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TRENDS

THE WEB AND THE ADVENT OF "SUPERINTEGRATION/CREATION"

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Abstract: *Throughout history, the progressive acquisition of knowledge by mankind has involved five distinct tasks: learning, sharing, integrating, archiving, and then reacquiring (to start the process again) information, discoveries and ideas. The advent of innovations such as language, writing, printing, telecommunications and information technology have each dramatically increased the speed and volume of knowledge acquisition by optimizing our ability to accomplish one or more of these tasks. The Web now permits global, Web-based communities to combine all five of the traditional steps into a single democratic, merit-based, neural, real-time, ongoing, evolving, integrating process of knowledge acquisition. This revolutionary process may be referred to as "SuperIntegration/Creation," and can be expected to have a profound impact on how we live, work and learn.*

Introduction: The ability of humankind to take incredible things for granted is remarkable, and especially so where such things are in constant, everyday use. Thus it is that the significance of the Web is too often ignored rather than properly appreciated.

True, the enthusiastic chants of the Internet bubble years that "the 'Net will change everything!" did prove to be the outrageous claims of the naïve, the irrationally exuberant, and the cynically opportunistic, at least with respect to the time frame within which that transformation was predicted to be realized.

The World Wide Web that was enabled by the deployment of the Internet, on the other hand, is another matter. The potential impact of the Web extends far beyond its ability to facilitate education and everyday information gathering. Instead, it represents the means by which the next great explosion of collaborative intellectual discovery will occur, and will enable the type of sudden and rapid advancement of the arts, sciences and even human society itself that has occurred only a small number of times in the past. A brief review of these previous great leaps forward, and the enabling discoveries that made them possible, serves to demonstrate that this prediction is not conjectural, but a certainty.

If this premise is accepted, then the nurturing of the Web, and the extension of its availability to all people everywhere, becomes not an ideal so much as an imperative. In that context, the implementation of the Semantic Web (see the Feature Article and Editorial in this issue) is an opportunity not to be neglected.

Innovations Enabling Advancement: It is a scientifically accepted conclusion that the humans of today are essentially identical (including in intellectual capacity) to those first modern humans that appeared upon the scene more than 100,000 years ago. And yet it was tens of thousands of years before *homo sapiens* discovered agricultural principles, began cultivating food crops and settled down in villages. From that point forward, the pace of knowledge acquisition increased radically. The result was the development of conceptual *tours de force* such as mathematics, advanced arts and science. In due course, the industrial age dawned, followed eventually by the computer age. Now, we are embarking upon what might be called the Age of the Web.

What enabled this accelerating rate of advancement?

The base dynamic was (and continues to be) the ability to build upon the **information, discoveries and ideas** that were acquired and developed by others, and particularly of those that have come before. This process depends upon the following steps:

- **Learning** something new (acquiring new information, and reaching new conclusions)
- **Sharing** the new information and discoveries (rather than hoarding it for personal advantage)
- **Integrating** that information with other information and/or newly acquired information to a purpose
- **Archiving** the information, in accurate form, for future generations
- **Reacquiring** that archived information (i.e., knowing it exists and how to find it)
- **Learning** something new as a result, and repeating the cycle

Each time there has been an important advancement in our ability to perform one (or more) of these process steps, there has been a commensurate advancement in our ability to build upon *information, discoveries and ideas* more productively and rapidly.

Until the last few decades and the wide deployment of computers, databases, networks and (most recently) the Web, browsers and search engines, dramatic advancement has been possible in only two of these steps: the ability to *share* information and the ability to *archive* it. And yet significant advancements in just these two processes have been matched by explosive advancement in human knowledge.

Let us briefly examine each of the major leaps that have occurred in pre-history and history to see how improvements in *sharing* and *archiving* have resulted in a complimentary leap in the advancement of knowledge acquisition, as a foundation for evaluating how the advent of the Web will enable the next great leap forward in the acquisition and utilization of knowledge.

The first great leap forward: Language: The manifestation of human intelligence that gave rise to the first burst of advancement was doubtless language, which allowed the predecessors of modern humans to *share* information in greater detail and complexity than can other animals. Through language, not only could the location of necessities be conveyed from one individual to another, but so also could valuable discoveries, such as the observation that animals moved to certain places, and by certain routes, at predictable times of the year – and that certain natural phenomena could be used as indicators of when those times of year had arrived.

As a result, the knowledge acquired by individuals could not only be shared on a current basis, but could also be verbally passed down from one generation to another – the earliest advancement in *archiving* discoveries and strategies since the evolution of genetically programmed instinctual behavior and the ability to teach by visual example.

