

A CURRICULUM FOR THE 21st CENTURY

**AN INTERACTIVE EXPLORATION OF THE
OTHER HALF OF THE UNIVERSE THROUGH
PATTERN, INFORMATION, INTELLIGENCE, CONSCIOUSNESS**

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A curriculum for the 21st century? An interactive exploration of the other half of the universe through pattern, information, intelligence, and consciousness?

What is this concept? Simply that there are many elements of present-day science, commerce and beyond which could be pulled into a single comprehensible perspective that is currently lacking. We in general, and students in particular, have arrived at a point where it is literally confusing to try to reach an understanding of all the simultaneously burgeoning fields of knowledge. Terminal compartmentalization and specialization is a capitulation to the frustrating futility of trying to integrate it all into a central vision. For centuries The Church in the west provided such a vision. Subsequently science, and especially physics, provided that perspective. Now these former frameworks seem no more than shattered shards and no structure has arisen to replace them.

Paradoxically that structure has in fact fully developed, but in keeping with one aspect of its nature it is largely invisible.

Like fish in the ocean that have no way of seeing the water which constantly surrounds them, astoundingly little academic awareness is directed to the sea of pattern and information which constitutes the ocean of existence we move through. This is a particularly rich moment when a radical increase in the understanding of what is essentially "going on" in the existence around us and how we experience it, can be triggered by pointing out an integrating perspective which is at once obvious but as yet largely unseen. We stand as a saturated solution ready to instantly crystallize once a seed is provided.

That perspective, that realization, is sorely needed if education is to be experienced as anything more than an overwhelming barrage of loosely connected and ever expanding topic areas which simply no longer fit in the years available for schooling. A new approach is possible which would restore the renaissance sense of a comprehensible universe encompassed by a basic set of first principles from which all else flows. It would at the same time remove the artificial barrier which prevents science as we know it from moving into new areas of knowledge which it has hitherto branded as heresy, simply because it lacked the fundamental conceptual tools needed to think

about those. Too many people, and too many highly intelligent people, have had incontrovertible experiences in the realm of the transpersonal to accept science's condemnation of it all as fraud and delusion. For those who have experienced phenomena in that realm, all science's charge does is to highlight the inadequacy of science as currently constituted. We can no longer live in the world of Newton's falling apple. We never could. There was always far more happening here than mere mechanics. But now the limitations of that paradigm are becoming impossibly constraining, and they no longer speak to the essence of our experience of the ordinary, let alone the extraordinary.

In our own lifetimes we have moved from a world of mechanics to one of information, in ways large and small. The vending machines of our youth were monuments to mass and momentum where coins would be identified, change made, and products dispensed on the basis of Newtonian principles. Today (thanks to inflation-both financial and intellectual) what is identified is often paper money, recognized on the basis of pattern using optics and microprocessors. And often the "product" is a duplication or reworking of information as in a Xerox photocopier or the compilation of a selection of songs from an optical disk onto a cassette tape. Things have really shifted, the viewpoint informing our educational approach has not.

Before presenting a schematic of a proposed curriculum I would like to take you on a brief overflight of the vast territory which can clearly be regarded as aspects of the new science of information. Some of this we have discussed before. But I think it is useful to take this tour through the territory, for I suspect that on the journey the same pattern which has become so clear to me will spontaneously emerge for you with little didactic prompting on my part.

Perhaps the most telling place to start is in recreation. Whatever has permeated thoroughly to that level has embedded itself deeply in our reality. It will also suggest how broadly defined "information" has become.

In a sense other than which Marshall McLuhan originally intended, the medium often contains an implicit message in its very form—especially when that form changes. This has occurred in several recreational areas where the technique of information storage has undergone a radical change—breaking free of a storage mode that echoed the reality originally being captured, and substituting one that overtly delivers the message that we're dealing with pure information here—and anything is possible. As long as movies consisted of little sequential images, and records had a vibrational structure engraved in their surface the time play of information which was occurring was camouflaged.

But with the advent of first the VCR and the CD player and now DVD's and iPods the last tethers to unprocessed reality were broken, and the true nature of what was occurring was revealed. It was as large a step as our first step on the moon, and it was probably no coincidence that they were essentially synchronous in the timetable of history. For historical bounds were loosed in both instances. As one of the Apollo astronauts phrased it so well, the curve of evolution was bent and there is an important implicit message in the fact that the primary, in fact almost the sole, use of space has been for information gathering or transmission using satellites.

In the shift from the tracking of the material stylus to the immaterial probing of the green laser light of the CD player devouring bits at incomprehensible rates a discontinuity of monumental proportions entered the flow of history. And in the same way video-recording made images and time itself far more plastic than had ever been imagined possible. At a superficial level to be sure, but a noteworthy level nonetheless, the earlier popular debate about the relative merits of BETA vs. VHS VCR recording, and the more recent ones about PCs vs. Macs, signaled a cognizance of and a comfort with a new world of information. This common sophistication about information storage, retrieval, and processing is a breathtaking benchmark of what the true changes in this century have been about.

Still within the recreational playground the seeming infinity of programming available on cable TV and the insatiable appetite for news programs of every sort speak to another aspect of this information revolution. As does the linking up of more and more homes to fiber optic pathways capable of delivering mind-numbing data rates. The "construction" of the information equivalent of the interstate highway system, an ultra-high capacity fiber optic network throughout the whole country for data transmission rapidly became an inevitable necessity.

