order to write. We don't have to meet people in search of relationships. We don't have to visit libraries. We don't need books to understand. We no longer need skills of survival to travel from here to there. We don't have to fix or maintain or renew (we recycle!). We don't have to write letters. We don't have to imagine. We don't have to think. In the quantum-derived digital world, and for most all of us, everything, simply, happens.

We're getting closer to the guillotine...

Fire, iPads, Angry Hominids, and the Wrath of Zeus

We are all astounded by the ability of a child to learn. Indeed, I have been told fascinating stories by parents who place iPads in the laps of their 18-month year old children. Fantastically, the children learn to use the devices on their own, and within very short order. They discover the button, they push it, and they manipulate what they see. My comment on this: of course they do! That's why they were invented! To reduce the effort of discovery to elemental objectives: one button to push (and in newer iterations, even that has been removed); desirable colors and forms to swipe; the immediate gratification of feedback that encourages further swiping!

If seeking convenience and simplicity were the reason for the invention of the iPad, then why are we so surprised that an 18-month old child would master it in such short order. Indeed, we should be proud to have achieved our objective. Then, we should quickly turn it off, hide it, and begin teaching the child to listen, observe, understand, and learn about the world that surrounds him or her, the good, the bad, the easy, and the challenging, and the interconnectedness that lies between all of it. And make no mistake, once

that's done, we can give them the iPad again to help in their journey.

You see, digital is not a form of thought. Rather, it defines a new class of tool and technique we can use to achieve particular goals. This is important. It is simply a tool. The fact is, the human condition remains as it has since one particular hominid, at the dawn of our species, in an act of frustration that manifested itself in an angry frenzy of banging rocks against one another, unexpectedly created a spark. Her discovery, born of accident (and, likely, a little surprise), led her to uncover something that would impact social behavior forever afterwards. Fire. Prior to her angry outburst, those who preceded her learned to endure, and survive, the coldest environments on earth. Then, in one frantic act of frustration, she forever mitigated one critical challenge to her community's survival.

Fast-forwarding three or four hundred millennia, her distant progeny unleashed the potential for all knowledge to be accessed by the push of one button. The point here is this: neither fire nor knowledge, nor the iPad, is of any value on its own. The important part is the learning and understanding that are required, first to learn, then to apply, all of them, meaningfully. It wasn't fire alone that motivated Prometheus and scared the bejesus out of Zeus. He chained Prometheus to a cliff where crows feasted on his liver for all eternity precisely because of the potential and power that the understanding and use of fire provided humankind.

Like Planck, Einstein, de Broglie, Compton, Bohr, and others many millennia later, she who discovered fire unleashed the potential to mitigate an impediment to existence. In doing so, she removed the necessity of bearing with what had theretofore been a significant obstacle to survival. But fire, much like quantum phenomena, and much like the technological accomplishment the combination of the two ultimately led to called the iPad, it is a tool we have created. In its mastery it allows us to accomplish greater goals and achievements. Fire, quantum mechanics, and iPads are not ends in themselves. Yes, we must learn the skills involved in how they are used. However, and more importantly, we must acquire the knowledge and ability to think in order to use them in contextually meaningfully ways. They are the means to reach more deeply into understanding and improving who we are, and in doing so enable us to impact ourselves and the communities in which we live.

Simply knowing that fire, quantum mechanics, and iPads exist is not enough to understand their potential and to use them in meaningful ways.

Rather, we must first understand what they are, how they became, and how they function. We have to understand their place in the world, how they emerged, what they imply, and how they enable us in both obvious and unique ways. In elementary school, the walls of our classrooms fascinated me. They were walls, but they had wheels on top! Then, in one unforgettable moment of understanding, I watched in awe as our teacher, with a simple push, removed all of the walls separating our class from the ones beside us. The walls I had been sitting within for weeks to that point simply accordioned away into corner pockets. Our classroom was suddenly four times the size and quadruple the population. I witnessed engineering to a degree beyond the mousetrap my grandfather taught me to make. In that environment, and for the next few weeks, we entered the project phase of our unit of learning on Ancient Civilizations. Myself, in this flexible learning space circa 45 years ago, I rebuilt Olympia. And it was good. Nine years later I would build a guillotine.