With the evolution of language, the human species was able to populate even the most inhospitable parts of the world, because inventions as humble (but significant) as the needle and sinew-thread enabled the development and use of warm, sewn garments. These innovations could be shared and passed down from generation to generation, and allowed the migration of bands of humans into progressively colder and more hostile environments. Other discoveries had impacts of similar importance.

But language, without a more reliable means of archiving and more established lines of communication, was an imperfect foundation upon which the progressive advancement of knowledge could be based. It is believed that in prehistory, as today, hunter-gatherer societies were based upon bands of only a few families, which met perhaps once or twice a year with other, related bands totaling a tribe of perhaps a few hundred individuals. Thus, the potential to *share* new discoveries was systemically limited to, at most, that number of individuals. The discoveries of another tribe could be learned through the occasional capture of members of that tribe and through trading relationships, but in the former case the willingness to accept the customs of enemies might be limited, and it may have been many thousands of years before human population density and sophistication developed to the point that trade became conventional.

Finally, when new discoveries were made, droughts and other natural disasters could befall the individual bands and tribes that had made these discoveries, resulting in their loss.

Useful discoveries might also fall into disuse (and therefore become lost), if they became superfluous under changing conditions. For example, we know that humans reached Australia more than 50,000 years ago – and that the nearest land to Australia at the time was at least 55 sea miles away. As a result, a society necessarily existed at that time that was capable of building sophisticated boats capable of permitting a pioneer population to island-hop its way down the archipelago of Southeast Asia, often venturing forth to seek land that could not be seen over the horizon.

And yet that impressive technology was lost (or became superfluous) in the years that followed: by the time that Europeans arrived tens of thousands of years later, the aboriginal inhabitants of Australia were leading a far more basic hunter-gatherer existence than their predecessors may be presumed to have pursued. Some anthropologists now believe that a similar phenomenon occasioned the first peopling of North America via boat perhaps 30,000 years ago (or more), via an Arctic route.

Thus, without a reliable means to share knowledge broadly within a single generation, or to pass that knowledge from one generation to another, there was scant opportunity to advance learning by building discoveries upon discoveries, or to permit abstract thinking to evolve. How many Newtons and Einsteins were wasted in the last hundred thousand years as a result? And how many innovations (like the lost boats of the Australasian pioneers) were developed by gifted individuals, that have been lost forever from view?

Only with the eventual settling of bands and tribes into year-round locations as a result of the advent of agriculture did a more structured society evolve, and with that development, the persistent need to fix information in a tangible medium and the conditions in which a technique for doing so could be conceived.

The second great leap forward: Writing The advent of writing was the second revolutionary innovation that truly "changed everything," as it not only hugely advanced the state of the art of *archiving*, but also radically expanded the ability to *share* information, ideas and discoveries across distance and time.

While initially writing may have been limited to recording commercial data (in the Fertile Crescent) or the heroic deeds of kings (in Mesoamerica), once conceived, its utility for other purposes was rapidly realized. Now, the preservation of useful information, discoveries and ideas was no longer solely dependent upon the incentive and opportunity to convey them verbally from generation to generation, but the integrity of data and conclusions could be preserved as well, even if their custodians made no current use (or even remembered the existence) of these writings.

With the ability to preserve information, ideas and discoveries, came a much richer opportunity to *integrate* new information and discoveries with old, to prove or disprove earlier theories and build upon the results, and to base new ideas and theories on those that had come before. For the first time, data and ideas could be accurately transported, and seekers of knowledge could travel to the site where valuable information was known to be maintained. One result was the opportunity for explosive advancement in abstract thinking in areas such as philosophy, mathematics and astronomy, as well as practical disciplines like irrigation, construction and ceramics.

Over the next several millennia, where stable societies existed over long periods of time (as in Sumer, Babylonia, Egypt, Greece and Rome), rapid advancement occurred in multiple areas of knowledge. With increasing trade between broadly separated peoples over established land and sea routes, copies of archived knowledge could (and were) increasingly shared, resulting not only in wider derivative innovation, but in the preservation of learning (at least in part) when disaster befell, as tragically occurred with the destruction of the Royal Library of Alexandria.

The third great leap forward: Enhanced Availability The innovation that enabled the next great leap forward was not revolutionary but evolutionary: the invention and proliferation of the printing press. With the ability of information, discoveries and ideas to be disseminated and *shared* more broadly, many more individuals had the opportunity to *integrate* information, and contribute their own intellectual discoveries to build upon the work of others. With the creation of more copies of any single source of knowledge,

finding their way into *archives*, vulnerability to loss was vastly diminished. And finally, with books becoming more available and affordable, the ability to read became a skill more worth acquiring.