When "Grand Theft Auto" becomes the favorite past time of Homo Ludens, and ever-growing computer firepower and programmer brainpower is directed at accelerating the complexity, sophistication, and verisimilitude of this "game", we have entered a "new age." And some of these "games" such as the game of "Life" serve as direct entryways to frontier thinking using such cellular automata in fields as diverse as cosmology and molecular biology. A similar direct connection between play and cutting edge research exists in the area of personal computing. But even in their more mundane applications such as word processing, budgeting, and record keeping, home computers represent an immersion in information which was largely regarded as highly improbable thirty years ago. I well remember arguing that what is now obvious was then inevitable, and being greeted with skepticism at best and more often scorn.

A final facet of the "recreational" aspects of this ocean of information suggests what an infinity that sea may represent. The present state of "Artificial Reality" where computer controlled visual, audio, and tactile input create convincing artificial worlds only can hint at what may be ahead of us—particularly when that is somehow cast as a collective experience.

Turning to the arena of commerce the impact of the science of information is all pervasive. Computing has rapidly exponentiated into supercomputers on the high end with hypercomputers in development. In a truly exponential, and possibly super-exponential, process computers are designing computers from microcircuitry to overall architectures in a rocketing process of capability enhancement which is positive feedback at its wildest. At the same time the power available on a desktop dwarfs the common mainframes of two decades ago and far

surpasses the power of early Cray supercomputers. We have arrived at the point where computers are expanding off into so many directions in a super-nova-like burst that the term "computer" itself has passed into a kind of quaint generic obsolescence, much as has occurred with the term "vehicle."

For now radically different types of "computers" have appeared. Noteworthy are "neural nets" which rather than being digital processors, actually mimic the structure and function of the human mind. These devices can truly be said to learn how to associate selected input patterns with desired output patterns. Many curiosities and mysteries of human thinking are mirrored in these devices, such as the phenomena of "confusion" which occurs when more than about 10% of the theoretical capacity of the memory is used. Also reminiscent of human behavior is the fact that certain "pedagogies" are far more effective than others, and in all of them repetition is the key to learning. This is no longer the stuff of science fiction, it is current technology. One which 19th century chemistry, physics, and mathematics is an ineffective and irrelevant way of approaching. It is already being used in financial analysis and airport bomb detection to mention but two very "real world" applications.

"Computers" using "fuzzy logic" realistically representing the world of grays, rather than black and white (or the binary choice of only on and off), are now in ascendancy, especially in Japan. Once again, information and its representation, is taking a giant quantum leap forward.

So much so that the world of "traditional" artificial intelligence seems pedestrian and ancient in contrast. But this is not to downplay the large and growing role of such expert systems in fields such as airline route planning and seat pricing, or academic semester scheduling.

Computation and communication have more and more coalesced into one integral package highlighting the underlying essence of information that is involved. "Voice Over Internet Protocol" (VoIP) says it all. Voice mail, PBX switchboards, and fax machines speak to the incessant demand for more communication at higher speeds. In a non-electronic sense the

explosive growth of Federal Express speaks to the same phenomenon, the same craving, and the same need for the aforementioned information equivalent of the interstate highway system. At the same time much of what a computer does is focused on the transfer of data from one point to another within the same machine, an esoteric but critical communication problem. For it is the speed of light, the data transfer limit, which establishes the ceiling computers are currently constrained by. All wiring in computers is kept as short as possible, for data can only move a foot a nanosecond, and for a computer a nanosecond can be a frustrating wait.

A variant approach to supercomputing, connected computers (in the same building or over the internet) linking together tens of thousands of independent processors, leads to hypercomputing. And the key to this next step is the hyperspace manner in which a communication network is established between these processors, and the fashion in which data flow between them is managed. Again a communication problem at the core of "computation."

In the daily life of commerce, computer networking in a more traditional sense has leapt to the forefront, linking together minicomputers and desktops in a way that has doomed most mainframes to the fate of the dinosaurs. At the same time it has cut down the time needed to access information required by managers or employees from days to seconds in many cases.

Twenty years ago 300 baud was the standard. Now on DSL and cable modems hundreds of megabits per second enter the home.

Which is just in time. Because the tidal wave of information which the average computer user, never mind executive, lawyer, or researcher must swim through daily has given rise to the need to store electronic images of all the documents such an individual must constantly have at his fingertips, including the graphics which may be enclosed in those documents. At this point the storage, data retrieval, and data transmission requirements become astronomical. Much current software development is addressing these issues. Intense effort is

directed towards data retrieval and data association, whether it be through hypertexts or some far more sophisticated inferential technique. The necessity for such search capability in this sea of information has made Google a household name., both a noun and a verb

The highly advanced data compression methods used in making maximum use of satellite capacity, or in transmitting images from the far reaches of the solar system where absolute baud rates are limited by electric power constraints, have played an essential role in making the possibility of intelligently capturing thousands of documents at all feasible. Such data compression techniques delve deeply into the essence of information, squeezing out all redundancy and repetition, leaving an irreducible core to which the original message can be compressed. This is an incredibly conscious way of relating to information. At the same time it is commonly used in the information infrastructure of the current world. One application is to use it to maximize the utility of a personal computer's hard disk by automatically scrunching down everything that is ever stored on it, and automatically re-expanding that information whenever it is accessed. This intimate involvement with information is common knowledge among the technically literate, and incomprehensible to those outside. And is representative of the kind of current reality education, in its revised form, absolutely has to address.