The Points Between: Zen & the Art of Fire and Combustion

I have no doubt that, as a species, humans will benefit from some future variant of the technology of beaming so prevalent in the Star Trek universe. Indeed, and in digital terms, present technologies already permit us a form of this. However, there is something important in understanding the challenges of the postman in order to appreciate the magic of the send button within an email application. In the same vein, to fully appreciate the significance of quantum mechanics, we must first understand the analog world that preceded. We must understand paths between points in order to make sense of points of arrival. We have to find our ways through what are often arduous and challenging paths in order to discover and appreciate the conclusions to which they lead us. As we become more adept in our scientific and technological capacities to understand the world, so too do we continue to defy the cold. Perhaps ultimately we will learn to circumvent it altogether. We will continue to learn to survive longer, and we will continue developing the means to insulate ourselves from the endless passive hostility of the environments that surround us. With every achievement we make, we push back the shadows of what Carl Sagan called the *demon haunted world*.

However, in order to for our learning to push us ahead in meaningful ways, we must not only understand the manifestations of the technology

that enable us, we must also learn the modalities of thought, the elements of communication, the foundational concepts of science and technology that enabled those technologies to begin with. To do so, while we have the fortune of being able to use the achievements made by those who proceeded us via the tools they created by doing so (including, yes, the iPad), we must still learn the concepts behind them in order to understand them fully. With and within the communities in which we live, we can use fire, quantum mechanics, and the iPad to help us push ahead our levels of understanding of the world; however, we will be better equipped to do so if we can understand how they themselves work. By doing so, we will be better equipped to effect change that has not yet come to be, but will as a result.

Incidentally, I have just Googled "the formula for fire," and I found this:

Fire is the result of combustion of organic material and oxygen. For example. CH4 + 202 -- CO2 + 2H2O. But the colour of the fire is directly related to quantum physics.

- Quora

This is interesting to me on one particular level that (interestingly) has nothing to do with the mechanics or implications of the equation itself: the connection to quantum physics. I did not expect that. In light of all we've been considering, it's also a little synchronistic. For a certain few, there is, most definitely, immense value to this formula of fire. Equally so, it's absolutely meaningless for most people in their day-to-day pursuits. However, does this forego its importance to be learned? For a chemist, the formula bursts with significance: the nature of elemental relationships, the reactivity of elements in their raw states, and the means to harness the practical potential of the phenomenon for the benefit of human beings. For others however, including myself, it's a curious combination of numbers, letters, and symbols, that signify, well, not much beyond the possibility of having some connection to Hydrogen, Oxygen, and Carbon. And to others, it likely signifies even less.

The point is, rather than marginalize conceptual, theoretical, or factual knowledge, we should contextualize it according to the relevance and impact it has on each of our lives. Some of us will never have need for the chemical formula for fire. Others will. While this presents is a chicken and egg problem that has to be attended to in terms of effective sequencing, scope, and presentation of knowledge to be learned, I believe it's essential for learning

that it take place in a sequence: first, present something real and grounded terms; next, move to its deconstruction; then, extract the raw factual, theoretical, and situational elements; following that, proceed with the definition of those component parts; subsequently, reassemble those into a reflection of the original; and, finally, attempt to improve it. I suppose the question then becomes, to what depth of complexity and understanding should learners be expected to delve in order for each to succeed in realizing his or her own potential? I suppose the answer is, let people decide that bit on their own.

