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"THE HUMAN BRAIN AND THE ELECTRONIC COMPUTER: SOME SIMILARITIES AND SOME DIFFERENCES"

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The electronic computer is made up of crystalline, solid-state semi conductors. The atoms in a crystal are arranged in rigid arrays known as lattices. The inter-atomic forces that hold the lattice together usually make crystalline materials very strong. Most metals, for example, are crystalline. The human nervous system, in contrast, is made up of colloids, i.e., amorphous, often jellylike materials in which atoms and large molecules are suspended at random. There is no lattice structure in a colloid.

Electronic computers carry information as a flow of electrons between atoms in the crystal lattice. Crystalline "brains" are therefore very fast. The human brain codes its information as a relatively slow flow of atoms and molecules distributed haphazardly throughout the colloidal mass. The movement of these atoms can be enhanced or inhibited by chemicals. Information transfer time is slower because it is chemical in nature rather than atomic. It may involve the movement of electric charges from ionized gelatinous molecules to others, or the movement of ionized molecules within the gelatinous mass. Or it may consist simply of the chemically-induced movement of molecules from point to point. Our nerves use two types of data carrier: large molecules called neurotransmitters, that flow across the synapse (or gap) between nerve cells, and charged atoms called ions that move along the nerve to generate an electrical impulse.

The brain is presently one million times slower than computer hardware and this time-response gap is likely to increase in the next few years as faster hardware is developed! While the energy demands of hardware are decreasing as hardware response time gets shorter, human beings continue to require enormous amounts of energy for information transfer because of the slowness and massive nature of the molecular information carriers.

There is an important similarity in the way crystalline and colloidal systems transmit information. Both seem to operate using the binary code. Data in a computer are broken into "bits". An electronic circuit is switched on or off, and all information, no matter how complex, is recorded in this two-unit code. Similarly, a neuron in the nervous system either fires an electrical impulse or it does not. There are no in-betweens.

However, crystalline and colloidal brains <u>process</u> information very differently because of their contrasting structures. Because nerve cells operate by the movement of large, slow atoms and molecules, their reaction times are measured in milliseconds, (i.e., thousandths of a second). The fastest nerve cells carry electric code impulses at approximately twenty meters per second. The modern crystalline computer operates in picoseconds, (i.e., a thousand billionths of a second). This is a difference of a billion times, or nine orders of magnitude! This is why a single computer can operate in a "time sharing" mode, in which many humans work with it at the same time.

Furthermore, a billion times per second is no longer considered to be the upper limit of computer processing speeds. Recent observations indicate that on the surfaces of the newest semi-conductor materials, tiny magnetic elements can be seen switching (admittedly in an uncontrolled way) at rates approaching one trillion times a second. Computers are now becoming so fast at calculating that the signals leaving the central processor and travelling at roughly the speed of light, simply cannot get away quickly enough, and are overtaken by the onrush of fresh calculations, i.e., an electronic "log jam"!

As the electrons flow through computer circuitry at these awesome speeds, the speed of computation is limited only by the speed of light, i.e., 298,117,000 meters per second. For this reason, lasers and computers have their future linked in several ways because lasers can transmit data as quickly as computers can generate it.

On the other hand, the interaction between a computer and the world of human beings proceeds at an excruciatingly slow rate. The computer is both much faster than its input and output devices and much faster then the human being who is working with it. From the human view point, a computer seems to operate instantaneously; push the button and the answer appears, even though the computer may have gone through a million calculations. From the point of view of a computer, communicating with a human being takes a long time. Even if it had a direct link to the human nervous system, a computer must still send its information a billion times slower than it is capable of doing, and then wait the human equivalent of six years for a reply![1]

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1 "The Omni Book of Computers & Robots", (1978), ed. Owen Davies, Toronto, General Publishing Co. Limited, pp. 44 and 45

Although digital electronics presently dominate computing, it is not the only way that machines handle data. Optical devices process information by manipulating beams of light. The attractions of optical circuits are that they are faster and they can process data in parallel. Electronic switches are slower than the fastest optical type. However, a more serious limit on the speed of electronic circuits is the time it takes electrons to move from point to point. Light travels more quickly through air and optical fibers than electrons can through wires. Light can also travel a more direct path between two points than electrons, which often follow circuitous routes to prevent interference between circuits. Virtually all electronic computers are sequential-- they perform one operation at a time. A single optical device, such as a lens, can process information from many inputs at once. Optics also allows circuits to have more connections because photons do not carry any charge. Light signals -- unlike electrical currents -- do not interfere with one another if their paths come close or cross.