All of this imaging of documents implies an ever growing capability in computer graphics. Here every two years signals the advent of a new graphics standard boasting higher resolution, more colors, and faster screen drawing speeds. Computer aided design/computer aided manufacturer (CAD/CAM) with its associated computational/graphical "workstations" have pushed the edge of the envelope in this area. But the standard issue desktop computer has been quick to follow.

As great a burst of technological progress as all of this represents it is still only the first step across the threshold. Word processing, now ubiquitous, is the first hint of how well information processing can meet a long standing need, how well it can address the way that people would really like to do something, and how radical a change in how things are done all of this can add up to.

Word processing is a tremendous technological tool which easily accommodates the non-linear collage style of writing which for many people is the most comfortable and productive way to proceed. It reduces the threshold of pain for subsequent revisions to near zero, thereby producing far more coherent and polished final drafts. But it is only the first step.

Armies of writers who for many reasons prefer to put down their thoughts with pen or pencil on paper await automatic hand-written text readers which could quickly, accurately and cheaply convert hand-written drafts into a computer file.

And those who favor dictation still await the advent of a reliable and economical voice-recognition system with a wide vocabulary and the ability to decipher natural speech spoken at a normal rate. Scansoft Dragon Naturally Speaking and IBM Via Voice are big steps in the right direction, but much more needs to be done

These first two items are high on the want lists of many professionals. Moving a bit further down the list and out in time would be systems which could monitor news lines or journals as they are published and effectively respond to one or both of the following requests: Read this article and only tell me what is new in it, not the background information I already know; or Read this article and tell me what, if anything, it contains that I need to know. Either request presumes a challenging grasp of what the requester knows already, or needs to know.

This knowledge base would certainly not be simple to construct, but the payoff would be enormous. In the face of endless information inundation, such an approach will be absolutely necessary. In fact it already is.

This raises the key point that up to now the information/computer age has principally emphasized the ever increasing capability to generate overwhelming amounts of information. Future capability will have to be focused on the task of intelligently filtering through this monumental mound of data and text. Initially this can take the form of database queries in search of specific information.

This type of service is already currently provided in many forms. At a rudimentary level search engines such as Google permit the user to search vast the full extent of the internet using several keywords linked together with "and/or" constructs from Boolean logic. Such an approach is powerful in its scope and ability to focus on a sub-subtopic. It has the drawback that sometimes the really right reference would be in a graduate level text beyond the reach of Google at present (but Google is rapidly expanding its reach to all the world's literature and video sources).. A second problem is that sometimes a subtle misphrasing of a keyword or phrase will misdirect the search process to unfertile areas.

The ideal answer here would be access to a skilled pilot adept at sorting out such subtleties and able to expertly traverse the terrain of large databases. As an indication of how far along this evolution of the science and commerce of "Information" has proceeded, such services already exist in various specialized areas such as the law, engineering and medicine. And they take the logical next step, backing up the skilled database pilots with large networks of human experts on call to address queries not easily answered from a database. These human experts are able to point out the reference text worth looking into, or the engineer in the field who has the needed information at his fingertips. A whole second set of information pilots stand ready to put the caller in touch with the right expert using a specialized database which has been constructed to sort out which expert is appropriate or a given query. Technical services of this type have between 4000 and 5000 experts on tap. It reflects how far, how fast, the market for this filtering role has grown. But as valuable as such current services are, only the future will provide an effective way of automatically extracting the needed new information from the intimidating stack of incoming memos and articles, not to mention the ever-growing queue of electronic mail, that greets all professionals and most home computer users each morning.

In light of all these aspects of the current information universe which surrounds us, it seems remarkable that no systematic restructuring of a scientific curriculum has been initiated to adapt to this shift away from the billiard ball and test tube world of Newton and Lavoisier. For it is in science that the threads of this new information reality are omnipresent, and seem to naturally suggest a new integrating perspective that ought to lie at the core of all that is taught. It

would be instructive to look at three areas of traditional science from this new integrating perspective: molecular biology, self-referential systems, and physics/chemistry.

It is in the burgeoning field of molecular biology that the singular importance of the new science of information be most deeply felt.

For out of molecular biology comes the realization that life itself, in the scientific sense of the word, is in fact a process of information transmission, variation, elaboration and replication. A dance of pattern that is much less chemistry and much more code. But a code that takes on the form of an elaborate living architecture-capable of duplicating itself. From the sub-microscopic viewpoint used in the stunning IMAX film "We Are Born of Stars" genes as structures combine the towering power of our tallest skyscrapers with the dazzling intricacy of the most detailed Islamic architectural designs. All of it meaning something. In a situation where we are both the messenger and the message. Momentary carriers of a communication that races forward in time becoming ever more complicated along the way. In fact becoming complex enough so that the message becomes aware of itself and how it is coded and transmitted. Complex enough to start actively modifying itself towards ever increasing complexity. Perhaps eventually to a point of complexity capable of answering "To what end"—"From what beginning." For now the complexity is advanced enough to recognize other similar processes occurring in the universe. And to even set a few of its own in motion whether they be computers playing the game of "Life" as software, or software designing software, or computers designing subsequent generations of computers.

Looking into a new perception/understanding of the process of life itself ought to call attention to the revolution in science which has characterized the late 20th century. And although this directly involves biology and chemistry in its material aspects, what is actually going on is an exercise in bare information. Information operating on itself. Non-linear information. This is a radically new twist in the history of science, and of thought. The curve of evolution has been bent Sharply. And all of this has occurred in a remarkably short amount of time.