The act of teaching should provide windows into life at all levels, and provide learners with the aforementioned "peeks under the hood" into how things work. Once students have been exposed to how things exist, their own leanings, interests, aptitudes, and passions will emerge to guide them in ways that are unique to themselves. They may become mechanics, in which case the formula for fire means nothing. They may become engine designers, in which case the laws of thermodynamics and the formula for fire become indispensably meaningful. Unfortunately, it seems to me that the tendency of education today is to improve a car by installing a new model engine, with no regard to the theory and application of anything involved with the mechanics of internal combustion itself. Why? Simply, it's easier (for students and teachers alike) to skip the difficult bits and beam directly to the conclusion. By doing so, we affirm our mastery of consumption and instant gratification, and we stall. By doing so, we limit exposure to those things that would otherwise inspire the future of automotive genius: mechanics and mechanical engineers alike.

The Guillotine

In the Fall of 1983, I began my fourth and final year of French language studies. Four years of French were mandatory for those of us pursuing university studies, regardless of whether or not we knew why. In hindsight, most of us did not. To be honest, and precise in my recollection, the preceding three years of French had, well, sucked. My teacher for those years had been a non-native French speaker whose instructional repertoire began and ended with textbooks, worksheets, and the oral repetition of nouns and verbs, in predictable sequence, three blocks per week, forty weeks per year. And so, at the start of this final year, I grudgingly walked into the first French 12 class. I was not thrilled.

But. Surprise! Our teacher had become a she, and she was, in fact, French!

My twelfth year began and moved along. What had become a class I had dreaded in the years preceding was becoming the one I most anticipated each week. And while her own repertoire included tools and techniques *he* had used in years past, *she* was unpredictable, *she* was inspiring, *she* was motivating, and, most importantly, *she* actually spoke the language! Though I have since forgotten her name, I have not forgotten the impact she had on me. Though my French studies ended that year, I do not think I would remember as much, today, had it not been for her.

So, what was the difference? I think it was this: she took us places, made us work to get there, and then showed us how to beam there directly once we knew what was involved in getting there ourselves. We worked through textbooks, sometimes sequentially, sometimes not, but we did so predictably and with purpose. She encouraged us to speak, to make mistakes, and to correct one another, safely and constructively. She created an environment that captured the spirit of what we were learning. And most importantly, she asked us to dig more deeply into understanding the language by identifying, as we learned, things that interested us most about the language and its sociocultural foundations. We were assigned a term project (an older variant of the *Extended Essay*) with instructions that must have been something like this:

Research something of French social and/or historical significance and do the following: 1. Create a representation of what it is you choose. 2. Write an essay of no longer than 500 words, in French, using vocabulary and grammatical structures we have been and will be studying in this class. 3. Prepare to present your representation and essay during the second to last week of the term.

-Grade 12 French Assignment

I suppose it so happened at some point that in another class we had been studying the social consequences of criminal behavior under tyrannical monarchs with penchants for decapitation. Since I have always been attracted to machines and devices of many kinds, and since I had been reading a lot of Stephen King, and perhaps Edgar Allen Poe, I decided that I would research and build a guillotine (...yes. We are finally here, and hopefully in context).

In the time that followed as I worked on many levels towards completing the requirements of my task, I look back now and recall this: compared to what I have experienced as a teacher in my own professional career, we, as

students, had so many resources at our disposal that today have apparently vanished. Sure, we did not have computing resources in the sense we have them now, unless you can find any reasonable equivalence in a Commodore 64. We had no Internet. We had a library, with Encyclopedias, and Dewey Decimals! We had no mobile devices, unless calculators count (and I suppose they did at a certain level). We had no presentational resources beyond VCRs and 35mm film projectors. Our photos were on film, and we learned to use a Dark Room, and patience. Heck, we still had blackboards and chalk, white chalk. Every word we composed was penned. Attached to every composition, as a requirement, were three progressively rougher versions of the final copy. We cut, using scissors, and pasted, using glue. We were entirely analog, and quality relied on being entirely resourceful.