If the computer is to become an effective intellectual tool for the judiciary and the legal profession, the "interface" between the computer hardware and the judge or lawyer will have to be greatly improved. Otherwise, these professionals won't be able to use fully the speed and infallible memory of the hardware. At the present moment, the most used means of communication with the computer is still through a keyboard consisting of a series of keys or switches, each of which sends a single symbol to the hardware circuitry. The keyboard serves to instruct the hardware to add to or draw from a memory peripheral such as a disk or tape. This is extremely slow when compared to the capability of most computers to assimilate data.

Today, a simple personal computer is capable of accepting data at a rate of at least one hundred thousand bytes per second. By punching a keyboard as quickly as possible, an expert typist can create an input rate of perhaps ten (10) bytes per second, considering that each key depression generates eight (8) bits. On the average, it might run one (1) byte per second over a period of several minutes while the person keying in the information stops, thinks, reviews and corrects in their own mind before entering another symbol into the computer via the keyboard. Thus, a key operator in a sense utilizes only a one hundred thousandth of the computer's potential! Although the input of data to computers from the exterior world is at present in a very primitive state, there will eventually be a proliferation of input devices that will permit the computer to detect sounds, smells and visual images. The range of sensory input will more and more closely approach that of human beings.

A "bit" is a measure of amount of information, just as a liter, a kilogram and a meter measure volume, weight and length respectively. One bit is simply a choice between two equally probable messages. It is a "yes" or "no" answer to the hypothetical question: "Is it this one?". The answer "yes" resolves all uncertainty in the mind of the person receiving the message because he or she knows which of the two possible messages is the actual one. The answer "no" also resolves his uncertainty, because he or she knows the actual message is not the first but the second alternative. This is a highly versatile code because it needs only two symbols: "1" for "Yes" and "0" for "No". A "byte" is a sequence of eight bits.

A human being is trapped with an eye-brain-hand system circuitry and its associated long-action times. The reception of a visual stimulus from a computer screen requires about twenty (20) milliseconds. Its transmittal through the nerve fibers and synapses to the brain takes about two (2) milliseconds. The excitation of the brain's cortex by the stimulus requires about another thirteen (13) milliseconds, i.e., it takes a person a total of approximately thirty-five (35) milliseconds just to realize that something has been seen!

Under less than ideal conditions, i.e., with background noise, distractions and stress, this delay can be as much as one hundred (100) milliseconds.

Although the eye-hand reaction is perhaps the fastest reaction mode of the brain, from the time a visual stimulus is presented to a human being approximately one hundred and ninety-five (195) milliseconds elapse before the hand of that person can move in reaction to the stimulus. In that same time, a personal computer can perform about one million operations and deliver twenty-five thousand bytes of information to an output port! If the computer hardware could somehow be linked more intimately with the user, it appears that the hardware would still have little trouble keeping up, except perhaps when engaged in heavy calculations or large-scale retrieval from outside data bases. In fact, it could do this with lots of time left over for conducting its own housekeeping operations.[2]

Despite the relative slowness of the human eye-brain-hand circuitry, judges and lawyers can convert information into knowledge more quickly by using both their eyes and their hands

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[2] STINE, G. Harry, (1984), "The Silicon Gods", New York, Dell Publishing Co., Inc., p. 113

than by using their eyes only. Attorney Ken Chasse puts it this way:[3]