Many of the key early players such as James Watson of Watson and Crick fame are still very much alive and active in the field. And yet some forty odd years later the advances have been staggering. With the human genome project we constructed a transcription of the complete book of life from chemical to computer notation. Translation has followed. Already key sentences, paragraphs, and chapters have been deciphered. Even with the relative rudimentary information and manipulative techniques we have in hand, genetic engineering has made significant advances.

A sense of the processes at work here has filtered down into part of the common language where we speak of computer viruses, understanding to some extent their role as informational interlopers fouling up messages. And recognizing that some parallel process occurs within our very cells each time we get a common cold, known to be virus caused. Where these not quite living snippets of genetic information like crafty pirates infiltrate our defenses, finding a home for themselves where they propagate, often taxing the whole system in the process.

The eerie synchronicity of the overnight growth in our understanding of the subtle informational games that viruses play and the near simultaneous advent of the AIDS virus as a threat to man is a disquieting coincidence. Deadly disease is disturbing enough. But one that has the feel of espionage where messages are altered slightly to lethal effect is disorienting. It would be like opening the New Testament and finding each occurrence of the name "Jesus" replaced by that of "Satan." Only a proportionally miniscule number of words would have to be changed. The results would be monstrous. An assault by bacteria or parasites, even though fatal, feels far less horrifying than the internal revolution triggered by AIDS, or its terrifying cousin in genetic mayhem, cancer.

But stepping back from those dark valleys we've come to understand but not control, it's extremely noteworthy that we live in a time where an informational process so intimately involved in life and death issues is seen to have computational analogs, the much-publicized computer viruses. This speaks to a truly advanced involvement in and appreciation of the universe of information. One which should be captured in a curriculum.

Turning to self-referential systems in mathematics and physics the same deep involvement can be seen. And the same lack of a coherent curriculum. There has been an enormous amount of public press concerning non-linear dynamics, fractals and chaos, including a best selling book by James Gleick. Each of these topics involves self-referential or self-interacting systems in a reflexive universe. Once things can start interacting with themselves, feeding back into themselves, the process changes, immensely. The linear world of Newton is a well-behaved dream. Once the possibility of non-linear self-interaction or non-linear interaction with other entities (where the sum is more (or less) than the sum of the independent parts) is introduced a computational nightmare can easily erupt. It was not sheer stupidity that prompted early physicists and mathematicians to adopt linear tunnel vision by putting on blinders. Without computers problems could become mathematically intractable almost instantly. Each solution to a non-linear problem would be unrelated to others starting with near identical initial conditions. Once computers became ubiquitous it was inevitable that the blinders would eventually come off. There are two things to note here. The first is chaos theory itself. And the role that these offspring of our intelligence, computers, played in rocketing the sophistication of our view of the universe ahead. Intelligence acting on intelligence, providing it with the tools it needs for a major bootstrapping upwards. Information acting on information. And it's important to remember that we're only a decade or two into a new era where the acceleration of this kind of strong positive feedback can be felt. In comparison all previous science was conducted linearly. Built on previous information to be sure, and to that extent mildly non-linear. But what we're now experiencing is wildly non-linear. And there is a critical need not only to educate students in the individual tools of the accelerating domain, but to provide an overview of the process itself. What is happening here? Where is it going? And how fast is it getting there?

There are myriad aspects of chaos theory that could be highlighted at length here. For example how a mathematical understanding of the way in which a subtle change in one part of a system can produce a major effect on other part at a later time (the "Butterfly Effect"). And how this reshapes our view of the interconnectedness of the world, and perhaps universe, in a much more quantitative and substantial way. Not undercutting the tenets of mysticism, but instead speaking to the same insights in an entirely different language, and thereby reinforcing them.

Our attention could be directed to the role of sequential or iterative behavior in chaos theory in which wildly intricate patterns can be generated, not random, yet never exactly repeating. This stands in stark contrast to the geometrical simplicity and "purity" of nature as described by Pythagoras, Newton, Kepler or even Einstein. This is an essential point here concerning a qualitatively different role of time in natural systems that Gregory Bateson regarded as critical in attempting to understand mind and nature.

Rather than continuing with a lengthy litany of such implications of chaos theory, a few final examples should drive home the relation of all of this to the key issues of pattern information, intelligence, and consciousness.

One of the key philosophical, artistic, and scientific questions that traces its origins back to Pythagoras and beyond, is that of the role of order versus chaos in the universe. Chance vs. necessity. Randomness vs. predestination. And whether we can even tell the difference. Coincidence, especially those eerily impossible and meaningful coincidences that are elevated to the status of "synchronicities", whisper or scream in our mind that "life is more than it seems" on the surface, or according to science. As Jung so aptly and precisely described it—"an acausal connecting principle" clearly exists in our universe operating at variance with the "rules" of ordinary science. This presents a direct challenge to our power to discriminate between the random and the ordered.

This point is dramatically driven home by an example that is far from "synchronistic" or mystical. If presented with the number series 3.14159... most individuals with a high school education would immediately recognize this as the leading digits of pi. But if instead the number series ...74215630982736046129...were given, the natural response would be to say that the numbers look entirely random. This assumption would gain credibility if it were pointed out that for the next 1000 entries in the series each of the ten digits 0 through 9 appeared equally often. It really appears to be thoroughly random. And there is not a test that could be applied to show otherwise. But it isn't. It's the 100 to 120 digits in the full expansion of pi. And it's entirely

deterministic. A simple rule can be given for calculating the digits. But it can't be deduced from examining the digits themselves. If the digits presented had been ...333333333333333333... many people would correctly guess that it was part of the decimal expansion of the fraction $1/3$. Those sequences such as that for $1/3$ which we can easily recognize are but a tiny fraction of the infinity of absolutely deterministic decimal expansions. Most look absolutely random. Unless you know they are not. Randomness and Order. How do you tell the difference? You don't. You can't. Unless at a meta-level you "know what is going on."