Soon, institutional libraries became more commonplace, as did private collections of books. With the new wealth of access and more opportunities to obtain an education came a greater opportunity for original and sophisticated thinking, and more like-minded individuals with whom to carry on inquisitive discourse. True, those engaged in science had used Latin as a universal language for centuries to engage in the extensive (albeit slow) international sharing of information, discoveries and ideas. But there was also great deference to the conclusions of those that had come before – even thousands of years before, in the case of the Greek philosophers, anatomists and physical scientists. With the dawn of the Enlightenment, however, a new willingness to question and hypothesize took hold, conjoined with a great age of discovery that generated a wealth of information that cried out for interpretation.

The fourth great leap forward: Simultaneous Sharing   The next technical advancement was evolutionary in one sense, and revolutionary in another, and began with the electrical transmission of the first telegraph message. Now, information could be *shared* not only universally, but also at the same point in time and in substantially uninterpreted form, allowing multiple recipients to *integrate* that information, and form and then *share* conclusions based upon the same raw information. As wire services were established, and as newspapers bought and disseminated the information they provided, the first age of the "information silo" began to fade and a contemporaneous, wide area network of information availability began to evolve. With the invention of technologies such as microfiche and the willingness of libraries to *archive* newspapers, the ability for future historians to access raw, contemporaneous data for ongoing, independent analysis, *integration* and interpretation also expanded exponentially.

While evolutionary in the sense that electronic transmission was merely a faster form of delivery of information than letters, the immediacy and simultaneity of access that the telegraph made possible was revolutionary. And by globalizing and multiplying the places in which raw information could be *shared* and *archived*, the same data could be interpreted and creatively *integrated* from more and different perspectives than had ever been possible before.

With the subsequent invention and spread of the telephone, not only could remote data be accessed globally, but direct contact could increasingly be established with first hand witnesses. And with the eventual spread of television and the deployment of satellite feed technology and on-location camera crews, even first hand information acquisition on a mass basis became possible, albeit on a selective (and sometimes censored or slanted) basis.

The fifth great leap forward: New Learning, Reacquiring and Integration Tools   With the development of cheap, powerful and available computing power and the design of database technology, the stage was at last set for dramatic progress on the *integration* and *reacquiring* process steps. Now, vast quantities of data could not only be searched, but relationships could be discovered and modeling performed through automated processes, enabling tasks to be performed in seconds that might have taken years to accomplish before, if they could have been performed at all.

The result was that new types of discoveries became feasible that would have been impossible to make but a short time before, and theories could now be substantiated that necessarily would have remained theories indefinitely absent the means to test them. At the same time, rapid advancement in a bewildering array of learning tools (electron scanning microscopes, space probes, genomic sequencing techniques and so much more) created a supernova of new information for information technology to *integrate* and *archive* in a manner that would permit for easy future, automated *reacquisition*.

As the Twentieth Century approached its close, then, the infrastructure and tools that enable *information, discoveries and ideas* to be *learned*, *shared, integrated, archived,* and *reacquired* had made astonishing strides, reaching what seemed to be the ultimate platform upon which future human progress could be based for all time.

And then, the Web "changed everything" again.

The sixth great leap forward: The Unity of all Information, Discoveries and Ideas With the advent of the Web (and then the first graphical browsers and search engines), the ability to *learn*, *share*, *integrate, archive,* and *reacquire* information, ideas and discoveries truly exploded. Today, given a search engine, the most inexpensive of personal computer systems and some sort of telecommunications access, anyone anywhere in the world may access orders of magnitude more information in an instant than most human beings could hope to view in a pre-Web lifetime. And with the contemporaneous progress that has been made in telecommunications and the build-out of the Internet, all of the power of information technology may be deployed on a globally shared basis as well. With continued progress in areas such as Web Services and Network Centric computing, the ability to productively wield this power will continue to increase.

But something much more profound has become possible by means of the Web, and it is this capability that can be expected to provide the next, and perhaps the most radical, advancement of human knowledge and society.

In human terms, the access provided by the Internet and the information provided by the Web represent the single greatest avenue for equality of advancement by the individual in the history of the human race. And, for the same reason, these tools also represent the greatest opportunity for the advancement of knowledge in human history as well.