> *"You think better by using your hands. If you write while you think, your thinking is clearer, more exact, and progresses more smoothly. This is the case because your eyes see a physical representation of your thoughts, and use of your hands places ideas more firmly in your memory, and your thinking is more logical because of the structures imposed by language. But, hand writing is often too slow for one's thinking. The speed of a good word processor is therefore ideal for thinking and composing. On my word-processor I can type as fast as I can compose my thoughts into words. And because I can see what I compose as I compose it, I can correct and amend my thinking and my words -- the mechanisms for making corrections on a word-processor are very fast. You think better using your hands; and you can think best if you use your eyes while you use your hands-- hands for information creation; eyes for information feedback. The hand-eye coordination makes the brain more powerful and more creative; the word processor makes it all the more possible."*

Many judges write their first drafts of lengthy judgments by hand instead of dictating them. While writing by hand is clearly slower than dictating, it frequently offers significant advantages. Among these is the ability to reflect on what has been written in order to contextualize what needs to be done. Some judges have now taken the next step by typing their own draft on a word processor or personal computer. Work product is delivered in a faster and neater manner, and the ability to "see" in type what the judge is trying to say often

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3 "Centralized Legal Research is for Every Law Office", (1985) 1 Canadian Computer Law Reporter, p. 22

helps shape his or her thoughts. As a result, the work requires far fewer drafts. The gains achieved by avoiding additional drafts often outweigh the extra time consumed in composing the first draft in this fashion.

For lawyers, it should be noted that if the signals flowing to the brain for decision-making end before the signals involved with action based on the decision begin, probability is high that the person will take the correct action. However, if the decision-making signals persist after the action signals begin, the probability of error is high. In other words, if a lawyer is not sure he or she has made the right decision, he or she will continue to worry about it while taking whatever action seems to be immediately appropriate.

As already mentioned, computer hardware usually works by serial technique, i.e., on-off data bits follow one another in a sequence in the channel or wiring between one part of the hardware and another in accordance with the instructions from the software. The brain also operates on a similar binary or on-off system, but on a different level. The operating module of organic systems is the neuron or nerve cell which can be made to "gate" or "burst" once; then it requires time to relax and renew its charge. The response time (or relaxation time) of a neuron is about 20 milliseconds. It transmits one bit of data, then can't transmit another until about twenty (20) milliseconds have passed and it has had time to reload or re-cock itself.

The basic gate element of the brain is the neuron. It is significantly different from the solid-state crystalline semi-conductor gate because a neuron can be gated by many other neurons and can itself gate or inhibit gating of multiple neurons. This is the basis for the incredible parallel operating complexity of the brain. A signal that is too big or too complex to be sent down the strictly limited information channel of a single neuron chain is split into a number of smaller signals. These are transmitted down <u>parallel</u> or side-by-side channels simultaneously (or nearly so) and are recombined at the other end of the channel. The net effect is that a person can view a pattern in its entirety, making decisions based on the whole as well as the parts.

Nerve cells are not all alike. Their very differences constitute the coding system by which the brain processes information. This multichannel system is the secret of the nervous system and differentiates it from all our communication artifacts such as the telephone, the television, and the computer. Brain programs are only partly like the algorithms of computer software in which every step is logical[4].

Scientists are now learning some lessons from the fact that the brain processes information in ways which are peculiarly (even perversely) human, rather than mechanical in the old sense. For example, they have made the paradoxical discovery that forgetting serves a very important function and is a bi-product of learning. As a result, computers are now being programmed to forget selectively just as the brain does, rather than store every item of information in their memory.

Human memory does not store information infallibly and reproduce it impeccably merely by organizing it according to uniform and highly constrained sets of rules. At first sight, it seems incredibly inefficient of evolution not to have developed an autonomous mechanism of that sort, i.e., one unaffected by context, use and personal meaning. On further consideration, however, such a type of memory has only surface conveniences. Human beings are not designed to function uniformly. Their success as a species arises in part from their lack of specialization. Mechanical accuracy is not what humans are best at, and it is not what most people want to be

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[4] YOUNG, J.Z., (1978), "Programs of the Brain", New York, Oxford University Press, p. 6

best at. The brain is not a device for processing information in a one-dimensional, linear fashion only. Unlike the computer, which is subject to very little "noise" in the form of electrical interference and which works by performing a long chain of simple operations at high speed, the brain is both "noisy" and slow. However, it uses its colossal number of components to pass information along many different channels at the same time. The brain is probable rather than certain in its action, arriving at many answers, some more nearly correct than others, and these answers are modified continually by feedback of new information.