This "knowing what is going on" is the essential core of the curriculum for the 21st century. It encompasses an interlocking hierarchy of pattern, information, intelligence, consciousness. There is a causative flow in both directions. Once that flow is understood the key role of pattern interacting with pattern becomes clear, as does the primacy of relationships rather than objects as the basic entities in terms of which this universe can be perceived and understood.

Consider the number 314159. To make clear the necessary context that information provides for pattern, intelligence for information, and consciousness for intelligence, express the number in binary form. This is done simply to avoid the confusion which could ensue about the numbers if written as arabic numerals, which many might argue are inherently patterns. On retrospect it would be seen as unnecessary. But probably only in retrospect. In binary thus 314159 becomes 1001100101100101111. This could be envisioned as the on and off flickering of a light bulb where "1" would be on for one second or "0" off for one second. This would appear pretty random. As it would if it occurred as static bursts of sound on the radio. The point may be clearer if this is written as - -- - -- - ----. It literally doesn't look like much. Yet we know there is a pattern there because (and this is critical)-because we know that it is information. Pi: There is a fixed relationship between the elements. That makes it a pattern. In this case there is a hidden context that makes each position a marker for a different value, all of which are then added together. This may seem a highly stylized and intricate context But all perception imposes a context, even if it is as simple as vertical versus horizontal.

"Pi" was the context of information which converted a phenomenon which at first seemed random into a pattern. But without the context of intelligence there is no information. All of the "calculations" within a computer are only patterns of electronic activity interacting with other patterns of electronic activity in a wondrously choreographed dance. There is no information if there is no intelligence to interpret the pattern as information, as a representation of something else.

Information is the representation of one phenomenon in terms of something else. Information is a relationship. When we take the temperature we convert a phenomenon into a number on a device, the position of a needle on a dial, or the length of a tube of mercury or alcohol. Pi as a number is a representation of the ratio of the circumference of a circle to the diameter. It is neither. As a representation it is in a relationship. In this particular example it describes the relationship between two things. A relationship that was deemed important enough to make the number associated with it quite famous.

Stepping back for a moment and zooming in on the computer example it turns out that from another perspective there is perhaps a sub-hierarchy of five or six levels of information at play here, only the highest one of which we could ordinarily relate to as "information" as has just been discussed. The other sub levels warrant mention.

The data a computer program may be processing is a special type of pattern where "information" as we usually use the term has been encoded as a series of on and off electronic, magnetic, or optical states in such a way as it can be acted on, processed, or serve to direct the flow of processing. At the next higher level there is the computer program, encoded in the same way, but serving a markedly different role, one that is far more "active." These patterns describe the intended flow of action. And the very description is encoded in such a way as to execute those actions when placed in the right electronic context. Lending new meaning to the concept of Logos, "and the word was made flesh." The third level in this hierarchy are the operating system instructions which at a meta level maintain the flow of the environment and when called upon, cede partial control to individual programs. Maintaining the "void" as it were. At the fourth level

of information there is the architecture of the circuitry itself, the Byzantine geometry of very large scale integration where races of three dimensional space against time are conducted, choreographed to a fraction of a billionth of a second in exquisite precision. In an almost entirely different universe of "information", at the fifth level there is the applied voltage driving all of this. A simple matter of on or off. Used everywhere. Brute strength. But its own kind of information. A difference that makes a difference. One very important definition of information due to Gregory Bateson. Another difference that makes a difference is the "here and not there" of the conductors and insulators.

All of this could be calculating the digits of Pi beyond measure through eternity. And yet if there were no intelligence that knew of the existence of Pi, no intelligence that knew that this was what the computer was producing as output, these five levels of "information" beneath the sixth level with its context of intelligence somehow seem "mindless" and hollow. And yet human life is such a "mindless" information processing system that somehow, miraculously, developed to the point of providing its own sixth level (and may be on the verge of a seventh).

As critical as intelligence is for the complete actualization or very existence of information in the full sense of the word, intelligence alone is not enough. Although intelligence provides context for, and in doing so provides meaning to, information, it does not provide direction. It does not provide motivation. Information is what is seen. Pattern is how it is represented. Intelligence provides illumination to what is seen like a spotlight But it is consciousness that directs the play of the spotlight. The endless interplay of one piece of information after another and with another. Provides the context for and gives meaning to intelligence.

The four stages in this hierarchy of pattern, information, intelligence and consciousness, and the way each provides context for and meaning to the level immediately below, evocatively suggests levels higher still which we can occasionally glimpse glimmerings of, and perhaps with directed practice can perceive more directly.

As long as science fixates on number, objectivity, and control rather than turning its attention to pattern, context and relationship, this four-fold hierarchy will remain largely hidden, and we will lack the very vocabulary and elementary concepts to perceive and explore the other half of the universe we have been ignoring. We won't even have an adequate grasp of the science and mathematics we do use. Much of science and mathematics is taught and understood in a state that closely approximates sleepwalking. It totally and understandably confuses and alienates those not inclined towards science and math. More devastatingly, those who do have a taste for these subjects often end up with no grasp whatsoever on what they are doing and why they are doing it. This can apply to truly understanding techniques or operations in mathematics. Or in comprehending how a description of the essence of the structure of a physical system implicitly leads directly to the behavior it will exhibit and the equations that will describe it. To many students and professionals physics is either a subset of magic, or a trip through a conceptual jungle armed only with a pen knife and a faulty flashlight. The essential patterns and relationships do not become clear. Nor the fact that a very human trial and error iterative mathematical approach can serve far more effectively in many cases than pure error-free deductive reasoning.