At the most basic level, making the Web available to all of humanity is akin to packing more transistors on a single chip. Whereas twenty years ago a few tens of millions of people in the entire world had access to first-hand academic libraries at one time, now there are over a billion people that can connect to millions of pages of information, discoveries and ideas of comparable quality. Just as the power of computer chips today is immeasurably greater than that of those deployed in the early days of the silicon revolution, the mental processing power of the planet will explode as a billion – and soon more – individuals can access "system resources" through the Web, as well as conjoin their intellects in what amounts to the parallel processing *integration* of all existing knowledge to spawn new ideas and make new discoveries. And no more need the intellects of potential Einsteins and Newtons be limited in their ability to flourish, regardless of where they may live, if connectivity is within reach.

The results will be even more dramatic, because the Web, enabled by the Internet, dramatically facilitates the operation of each of the five key steps that have led to the advancement of knowledge throughout human existence.   Consider the following brief summaries, each of which captures only the spirit of the revolution that has occurred:

> ***Learning:*** Those that live in the First World can locate data in minutes that would have taken hours to acquire in traditional libraries, and those in the Third World who have never had access to libraries may now acquire knowledge that might have remained hidden from them for life. New ideas are being formed on a constant basis using on-line resources; many of these ideas would never have been formed absent the wealth of information, discoveries and ideas that can be accessed on the Web. Even the quantity (if perhaps not the quality) of ideas being formed has surely increased, prompted by the incentive of sharing ideas and insights using this new medium (Blogs are the most recent example of this phenomenon; the ideas presented at this Website are another).

> ***Sharing:*** Examples: People who have not written a letter in decades send hundreds (and even thousands) of words a day to specific recipients, as well as to unknown numbers of readers at chat rooms, discussion boards and other electronic destinations. Scholarly work that used to be available only in expensive journals found only in academic and urban libraries is increasingly posted on public sites. Unique resources that until now were made available only to qualified scholars by appointment, such as the notebooks of Isaac Newton, are being scanned and added to the Web, so that anyone can study Newton's genius as manifested in the details of his thoughts as they were recorded in his own hand. Enormous amounts of information of great value, such as aerial photos, topographic maps and statistical data can be downloaded that formerly would have been available only in a tangible, proprietary, costly form. Open source and Creative Commons licensing models are being more and more pervasively used, augmenting a new on-line ethos of no-cost sharing that has heretofore been unknown outside of academic circles.

Archiving: Not only are untold thousands of pages of information, discoveries and ideas added to the Web each day, but this new material is being acquired and indexed on a constant basis by search engines. In the scant space of a decade, virtually every category of data by subject matter and by media type has either been added to the Web, or is in the process of being added. Entire libraries of material are in the process of being scanned and posted, resulting in the imaginable consequence that in another decade perhaps the majority of what is worth accessing may well be accessible.

Reacquisition: Traditional methodologies have been utilized to allow the efficient "local" reacquisition of information, discoveries and ideas (e.g., existing indices and bibliographic information for journals are available at hosting sites), and the first generation search engines of today provide a useful, if not highly precise, means of reacquiring what has been *archived* globally. New methodologies – such as the Semantic Web – are being created on an ongoing basis as well, each of which is intended on a macro or a specialized basis to increase the intelligence with which information, discoveries and ideas can be reacquired from the Web. Presumably, this is the technical area where the greatest continuing technical advancement will occur, in order to make more useful the riches that are constantly being added to the resources that are already available on the Web.

The big one: "SuperIntegration/Creation" I have purposely left integration until last, because it is at this level that the revolutionary aspect of the Web is most manifest, and at which historical labeling becomes inadequate, requiring a new term to describe what is happening in a multitude of new peer-to-peer, collaborative, on-line communities.   Let us adopt *"SuperIntegration/Creation"* as that term. *SuperIntegration/Creation* may be thought of as being simultaneously both a verb and a noun, and can be defined as follows:

> *The democratic, merit-based, neural, real-time, ongoing, evolving, sharing, integration and archiving of all information, discoveries and ideas that, on a Web-wide basis, represents our entire understanding of a subject at any point in time.*

SuperIntegration/Creation is occurring all over the Web, in venues as diverse as open source projects and the compilation of the Wikipedia <http://www.wikipedia.org> (the extremely successful, non-profit encyclopedia project). The elements of the definition above are worth explaining individually, using the Wikipedia as an example.

SuperIntegration/Creation is:

Democratic, because the Web knows no boundaries. Unless an (increasingly rare) password stands between a user and a site, language alone is a barrier to entry, and anyone may participate. Many on-line projects have little or no hierarchy of authority or decision-making. Not only can anyone launch or add to a Wikipedia entry, subject only to a level of quality control, but the Wikipedia is multilingual, with 33 different language versions in existence today that have 5,000 or more (and as many as 60,000) entries.