Unlike the highly uniform parts of a computer, nerve cells are highly individual. No two cells are exactly the same, nor do they respond to the same incoming information in the same way. The system is extremely redundant, yet extraordinarily divers.[5]

The more complex is any system, the more likely it is that one of its parts will malfunction. Redundancy is a means of keeping the system running in the presence of malfunction. To understand a complex system such as a large computer or the human brain, one cannot use ordinary formal logic, which deals

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[5] CAMPBELL, Jeremy, (1982), "Grammatical Man", New York, Simon & Schuster, Inc., p. 227

with events that definitely will happen or definitely will not happen. A probabilistic logic is needed, one that makes statements about how likely or unlikely it is that various events will happen. The reason for this is that computers and living organisms must function reliably as a whole, even though each of their component parts cannot be expected to perform perfectly all the time. The parts function correctly only with a certain probability, and this probability must be built in to the logic of the system. The aim is to ensure that even if single parts are very likely to malfunction, the chance of the entire system breaking down is reasonably small. As systems become more complex, this statistical property of overall reliability as opposed to the reliability of individual parts, becomes increasingly important.[6]

When communications between the centers in the brain break down, it may be due either to direct damage to a center of grey matter or to damage to the wiring between the centers. However, the connections between centers are often redundant, so that when damage occurs, messages can be sent through alternate connections. Thus the brain has an amazing adaptive capacity that is sometimes referred to as "plasticity". When the brain is working at its usual busy level of performance, it

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[6] CAMPBELL, Jeremy, op. cit., supra, note 5, p. 104

can be thought of as a three-dimensional layout of electrical switchboards in which many different areas are receiving messages, "lighting up" and sending messages back in response.[7]

As the brain becomes better understood, its special ways of generating knowledge are seen as being quite dissimilar to those of computers in many important respects. Computers are good at swift, accurate computation and at storing great masses of information. The brain, on the other hand, is not as efficient a number cruncher and its memory is often highly fallible; a basic inexactness is built into its design. The brain's strong point is its flexibility. It is unsurpassed at making shrewd guesses and at grasping the <u>total meaning</u> of information presented to it.[8]

The qualitative superiority of the brain over today's computers is even more striking than its compactness. Every cell, in the brain is directly connected to many other cells, in some cases to as many as 100,000. As a result, when we send a conscious impulse down to the recesses of memory to summon forth a point of information, the cells in which this

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7 ANDREASEN, Nancy C., (1984), "<u>The Broken Brain</u>", New York, Harper & Rowe, p. 91

8 CAMPBELL, Jeremy, <u>op. cit.</u>, supra, note 5, p. 190

information is stored communicate on a subconscious level with thousands of other cells, and a wealth of associated images pours out at the conscious level of thought. The fruits of this subconscious activity are intuitive insight, flashes of perception and creative inspiration, all made possible by countless connections among the cells[9].

The human mind reflects, i.e., it processes knowledge and is aware of the fact that it is doing so; today's computer still only processes data. There is a correspondence between knowledge and data but they must not be confused. Failure to establish this distinction leads to an informal identification of computers with humans. This identification appears in our every day language, where the same words are used to designate both functions of the human mind and functions of the computer.

Programming codes are often called "languages". The computer is said to "read" data. In fact, reading is a process of the intellect, the process which transforms the read data into knowledge. By contrast, the computer only stores data. The computer is said to "write" data, but writing is a human activity. The writer expresses a part of his knowledge in a static language, while the machine is capable only of printing

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9 JASTROW, Robert, (1981), "The Enchanted Loom: Mind in the Universe", New York, Simon & Schuster, p. 143

data. Similarly, it is said that the computer has "memory". In fact, it has only storage units which are capable of storing quantities of data, and retrieving it with almost perfect reliability. In contrast, the human memory has an extraordinary ability to associate new knowledge with the knowledge it already has but is often quite unreliable.