A second key concept arising from non-linear dynamics and chaos theory, is that when the possibility opens up that the sum is more or less than the sum of the parts, a revolutionary figure and ground reversal occurs, the interaction between the parts may have a large impact on the net behavior of the parts, and in fact may be the most noteworthy feature of the system. The parts as absolute independent objects becomes more and more a secondary description of system properties, and instead the primary description has to be in terms of interactions between parts. The parts end up being described almost entirely in terms of their relationships with the other parts. Interdependent relationships that connect, participants who are almost entirely defined by those relationships, rather than independent properties of isolated objects is really a far more perceptive way to relate to much of reality. Almost everything is a primarily phenomenon of dependent arising, a dance between two or more players where the dance is all. Our identity and personality (or more accurately the multiple identities and personalities we all possess) make far more sense from this from this perspective. Lending new meaning to Sandra Bernhard's phrase of

"Without me, you're nothing". Everything exists in coexistence. Coexistence is everything. The same applies to the hydrogen atom, or the proton. Going looking for indivisible "atoms" is a futile exercise in the "object" world. Finding choreographed dances of subatomic particles that never appear onstage alone is an evocative discovery in the "relationship" world. This figure-ground reversal takes some getting used to, but it is incredibly illuminating in areas as diverse as physics and family therapy.

A third and final model of how reality can behave is also provided by non-linear systems. The phenomenon of systems exhibiting gain and what occurs when that gain rises to a point where it can overcome dissipative losses. Nuclear energy gave language the phrase "critical mass". Electronics and lasers have popularized the concepts of gain and feedback to a lesser extent. Both speak to the same point. A condition where a small input, or even internal fluctuation, can be amplified to monumental proportions. There are usually some losses inherent in any system. And if the gain is not able to overcome those losses no dramatic change occurs. On the other hand if stored energy is available to be converted to output at a rate that exceeds internal losses, amplification can occur. If that amplified input signal is then fed back into the gain region (by light bouncing back and forth between mirrors surrounding the gain region in a laser, or loudspeakers feeding back into a microphone on stage and thus back into the "gain region" of the amplifier) a tremendous final output can occur limited only by the electrical energy being fed to the laser or public address amplifiers. Sometimes the mirrors or loudspeakers blow out before this happens.

This basic behavior can be seen in the population explosion, in the spread of epidemics such as AIDS, or more positively in the information explosion we are experiencing. When ever more powerful computers design ever more powerful computers a rapidly accelerating rate of growth in our thinking tools results. Opening up the possibility of an intimately symbiotic relationship between "mind" and "machine." As the AI of artificial intelligence becomes the IA of intelligence augmentation or perhaps more evocatively in terms of feedback and power, intelligence amplification, the sky and beyond becomes the limit. We may be on the verge of inventing futures for ourselves beyond the imaginings of all but a very few science fiction

visionaries such as William Gibson. Space may not be our next frontier. We may take a sharp right turn into unimagined frontiers of our own making.

In a laser, or on a stage with a PA system, it takes a few round trips for the signal to build up to the point where you first discover that a tremendous burst of feedback is about to drown out everything else that is going on. In the fifties computers were very isolated rarities. In the sixties they were about as common as fire stations, and about as expensive. In the seventies they began to proliferate and seriously undertake the process of self-design. Between 1980 and 1990, only ten years, we went from rudimentary Apple computers marginally capable of word-processing to ubiquitous Macintoshes and IBM clones capable of professional level desktop publishing and near-supercomputer number crunching power. The graphics approached the ability to replicate reality in real time. It is only in those ten years that we've started to get above threshold and the phenomenon has attracted widespread attention. That is only the initial audible whistle, the penetrating roar of full-throated feedback has yet to be heard. It will be the roar of planet earth blasting off into cyberspace. We've gone non-linear. Totally. Our planet, our lives, our minds will be radically transformed. In the twinkling of an eye when measured from the perspective of history. New meaning will be given to the phrase "Change Your Mind". More than we can guess.

As has been discussed, deep familiarity with the four fold flow of pattern, information, intelligence and consciousness can radically and revealingly reorient our view of science, substituting an emphasis on pattern, context and relationship for a fixation on number, objectivity and control.

There is a powerful perspective from which many of the assertions of physics and chemistry can simply and comprehensibly be seen as symmetry statements. These statements about symmetry can take the form of descriptions of behavior such as "opposite charges attract" or "similar magnetic poles repel." Alternatively the statements about symmetry can describe the geometrical arrangement of components in a system, such as "an electron occupying the space

surrounding a proton serving as the nucleus of hydrogen atom." The mathematics of physics and chemistry are simply the language used to describe in detail the implications of the symmetry at the heart of the system description. Pattern has implications for behavior. Physics explores the relationship between system pattern and system behavior. It is a rich and precise language in one, two, three or many dimensions.

Its simpler systems such as the hydrogen atom are perfectly symmetrical. The patterns describing the probable position of the electron are cloud like structures centered about the proton nucleus displaying varying degrees of complexity, but all highly symmetric.