Incidentally, during this same timeframe, on my own time and after school, I would spend time on a Commodore 64 to teach myself programming in a language called *Basic*. I taught myself enough to program a functional database of all of my records and CDs. That hobby, computing, has since become a professional skill. This may appear to be a digression, but it is not. Like the 18-month year old child and the iPad, it's entirely connected. But we'll dig into that a little more deeply a little later on.

In my high school years I studied a variety of academic subjects: Mathematics, Biology, Chemistry, Physics, Literature, Language, History, and, of course, French. We had equal access to classes in skills development that included, beyond Art, Drama, Electronics, Woodwork, Mechanics, Metalwork, Home Economics, and Drafting. While I was not all that interested in Home Economics, I certainly was in all the rest. My parent's home yet bears the evidence. What essentially became a cross-disciplinary effort owing to all of the above, the guillotine project took shape: research and composition happened in the library, planning in the drafting lab, construction in the wood shop, bladesmithing in the metal shop.

In the last days of that final year, and likely in quasi-intelligible French, I presented my research on the social, historical, and political origins and uses of the guillotine. My written presentation was followed, as required, by a working demonstration. For this I unveiled the meter high replica I had built and proceeded to decapitate what I recall having been a very large, red dye-filled carrot. While I can't remember the results of my effort, I don't imagine I faired too badly in terms of my assessment. What I can recall is how the entire exercise motivated me, and how it, to this day, remains one of

only a handful of school assignments (of hundreds? thousands?) that I can recall with any clarity.

In that one experience, I learned things that have remained with me since. I can recall only a few others in such clarity from my first 12 years of formal education. Yet, I did pass through 12 full years of it. What differentiated this particular activity from most everything else that was required of me was simple: it allowed me to understand how otherwise irrelevant and disconnected ideas fit together in ways that were significant and full of meaning. The guillotine, as a method of execution, was the product of a particular socio-cultural fabric very different from the one I had grown up in, and it was manifested through the engineering and mechanical prowess of the time.

For me, this challenge and opportunity became a comparative lens that led me to realize just how much there was to learn beyond what I already knew (...which is jolting since most 17 year olds believe they know most all, if not all, of everything). My guillotine was the product of investigation, research, theory, application, and discovery into the thought and behavior of times past. The exercise shone light on social issues of the present that I had, before that, never considered in much depth, if at all. It also required (allowed?) me to tap into my own preferences and past experiences: were it not for my grandfather years before, I may never have associated the mechanical value of pulleys and how the essential mechanics of mousetraps benefited a well-functioning guillotine.

Waves to Particles, Analog to Digital: Letting cummings Rest

We live in an age where our own technological successes may be responsible for a particular and widespread social misunderstanding. At the most basic level, we are yet very much bound by the requirements of life that must, as must waves, move from start to end despite the obstacles that may lie between. We cannot, physically, beam, no matter how many times we watch Kirk do so. Yes, we have advanced in science, technology, and understanding of the physical world. We've done so at a pace greater than ever before. We have advanced science and created technologies that have changed society in ways that only a few short years ago were themselves elements of science fiction. What has not changed, however, is the simple fact that we are yet the same sentient biological organisms we were millennia ago. And, beyond nourishment and love, we share one essential and overarching need with all of our grandfathers before: to learn. In that, we remain, like waves, reliant

on time, example, exposure, repetition, effort, and struggle that, despite our advances, have no substitutes in the process of learning.

Yet, we are part of a world that has forever been changed by the technologies we have created. While we cannot yet beam ourselves, we can freely beam anything we can imagine: images, movies, letters, entire encyclopedias, entire histories, entire libraries. We can print physical facsimiles of almost all of those things on paper, and, more recently, in 3D as well. We can create experiences of events that have never occurred that are indistinguishable from reality. We can project our emotions, our stories, our desires, our beliefs, our intentions, and our fantasies instantaneously to anyone, anywhere. In a world where Moore's Law continues to hold, and the power of computing technologies doubles with each passing year, we are moving into a future where beaming ourselves might too become a reality. But we're not quite there yet.