One speaks of "smart" terminals when in fact such devices are merely connected machines capable of a certain amount of data processing. One speaks of mechanical "brains" when in fact we are talking about mere circuitry, however complex. Only humans have brains and intelligence, and only humans can be stupid and mistaken. A computer can break down, be given an incorrect program, or given incorrect data, but it cannot be stupid or mistaken.[10]

It would appear that it is impossible to construct correct and highly efficient solutions to computing problems without using a strictly logical approach. It is also quite clear that human beings are incapable of completely logical behaviour. Indeed, strict logic in the context of human behaviour is often the exact opposite of reason and common sense. It must also be remembered that there is a fundamental

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10 WARNIER, Jean-Dominique, (1986), "Computers and Human Intelligence", New Jersey, Prentice-Hall, p. 10

difference between the actual knowledge possessed by a human being and the written expression of that knowledge. The nature of a human being and the nature of a machine are fundamentally different. Computers deal with data, frozen and static, while human beings think, discover the world around them and share ideas and feelings by many means other than language. The result is the creation of schools of thought, of cultures and of civilizations. The study of individual human beings will never be sufficient to completely explain the life and evolution of the human species.

Why are human beings incapable of acting and reasoning in a strictly logical way? There appear to be at least two reasons and these reasons are entirely independent of each other. Firstly, the universe in which humans live is constantly changing. Although it is not always noticeable, the world is evolving, and the saying that "There is nothing new under the sun" is quite incorrect. Secondly, human beings are only partially aware of the framework in which our lives are lived, and this framework is constantly evolving.

These reasons oblige human beings to live with risk. There are no actions which are logically necessary. Decisions are not taken having considered all of the facts (as lawyers and judges sometimes say). If full knowledge were required for every decision, no decision would ever be made. Humans do not live according to logical precepts, but rather using intelligence and common sense. While these may sometimes make use of a certain amount of logic, it has nothing to do with rigorous mathematical logic. All human activity begins and develops as a result of decisions made with human objectives and motivations in mind.

Decisions are made by human beings who use their knowledge to evaluate a given situation and then decide what to do. A decision is never strictly logical and is often reached in a way that does not obey the laws of probability. The person who makes a decision can never prove (in a rigorous sense) that the decision is not mistaken. It is only possible to justify the decision by describing the reasons that led to it.

It is highly unlikely that it will ever be possible to automate the process of decision making. All decisions are to some extent arbitrary, and their correctness forever open to discussion. Controversy among historians about the correctness of decisions taken centuries ago is proof of this, e.g., it is still reasonable to ask whether Caesar was right in invading Gaul! All decisions, because they are made by human beings, include an emotional component. Indeed, the value of decisions comes from the very fact that they can be made only by human beings and that they are intelligent acts not strictly in the logical domain, although they may (and should) be the result of careful thought and reflection.

As to the possibility of the judiciary using computers for judicial reasoning[11]:

> *"...the judge's unconscious "philosophy", (even if he does not know he has a philosophy, or tries to suppress it), is the **decisive** fact. His insight of desirable consequences will generally "fill the gap". He cannot, after his long experience, fail to have a pretty accurate pattern intuitive (not emotional) of relationships in his mind -- have a truer view about law than any other person in the system as it heads towards development. He remains human and is no computer. Insights govern his "dynamic knowing" -- improving with time -- leading to higher and higher insights as time goes on. It was Holmes J. who declared "I care nothing for the systems, only for the insights". They increase the probability that, at least, no one could do any better. We can grasp meanings because we have a "common memory" of a sound pattern of legality.*
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> *Insights include qualities that are purely human such as compassion, desirable human goals, honesty, intuitions based on cultural traditions. One appalling new peril is that the technocrats are trying to fix "concepts" at a non-human level **of what** the computer can be instructed to employ as an instrument for deciding "desirable" goals and ideals. Many Americans are hoping to make computers "artificially intelligent", so that they alone could solve our major political, social and philosophical problems. That means, of course, that the programmer imposes **his own view** of what is desirable and scientific. He needs ironclad terms that will not*