Sometimes the symmetric nature of the forces involved can become apparent to the eye, as in the case of crystals. Here visible structure reflects the stable balance of forces that are possible in symmetric patterns such as the triangle, square, hexagon, cube, tetrahedron, etc. Pythagoras' regular solids find expression at the atomic level. Dynamic symmetries become apparent in the vibrating strings of a guitar, especially when the guitarist carefully suppresses all motion at the center of a vibrating string causing the frequency to double in pitch as the harmonic rings out

It is really critical, and rare, to understand how all this behavior directly flows from the symmetry implicit in the description of a system, whether it is a hydrogen atom or the solar system. The mathematics involved only serve to derive explicit expressions describing this implicate order. It doesn't add anything on that isn't already there. The kernel of implicit behavior folded into the very geometry of position and the way the forces act (usually in a straight line between bodies in a system - so-called "central forces") is unfolded into equations which permit the system to be read as a text, and numerical quantities related to the systems static or dynamic character to be calculated. It is crucial to be able to read equations as a musical score - not an end in themselves - black squiggles on white paper - but rather as a springboard to being able to "hear" the "music" of the systems inherent pattern. And in that, to be able to perceive the similarity between systems that at first glance seem totally unrelated, but which in terms of their basic "music" reveal the same essential pattern of interplay. As in the

connection between light amplification in a laser and screeching feedback from a loudspeaker onstage.

This shift in perspective to a pattern-based outlook can free us from the tyranny of viewing science, and nature, in terms of number, objectivity, experiment and control. That can be replaced by a perception of science and nature in terms of pattern, relationship, interaction and participation.

This will not only lead to a clearer and deeper understanding of physics and chemistry but also to a richer and fuller experience of nature and life.

Because physics, when limited to number and control and excluding pattern and relationship, blocks us from having the eyes to see, the vocabulary to describe, and the concepts to think about "the other half of the universe." The half that includes experiences of coincidences, effective prayer, precognition, myth, deep connectedness. It is no surprise that we see "... through a glass darkly" those phenomena that we have no systematic way of thinking or talking about.

Blinded and tongue-tied defenders of this other half of the universe are at a severe disadvantage. Especially when confronted by the dogmatic high priests of the church of scientism, ever ready to conduct an inquisition laced with ridicule and scorn. Not to mention the occasional fire-bombed career. Scientism has become viciously paranoid with a defensive line of attack dogs ready to destroy any threat to a thought system that has become ever more rigidly closed.

To give defenders of the Church of Science their due, there is a very necessary filtering function which must be performed to weed out hare-brained concepts and fraudulent schemes. The "dumbing" of America and its willingness to pay serious attention to utter bunk can give rise to an understandable upwelling of contempt among scientists concerned with validity. But a few showmen have turned vigilante-like defense of the faith into a lucrative profession. James Randi,

Martin Gardner, and Carl Sagan come immediately to mind. Closed minds result from saganism, which is an arrogant ignorance arising from a limited experience of reality. The pompous sneer is its trademark. The brain police have become the secret police. As AA points out "Condemnation without investigation is the worst form of ignorance." And its cost to both science and life has become intolerable.

But rather than leaping feet first into the realms of the paranormal, mysticism, and the occult I would suggest an evolutionary approach. For I have an equal lack of respect for much of the mystical outpourings that have flooded the bookstores since the 1960's. Especially those which in a neo-reductionist approach invoke quantum mechanics or chaos theory as an explanation for "action at a distance" in some sort of justification for mystical phenomena. This really feels like another attempt to explain the greater in terms of the lesser. As was discussed in terms of the hierarchy of pattern, information, intelligence, and consciousness, this may be a case of trying to explain the enabling context in terms of the level below which it informs and gives meaning to. A real reversal of causal flow. Beyond that, mysticism has an unhappy history of repeatedly reaching for the most recently understood physical phenomenon as "The Explanation". It began with "vibrations" in the early days of mechanics, followed by "magnetism", "light", "electricity", "Bell's Theorem and non-locality" or more recently chaos and string theory. There is something both trendy and mindless in such attempts to acquire the substance of validity and a futuristic flavor by appropriating the latest "hot" concept in science. Attaching a Mercedes Benz "star" to the hood of a Kia yields a joke, not a Mercedes Benz.

A more productive path would be to allow a way of perceiving and explaining paranormal phenomena to evolve gradually out of a deeper and clearer understanding of the patterns of normal phenomena and how they interact with each other. In this way a more natural bridge can be constructed between the two worlds we live in, rather than one hastily thrown together in a post hoc attempt to provide justification for what we are already cloudily convinced exists.

This natural flow from physics to meta-physics would occur because the metaphysical basis of ordinary science is elevated from the hidden status of unconscious assumption. The central hierarchy of pattern, information, intelligence, and consciousness directly raises the three

central issues of metaphysics: ontology (the science of being what is?); cosmology (the science of the fundamental causes and processes in things - how did it get here and what is it doing?); and epistemology (the science of the method and grounds of knowledge especially with reference to its limits and validity - what do we know and how do we know it? - how do we know what is?). It has been aptly noted that asserting that one does not have a philosophical basis or metaphysical perspective does not mean that one does not in fact have one, only that it is most likely a poor one.

It is entirely possible (but not guaranteed) that a careful examination of the four fold flow of pattern, information, intelligence and consciousness would shed coherent light on several areas of strong current interest. This would include parapsychology, especially in light of our now closer ties to the former soviet republics where such phenomena have been researched extensively.