Merit-based, because participation in many Web-based communities is not only resume-neutral, it may even be anonymous. Many projects do not identify individual authors of any of the constituent parts of their work product. Thus, participation and inclusion of individual output is based on the community's opinion of the knowledge and skills of each community member rather than on that individual's credentials or titles in the real world. At the Wikipedia, anyone can launch or add to an entry. If the quality of their contribution is judged to be high, then the entry stays.

Neural, because a large, varying and concurrent number of participants can join in a process, each of whom plays a collaborative part. No one "owns" a Wikipedia entry; anyone can add to an existing entry – and does, adding new information, sub-topics and insights unbounded by the conceptions of any single author.

Real-time, because an increasing number of Web-based projects have no defined workday, or referential time zone (the Wikipedia never sleeps).

Ongoing, because many Web-based projects have no reason for an end date – they are processes more than they are projects, and because they are not fixed in tangible media, they may have

(but technically need not) even have version or edition numbers. As new information becomes available and new events occur, they can be folded into the project. The Wikipedia by definition will never be "finished" any more than will the Linux kernel.

Evolving, because many Web-based projects involve not just information, but also discoveries and ideas as well. Thus, even historical data may be reinterpreted, or act as the basis for new discoveries. Not only are new Wikipedia entries being added on a constant basis, but each individual entry becomes its own micro *SuperIntegration/Creation* project, limited only by the number and enthusiasm of those that have an interest in a that topic. See for example, the detailed entry on World War I <http://en.wikipedia.org/wiki/World_war_I> with its comprehensive outline and hundreds of out-bound links. But for a real example of the cultural richness and enthusiasm of the Wikipedia, see the current index for the beloved, wise (and now retired) comic strip, "Calvin and Hobbes," reproduced at left.

SuperIntegration/Creation has been in existence as an unconscious social process for as long as humanity has existed (culture is one name we give to it), but it has not been capable of existing in as comprehensive a form as the Web permits since human beings were hunter gatherers, when each band could participate in the creation and maintenance of, and hold in its collective consciousness, all that was known at that point in human history.

Web-based SuperIntegration/Creation is revolutionary in that it simultaneously, rather than serially, incorporates all of the process steps that I have addressed in this article: those that participate in a Web-based process at once are *learning, sharing, integrating, archiving* – and then learning again. What a Web-based community is experiencing therefore is both a process (the verb) and the instantiation of what at that point in time of what that community collectively knows, is thinking, and is discovering (the noun).

Taken together, the Web itself is a vast, organic SuperIntegration/Creation project -- what a French Jesuit philosopher named Pere Pierre Teilhard de Chardin in 1925 presciently called the "Noosphere:" the layer of all human knowledge and culture surrounding the globe.

Summary: Are the products of collaborative projects like the Wikipedia superior to their historical antecedents (such as encyclopedias)? In some cases yes (e.g., art projects) and in some cases no (e.g., Wikipedia type-projects that demand involve scholarship, without suitable quality control). The important point is that they are *different* in important ways that will yield results that would not be possible by normal, step-wise, centralized, more hierarchical and self-selecting methods.

Conclusions: At the dawn of mankind, sharing of knowledge was universal within small groups, but the acquisition of knowledge was extremely slow, and that knowledge was vulnerable to loss. Over time, successive cultural and technological innovations enabled sudden leaps in mankind's ability to learn, share, integrate, and archive information, discoveries and ideas. While this process was orderly, it was also step-wise (and therefore time consuming) and elitist, in that the ability to participate was limited to those with the requisite resources, social privileges, proximity and education.

The advent of the Web and the process/reality of *SuperIntegration/Creation* that it enables, "changes everything" about how we acquire and use knowledge to a greater extent than perhaps any prior innovation since the acquisition of language. This new Web-enabled ability to think and exist within an evolving knowledge process, rather than to individually "know" only an erratically updated body of knowledge, is likely to have profound consequences on how we learn, think, and make new discoveries. Similarly, the lack of hierarchy and freedom of participation in many SuperIntegration/Creation settings upsets many traditional age, title and education-based power relationships.

As time goes on, one can expect more and more communities to arise on the Web, and these communities will engage in ever more challenging SuperIntegration/Creation processes. In the near future, we may spend more and more of our education, work and recreational time in such settings.

Perhaps, this latest revolutionary leap in how we acquire knowledge, as with our acquisition of the gift of language so many millennia ago, may even change what it means to be a human being.

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