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[11] MAHER, Frank, "Words, Words, Words", (1984) 14 Melbourne University Law Review, p. 468 at 504

> *vary -- as with the behaviourists -- yet his personal bias can affect his programming.*
> *Wisdom is ignored or deprecated -- as are our ideas of the "just", the "decent", the "good" by those who regard human beings as highly complex machines.* ***Donoghue*** *would not have been decided as it was by such mechanical reason: it included our old ideas of concern for "neighbours" and common sense. There is nevertheless a mania in some quarters for the rigid concept, the rigid linear thinking process, the abolition of paradoxes and the random. One expert on computers, Joseph Weisenbaum, vigorously assails this "scientific arrogance". He cites the sensible response of a wise English commentator of the perils of ignoring value insights. Lawyers must be aware of computerized law in this respect, of the concepts and language and subtle reasoning which are in danger of being destroyed for the convenience of computer planners acting on their own materialist ideas of good and bad."*

A logical choice cannot really be executed by a human being, since the human is always free to make a decision opposite to that indicated by purely logical considerations. Logical choices can be programmed: decisions cannot. This is of fundamental importance because the computer technologist and the lawyer and judge using the computer must together make the decisions leading to the creation of computer systems that will implement these decisions. The decisions are implemented by the computer system by executing the logical choices that govern the storage, transmission and transformation of the data in the system. This data, made available at the appropriate time and place and in the appropriate form, will be used to provide information needed by judges and lawyers in order to make yet other decisions. In short, human beings decide, while machines execute instructions and logical choices.[12]

With the advent of the digital computer, it is not difficult to understand the confusion that has arisen between decisions and logical choices. However, it is crucial that human beings rid themselves of this confusion and keep constantly in mind the fact that the logical choice is always the result of a prior decision. This clearly shows the subordinate position of the computer: the computer is not responsible.[13]

The computer revolution is essentially an extension of the left-brain evolution. Computers are actually extending the ability to do abstract logical thinking. While computers are still inadequate for the kind of thinking done by the right brain, they can do most left-brain tasks a million times faster than the human brain and have already made obsolete many pure left-brain clerical jobs. Any job that only requires following well-defined logical rules is generally better done by a

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[12] WARNIER, Jean-Dominique, op. cit., supra, note 10, p. 44

[13] WARNIER, Jean-Dominique, op. cit., supra, note 10, p. 102

computer. Since computers "think" in digital words, they are subject to the same limitations as people thinking in words; the words must be handled sequentially one at a time so that no flexible process similar to intuition is possible.[14]

Just as mankind's great leap from the stone age was based on the synergy of the left and right brains, further progress in the computer age will be based on a new kind of synergy of humans and computers. This new order will require a new kind of thinking and a new emphasis in education and professional training. The present verbal emphasis in legal education has always produced a few creative individuals and a large majority of people who are uncreative, but strong in left brain skills. This has historically been acceptable because there were a large number of uncreative clerical jobs that required these skills[15].

In the future, however, those jobs will be done by computers. Formal professional training must therefore change its emphasis and concentrate more on development of those particular skills that are poorly done by computers. Development of creativity and holistic thinking ability should

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[14] BLAKESLEE, Thomas R., (1980), "The Right Brain", New York, Berkley Books, p. 111

[15] Ibid., p. 112

have top priority. While routine calculation skills are no longer important, the left brain's ability to translate the right brain's intuitive insight into logical verbal sequences remains extremely important.[16]

The right brain has the creativity to bridge gaps and make intuitive breakthroughs, but it cannot test that intuition or communicate it to other people or to computers. The left brain has access to the intuitions of the right brain and can test them and convert them to human language and to the logical language of computers. The computer augments the abilities of the left brain with great accuracy and with speed a million times faster[17].

As computers continue to improve in speed and capacity it becomes more and more important for judges and lawyers to fill the creative roles of (1) analyzing the computer-stored information, (2) creating knowledge and (3) applying innovative solutions to people's problems. With routine linear thinking left to computers, litigants and clients will have little need for "human computers" with atrophied right brains.[18]

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[16] Ibid.