Many of the most commonly experienced phenomena have far more to do with pattern and information than the falling apples of Sir Isaac Newton. Information "leaks" in unexpected ways. Or in that mode where the universe is more like a pun than a definition, bits of information, meaningless in themselves, take on startling significance when spatially or temporally juxtaposed with each other. As if a grand game of "catch" were going on in the universe with balls of information and meaning being tossed back and forth, through space and time, with some unseen acausal connecting principle synchronizing the flow of events. Coincidences, precognition, clairvoyance, telepathy, archetypes all speak this language. It is time we learned it. Thoroughly.

Reaching further out to a fuller appreciation of the role of time in dynamic casual systems (as explored by Bateson), perhaps questions can be profitably posed and answered concerning whether time itself has a varying character, and as such can leave a fingerprint on processes begun at a certain instant. And can that character of a moment of time be seen in the planetary patterns of the night sky? From one perspective this seems absolutely ridiculous. But until the role of consciousness in the universe is more systematically and solidly understood, structures such as astrology have to remain open questions. For the planetary display is a natural interface linking the here and now with the infinite and the eternal. We have come to learn the myriad

ways the rapid lunar and solar clocks influence our affairs, often with surprisingly important effects but through invisibly subtle pathways.

As outlandish as such a suggestion might seem, it is important to remember that we are dealing with a universe that in us managed to achieve consciousness and self-consciousness. We may be able to replicate that in our computational clones, and even may be able to develop systems sophisticated enough so that consciousness spontaneously arises rather than being explicitly programmed in. But the amazing fact that "mere meat" was able to do this should not be forgotten. It should stand as a reminder of the astounding surprises this universe is capable of. The wonder of it all is actually difficult to grasp experientially. But it is a realization worth cultivating and regularly revisiting. The study of the four fold flow of pattern, information, intelligence, and consciousness is a direct way of strengthening this useful self-realization.

That same four fold study is a particularly apt way to approach the holographic storage of information, whether it be in photographic plates, our minds, neural nets, or the universe as a whole. The field of neural nets has much to teach us concerning information representation, storage and interplay - especially that of pattern with pattern. In neural nets a piece of information is stored in a distributed way rather than being contained in one spot. Beyond that, it is stored as the connection between related entities, rather than as the contents of those isolated entities, which would have been another way of achieving "distribution". A new paradigm of information reaches out to us here for greater appreciation.

And we need all the insights we can gather into information as a central phenomenon of human experience. We are in the process of being inundated in a tidal wave of timely and relevant information. Richard Wurman's study on "Information Anxiety" surveys the scope and growth of the inundation. We have a desperate need to achieve some control of this flood. For information, like technology before it, is taking on the characteristics of a living system (as James Hougan terms it a "chreod") in some ways more Frankenstein than friend in the stresses it imposes on our minds and time.

A better structural understanding of the phenomenon of information and its relationship to intelligence and consciousness is clearly called for in this regard. Otherwise our "solutions" will be ad hoc and insufficient. Perhaps in opening up this new area of study some new inspired insights might come our way, along with a better understanding of the process of inspired insights.

To raise the issue of "information management" is to indirectly touch on the most critical "information management" problem of all in our time, education. If we delivered milk to convenience stores the way we deliver information, concepts and experience in education, the streets would be filled with dog carts pulling five gallons apiece hither and yon with predictable results. A lot of sour milk.

Curricula need to be radically reshaped, not only to cover essential topics in a comprehensive, exciting, interesting manner, but also to strip away the tyrannical tendency of many departments to insist on teaching material in a style that is true to the purist core of the discipline involved. Whether that is impossibly rigorous, incomprehensibly abstract, or overwhelmingly all-inclusive, the end result is the same. A job poorly done at exorbitant cost. A cost we can no longer afford, whatever the motivation for this behavior.

Education has so far fended off the kind of revolutionary redefinition that has occurred in many other retail service and sales industries, whether it is television broadcasting, food delivery, gas stations or even medical care, another bastion of conservatism and profit-margin maintenance. Education is the last holdout. Understandably so because it depends on its clients performing a stupendous act of sleepwalking. With 4-year education costs easily reaching the \$200,000 - \$400,000 range, families are purchasing the equivalent of several luxury cars or a fair fraction of a home with none of the "Consumers Reports" information and meaningful comparison shopping that they lavish on buying a camcorder. In part because they have little meaningful choice. The academy can destroy any threat to its hegemony and monopoly with the lethal weapon of withheld accreditation. Like a motel chain there are beds to be filled and

salaries to be paid.

The situation is way out of equilibrium. It will not hold. New technologies of information delivery (cable, DVD's, computer aided instruction, virtual reality classrooms) will of necessity entirely reshape the process of education. Teacher-student, and student-student interaction will still be essential. Rather than being diminished, its role will be enhanced by giving to machines the things machines can do in terms of education tasks. The traditional approach has many virtues which some will still be willing to pay for as an extreme luxury. But for many others for whom college education is becoming a cost-driven impossibility, technology may come to the rescue.

The colleges and universities may along the way discover that they have grossly underestimated the potential demand for low-cost access to DVD's of lecture series. These are now available, but at a premium price. In a time when information and concepts largely define the world in which we exist, many adults over 35 would welcome the chance to experience lecture series on topics of interest for the sake of pure learning, not necessarily for credit. For many adults now realize that not only youth, but also education is wasted on the young—themselves when they were young. If commuting hassles could be avoided, time flexibility achieved, and low viewing costs maintained through development of a relatively mass market, tremendous benefits could result for everyone involved, and for society as a whole.