Our misunderstanding is that we can do that now, at least in terms of those things we would like to achieve in life. And that I fear is a direct consequence of having achieved the ability to free ourselves from many of what were once life's more challenging, unpleasant and unavoidable bits. We can achieve things that were, not so long ago, forever out of the reach of most everyone, except perhaps those of immense wealth and power. We are no longer required to create, produce, maintain, anything. And yet we lack nothing. We can acquire almost anything we desire without leaving our sofas, and receive it almost instantaneously. We don't work to achieve; we anticipate success. We don't earn wealth; we expect it. Only a few decades ago, this was the stuff of science fiction. Our ability to do these things is fact. However, that same ability is perhaps fostering the delusion that all of one's goals in life can be accomplished in the same way.

Even before modern technologies, cummings lamented:

> *"To be nobody but*
> *yourself in a world*
> *which is doing its best day and night to make you like*
> *everybody else means to fight the hardest battle*
> *which any human being can fight and never stop fighting."*
>
> — e.e. cummings

This poem expresses the angst of the battle to preserve identity and individualism in the face of the forces of conformity. However, I'm not sure cummings would agree to his sentiment's most recent manifestation as the narrative overlay of a recent Volvo commercial. It is a clever use of his poem that plays on that primal aversion all humans share: to resist conformity, to be unique. The solution it provides? Buy a Volvo. This is done via those same new technologies that connect us all instantaneously and promise us independence. However, they likely achieve exactly the opposite. While they should and are presumed to be liberating, ultimately, they conform us all more effectively than anything cummings would have thought imaginable. Education itself has not escaped the consequences of quantum-cum-digital promises and panaceas, I believe to its own detriment.

My career in education began in the 1990s, at the dawn of practical computing, cellular communications, and the Internet itself. Much of what I experienced in my own formal education has, in that same timeframe, disappeared. While I can't imagine it's been forgotten by others of my age or older, my peers puzzle me by condemning "traditional education." They trend towards a 21st Century inquiry-based approach to education: applied approaches to learning within which technical resources abound, that in their design foster skills in critical and independent thought. But! The things that stand out for me in my reflection on my own education reflect exactly that. I recollect Olympia and guillotines and the encouragement to investigate and discover. I would venture to say we are somehow, now, trying to go back to what we had, albeit, without iPads and the Internet. Current technologies provide us with incredible new tools. However, despite their power and capacity to remove perceived complication from life, they should not replace our need to learn the analog and the digital, to understand the wave in order to appreciate the particle, and to learn whatever is foundational before we rely on the convenience that achievement often brings.

Education should provide us with the ability to investigate the real world as a first step to deciphering it. But in order to understand it, we must internalize the rules, principles, and concepts that define it. We must be provided the tools to do so, not as ends in themselves, but as objects that permit us to behave in ways and accomplish tasks that allow us to contextualize the foundational elements we are striving to learn. And education should provide a sequence of learning that enables critical thought, behavior, and the path to creativity and originality. We must learn what is, how it is, why it is, and then

be permitted and encouraged to investigate ways to make it better.

We need the saw to cut the wood that will frame the house that requires the geometrical theorems in order to design the blueprints that depend upon mathematical equations to determine the dimension of the wood to be used. We must appreciate the use of space and concepts of usability and design and how they correspond to human needs and behaviors. We must appreciate the ideas that preceded us and how they have evolved to benefit our own lives. We must appreciate the consequences of what we do and how by improving what we and those before us have accomplished can improve the ways those who follow us will live. Education should provide saws, slide rules, brushes, and iPads. However, Education must also provide both the practical and foundational knowledge required to master the essential social, theoretical, mathematical, communicative, and grammatical skills that achievement depends upon. Only then will we be able to move closer to beaming ourselves as now only fictional characters do.