[17] Ibid., p. 113

[18] Ibid.

The creative human personality has a number of common psychological traits that are shared by both artists and scientists, indeed, by all creative people:

1. **A strong commitment to a personal aesthetic.** This is the drive to wrest, order, simplicity, meaning, richness or powerful expression from what is seemingly chaos. Creators have a high tolerance for complexity, disorganization and asymmetry. They often enjoy the challenge of cutting through chaos and struggling toward resolution and synthesis.
2. **The ability to excel in finding problems.** By asking the right question and finding the right problem, creators can define and "see" the boundaries of their fields that can be extended or broken.
3. **Mental mobility.** This allows creative people to find new perspectives on and approaches to problems. Creative people have a strong tendency to think in terms of opposites and contraries while they seek a new synthesis of ideas. They often think in analogies and metaphors and challenge assumptions.
4. **The willingness to take risks.** Creators constantly seek excitation and stimulation. Along with risk taking come the acceptance of failure as part of the creative quest and the ability to learn from such failures.

5. **Objectivity.** Creative people not only scrutinize and judge their ideas or projects, they also seek criticism.
6. **Inner motivation.** Creators are involved in an enterprise for its own sake, not for school grades or pay cheques. Their catalysts are the enjoyment, satisfaction and challenge of the work itself.

These traits are hardly the stuff of computers!

Compensatory brain mechanisms enable older professionals to perform as well as younger ones -- _if_ the work involves intense concentration rather than memory, sensory skills or rapid motor movements. Although the brain forms plaques and lesions as a person ages - effectively reducing the actual amount of the nerve cells present - it compensates for that loss by increasing the connections among the remaining cells. Therefore, a sixty-year-old lawyer is able to sustain the same attention span as his thirty-year-old colleague.

The brain actually suffers "software" degradation as a result of idleness and lack of inputs. Lack of stimuli causes humans to exhibit "sensory" deprivation syndromes. On the other hand, computer hardware can wait on standby indefinitely as long as it is provided with energy.

Automating any job in a law office or court house requires that the entire task and all its constituent elements and variables be totally understood by a human brain at the start. It must be possible to "write the mathematical model". Every part of the task, i.e., everything that changes or might change, and every possible failure must be known and understood so that the task can be reduced to a mathematical equation. Such equation is basically a written analog or shorthand expression relating to the real world. Nothing can be properly automated unless all the variables and their mutual effects on one another are first totally understood by a human being. There are still very few tasks, operations or techniques respecting the processing of information and the developing of knowledge in the legal profession that are yet understand completely enough to entrust them entirely to a computer.

Computers cannot straighten out a system or organization by simply taking over the management of that system. A computer is merely an intellectual tool to permit the use of the mind more efficiently and effectively. If humans are having trouble operating or controlling a system, that usually means they don't yet fully understand the system. Use of a computer under these circumstances will simply speed up the error rate because the computer software will contain all of the non-understandings, misunderstandings, prejudices and incorrect or incomplete data that is causing a problem with the system in the first place.

Computers store data very effectively. However, as very few people have yet written intelligent software to organize the data, retrieving useful information is sometimes no easier than the old way of going through the files with a good file clerk. The legal profession and the judiciary need software with a new and more efficient approach. Lawyers and judges today need programs that the software industry is still not yet prepared (or able) to create. This is the reason why so many law offices and court houses are exasperated by their own data processing departments. Software developers currently must anticipate all the uses of that software ahead of time.

It shoud be remembered that today's computers don't know what they know, i.e., the content of data means nothing to the machine. Without an artificial intelligence capability, the computer has a great deal of information but no knowledge. However, the initial enthusiasm surrounding the possibility of developing computers with "artificial intelligence" has recently been somewhat tempered by the realization of the enormity of the task. Most of these efforts are now being concentrated on developing "expert" systems.

There is an important distinction between <u>intelligence</u> and <u>expertise</u>. As these terms are generally used, they connote related but quite different things. Intelligence has to do with ability to learn; expertise connotes knowledge that one has already acquired. Intelligence refers to general intellectual competence; expertise connotes in-depth understanding of a specific domain. Intelligence rests on a set of cognitive abilities for abstraction, classification, generalization, drawing inferences and analogies; expertise is the ability to access and apply information about a given topic on demand.

The following should be included among things that an expert should be able to do[19]:

"-Assimilate new information and revise or enlarge one's knowledge base in one's area of expertise.

-Tell the difference between other experts and non-experts in the area.

-Discriminate among levels of certainty with respect to elements in one's knowledge base; qualify one's answers to questions with reliable judgments of their dependability.

-Use information inferentially to answer questions the answers to which one has stored only implicitly.

-Recognize contradictions within one's own knowledge

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[19] NICKERSON, Raymond S., "<u>Using computers: Human Factors in Information Systems</u>", (1986), Cambridge, p. 305

base or between one's knowledge base and new information.

-Perform adequately under conditions of uncertain or incomplete information.

-Recognize when one needs additional information in order to solve a particular problem, and, usually, know whether that information is obtainable.

-Know whether a problem one has been asked to solve is sufficiently unambiguous and well formed to be approachable.

-Explain what one is doing and why.

-Understand the limits of one's own expertise.

To amplify on the last item: one very important type of knowledge that an expert has is knowledge of his own knowledge vis-a-vis his area of expertise. He knows not only what he knows but, in a sense, what he does not know. Further, he can distinguish, within limits, between what he does not know and what is not known. The expert has a model of his area of expertise, of his own knowledge, and of how the one relates to the other. For example, with respect to questions he cannot answer, he should be able to distinguish among (a) nonsensical questions, (b) questions that do not relate to the domain, (c) meaningful questions the answers to which are likely to be known by other experts within the domain, and (d) meaningful questions the answers to which are not (yet) known by anyone--that is, questions that exceed the knowledge base of the domain. In short, an expert should be able to make judgments of meaningfulness, relevance, difficulty and answerability."

The ability to modify rapidly its own software may be one of the most important factors in an entity's intelligence. The manner in which the system's software has been written will affect the entity's capacity to adjust to novel happenings in its environment. The more efficient a software is (i.e., the more quickly it runs, the less prone it is to errors and breakdowns and the less "program space" it occupies) the more intelligent the entity. The bigger and wider the range of programs with which a system is equipped and with which its central processor can cope, the more intelligent is the creature.[20]

Doubts about the computer as the guiding model of human thought stem from the two (2) principal considerations. Firstly, the community surrounding a cognizing individual is critical. From those around them human beings come to understand which sorts of views are considered acceptable, which are false or dangerous, justified or unjustified. Such judgments cannot initially be made by an individual but must stem from a collectivity. Because all people belong to communities, it makes sense to indicate that a computer can make a mistake or is unjustified in its beliefs. The computer is simply executing what it has been programmed to execute, and standards of right and wrong do not enter into its performance. Only those entities that exist within, interact with and are considered part of, a community can be so judged.

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[20] EVANS, Christopher, (1979), "The Micro Millennium", Simon & Schuster, Inc., New York, p. 191

Secondly, there is a deep difference between biological and mechanical systems. Is it difficult to conceive of human beings apart from their membership in a species that has evolved over the millennia, and as other than organisms who themselves develop according to a complex interaction between genetic proclivities and environmental processes over a lifetime. To the extent that thought processes reflect these bio-developmental factors and are suffused with regressions, anticipations, frustrations, and ambivalent feelings, they will differ in fundamental ways from those exhibited by a nonorganic system. It did not have to be this way--biological systems might have been just like inorganic (mechanical) systems-- but it is clear that they are not.[21]

Regardless of developments or the rate of accelerating change, one thing remains constant. The world's smallest yet most efficient high capacity computer weighs less than four pounds, is smaller than a football and has a capacity equivalent to ten (10) billion logic circuits. Nothing yet made can match it. It is the seat of all creativity. Each person has one and many poeple have the services of several others. It is the human brain!

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[21] GARDNER, Howard, (1985) "The Mind's New Science", Basic Books Inc., New York, p. 388